Bruhath Bengaluru Mahanagara Palike

Narashima Raja Square

Bengaluru

Remodeling of Primary & Secondary Storm Water Drains in Bengaluru Under JNNURM Scheme

Koramangala Valley

Feasibility & Detailed Project Report

Volume – I

December 2006

STUP Consultants P. Limited

FEASIBILITY & DETAILED PROJECT REPORT

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EXECUTIVE SUMMARY

INTRODUCTION

The total area of Bangalore city is approximately 225 Sq.m. and is divided by 4 major valleys namely Chellaghatta, Hebbal, Koramangala and Vrishabhavathy valley with total length of primary. and secondary drains more than 230 Km. Chellagatta main valley originates from palace ground in Jayamahal and join Bellander lake. Hebbal main valley starts from Mathikere and joins Hebbal Lake. Koramangala main valley originates from Subhashnagar and joins Bellandur lake and Vrishabhavathy main valley originates from Sankey tank and joins Vrishabhavathy valley near Mysore road.

Due to rapid urbanization, the rate of growth of population in Bangalore has been explosive during the last two decades. Bangalore being a chosen destination for software, Biotech and other industrial entrepreneurs has further escalated the population rise. This has obviously caused additional strain on the already overloaded city infrastructure. The large scale construction of Office premises, residential accommodation and ether similar construction, to meet the demands of the rising population has resulted in :

i) Increased ground coverage and pavements
ii) Developments inside the buffer storage areas and tanks'
iii) Encroachments into the storm water drain
iv) Uncontrolled discharge of sewage and effluents inside the Storm water drain
v.) Constructions inside the drain to facilitate running of other utilities.

Bangalore Mahanagara Palike, agency responsible for the maintenance of the city's infrastructure has taken up the project of remodeling the entire storm water drain to improve the efficiency of the storm water drainage system and entrusted the work to M/s. STUP Consultants P. Limited.

The scope of work includes

I) Preparation of :

a) Feasibility Report
b) Detailed Project Report
c) Construction Management for 4 valleys:
    a) Vrishabhavathy Valley
    b) Koramangala Valley
    c) Chellaghatta
    d) Hebbal

II) Detailed scope of services

- Detailed topographical and geo-technical survey
- Assessment of quantity and quality of drainage discharge
- Analysis of the existing system
- Prevention of sewerage entering drains (to the possible extent)
- Hydraulic and structural designs and drawings
- Cost estimation and Bill of Quantities
- Technical specifications
- Cost benefit analysis
- Bid documents
- Slicing and Packing (Phasing for Implementation)
- Assistance inviting and evaluating Bids
- Project management and Quality assurance
- Training of BMP staff

While Remodeling proposals on the entire Storm water drain system is in progress, the report on Koramangala valley remodeling is being submitted as a first part in 2 Volumes namely:

Volume 1 - Detailed Project Report

Volume 2 - Drain Alignment Plan, Longitudinal Section & General arrangement Drawings.

OUT COME OF THE PROJECT:

Sustainable ecosystem for lakes, river beds and other water bodies around river valleys, prevention and management of floods in low-lying areas and liveable environ for citizens and residents.

WORK METHODOLOGY

To asses the existing condition of the drain a detailed topographical survey has been carried out using total stations in which the alignment of the drain, length of the drain, adjoining buildings, culverts *I* bridges, cross section of the drain etc are identified.

Condition survey of the drain and bridges were also carried out in which the bed condition of the drain, walls, level of silting in the drains, obstructions, sewage entry points to the drain, pipe crossings, manholes etc., were also identified and listed in the formats. The condition of bridges and culverts have also been assessed. Various low lying areas were identified during reconnaissance survey which are prone to flooding and the bottle necks and reason causing flooding were identified.

It is an established fact that the high intensity, high volume rainfall follows laws of probability which can be established for a place like Bangalore where rainfall data for over 25 - 30 years is available. These mathematical laws generally called as "extreme value distributions" enable one to correlate the intensity of rainfall and the chances (probability) of that rainfall taking place within a given time frame (1 hour, 12 hours, 24 hours, etc.) when such precipitation takes place, the amount of water. that will flow from various parts of the catchments area to the drains can be calculated based on knowledge of the type and characteristics of terrain (in terms of its absorption and runoff) type of drains, sectional areas of drains and their slopes, etc.

This method, (Called Rational Method) being logical and incorporating various actual physical characteristics is considered to be a powerful method for predicting the maximum expected floods. However, to evaluate and fix various physical parameters of

catchment areas (i.e properties) and to fit rainfall data is a difficult task. Even when carried out, it needs to be confirmed by observation of actual water discharge against the calculated discharge., A set of catchment parameters need to be consistently chosen and adjusted in prediction model whose predictions shall match with the actual observations of flood. This stage is termed as the "Calibration of the System".

The rational method is a very powerful method for design of a "Greenfield" project (i.e new towns, new development areas, etc.). However, this method is not adequate on its own for studying the existing systems which have been developed over a period of time without having any systematic design philosophy behind its design.

Therefore, as a first step in improving the existing system it is necessary to take following steps:

a) Repair and rehabilitation of damaged portion of existing drains.
b) Cleaning and clearing of waterway by removal of debris, artificial constrictions, blockages, etc.
c) Making the entire drain system internally consistent over its full length.

Once the above is achieved, the probabilistic predictions of discharge, velocity and capacity can be compared with those of actually observed floods. This will enable one to establish correct mathematical model which is then used for "optimizing the design for other portions of drainage channels (i.e. primary, secondary and tertiary drains) and make the whole system internally consistent. and cost effective.

At present, the mathematic model for rainfall in Bangalore has been established based on rainfall data of part several years. Also, the parameters of catchment have been evaluated and the first order prediction model is prepared.

This model has been used to make first predictions of the expected flood. This is found to yield higher flood levels than those actually observed and will need second stage corrections. This can be effectively done after completing three stages of repair/rehabilitation me!1tioned above.

Meanwhile, these first order results, have been used as a guideline in preparing proposals of widening / additional capacity of drains at local portions in such a way as to make the system internally consistent.

DESIGN PHILOSOPHY

The data required for adequacy analysis of drain like rainfall data, topography and land use from satellite imagery are collected. The detailed technical and hydraulic analysis have been carried out to assess the hydraulic capacity of the drain and bridges. Various statistical analysis were studied for rainfall and the method which is best suited to the site condition, i.e. CPHEEO method has been selected and analysed.

RECOMMENDATIONS'

To improve the section of the drain and to minimize the flooding, various drain improvement methods are suggested are :

1 Provision of gratings for closed drain for allowing water to the drain with openings for cleaning the drain.

2 Plugging of all openings to the drain made for draining ground water to the main drain where the drain wall tap is higher than the ground level/road level and construct side drain leading off storm water to the down stream end.

3 Provision of pointing to inside of existing stone masonry drain wall.

4 Provision of bed to drain to improve the flow

5 Provision of bed and wall for drain wherever they do not exist to improve the drain hydraulics.

6 Removal and reconstruction of drain wall wherever the drain wall is in dilapidated conditions.

7 Provision of embankment in the pitching and lined bed for drain where enough land is available.

8 Provision of Bypass drains to reduce the load on the existing drain.

9 Provision of cut off drain around the low lying area to prevent outside water entering the low lying area and construction of sump for pumping out water at a location closer to the main drains (downstream end) and easily accessible to reach the truck mounted pump.

10 The improvement shall be taken up from the; down stream of the valley. If remodeling is commenced from upstream side, situation at the downstream end would further get aggravated.

11 Increase the drain wall height to increase the carrying capacity of the drain wherever required. Provide parallel drain adjacent to the raised drain wall to dispose the ground water to down stream of drain.

12 All obstructions like bridges/culverts, utility lines, manholes, etc. shall be removed and rebuilt wherever required.

13 All silt/debris from the drain shall be removed.

14 Providing drain improvement to Koramanagala area in 2 phases like:

a) Phase 1 - improvement to existing drain

b) Phase 2 - construction of bye pass drain of adequate capacity as approved

15 Providing Kutcha drain from Koramangala to Bellandur lake

16 Set-up a vigilance squad to prevent debris dumping, encroaching of drain, local obstruction, such as, pipe crossing, construction inside the drain, any construction other than required for storm water in drainage.

17 Encourage rain water harvesting in institutions, public parks, open grounds, etc., like Mico factory, National Dairy Research Institute, National Games village, St. John's Hospital, Defense land, etc.

ENVIRONMENTAL AND SOCIAL IMPACTS

Storm drains carrying sewage and solid wastes are causing environmental hazards such as :

1. Pollution of ground water source.
2. Odour problem
3. Mosquito menace
4. Unhygienic conditions are causing health hazards

Remodeling of Primary and Secondary Storm Water Drains in Bangalore C

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The inadequate size of the drains causes flooding of the areas which includes low lying areas such as, Journalist colony, Sudham Nagar, Sampangi Ram Nagar, Shanthinagar, Wilson Garden, Laxman rao slum, Ejipura, S.T.Bed, Kormangala, LIC Colony, Bismilla Colony, BTM Dollars Colony causing damage to properties, affecting social life of local residents.

Therefore, to minimize flooding, proposals for immediate and long term are prepared for Koramangala valley.

Cost Estimation:

For implementation of the various recommendations a detailed cost estimation has been prepared, and is shown as Below:

For effective functioning of any system, requires maintenance. The operation and maintenance requirement have been identified and costing is indicated.

ABSTRACT OF COST FOR REMODELING OF PRIMARY & SECONDARY STORM WATER DRAINS IN KORAMANGALA VALLEY

Sl.No.	Description	Amount (Rs. In Lakhs)
1	Cost for Remodeling of Primary & Secondary Storm Water Drains, Construction of New Drains near low lying areas, Formation of Service Roads etc.,	10,303.32
2	Cost for Remodeling of Bridges / Culverts constructed across Primary & Secondary Storm Water Drains.	380.12
3	Cost for shifting utility lines, footpath improvement works, barricading, traffic diversion, strengthening of diversion routes etc.	534.17
4	Construction of Detention Ponds / Retarding Basins	150.00
5	Construction of Wells with pumping arrangement in low lying areas	300.00
6	Procurement of desilting machine	0.00
7	Miscellaneous and rounding off	0.02
8	Advisory, Project Management & Establishment Charges (1.5 % of Item 1 to 7)	175.01
	Sub Total	**11,842.65**
9	Phase – I Construction of new drain from Koramangala 80 ft. road via. Ejipura main road, ASC centre, Defence dairy farm land upto Bellandur Tank	3,129.06
10	Phase – II Construction of new drain along Koramangala 80 ft. road upto Jakkasandra layout	3,237.96
	Total (Including Phase – I Proposal)	**14,971.71**
	Total (Including Phase – II Proposal)	**15,080.61**
11	Annual Operation & Maintenance Cost (1.5 % of Item 1 to 7)	175.01

Funding Pattern as Per JNNURM Guidelines

Estimated Capital Costs:
(Cost Rs. in Crores)

Name of Component	Capital Cost as per DPR	Years					
		2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
Remodeling of Storm Water Drain Network in Koramangala Valley							
Koramangala Valley	118.43	47.37	47.37	23.69	-	-	-
Total	**118.43**	**47.37**	**47.37**	**23.69**	**0.00**	**0.00**	**0.00**

Funding pattern for Remodeling of Storm Water Drains in Koramangala Valley (Rs. in Crores)

Funding Pattern	Total	2006-07	2007-08	2008-09
GOI Grant 35%	41.45	16.58	16.58	8.29
GOK Grant 15 %	17.76	7.11	7.11	3.55
BMP financing	59.22	23.69	23.69	11.84
Total	**118.43**	**47.37**	**47.37**	**23.69**

Note: The funding pattern proposed is based on the JNNURM guidelines.

CHAPTER – 1

INTRODUCTION AND BACKGROUND

1.1 GENERAL:

Bangalore, the capital of Karnataka, is one of the fastest growing cities in India with a current estimated population of 5.8 million people, spread over an area of about 225 Sq.km. and is situated at an altitude of about 894 m. above MSL.

Bangalore was once well known for its open parkland environment with significant number of large traditional tanks with a good network of waterways and thick vegetative cover. Rapid increase in population, industrialization and migration of people from rural Karnataka and rest of the country in a relatively short span of time has put more pressure on the utilities and services, which are already loaded beyond their capacities. Storm water drains are one of the most affected services in the city. The problem is aggravated by uncontrolled urbanisation, infringement by other utilities, encroachments and indiscriminate dumping of solid wastes and over flowing of sewers in drain. Other secondary problems includes sedimentation, vegetation growth and sewage outlets into the drains, etc. Due to the above, there is reduction in carrying capacity of the drains causing localized flooding to the settlements adjacent to the drains and tanks, in low lying areas. Many tank beds have been converted into residential layouts causing disappearance of water body which otherwise would have acted as detention ponds / holding tanks. The damage caused by the floods, are very serious in terms of life and property. Therefore, there is an urgent need to examine the status of existing storm water drainage system, the reasons for the frequent flooding and devise possible remedial measures to alleviate the damage.

1.2 PROJECT BACKGROUND:

The stated goal for remodeling of existing storm water drain project is to improve the carrying capacity of the existing system, for the delivery of storm water without flooding the low lying areas of the city and also to provide improvised environmental sanitation services to the city of Bangalore, with emphasis on the urban poor and vulnerable groups and within a process of long term environmental, economic, social and institutional sustainability.

During recent monsoon, Bangalore city experienced unusually high intensity rainfall, which resulted in substantial damage to both life and property.

Bangalore Mahanagara Palike (BMP), the agency responsible for maintenance of the city's infrastructure with an endeavour to obviate the problems faced by the city, therefore took up the project including preliminary investigations, detailed survey, system analysis and proposals for improvements and capacity augmentations of the existing drainage system in Bangalore.

Bangalore Mahanagara Palike invited proposals from competent consultants based on the approach document prepared by BMP and entrusted the work to M/s. STUP Consultants Private Limited, Bangalore to provide necessary technical support to set priorities on existing drainage system rehabilitation needs, and to explore the potential options for augmenting the carrying capacity of the system, considering future hydraulic design requirements in Bangalore City.

Further, the outputs of this study will provide the basis for developing a comprehensive plan for the drainage system and detailed proposals for selected improvement projects to be implemented by BMP.

Bangalore city topography is marked by the presence of Four Primary valleys, viz.,
1.Vrishabhavathy Valley
2.Koramangala Valley
3.Challaghatta Valley
4.Hebbal Valley

Based on the survey conducted, the length of the primary drains in the four major valleys are as shown in the table below:

Sl.No.	Name of the Valley	Primary Drain Length (m)
1.	Vrishabhavathy Valley	32,038
2.	Koramangala Valley	19,634
3.	Challaghatta Valley	16,152
4.	Hebbal Valley	25,800
	Total length of drain	**93,624**

This volume of the report forms the detailed project report for Koramangala Valley.

1.3 OBJECTIVES OF THE PROJECT:

The objectives, defined in broad terms are:

- To study the main reasons for failure of the existing storm water drains to dispose the storm water without flooding the areas of the city.

- To study the carrying capacity of the existing primary and secondary storm drains.

- To suggest modifications to the primary and secondary storm drains in respect of improvement, in flow characteristics and capacity.

- To study the feasibility of segregating sewage from storm water and the extent practicable.

- To provide rehabilitation to culvert / bridges constructed across storm water drains.

- To reconstruct the culverts/bridges, that are causing hindrances to free flow of water in the drains.

1.4 REPORT OBJECTIVES:

This report provides, details of existing storm water drainage system in Koramangala Valley, wherein it also provides a strategic framework to ensure better management of drainage assets in Bangalore which also has significant implications in:

- Future management of storm drainage system in Koramangala Valley.

- Strategies to be followed for implementation of improvement measures.

- Resources generation to achieve the stated objectives and targets.

For the report purpose, the studies made are:

- Identifying the low lying area and reasons for flooding
- Assessment of existing condition of drainage system
- Evaluation of development options for existing system.
- Examining option / strategies for the preferred options for local applications.
- Preparation of cost estimates for works and associated operation and maintenance.
- Review of existing management of drainage system and the recommendations for institutional improvements.
- Identification of further studies and investigation required for refinement.

Further, for the preparation of this report, supplementary sources are considered at a macro level and also the results of those studies and investigations are integrated into this report.

This report has the following structure:

VOLUME I	Main Report
VOLUME II	Drain Alignment Plan, Longitudinal Section, Cross Section & General Arrangement Drawings for Koramangala Valley.

1.5 SCOPE OF ASSIGNMENT:

A Brief scope of assignment to be rendered by the Consultants as defined in the TOR is given below:

- Detailed topographical and geo-technical survey
- Assessment of quantity of runoff

- Adequacy analysis of existing drains
- Hydraulic and structural designs and drawings
- Cost estimation and Bill of Quantities
- Technical specifications.
- Bid Documents
- Slicing and Packaging (Phasing for Implementation)
- Assistance in Inviting and evaluating Bids
- Project Supervision

1.6 PHASES OF THE PROGRAMME

The consultancy services which is to be carried out in three (3) phases are as given below:

Phase 1: Technical, Economical and Environmental Feasibility Study of the Project of Remodeling of the Storm Water Drain System.

Phase 2: Detailed engineering design, preparation of tender documents, cost estimates for the remodeling work, Preparation of Bid document and assist BMP to entrust the work to experienced, competent and successful agency.

Phase 3: Supervision of the construction works.

1.7 PREAMBLE TO INCEPTION REPORT AND FEASIBILITY REPORT:

Reference are made in this section to the earlier inception report and feasibility report. Wherein the inception report clearly narrates the identification of different valleys, conditions of existing storm drains, new drains (i.e., not considered in TOR), low lying areas in different drainage zones, etc. in this report. The details from previous data, recommendations made during past initiatives, current approach, methodology, design procedures and work plans adopted for preparation of feasibility report are indicated in this report.

Based on through understanding of prevailing site conditions and the observations and comments furnished by BMP over the approach and methodology proposed in our inception report for the preparation of detailed project report. A techno - economical feasibility report was prepared and submitted to BMP during March, 2003. Wherein, detailed condition survey/assessment of existing system, reasons for the failure of the system, analysis of rainfall data for a period of 25 years for different intensities and frequencies, detailed landuse and land cover analysis for the entire catchment area, categorising the landuse and land cover data into different categories of landuse,

identifying micro/sub catchments contributing for each drainage zones, adequacy analysis of the existing system for different year return periods, identification of the reasons for its inadequacy, identification of problematic areas, condition survey/assessment of existing cross drainages for its structural stability and hydraulic capabilities, existing environmental and sanitation conditions, etc. are narrated in detail.

After having consecutive discussion and number of site visits for cross verifying the analysis results for its hydraulic behaviour with prevailing site conditions. Strategic actions and recommendations were proposed, alternative proposals were identified, existing tertiary drains, which require improvements were identified and accordingly mitigative measures were suggested. Detailed analysis, designs and drawings for the proposed structures were prepared, strip plans indicating properties requiring acquisition and proposed works, preliminary cost estimates, phasing and slicing of works, draft tender documents were done and submitted to BMP for better understanding of the systems functionality.

After the acceptance of the proposals and recommendation suggested in the feasibility report by BMP, at this juncture, it is proposed to submit, detailed project report and drawings for Koramangala valley to BMP for execution and its further necessary action.

CHAPTER - 2

ASSESSMENT OF EXISTING STORM WATER DRAINAGE SYSTEM

2.1 INTRODUCTION:

Bangalore city is at an altitude of 894 m. above MSL and has the general advantage of natural valleys offering good drainage for storm water. However, misuse of these valleys result in flooding. The two main factors responsible for flooding in Bangalore are:

- A general neglect of the basic functions of the major drains which has allowed numerous channel restrictions to occur and caused a general down grading of the channel capacities, without provision for floods larger than design and;

- The apparent acceptance of a design standard for main drains in the core area that is extremely low by accepted standards for a large city with rolling topography.

The study concerned with tertiary drains and their level of services offered is outside the current scope.

The area covered by the study is basically the area administered by Bangalore Mahanagara Palike. A locality plan showing the extent of study area has been included as Figure 2.1.

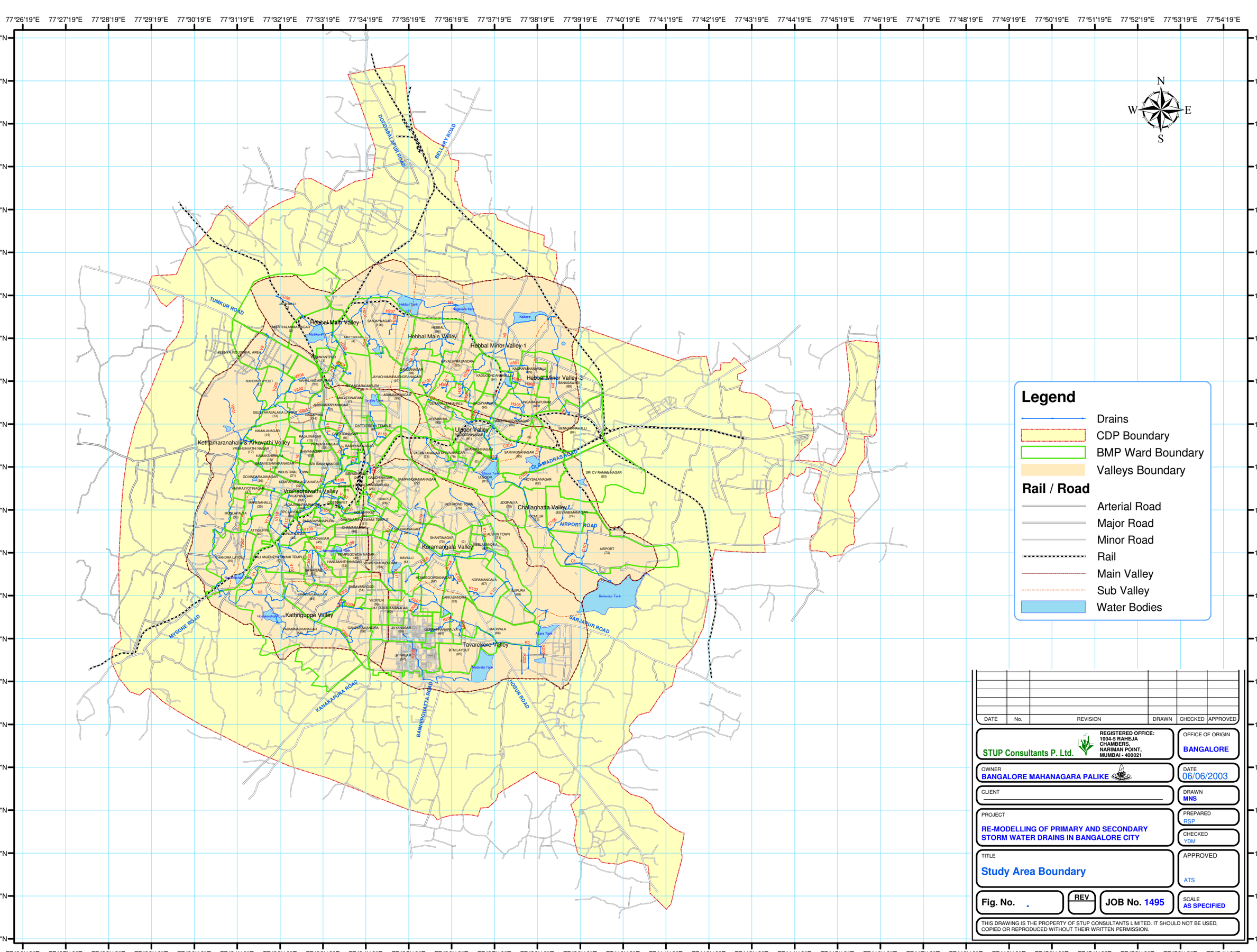
2.2 DESCRIPTION OF CATCHMENTS:

Bangalore is situated on the divide between the Cauvery Basin and the Ponnaiyar Basin, at an elevation of approximately 894 m. above MSL and also with nearly 40% of the projected future population living within the Cauvery Basin. There are four major valleys and five minor valleys. Three of the four major valleys namely, Vrishabhavathy (V-Valley), Koramangala (K-Valley) and Challaghatta (C-Valley), run generally from North to South direction dividing the greater part of the metropolitan area into three separate and distinct drainage zones. A fourth major valley, referred to as the Hebbal series (H-valley), forms the drainage zone to the North of the ridge and runs in Northeast direction.

Five minor valleys, the Kathriguppe and the Tavarekere lie to the South, the Kethamaranahalli and Arkavathi lie to the North-West, Hebbal minor valleys 1 & 2 lie

77°26'19"E 77°27'19"E 77°28'19"E 77°29'19"E 77°30'19"E 77°31'19"E 77°32'19"E 77°33'19"E 77°34'19"E 77°35'19"E 77°36'19"E 77°37'19"E 77°38'19"E 77°39'19"E 77°40'19"E 77°41'19"E 77°42'19"E 77°43'19"E 77°44'19"E 77°45'19"E 77°46'19"E 77°47'19"E 77°48'19"E 77°49'19"E 77°50'19"E 77°51'19"E 77°52'19"E 77°53'19"E 77°54'19"E

13°9'7"N 13°8'7"N 13°7'7"N 13°6'7"N 13°5'7"N 13°4'7"N 13°3'7"N 13°2'7"N 13°1'7"N 13°0'7"N 12°59'7"N 12°58'7"N 12°57'7"N 12°56'7"N 12°55'7"N 12°54'7"N 12°53'7"N 12°52'7"N 12°51'7"N 12°50'7"N 12°49'7"N 12°48'7"N



DATE	No.	REVISION	DRAWN	CHECKED	APPROVED

STUP Consultants P. Ltd.

REGISTERED OFFICE: 1004-5 RAHEJA CHAMBERS, NARIMAN POINT, MUMBAI - 400021

OFFICE OF ORIGIN: BANGALORE

OWNER: BANGALORE MAHANAGARA PALIKE

DATE: 06/06/2003

CLIENT:

DRAWN: MNS

PROJECT: RE-MODELLING OF PRIMARY AND SECONDARY STORM WATER DRAINS IN BANGALORE CITY

PREPARED: RSP

CHECKED: YDM

TITLE: Study Area Boundary

APPROVED: ATS

Fig. No. .

REV

JOB No. 1495

SCALE: AS SPECIFIED

to the North-East. All these valleys lie to the east, lie outside the tributary areas of the major valleys and drain independently. The catchment boundaries of major and minor valleys are shown in Figure 2.2.

Details of these catchments are given in Table 2.1.

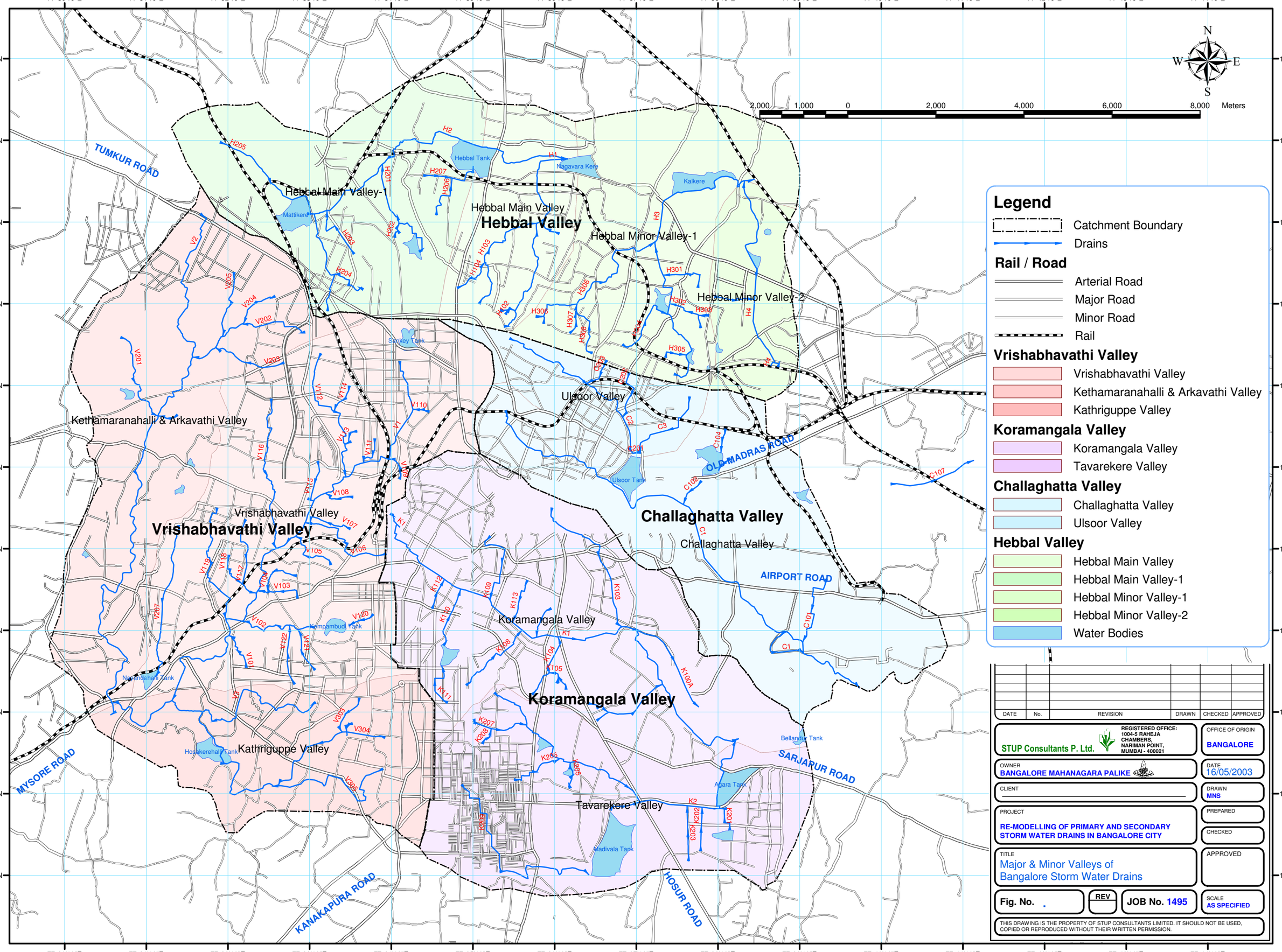
TABLE 2.1 SUMMARY OF STORM WATER DRAINAGE CATCHMENT

Valley Names	Major & Minor Valleys	Drop (m.)	Pri. Drain Origin Point	Pri. Drain Terminal Point	Catchment Area (Ha.)	Total Length of Primary Drain (m.)	Municipalities in catchment
Vrishabhavathi Valley	Vrishabhavathi Main Valley	120	Sankey tank	Kenchanahalli Near Mysore Road	4,070	13,888	BMP, Kengeri & Patanagere
	Kethamaranahalli & Arkavathi Valley		Near Peenya Indl. area	Kenchanahalli Near Mysore Road	3,045	13,300	
	Kathariguppe Valley		Near Srinivasnagar	Rajarajeshwarinagar	1,819	4,850	
Koramangala Valley	Koramangala Main Valley	20	Near Majestic Area	Bellandur lake	3,548	12,000	BMP, Bommanahalli & Mahadevepura
	Tavarekere Valley		Near NIMHANS Hospital	Bellandur lake	2,690	7,625	
Challaghatta Valley	Challaghatta Main Valley	30	Near Vasanthnagar	Bellandur lake	3,168	12,000	BMP, Krishnarajapura
	Ulsoor Valley		Near Jayamahal Extn.	Ulsoor lake	710	4,150	
Hebbal Valley	Hebbal Main Valley	30	Near Matadahalli	Nagavara lake	836	4,425	BMP, Dasarahalli & Bayatarayanapura
	a) Hebbal Main Valley – 1		Near I.I.S.C	Hebbal lake	2,590	9,000	
	b) Hebbal Minor Valley – 1		Near Jaibharathnagar	Kalkere lake	1,529	7,375	
	c) Hebbal Minor Valley – 2		Near Chikka Banasawadi	Kalkere lake	754	5,000	

Note: Catchment areas indicated in the table is inclusive of CMC / TMC areas coming within respective catchment boundaries.

2.3 DESCRIPTION OF KORAMANGALA VALLEY:

2.3.1 Koramangala Valley:


77°30'19"E
77°31'19"E
77°32'19"E
77°33'19"E
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77°43'19"E
77°44'19"E
13°4'7"N
13°3'7"N
13°2'7"N
13°1'7"N
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2,000 1,000 0 2,000 4,000 6,000 8,000 Meters
TUMKUR ROAD
Hebbal Main Valley-1
Hebbal Main Valley
Hebbal Valley
Hebbal Minor Valley-1
Hebbal Minor Valley-2
Hebbal Tank
Nagavara Kere
Kalkere
Mattikere
Sankey Tank
Ulsoor Valley
Ulsoor Tank
OLD MADRAS ROAD
Kethamaranahalli & Arkavathi Valley
Vrishabhavathi Valley
Vrishabhavathi Valley
Challaghatta Valley
Challaghatta Valley
AIRPORT ROAD
Kempambudi Tank
Koramangala Valley
Koramangala Valley
Nayandahalli Tank
Kathriguppe Valley
Hosakerehalli Tank
Bellandur Tank
SARJAPUR ROAD
Agara Tank
Tavarekere Valley
Madivala Tank
MYSORE ROAD
KANAKAPURA ROAD
HOSUR ROAD
Legend
Catchment Boundary
Drains
Rail / Road
Arterial Road
Major Road
Minor Road
Rail
Vrishabhavathi Valley
Vrishabhavathi Valley
Kethamaranahalli & Arkavathi Valley
Kathriguppe Valley
Koramangala Valley
Koramangala Valley
Tavarekere Valley
Challaghatta Valley
Challaghatta Valley
Ulsoor Valley
Hebbal Valley
Hebbal Main Valley
Hebbal Main Valley-1
Hebbal Minor Valley-1
Hebbal Minor Valley-2
Water Bodies
DATE
No.
REVISION
DRAWN
CHECKED
APPROVED
REGISTERED OFFICE:
1004-5 RAHEJA CHAMBERS,
NARIMAN POINT,
MUMBAI - 400021
STUP Consultants P. Ltd.
OFFICE OF ORIGIN
BANGALORE
OWNER
BANGALORE MAHANAGARA PALIKE
DATE
16/05/2003
CLIENT
DRAWN
MNS
PROJECT
RE-MODELLING OF PRIMARY AND SECONDARY STORM WATER DRAINS IN BANGALORE CITY
PREPARED
CHECKED
TITLE
Major & Minor Valleys of
Bangalore Storm Water Drains
APPROVED
Fig. No. .
REV
JOB No. 1495
SCALE
AS SPECIFIED
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The Koramangala valley comprises of two sub catchments i.e., Koramangala main valley and Tavarekere valley.

Koramangala main valley starts from the vicinity of Bangalore city railway station near Subashnagar and runs through busy Cottonpet area, Narasimharaja road, J.C. Road, Wilson Garden area and flows through Koramangala area and ends at Bellandur tank.

Koramangala main valley primary drain comprises of fourteen secondary storm drains, covering the entire Koramangala main valley. The details of these drains are as mentioned in Table 2.2 and are shown in Figure 2.3.

The other segment known as Tavarekere valley which starts from NIMHANS hospital campus near Byrasandra and runs through Balajinagar, Bismillahanagar, Lakshmipura, Tavarekere, Mudduramanagara, B.T.M layout, Madivala, H.S.R. Layout and Venkatapura ends at Bellandur tank. The overflow of Agara tank also flows into this drain and joins Bellandur tank.

The Tavarekere valley comprises of one primary drain and ten secondary storm drains. Details of these drains are also mentioned in Table 2.2 and are shown in Figure 2.3.

TABLE 2.2 DETAILS OF KORAMANGALA VALLEY STORM DRAINS

Sr. No.	Drain ID	Name	Type	Start	End	Length (Mts.)
Koramangala Main Valley (K1):						
1	K100	Koramangala	Pri.	Near Upparpet Area	Bellandur Tank	12,000
2	K101	Koramangala layout (1)	Sec.	Hosur Road	Koramangala Slum	2,000
3	K102	Koramangala layout (2)	Sec.	Hosur Road	Jyothi Nivas College	300
4	K103	Austin Town	Sec.	Brigade Road	Neelasandra	3,400
5	K104	Laksandra	Sec.	Sampangiramnagar	Annepalya	1,700
6	K105	-	Sec.	-	-	-
7	K106	-	Sec.	-	-	-
8	K107	Lakshmanna Garden	Sec.	Langford Town	Jalakanteshwarapur	770
9	K108	Siddapura	Sec.	Jayanagar I st. Block	Wilson Garden	1,925
10	K109	R.R.M. Roy Extn.	Sec.	Kanteerava Stadium	Sudhamanagar	2,000
11	K110	Lalbagh	Sec.	Lalbagh tank	J.C.Road	625
12	K111	Jayanagar	Sec.	Jayanagar 3rd Block	Lalbagh tank	950
13	K112	Kalasipalya	Sec.	Paravathipura	Kumbaragundi	715
14	K113	Koramangala Slum	Sec.	Rajendranagar	Akhila Karnataka Animal Rehab. Centre	1,100
15	K114	Akkithimanahalli	Sec.	Divyashree Chamber	K.S.R.T.C. Training College	2,225
					Total Length of Primary Drains	**12,000**
					Total Length of Secondary Drains	**17,710**
Tavarekere Valley (K2):						
1	K200	Tavarekere Valley	Pri.	Nimhans Hospital	Agara Tank	7,625
2	K201	Vanganahalli	Sec.	Vanganahalli	Near Agara Tank	1,350
3	K202	Yellukunte	Sec.	Yelukunte	Venkatapura	950
4	K203	H.S.R Layout	Sec.	Crompton Greaves	Outer Ring Road	1,200
5	K204	Madivala	Sec.	Near Madivala Tank	Hosur Road	705
6	K205	Tavarekere	Sec.	Mudduramanagar	Bismillahanagar	525
7	K206	Guruppanapalya	Sec.	Tayappanahalli	Bovi Colony	1,245
8	K207	Krishnappa Garden	Sec.	Bairasandra Extn.	Bannerghatta Road	1,225
9	K208	Law College	Sec.	Tilaknagar	Krishnappa Garden	425
10	K209	J. P. Nagar	Sec.	Jayanagar 4th Block	C.S.B. Junction	9,500
11	K210	Puttenahalli	Sec.	J.P.Nagar, Puttenahalli	Dollars Colony	1,700
					Total Length of Primary Drains	**7,625**
					Total Length of Secondary Drains	**18,825**

2.4 RECONNAISSANCE SURVEY:

77°30'19"E 77°31'19"E 77°32'19"E 77°33'19"E 77°34'19"E 77°35'19"E 77°36'19"E 77°37'19"E 77°38'19"E 77°39'19"E 77°40'19"E 77°41'19"E 77°42'19"E 77°43'19"E 77°44'19"E

13°4'7"N 13°3'7"N 13°2'7"N 13°1'7"N 13°0'7"N 12°59'7"N 12°58'7"N 12°57'7"N 12°56'7"N 12°55'7"N 12°54'7"N

N W E S

2,000 1,000 0 2,000 4,000 6,000 8,000 Meters

TUMKUR ROAD

Hebbal Main Valley-1

Hebbal Main Valley

Hebbal Minor Valley-1

Hebbal Minor Valley-2

Ulsoor Valley

Kethamaranahalli & Arkavathi Valley

OLD MADRAS ROAD

Vrishabhavathi Valley

Challaghatta Valley

AIRPORT ROAD

Koramangala Valley

Kathriguppe Valley

MYSORE ROAD

SARJAPUR ROAD

Tavarekere Valley

KANAKAPURA ROAD

HOSUR ROAD

Legend

Drains

Rail / Road

Arterial Road
Major Road
Minor Road
Rail

Vrishabhavathi Valley

Vrishabhavathi Valley
Kethamaranahalli & Arkavathi Valley
Kathriguppe Valley

Koramangala Valley

Koramangala Valley
Tavarekere Valley

Challaghatta Valley

Challaghatta Valley
Ulsoor Valley

Hebbal Valley

Hebbal Main Valley
Hebbal Main Valley-1
Hebbal Minor Valley-1
Hebbal Minor Valley-2

DATE	No.	REVISION	DRAWN	CHECKED	APPROVED

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OFFICE OF ORIGIN: BANGALORE

OWNER: BANGALORE MAHANAGARA PALIKE

DATE: Oct 2003

CLIENT:

DRAWN: MNS

PROJECT: RE-MODELLING OF PRIMARY AND SECONDARY STORM WATER DRAINS IN BANGALORE CITY

PREPARED:

CHECKED:

TITLE: Major & Minor Valleys of Bangalore Storm Water Drains

APPROVED:

Fig. No. .

REV

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SCALE: AS SPECIFIED

Reconnaissance survey was carried out in Koramangala valley including Tavarekere valley. The critical locations which cause obstruction to smooth flow of water have been identified and photographed.

Reconnaissance survey was carried out with a view to :

•Descriptize the contributory areas of different drains

•Investigate the condition of drains, cross drains, type of construction, extent of bed lining, etc.

•Examine feasibility of widening / deepening of the drain to carry the design flow.

•Extent of land requirement for widening

•Status of land use pattern / type and intensity of development adjoining the drain (i.e., residential, commercial, industrial or vacant land etc.)

•and other issues which have bearing on the drains.

2.5 REPORT ON FIELD SURVEY OF DRAINS IN KORAMANGALA VALLEY:

2.5.1 METHODOLOGY

Having identified the drains, the chainage were marked along the drain after measuring the length of the drain starting from `0' chainage at the upper starting point and the chainage increasing towards the down stream direction.

Entire topographic survey was done based on local coordinate system using total station equipment and traversing it all along the drain. Every point is surveyed for its planimetry and height. For heights inside the drain, this was necessary since conventional levelling was not feasible as the drain bottom is at a very low level and also at some places compared to the sides of the drain. By resorting to Total station equipment's, the names of the roads, localities and important land marks were picked up at site and incorporated along with others details.

The heights were given to points with the help of Total stations based on T.B.Ms

established all along the drains on permanent objects such as culverts. Before that, the existing GTS B.Ms established by Survey of India were checked for stability and after ensuring the stability of these B.Ms the levelling was done to establish T.B.Ms all along the drain.

•Methodology adopted in representing the drains in the drawing:

Plan showing details of drains, land marks, bench marks, encroachments,, locations where sewage entering into storm water drain, condition of retaining walls, location of bridges and cross drainages and utility crossing are identified in the drawing to a scale of 1:1000 and longitudinal section details of drains in 1:1000 / 1:100 are proposed in the same drawing.

As per TOR, each primary and secondary drains in all the valleys are to be identified w.r.t to their respective predominant locality names and correspondingly numbering has been made.

For ease of identification, sub drains in all the valleys have been identified from down stream end, accordingly, numbers have been assigned for each secondary drains in the respective valleys and the same are to be read as follows.

Eg. : 1) K100 = K1 represents Koramangala main valley first primary drain.

2) K101 = K1 represents Koramangala main valley first primary drain & 01 indicates first Secondary drain in Koramangala main Valley.

•Elevation drawings of culverts / bridges:

The vent way measurements were collected at site along with width of piers / columns and also heights at various levels of the culverts along with information regarding the type and material of piers / columns, slabs over culverts and parapet wall. These culverts were serially numbered and each culvert has an identical number both in strip map and its elevation drawing. The sectional drawings also show the pipes, manholes, etc. that come immediately at that location.

•Longitudinal Section:

Showing heights at bed level at every 25 m. apart on a horizontal scale of 1:1000 and on vertical scale of 1:100 has been made for every drain.

•Cross-section:

Cross section at every 25 m. interval has been made showing drain depths, levels at top of the silt, bed level and also at the edges of the drain. Heights were given on top of drain wall and also at the adjoining land. The section also indicate whether the walls / buildings that rests on the drain at that particular section.

•Other Items:

Locations where public have the tendency of dumping garbage in the drain, sewer outlets are noted at sites along with its measurements and also utility lines inside and across the drain etc., are indicated separately in the condition survey formats.

2.6 DETAILS OF EXISTING STORM DRAINS IN KORAMANGALA VALLEY :

2.6.1 OBSERVATIONS DURING SITE INVESTIGATIONS OF KORAMANGALA MAIN VALLEY STORM DRAIN (K100):

Koramangala valley comprises of two valleys namely Koramangala main valley and Tavarekere valley.

Among the two valleys, Koramangala main valley is the longest valley and it starts from busy and congested Subashanagar area and runs through Cottonpet, Akkipet, Sourastrapet, Sulthanpet K.R. Market area, Narasimaraja road, J.C. Road, Wilson Garden area and flows through Koramangala area and terminates at Bellandur tank.

The other segment known as Tavarekere valley which starts from NIMHANS hospital campus near Byrasandra and terminates at Bellandur tank, the overflow of Agara tank is also connected to Bellandur tank.

Koramangala main valley nalla is divided into 10 segments, for ease of assessment. The details of each segment is as mentioned below :

Segment - 1 (Chainage 0.00 m. to 1,000.00 m.)

(From Subashanagar near O.T.C. Road upto B.V.K. Iyengar Road)

This section of the drain starts from a very busy commercial and congested residential area near Subashanagar and continues upto fruit market area near BVK Iyengar road. As per the preliminary investigations made by the consultants, it was noticed that localities surrounding Upparpete, Cottonpete, Akkipete, Chickpete, Cubbonpete, Sourastrapete, Thargupete, Nagarthpete, Mamulpete and Sulthanpete area forms the part of contributory areas for this section.

- This reach of storm drain is almost covered with RCC/BS slabs.

- Number of residential and commercial establishment are noticed on either side of the drain.

- Due to non functionality of tertiary drains, localised flooding problems are observed at many places. i.e., near Chickpete, Akkkipete, Sourastrapete and Mamulpete areas.

- The width of drainage channel varies from 2.5 m to 3.0 m & depth varies from 1.2 to 1.6 m.

- S.S.M. Masonry walls have been constructed on either sides, the condition of the side walls is in good to moderate condition.

- Dumping of solid waste, garbage and silt deposition is noticed at many places inside the channel, thereby causing obstruction for free flow of water in the channel.

- Natural alignment of drain is altered at many places. Due to which, the width of the drain is reduced at many places.

- The drainage channel flows across many minor culverts. Detail information about drain and culverts cannot be obtained, because it is all covered/encroached under commercial establishment.

•Large number of utility crossings and cables are observed at many places in this reach.

Segment - 2 (Chainage 1,000.00 m to 2,000.00 m.)

(From B.V.K. Iyengar Road upto 2nd Cross, New Bamboo Bazar Road))

This reach of the drain starts from fruit market area near B.V.K. Iyengar road and continues upto New Bamboo Bazaar road. As per the preliminary investigations made, it was noticed that localities surrounding Cubbonpete, Nagarthpete, K.R. Market area, Silver Jubilee Park, N.R. Road, New Tharagupete and part of Kalasipalya area forms the part of contributory areas for this section.

•This reach of storm drain is almost covered with RCC/BS slabs.

•Number of commercial establishment are noticed on either side of the drain.

•Due to non functionality of tertiary drains, localised flooding problems are observed at many places. i.e., near K.R. Market area, Kalasipalya bus stand, N.R. Road and Bamboo bazar area.

•Recently BMP has desilted this reach of drain and removed some of the unauthorised structures that where constructed over the drain near K.R. Market and further, new RCC walls have been constructed on either sides of the drain.

•The width of drainage channel varies from 4.0 m to 6.0 m & depth varies from 1.8 to 2.0 m.

•S.S.M. Masonry walls have been constructed on either sides, the condition of the side walls is in good to moderate condition.

•Drain width is considerably reduced near N.R. Road upto 3rd cross Bamboo bazar.

•Dumping of solid waste, garbage and silt deposition is noticed at many places inside the channel thereby causing obstruction for free flow of water in the channel.

•The drainage channel flows across many minor culverts. Detail information about

drain and culverts cannot be obtained, because it is all covered/encroached under residential buildings/commercial establishment.

•Large quantity of sewage is being discharged into storm drain from restaurants and other commercial establishments.

•Large number of utility crossings and cables are observed at many places in this reach.

•During the investigation only one culvert was identified, i.e., near K.R. Market (behind Darga). which is an arch culvert of 8 m width, with 5 vents, constructed using lime mortar.

Segment - 3 (Chainage 2,000.00 m to 3,000.00 m.)

(From 3rd Cross, New Bamboo Bazar Road upto 2nd Cross Road, Sudhamanagar).

This part of the drain reach starts from a busy commercial bamboo bazar area and continues upto Sudhamanagar. As per the preliminary investigations, it was noticed that localities surrounding Kalasipalya, Parvathipura, Journalist Colony, Kumbaragundi, J.C. Road and Sudhamanagar area forms the part of contributory areas for this section.

•This reach of drain is open drain except near J.C. Road & Lalbagh Road.

•Service road has been encroached and number of commercial establishment have been constructed on either side of the drain in bamboo bazar area.

•Drain width is reduced near 3rd cross Bamboo bazar upto 1st main J.C. Road.

•Large number of utility crossings are noticed under the commercial building near 1st main J.C. Road.

•Multistoreyed commercial complex have been constructed over the storm drain near J.C. Road & Lalbagh Road.

•Due to non functionality of tertiary drains, localised flooding problems are observed at many places. i.e., near Bamboo bazar area, Kumbaragundi Journalist colony and Sudhamanagar.

- Secondary storm drain (K112) which starts from Minerva circle flows through Journalist colony and joins the main drain near Kumbaragundi.

- The width of drainage channel varies from 7.5 m to 10.0 m & depth varies from 2.2 to 2.4 m.

- S.S.M. Masonry walls have been constructed on either sides, the condition of the side walls is in good to moderate condition.

- Dumping of solid waste, garbage and silt deposition is noticed at many places inside the channel thereby causing obstruction for free flow of water in the channel.

- One of the vent way of Lalbagh road bridge is completely blocked due to solid waste accumulation.

- Detail information about cross drain across J.C. Road cannot be obtained, because it is all covered/encroached on either side by commercial establishments. But, during drain inventory survey, it is found that 3 spans of 1.2 m. width and 1.6 m. height and covered with stone slabs exists.

- Large quantity of sewage flow is being discharged into storm drain from restaurants and other commercial establishments.

- Large number of utility crossings and cables are observed at many places in this reach.

- The drain throughout its stretch has service roads on either sides of the drain from J.C. Road upto Sudhamanagar. Few footbridges also exists in this reach.
- Two nos. of public toilet blocks has been constructed over the drain between J.C. Road and Lalbagh road. Raw sewage from these toilet blocks is being directly discharged into storm drain and also support structures of these blocks are causing accumulation of silt and debris, which intern is obstructing free flow of water.

- Secondary drain (K110) which starts from a location near Lalbagh and joins the main

drain near 2nd Cross Sudhamanagar.

•The bed levels of subdrains and the main drain is almost at the same level.

•Sewerage system and Solid waste management system is inadequate in the adjoining areas.

•Minor cracks and cavities in the drain wall are noticed for a height of about 1.5 m. from the drain bed.

•1000 mm. dia. BWSSB Water supply pipe is crossing the drainage channel near Lalbagh road bridge location.

Segment - 4 (Chainage 3,000.00 m to 4,000.00 m.)

(From 2nd Cross Road, Sudhamanagar upto K.S.R.T.C. Bus Depot near K.H.Double Road).

This section of the drain starts from Sudhamanagar and continues upto K.S.R.T.C. Bus Depot near K.H.Double Road.. As per the investigations made it was noticed that localities surrounding Sampangiramnagar, Raja Ram Mohan Roy Extn., Sudhamanagar, and Annipura form the part of contributory areas for this section.

•This reach of storm drain is an open drain and Service roads exists on either side of the drain for the full length.

•Due to non functionality of tertiary drains, localised flooding problems are observed at many places. i.e., near Sudhamanagar, Annipura, Raja Ram Mohan Roy Extn. & Shanthinagar.

•Secondary storm drain K109 which starts from a location near Kanteerava stadium and flows through Sampangiramnagar & Raja Ram Mohan Roy Extn. joins the main drain at Annipura near K.H. Road.

•The width of drainage channel varies from 11.0 m to 13.0 m & depth varies from 1.6 m. to 2.2 m.

- S.S.M. Masonry walls have been constructed on either sides, the condition of the side walls is in good to moderate condition.

- Large quantity of silt & garbage deposition is noticed at many places.

- The width of the drain is reduced near Annipura.

- Large nos. of utility crossings are observed near the culvert location at K.H. Road.

- Large quantity of floating materials and raw sewage flow is observed in the drain.

- The bed levels of sub-drains and the main drain is almost at the same level.

- Minor cracks and cavities in the drain wall are noticed for a height of about 1.5 m. from the drain bed.

- Vegetal growth is observed at many places in the drain wall.

- Drain bed is in natural condition, except at few places stone slabs have been laid.

- Drain wall needs to be reconstructed at few places in this reach.

Segment - 5 (Chainage length of about 4,000.00 m to 5,000.00 m.)

(From K.S.R.T.C. Bus Depot near K.H.Double Road upto Bannerghatta Road, near Jalakanteshwarapura).

This section of the drain starts from K.S.R.T.C. Bus Depot near K,H.Double Road and continues upto Bannerghatta road near Jalakanteshwarapura. As per the preliminary investigations made by the consultants, it was noticed that localities surrounding Shanthinagar, Langford town, Richmond town, Akkithimmanahalli, Jalakanteshwarapura, Vinayakanagar, Wilson garden, Siddapura, Arekempanahali, Someshwarapura and Venkatareddy layout forms the part of contributory areas for this section.

- This reach of drain is an open drain.

- Service roads exists on left hand side of the drain upto Wilson garden 9th cross road and further service road has been encroached on either side of the drain near Vinayakanagar.

- Due to non functionality of tertiary drains and also floor level of residential buildings are below drain bed level, localised flooding problems are observed at many places. i.e., near Shanthinagar, Arekempanahalli, Venkatareddy layout & Vinayakanagar areas.

- Secondary storm drain K107 & K114 which starts from a location near Divyashree chambers at Shanthinagar and flows through Langford town and joins the main drain near K.S.R.T.C. Bus Depot Another secondary storm drain K108 from Siddapura, which flows through Wilson garden joins the main drain in this reach. Further, bed level of these drains and main drain is almost same.

- Large number of residential buildings have been constructed over the drain wall near Vinayakanagar.

- Large number of sewer outlets from residential buildings are noticed near Vinayakanagar.

- The width of drainage channel varies from 10.5 m to 13.5 m & depth varies from 1.5 m. to 2.0 m.

- The drain width is considerably reduced near Vinayakanagar, due to construction of residential buildings at the edge of the drain wall intern providing less scope for providing improvements to the drain.

- S.S.M. Masonry walls have been constructed on either sides, the condition of the side walls is in good to moderate condition.

- Large quantity of silt & garbage deposition is noticed at many places.

- Large nos. of utility crossings are observed near the culvert location at Bannerughatta

Road.

•Large quantity of sewage flow is observed in the drain.

•The bed levels of subdrains and the main drain is almost at the same level.

•Minor cracks and cavities in the drain wall are noticed for a height of about 2 m. from the drain bed.

•900 mm dia. BWSSB Water supply pipe is crossing the drainage channel near Bannerghatta road bridge location.

Segment - 6 (Chainage length of about 5,000.00 m to 6,000.00 m.)

(From Bannerghatta Road, near Jalakanteshwarapura upto Muthumariamma temple, near Lakshman Rao Nagar foot bridge location).

This section of the drain starts from Bannerghatta Road, near Jalakanteshwarapura and continues upto Muthumariamma temple, near Lakshman Rao Nagar foot bridge location. As per the preliminary investigations made by the consultants, it was noticed that localities surrounding Anepalya (Gajendranagar) Pothallapa garden, MICO factory premises form the part of contributory areas for this section.

•This reach of drain is an open drain.

•Service roads exists on both sides of the drain upto Hosur road and further on right hand side, service road has been encroached and few residential buildings have been constructed over the drain wall near Potthalappa garden.

•Due to non functionality of tertiary drains and also floor level of residential buildings are below drain bed level, localised flooding problems are observed at many places. i.e., near Pothalappa garden areas.

•Drain reach from Hosur Road upto Mutthumariamma temple is in natural condition.

- Dense residential hutments have been developed on either side of the drain near Lakshman Rao Nagar slum.

- The drain reach near Lakshman Rao Nagar slum foot bridge location is taking a sharp meandering, which is altering the hydraulics of flow and intern obstructing free flow of water.

- The width of the drainage channel is drastically reduced from 16 m. to 8 m. near the slum area and also there is no proper approach to the drain from road due to dense hutment development.

- BWSSB sewerage system is not extended to the entire locality and also all the lateral pipe lines are directly discharging raw sewage into storm drain.

- The width of drainage channel varies from 18.0 m to 22.5 m & depth varies from 1.5 m. To 1.8 m.

- S.S.M. Masonry walls have been constructed on either sides upto Hosur road and the condition of the side walls is in good to moderate condition.

- Large quantity of silt & garbage deposition is noticed at many places near Vinayakanagar.

- Large nos. of utility crossings are observed near the culvert location at Bannerughatta Road.

- BWSSB sewer pipeline is broken near Hosur Road due to which large quantity of sewage flow is observed in the drain.

- The bed levels of subdrains and the main drain is almost at the same level.

- Minor cracks and cavities in the drain wall are noticed for a height of about 2.2 m. from the drain bed.

- Vegetal growth is observed at many places in the drain wall.

- 1200 mm dia. BWSSB water supply pipe is crossing the drainage channel near Bannerghatta road bridge location.

Segment - 7 (Chainage length of about 6,000.00 m to 7,000.00 m.)

(From Muthumariamma temple, near Lakshman Rao Nagar foot bridge location upto Viveknagar Bridge Location).

This section of the drain starts from Muthumariamma temple, near Lakshman Rao Nagar foot bridge location and continues upto Viveknagar bridge. As per the preliminary investigations made by the consultants, it was noticed that localities surrounding Neelasandra, Austin town, Victoria layout and Viveknagar area form the part of contributory areas for this section.

- This reach of drain is an open drain.

- Due to non functionality of tertiary drains and also floor level of residential buildings are below drain bed level, localised flooding problems are observed at many places. i.e., near Rose garden area.

- Drain reach from Mutthumariamma temple upto Austin town drain joining location it is in natural condition and further, the drain reach is having masonry walls on both sides.

- Dense residential hutments have been developed on right hand side of the drain near Lakshman Rao slum.

- Hutments have been removed and RCC residential buildings have been constructed by Karnataka State Slum Clearance Board (K.S.S.C.B.) for slum dwellers, leaving less scope for drain widening and continuation of service road.
- The width of the drainage channel is reduced from 22 m. to 18 m. near corporation EWS quarters near Viveknagar bridge and also there is no proper approach to the drain from road due to dense hutment development.

- Sewage/water stagnation is observed near L.R. Nagar slum area.

- Secondary storm drain K103 from Brigade road joins the main drain near Ambedkarnagar foot bridge.

- S.S.M. Masonry walls have been constructed on either sides from Austin town drain joining location upto Viveknage bridge location and also the condition of the drain walls is in good to moderate condition.

- Large quantity of silt & garbage deposition is noticed at many places near L.R. nagar slum.

- The drainage channel flows across 1 no. of foot bridge.

- The width of drainage channel varies from 12.0 m to 18.0 m & depth varies from 2.3 m. To 2.7 m.

- BWSSB sewer pipe line is broken near newly constructed foot bridge i.e., near Ambedkarnagar due to which large quantity of sewage flow is observed in the drain.

- Minor cracks and cavities in the drain wall are noticed for a height of about 1.5 m. from the drain bed.

Segment - 8 (Chainage length of about 7,000.00 m to 8,000.00 m.)

(From Viveknagar bridge location upto National games village).

This section of the drain starts from Viveknagar bridge and continues upto National games village. As per the preliminary investigations made by the consultants, it was noticed that localities surrounding Gowda Muniswamy garden, Ejipura and A.S.C. centre defence area form the part of contributory areas for this section.

- This reach of drain is an open drain.

- Due to non functionality of tertiary drains and also floor level of residential buildings are below drain bed level, localised flooding problems are observed at many places near Ejipura area.

- Drain reach from Viveknagar bridge location upto back yard of National games village it is very narrow and also in natural condition and further, the drain reach is having RCC wall on one side (i.e., towards N.G.V.) and there is no wall on the other side.

- Dense residential hutments have been developed on down stream of Viveknagar bridge location.

- The width of the draiange channel is reduced from 16 m. to 9 m. behind National games village and also there is no proper approach to the drain from road due to hutment development.

- Few sub drains behind N.G.V., from Ejipura side is joining the main drain.

- Sewage/water stagnation is observed near National games village.

- The width of drainage channel varies from 9.0 m to 14.0 m & depth varies from 1.8 m. to 2.2 m.

- Large quantity of silt & garbage deposition is noticed at many places near Viveknagar bridge and further down stream.

- Minor cracks and cavities in the drain wall are noticed for a height of about 1.5 m. from the drain bed.

- Large quantity of sewage flow is observed in the drain.

Segment - 9 (Chainage length of about 8,000.00 m to 9,000.00 m.)

(From National games village upto Koramangala 1st Cross Road).

This section of the drain starts from National games village and continues upto Koramangala 1st Cross Road. As per the preliminary investigations made by the consultants, it was noticed that localities surrounding Ejipura, Ashwini layout,

Srenivagilu tank bed, and Koramanagala layout area form the part of contributory areas for this section.

- The drain reach inside National games village complex is a covered drain.. Large number of RCC columns have been constructed inside the drainage channel. Which intern is obstructing free flow of water and also large quantity of solid waste is being accumulated.

- Drain reach inside National games village complex is covered and amenities like swimming pool etc. have been provided for residents of N.G.V. complex.

- Natural alignement of drainage channel is altered behind National games village complex.

- The drain reach after National games village complex upto Koramangala 1st Cross is an open drain.

- Secondary storm drains K101, K102 which starts from Hosur road checkpost location & K113 starting from Rajendranagar is joining the main drain behind BMTC bus depot in this reach.

- Due to non functionality of tertiary drains and also floor level of residential buildings are below drain bed level, localised flooding problems are observed at many places. In Ejipura, Ashwini layout and Srenivagilu tank bed area.

- Drain reach from back yard of National games village upto Ejipura Church road bridge location, it is very narrow and also in natural condition.

- Sewage/water stagnation is observed near inner ring road.

- The width of drainage channel varies from 8.0 m to 12.0 m & depth varies from 1.5 m. To 1.8 m.

- Minor cracks and cavities in the drain wall are noticed for a height of about 1.5 m. from the drain bed.

•Large quantity of sewage flow is observed in the drain.

Segment - 10 (Chainage length of about 9,000.00 m to 10,000.00 m.)

(From Koramangala 1st Cross Road upto Koramangala 1st Block, 8th Cross Road).

This section of the drain starts from Koramangala 1st Cross Road and continues upto Koramangala 1st Block, 8th Cross Road. As per the preliminary investigations made by the consultants, it was noticed that localities surrounding Srenivagilu tank bed, Jakkasandra and Koramanagala layout area form the part of contributory areas for this section.

•This reach of drain is an open drain.

•The drain reach near Seva Gangothri Apartment is taking a sharp meandering, which is altering the hydraulics of flow and intern obstructing free flow of water.

•There is no service road on either side of the drain.

•Large number of approach bridges with multiple spans and support structures for resting utilities have been constructed inside the drainage channel by private apartment owners. Which intern is obstructing free flow of water and also causing large quantity of solid waste accumulation.

•Due to non functionality of tertiary drains and also floor level of residential buildings are below drain bed level, localised flooding problems are observed at many places. In Koramangala, Srenivagilu tank bed and Jakkasandra area.

•Sewage/water stagnation is observed near Koramangala 1st main road.

•The width of drainage channel varies from 10 m to 14 m & depth varies from 1.8 m. to 2.2 m.

•Minor cracks and cavities in the drain wall are noticed for a height of about 1.5 m. from the drain bed.

•Large quantity of sewage flow is observed in the drain.

Segment - 11 (Chainage length of about 10,000.00 m to 12,000.00 m.)

(From Koramangala 1st Block, 8th Cross Road upto a location near Bellandur tank).

This section of the drain starts from Koramangala 1st Block, 8th Cross Road and continues upto a location near Bellandur tank. As per the preliminary investigations made by the consultants, it was noticed that localities surrounding part of Koramanagala layout area form the part of contributory area for this section.

•This reach of drain is an open drain.

•The drain reach after Koramangala 1st Block it is in natural condition and very recently BMP has desilted and widened the entry point of the drain near the marshy land and the gradient at this location is very flat.

•There is no service road on either side of the drain.

•Large number of approach bridges with multiple spans and support structures for resting utilities have been constructed inside the drainage channel by private apartment owners. Which intern is obstructing free flow of water and also causing large quantity of solid waste accumulation.

•Due to non functionality of tertiary drains and also floor level of residential buildings are below drain bed level, localised flooding problems are observed at many places. In Koramangala, Srenivagilu tank bed and Jakkasandra area.

•Sewage/water stagnation is observed near Koramangala 1st main road.

•The width of drainage channel varies from 10 m to 14 m & depth varies from 1.8 m. to 2.2 m.

•Large quantity of sewage flow is observed in the drain.

2.6.2 OBSERVATIONS DURING SITE INVESTIGATION OF SECONDARY DRAINS IN

KORAMANGALA MAIN VALLEY:

2.6.2.1 Koramangala Layout Drain: (K101)

(Hosur Road to Koramangala Slum), (Chainage length of about 2,000.00 m.)

This section of the drain starts from a place near MICO factory on Hosur Road and confluence's with main drain near National Games Village. As per the preliminary investigations made by the consultants, it was noticed that localities surrounding Koramangala 5th, 6th & 7th Block forms part of contributory areas for this section.

- The drain reach between Koramangala 5th block to a place near Koramangala club is covered with RCC slab. Further, from Koramangala 80 ft. road it is open drain

- The width of drainage channel is about 2 m to 5 m & depth varies from 1.2 to 1.8 m., in this section.

- This stretch has residential buildings, apartments and service road on either side of the channel.

- Large number of utility crossings & manholes are observed near Koramangala 80 ft. Road

- Large quantity of earth, silt deposition and garbage dumping is noticed inside the drain.

- Masonry sidewall have been constructed all along the channel on either side. The condition of the side walls is in good to moderate condition.

- The drain bed is in natural condition.
- The locality adjacent to Koramangala club has been developed well below the HFL level of the SWD and intern causing localized flooding.

2.6.2.2 Koramangala Layout Drain - I: (K102)

(Hosur Road to Jyothi Nivas College), (Chainage length of about 300.00 m.)

This section of the drain starts from a place near Hosur Road and continues upto

Koramangala 80 ft road. As per the preliminary investigations made by the consultants, it was noticed that localities surrounding Koramangala industrial area & Koramangala 5th Block forms part of contributory areas for this section.

- The width of drainage channel is about 1 m to 3 m & depth varies from 1.0 to 1.4 m., in this section.

- This stretch has industrial establishments and few open fields on either side of the channel.

- A portion of the drain reach near Koramangala 5th block is covered with RCC slab.

- Masonry sidewall have been constructed all along the channel on either side. The condition of the side walls is in good to moderate condition.

2.6.2.3 Austin Town Drain (K103):

(Brigade Road to Neelasandra), (Chainage length of about 3,400.00 m.)

This section of the drain starts from a place near Brigade Road and confluence with the main drain near Neelasandra main road. As per the preliminary investigations, it was noticed that localities surrounding Brigade Road, M.G. Road, Ashoka nagar, Victoria layout, Austin town, Jayrajnagar, Ukadapalya, Elagondanapalya, Vannarpet, Neelasandra and rose garden area forms part of contributory areas for this section.

- The width of drainage channel is about 5.0 m to 13.0 m & depth varies from 1.0 m to 1.6 m., in this section.

- This stretch has commercial establishments, residential buildings, apartments and service road on either side of the channel.
- The drain reach near football stadium is open drain. And very recently it has been covered for a certain length and being utilised for vehicular parking by commercial establishments.

- The tertiary drain which flows from BMP multilevel parking area near Shoppers Stop complex and flows inside Kendiriya Vidhyalaya is covered and it is almost collapsed at many places.

- Approach bridges constructed by private apartments owners near Palm groove road is having very inadequate vent size and intern obstructing free flow of water.

- Power transmission line towers are noticed at many places all along the drainage channel near Austin town.

- Large quantity of earth, silt deposition, garbage dumping and vegetation growth is noticed inside the drain.

- Masonry sidewall have been constructed all along the channel on either side. The condition of the side walls is in good to moderate condition.

- The drain width is considerably reduced at few places.

- The height of sidewall at many places are well below groundlevel, thereby allowing silt/earth to enter into drainage channel.

- The drain bed is in natural condition.

- Sewerline of about 450 mm dia has been laid across SWD near Bazar street.

- Pilot drain has been constructed to convey summer flow from Bazar street upto primary drain.

- Due to non functionality of tertiary drains and also floor level of residential buildings are below drain bed level, localised flooding problems are observed at many places. i.e., near Rose garden area.

- Minor cracks and cavities in the drain wall are noticed for a height of about 1.5 m. from the drain bed.

- The bed level of this secondary drain and primary drain is almost at the same level

- Large quantity of sewage flow is observed in the drain.

2.6.2.4 Laksandra Drain (K104):

(Sampangiramnagar to Annepalya), (Chainage length of about 1,700.00 m.)

This section of the drain starts from a place near Sampangiramnagar near Lakasandra and confluence with the primary drain at Annepalya near Pothalappa garden. As per the preliminary investigations made by the consultants, it was noticed that localities surrounding Sampangiramnagar, Lalajinagar, Chandrappa layout, Guptha layout, Govardhanagar, Ranga Dasappa layout, Pukraj layout, Part of Lakasandra and MICO factory premises forms part of contributory areas for this section.

- This reach of drain is an open drain upto MICO factory and further, it flows through factory premises and it is covered upto main drain.

- The width of drainage channel is about 1.2 m to 1.6 m & depth varies from 1.2 to 2 m., in this section.

- This stretch has residential buildings and commercial establishments on either side of the channel.

- Large quantity of earth, silt deposition, garbage dump and vegetation growth is noticed inside the drain

- Steel grating has been installed near MICO factory entrance/cycle stand.

- Masonry sidewall have been constructed all along the channel on either side. The condition of the side walls is in good to moderate condition.

- The height of sidewall at many places are well below groundlevel, thereby allowing silt/earth to enter into drainage channel.

- Due to non functionality of tertiary drains and also floor level of residential buildings are below drain bed level, localised flooding problems are observed at many places. i.e., near Pothalappa garden area.

- Minor cracks and cavities in the drain wall are noticed for a height of about 1.0 m. from the drain bed.

- The drain bed is in natural condition.

2.6.2.5 Adugodi Drain: (K105)

(Adugodi to Laksandra), (Chainage length of about 350.00 m.)

This section of the drain starts from a place near Bangalore Milk Dairy training institute and confluence with the Laksandra drain (K104) near Pukraj layout at Bannerghatta Road. As per the preliminary investigations made by the consultants, it was noticed that localities surrounding Nanjappa layout and part of Adugodi forms part of contributory areas for this section.

- This drain reach is an open drain and lies inside the MICO factory sports complex.

- The width of drainage channel is about 1.2 m to 1.8 m & depth varies from 1.2 m to 1.6 m., in this section.

- This stretch has dense residential buildings on one side and MICO factory campus on the other side.

- Large number of sewer outlets being directly connected to this drain is noticed.

- Large quantity of earth, silt deposition and garbage dump is noticed inside the drain.

- Masonry sidewall have been constructed all along the channel on either side. The condition of the side walls is in good to moderate condition.
- The height of sidewall at many places are well below groundlevel, thereby allowing silt/earth to enter into drainage channel.

- The drain bed is in natural condition.

2.6.2.6 Lakshmana Garden Drain: (K107)

(Langford town to Jalakanteshwarapura),(Chainage length of about 770.00 m.)

This section of the drain starts from a place near Langford town on Hosur Road and confluence with primary drain near Vinayakanagar. As per the preliminary investigations made by the consultants, it was noticed that localities surrounding Langford town, KSRTC colony, Jalakanteshwarapura & Vinayakanagar forms part of contributory areas for this section.

- This reach of drain is an open drain.

- The width of drainage channel is about 2.0 m to 4.0 m & depth varies from 1.4 m to 1.8 m., in this section.

- The drain inside the burial ground is open and in natural condition and further the reach near Vinayakanagar is covered with BS slab.

- Large quantity of silt deposition and garbage dumping is noticed inside the drain.

- The bed level of this secondary drain and primary drain is almost at the same level

- Masonry sidewall have been constructed all along the channel on either side. The condition of the side walls is in good to moderate condition.

- Drain bed is in natural condition.

2.6.2.7 Siddapura Drain: (K108)

(Jayanagar 1st Block to Wilson Garden), (Chainage length of about 1,925.00 m.)

This section of the drain starts from a place near Jayanagar 1st Block and confluence with the main drain near Wilson Garden. As per the preliminary investigations made by the consultants, it was noticed that localities surrounding Jayanagar 1st Block, Someshwaranagar, Arekempanahalli, Siddapura, Chinnayanapalya, Hombegowdanagar & Wilson Garden forms part of contributory areas for this section.

- This reach of drain flows through dense builtup and low lying area.

- The width of drainage channel is about 2.5 m to 4.0 m & depth varies from 1.0 m to 1.4 m.

- This stretch has residential buildings, horticulture nursery's, service road and few open fields on either side of the channel.

- Large quantity of earth, silt deposition and garbage dumping is noticed inside the drain.

- Masonry sidewall have been constructed all along the channel on either side except for a few length near Marigowda road. The condition of the side walls is in good to moderate condition.

- Large number of manholes have been constructed inside the channel near Arekempanahalli.

- Large quantity of silt, large number of cables and BWSSB pipelines are noticed at the existing culvert location, near Marigowda road.

- Drain reach from Marigowda road upto Primary drain joining location it is covered with RCC slab/BS slabs.

- The width of the drain is reduced near Marigowda road and further near Hombegowdanagar.
- Large quantity of silt and garbage dump is noticed inside the drain near Govt. girls junior college.

- Utility lines laid across SWD is noticed at many places .

- Minor cracks and cavities in the drain wall are noticed for a height of about 1.5 m. from the drain bed.

- The bed level of this secondary drain and primary drain is almost at the same level

- Due to non functionality of tertiary drains and also floor level of residential buildings are below drain bed level, localised flooding problems are observed at many places. i.e., near Arekempanahalli and Wilson garden area.

2.6.2.7 R.R.M Roy Extn. Drain: (K109)

(Kanteerava stadium to Sudhamanagar),(Chainage length of about 2,000.00 m.)

This section of the drain starts from a place near Kanteerava stadium and confluence with the main drain near Sudhamanagar. As per the preliminary investigations made by the consultants, it was noticed that localities surrounding Kanteerava stadium, Sampangiramnagar extn., Mission Road, Srinivasa Colony, Rajaram Mohan Roy extn. and Sudhamanagar forms part of contributory areas for this section.

- This reach of drain is almost covered by RCC slab upto Sampangiramnagar and further with BS slabs upto primary drain joining location.

- The width of the drain is reduced near Mission road and further near Sampangiramnagar.

- The width of drainage channel is about 2.5 m to 5.0 m & depth varies from 1.4 m to 2 m., in this section.

- The drain reach is taking a 90 ^{0} turn at two locations, which intern is reducing the velocity and intern causing backflow of water.

- This stretch has residential buildings and commercial establishments on either side of the channel.

- Large quantity of earth, silt deposition and garbage dump is noticed inside the drain.

- Masonry sidewall have been constructed all along the channel on either side. The condition of the side walls is in good to moderate condition.

- Utility lines laid across SWD is noticed at many places.

- Due to non functionality of tertiary drains and also floor level of residential buildings are below drain bed level, localised flooding problems are observed at many places. i.e., near Sampangiramnagar Extn., Mission road and Raja Ram Mohan Roy Extn. Area.

- The bed level of this secondary drain and primary drain is almost at the same level

2.6.2.8 Lalbagh Drain: (K110)

(Lalbagh tank to J.C. Road), (Chainage length of about 625.00 m.)

This section of the drain starts from Lalbagh botanical garden and confluence with Koramangala valley main drain near Sudhamanagar. As per the preliminary investigations made by the consultants, it was noticed that localities surrounding Mavalli, V.V. Puram, Upparahalli, Krumbigal Road and part of Sudhamanagar forms part of contributory area for this section.

- This reach of drain is almost covered except at few places.

- The width of drainage channel is about 1.4 m to 2.0 m & depth varies from 1.2 to 1.6 m., in this section.

- This stretch has dense residential buildings and commercial establishments on either side of the channel.

- Large quantity of earth, silt deposition and garbage dump is noticed inside the drain.

- Masonry sidewall have been constructed all along the channel on either side. The condition of the side walls is in good to moderate condition.

- The height of sidewall at many places are well below ground level, thereby allowing silt/earth to enter into drainage channel.

- Utility lines laid across SWD is noticed at many places.

•Minor cracks and cavities in the drain wall are noticed for a height of about 1.0 m. from the drain bed.

•Drain bed is in natural condition.

•The bed level of this secondary drain and primary drain is almost at the same level

2.6.2.9 Jayanagar Drain: (K111)

(Jayanagar 3rd Block to Lalbagh tank), (Chainage length of about 950.00 m.)

This section of the drain also starts from a place near Jayanagar 1st Block and confluence with Lalbagh botanical garden lake. As per the preliminary investigations made by the consultants, it was noticed that localities surrounding part of Jayanagar 2nd Block, South End Circle area, Vijaya College, Kanakanapalya and Ashoka piller area forms part of contributory area for this section.

•This reach of drain is almost covered.

•The width of drainage channel is about 0.8 m to 1.2 m & depth varies from 1.2 to 1.4 m., in this section.

•This stretch has dense residential buildings and commercial establishments on either side of the channel.

•Large quantity of earth, silt deposition and garbage dump is noticed inside the drain.

•Masonry sidewall have been constructed all along the channel on either side. The condition of the side walls is in good to moderate condition.

•The drain reach opposite Vijaya college is covered with BS slabs.

•Utility lines laid across SWD is noticed at many places.

•Minor cracks and cavities in the drain wall are noticed for a height of about 1.0 m.

from the drain bed.

•Drain bed is in natural condition.

2.6.2.10 Kalasipalya Drain: (K112)

(Paravathipura to Kumbaragundi), (Chainage length of about 715.00 m.)

This section of the drain starts from a place near Kalasipalya and confluence with the main drain near Kumbaragundi. As per the preliminary investigations made by the consultants, it was noticed that localities surrounding Kalasipalya, Parvathipura, Journalist Colony & Kumbaragundi forms part of contributory areas for this section.

•This reach of drain is open drain.

•Large quantity of sewage flow is noticed inside the drain.

•The width of drainage channel is about 4.0 m to 6.0 m & depth varies from 1.6 m to 2.0 m., in this section.

•This stretch has dense residential buildings and commercial establishments on either side of the channel.

•Large quantity of earth, silt deposition and garbage dumping is noticed inside the drain.

•Masonry sidewall have been constructed all along the channel on either side. The condition of the side walls is in good to moderate condition.

•The drainage channel flows across 7 culverts which are having very inadequate vent way.

•Utility lines laid across SWD is noticed at many places i.e., near Kalasipalya cross Roads and A.M. Road.

•The bed level of this secondary drain and primary drain is almost at the same level

- Minor cracks and cavities in the drain wall are noticed for a height of about 1.0 m. from the drain bed.

- Drain bed is in natural condition.

- During reconnaissance survey, it was observed that except at few places service road land has been encroached all along the drain in Journalist colony.

2.6.2.11 Rajendranagar Drain: (K113)

(Koramangala 8th Block to Koramangala Indoor Stadium), (Chainage length of about 2,225 m.)

This section of the drain starts from a place near Royal Parikrama Centre in Koramangala 8th Block and confluence with the main drain near Akhila Karnataka Animal Rehab. Centre. As per the preliminary investigations made by the consultants, it was noticed that localities surrounding Rajendranagar and Koramangala 8th Block forms part of contributory areas for this section.

- This reach of drain is open drain.

- Large quantity of sewage flow is noticed inside the drain.

- The width of drainage channel is about 3.0 m to 4.5 m & depth varies from 1.2 to 1.8 m., in this section.

- This stretch has dense residential buildings and few vacant lands on either side of the channel.

- Large quantity of earth, silt deposition and garbage dumping is noticed inside the drain.

- Masonry sidewall have been constructed all along the channel on either side. The condition of the side walls is in good to moderate condition.

- The bed level of this secondary drain and primary drain is almost at the same level.

- Minor cracks and cavities in the drain wall are noticed for a height of about 1.4 m. from the drain bed.

- Drain bed is in natural condition.

2.6.2.12 Akkithimanahalli Drain: (K114)

(Divayashree Chambers to K.S.R.T.C. Training Centre), (Chainage length of about 1,100.00 m.)

This section of the drain starts from a place near Divayashree Chambers at Akkithimmanahalli and confluence with the main drain near K.S.R.T.C. Training centre. As per the preliminary investigations made by the consultants, it was noticed that localities surrounding Shanthinagar & Akkithimanahalli forms part of contributory areas for this section.

- This reach of drain is covered with RCC slab in the initial reach and then it is open drain.

- Large quantity of sewage flow is noticed inside the drain.

- The width of drainage channel is about 1.6 m to 2 m & depth varies from 1.2 to 1.8 m., in this section.

- This stretch has dense residential buildings on either side of the channel.
- Large quantity of earth, silt deposition and garbage dumping is noticed inside the drain.

- Masonry sidewall have been constructed all along the channel on either side. The condition of the side walls is in good to moderate condition.

- BWSSB Manholes that have been constructed inside the channel are noticed at many places.

- The bed level of this secondary drain and primary drain is almost at the same level

- Drain bed is in natural condition.

2.6.3 OBSERVATIONS DURING SITE INVESTIGATION OF MAIN DRAIN IN TAVAREKERE VALLEY (K2):

Tavarekere valley nalla is divided into 7 segments, for ease of assessment. The details of each segment is as mentioned below :

Segment - 1 (Chainage 0.00 m to 1,000.00 m.)

(From Sanatorium Road near NIMHANS hospital complex upto Mundukar Fire Service College, near Jayanagar East Block)

This section of the drain starts from Sanatorium Road near NIMHANS hospital complex and continues upto Mundukar Fire Service College, near Jayanagar East Block. As per the preliminary investigations made by the consultants, it was noticed that localities surrounding NIMHANS hospital, Byrasandra and Jayanagar East block areas forms the part of contributory areas for this section.

- This reach of storm drain is an open drain.

- The width of drainage channel varies from 2.5 m to 4.5 m & depth varies from 1.2 to 1.7 m.

- This Drain reach is in natural condition in the hospital complex and further S.S.M. Masonry walls have been constructed on either sides, the condition of the side walls is in good to moderate condition.
- Large quantity of silt and vegetal growth is observed inside the drain.

Segment - 2 (Chainage length of about 1,000.00 m to 2,000.00 m.)

(From Mundukar Fire Service College, near Jayanagar East Block upto Tank bund road near Bismillahanagar).

This section of the drain starts from Mundukar Fire Service College, near Jayanagar East Block and continues upto Tank bund road near Bismillahanagar. As per the preliminary investigations made by the consultants, it was noticed that localities surrounding Suddauguntepalya and Bhavaninagar area form the part of contributory areas for this section.

- This reach of drain is an open drain.

•Recently during development of park new SSM walls have been constructed in this reach from Bannerughatta road upto tank bund road, it is in good condition and existing drain bed is in natural condition.

•Large quantity of sewage flow is observed.

•Secondary storm drain K207 from Krishnappa garden joins the main drain near Mundukar Fire Service College.

•The width of drainage channel varies from 3.0 m to 5.0 m & depth varies from 1.3 m. to 1.7 m.

•Minor cracks and cavities in the drain wall are noticed for a height of about 0.6 m. from the drain bed.

Segment - 3 (Chainage length of about 2,000.00 m to 3,000.00 m.)

(From Tank bund road near Bismillahanagar upto Brindavannagar).

This section of the drain starts from Tank bund road near Bismillahanagar and continues upto Brindavannagar. As per the preliminary investigations made by the consultants, it was noticed that localities surrounding Guruppanapalya, Bismillahanagar and Tavarekere area form the part of contributory areas for this section.

•This reach of drain is an open drain.

•Floor level of residential buildings is much below the drain bed level in this reach.

•SSM masonary walls have been constructed upto Bismillahanagar and further, it is in natural condition and residential building walls itself is acting as retaining wall.

•Large no. of dyeing industries that are situated along side of the drain are discharging toxic liquid waste directly into SWD.

•Natural alignment of the drain is drastically altered near Bismillahanagar.

•Drain gradient is very minimum in this reach.

•Drain width is drastically reduced near Bismillahanagar.

•The drain reach is taking a 90 ^{0} turn at two locations, which intern is reducing the velocity and intern causing backflow of water.

•Large quantity of sewage flow is observed.

•Manholes and sewer pipelines are observed inside the drainage channel in this reach.

•Secondary storm drain K206 from Guruppanapalya and another secondary drain K205 from BTM layout joins this main drain near Lakshmi theater at Tavarekere. The crosssectional area of the primary drain is very narrow, near the confluenceing location.

•Large number of sewer outlets directly discharging into SWD is observed in this reach.

•The width of drainage channel varies from 5 m to 7 m & depth varies from 1.7 m. to 2 m. upto Lakshmi theatre and further the width of the drain varies from 8 m. to 10 m. and depth varies from 1.8 m. to 2.2 m.

•Minor cracks and cavities are noticed in the drain wall for a height of about 0.6 m. from the drain bed.

Segment - 4 (Chainage length of about 3,000.00 m to 4,000.00 m.)

(From Brindavannagar upto 36th Main Road, BTM Layout).

This section of the drain starts from Brindavannagar and continues upto 36th Main Road, BTM Layout. As per the preliminary investigations, it was noticed that localities

surrounding Maruthi Extn., Venkateshwara layout, Ramaiah garden, Mudduramanagar and BTM layout 1st Stage area form the part of contributory areas for this section.

- This reach of drain is an open drain.

- Floor level of residential buildings is much below the drain bed level in this reach.

- SSM masonry walls have been constructed and it is moderate condition

- Natural alignement of the drain is drastically altered near Ramaiah garden.

- The width of the drainage channel is drastically reduced near Ramaiah garden (i.e., near K.P.N Travels bus depot.)

- Large no. of residential building walls are resting over the drain wall is noticed in this reach

- Large no. of dyeing industries that are situated along side of the drain are discharging large quantity of toxic liquid wastes, directly into SWD.

- Drain gradient is very minimum in this reach.

- Large quantity of sewage flow is observed.
- Cavities and minor cracks are observed in the drain wall at many places in this reach.

- Large number of sewer outlets directly discharging into SWD is observed in this reach.

- The width of drainage channel varies from 7.0 m to 9.0 m & depth varies from 1.8 m. to 2.2 m.

- Minor cracks and cavities in the drain wall are noticed for a height of about 0.5 m. from the drain bed.

Segment - 5 (Chainage length of about 4,000.00 m to 5,000.00 m.)

(From 36th Main Road, BTM Layout upto Fern hill garden apartments near HSR Layout).

This section of the drain starts from 36th Main Road, BTM Layout and continues upto Fern hill garden apartments near HSR Layout. As per the preliminary investigations made by the consultants, it was noticed that localities surrounding Madivala, Chikka Madivala, Dollar Scheme colony and portion of HSR layout area form the part of contributory areas for this section.

•This reach of drain is an open drain.

•Floor level of residential buildings is much below the drain bed level in this reach.

•SSM masonary walls have been constructed and it is moderate condition and also under the flyover project B.D.A. has constructed new RCC walls on either side.

•Natural alignement of the drain is drastically altered near Madivala

•The width of the drainage channel is drastically reduced near Chikka Madivala

•Large no. of residential building walls are resting over the drain wall is noticed in this reach

•Secondary storm drains K204 from Madivala tank joins the main drain in this reach near C.S.B. Junction.

•Large quantity of toxic industrial effluents is being discharged into the storm drain by the industries situated in Bommanahalli industrial area.

•Drain gradient is very minimum in this reach.

•Large quantity of sewage flow is observed.

•Cavities and minor cracks are observed in the drain wall at many places in this reach.

•Large number of sewer outlets directly discharging into SWD is observed in this

reach.

•The width of drainage channel varies from 10.0 m to 14.0 m & depth varies from 2.0 m. To 2.4 m.

•Minor cracks and cavities in the drain wall are noticed for a height of about 0.5 m. from the drain bed.

Segment - 6 (Chainage length of about 5,000.00 m to 6,000.00 m.)

(From Fern hill garden apartments near H.S.R .Layout upto H.S.R. Layout near Agara tank).

This section of the drain starts from Fern hill garden apartments and continues upto H.S.R. Layout near Agara tank. As per the preliminary investigations made by the consultants, it was noticed that localities surrounding H.S.R. layout sector 4, 6 & 7 areas, Teachers colony, Venkatapura form the part of contributory area for this section.

•This reach of drain is an open drain.

•Secondary storm drains K201, K202 & K203 joins the main drain in this reach near H.S.R. layout Sector 7.

•Recently Agara tank restoration project has been taken up by B.D.A. Under this project B.D.A. has constructed size stone masonry wall on both side to segregate sewage from entering the lake.

•SSM masonry walls have been constructed and it is good condition.

•Large quantity of toxic industrial effluent & sewage flow is being noticed in the storm drain.

•Drain bed is in natural condition.

•Drain gradient is very minimum in this reach.

•The width of drainage channel varies from 13.0 m to 16.0 m & depth varies from 1.6

m. To 2.0 m.

•Cavities and minor cracks are observed in the drain wall at many places in this reach.

Segment - 7 (Chainage length of about 6,000.00 m to 7,625.00 m.)

(From H.S.R. Layout near Agara tank upto a location near Bellandur tank).

This section of the drain starts from H.S.R. Layout near Agara tank and continues upto a location near Bellandur tank. As per the preliminary investigations made by the consultants, it was noticed that localities surrounding Teachers colony and Venkatapura form the part of contributory area for this section.

•This reach of drain is an open drain.

•Recently Agara tank restoration project has been taken up by B.D.A.. Under this project B.D.A. has constructed size stone masonry wall on both side upto Sarjapura road near Jakasandra. Further, from Sarjapura road there is no defined alignment of storm drain upto Bellandur tank.

•Large quantity of vegetal growth is noticed beyond Sarjapura Road.

•Large quantity of toxic industrial effluent & sewage flow is being noticed in the storm drain.

•Drain bed is in natural condition.

•Drain gradient is very minimum in this reach.

•The width of drainage channel varies from 18.0 m to 24.0 m & depth varies from 1.8 m. To 2.4 m.

•Cavities and minor cracks are observed in the drain wall upto Sarjapur Road at many places in this reach.

2.6.4 OBSERVATIONS DURING SITE INVESTIGATION OF SECONDARY DRAINS IN TAVAREKERE VALLEY:

2.6.4.1 Vanaganahalli Drain: (K201)

(Vanaganahalli to Agara tank), (Chainage length of about 1,350.00 m.)

This section of the drain starts from a place near Vanaganahalli and confluence with the main drain near Agara tank. As per the preliminary investigations made by the consultants, it was noticed that localities surrounding HSR layout sector 4 & 3 forms part of contributory area for this section.

- This reach of drain is an open drain.
- Many places sewage stagnation inside the drain is noticed.
- The width of drainage channel is about 2.5 m to 5.0 m & depth varies from 1.4 m to 1.8 m., in this section.
- This stretch has sparse developed residential buildings and few open lands on either side of the channel.
- Large quantity of earth, silt deposition and garbage dump is noticed inside the drain.
- Masonry sidewall have been constructed all along the channel on either side. The condition of the side walls is in good to moderate condition.
- The height of sidewall at many places are well below ground level, thereby allowing silt/earth to enter into drainage channel.
- Number of RCC slab culverts are noticed in this reach, and they are of single span in nature and also in good condition.
- Cavities and minor cracks are observed in the drain wall at many places in this reach.
- Minor cracks and cavities in the drain wall are noticed for a height of about 0.5 m. from the drain bed.

2.6.4.2 Yellukunte Drain: (K202)

(Yellukunte to Venkatapura), (Chainage length of about 950.00 m.)

This section of the drain starts from a place near H.S.R layout 7th Sector on Bommanahalli Road near Mangammanapalya and confluences with main drain near H.S.R layout 5th Sector. As per the preliminary investigations made by the consultants, it was noticed that localities surrounding H.S.R layout Sector 7th forms part of contributory areas for this section.

- This reach of drain is an open drain.

- The width of drainage channel is about 2.0 m to 4.0 m & depth varies from 1.2 m to 1.75 m., in this section.

- This stretch has residential buildings, service road and few vacant lands on either side of the channel.

- Many places sewage stagnation inside the drain is noticed.

- Large quantity of earth, silt deposition and garbage dumping is noticed inside the drain.
- Masonry side wall have been constructed all along the channel on either side. The condition of the side walls is in good condition.

- In many places the height of the retaining wall is well below the ground level, intern allowing earth and silt to enter into the drain.

- Large quantity of sewage is flowing inside the drain.

- Number of RCC slab culverts are noticed in this reach, and they are of single span in nature and also in good condition.

- The height of sidewall at many places are well below ground level, thereby allowing silt/earth to enter into drainage channel.

- Cavities and minor cracks are observed in the drain wall at many places in this reach.

- Minor cracks and cavities in the drain wall are noticed for a height of about 0.5 m. from the drain bed.

2.6.4.3 H.S.R. Layout Drain: (K203)

(Crompton Greeves to Outer Ring Road), (Chainage length of about 1,200.00 m.)

This section of the drain starts from a place near H.S.R layout Sector VI on Bommanahalli Road and confluences with main drain near H.S.R layout VI Sector. As per the preliminary investigations made by the consultants, it was noticed that localities surrounding Mangammanapalya and H.S.R layout, Sector 6th forms part of contributory area for this section.

- This reach of drain is an open drain.

- The width of drainage channel is about 1.0 m to 3.5 m & depth varies from 0.8 m to 1.5 m., in this section.

- This stretch has residential buildings, service road and many vacant lands on either side of the channel.

- Many places sewage stagnation inside the drain is noticed.

- Large quantity of earth, silt deposition and garbage dumping is noticed inside the drain.

- Masonry sidewall have been constructed all along the channel on either side. The condition of the side walls is in good condition.

- Number of RCC slab culverts are noticed in this reach, and they are of single span in nature and also in good condition.

- In many places the height of the retaining wall is well below the ground level, intern allowing earth and silt to enter into the drain.

- Large quantity of sewage is flowing inside the drain.

- The height of sidewall at many places are well below ground level, thereby allowing silt/earth to enter into drainage channel.

•Cavities and minor cracks are observed in the drain wall at many places in this reach.

•Minor cracks and cavities in the drain wall are noticed for a height of about 0.5 m. from the drain bed.

2.6.4.4 Madivala Drain: (K204)

(Near Madivala tank to Hosur Road), (Chainage length of about 705.00 m.)

This section of the drain starts from a place near Someshwara colony at B.T.M layout 2nd Stage and confluences with main drain near Central silk board. As per the preliminary investigations made by the consultants, it was noticed that localities surrounding Someshwara colony & B.T.M layout 2nd Stage forms part of contributory area for this section.

•This reach of drain is an open drain.

•The width of drainage channel is about 2.5 m to 4.0 m & depth varies from 1.2 m to 1.5 m., in this section.

•This stretch has residential buildings, vacant lands on one side & outer ring road on the other side.

•Large quantity of earth, silt deposition and garbage dumping is noticed inside the drain.

•Masonry sidewall have been constructed all along the channel on either side. The condition of the side walls is in good to moderate condition.

•The drain reach infront of central silk board is covered with RCC slab.

•Many culverts with RCC hume pipes are noticed in this reach.

•The height of sidewall at many places are well below ground level, thereby allowing silt/earth to enter into drainage channel.

•Minor cracks and cavities in the drain wall are noticed for a height of about 1.0 m.

from the drain bed.

2.6.4.5 Tavarekere Drain: (K205)

(Muddurammanagar to Bismillahanagar), (Chainage length of about 525.00 m.)

This section of the drain starts from a place near B.T.M layout and confluences with main drain near Bismillahanagar. As per the preliminary investigations made by the consultants, it was noticed that localities surrounding Vysya bank colony, KEB colony, Maruthi layout, Muddurammanagar and portion of Guruppanapalya, and Tavarekere forms part of contributory areas for this section.

- This reach of drain is an open drain.
- The width of drainage channel is about 3.0 m to 5.0 m & depth varies from 1.0 m to 1.5 m., in this section.
- This stretch has residential buildings on either side of the channel.
- Large quantity of earth, silt deposition and garbage dumping is noticed inside the drain.
- Masonry sidewall have been constructed all along the channel on either side. The condition of the side walls is in moderate condition.
- The height of sidewall at many places are well below ground level, thereby allowing silt/earth to enter into drainage channel.
- Large number of sewer outlets directly discharging into SWD is observed in this reach.
- Cavities and minor cracks are observed in the drain wall at many places in this reach.
- Minor cracks and cavities in the drain wall are noticed for a height of about 1.0 m. from the drain bed.

2.6.4.6 Guruppanapalya Drain: (K206)

(Tayappanahalli to Bovi colony), (Chainage length of about 1,245.00 m.)

This section of the drain starts from a place near Tayappanahalli and confluences with main drain near Bovi colony. As per the preliminary investigations made by the consultants, it was noticed that localities surrounding Guruppanapalya, Tayappanahalli, Bovi colony and Bismillahanagar forms part of contributory area for this section.

- This reach of drain is an open drain.

- The width of drainage channel is about 3.0 m to 8.0 m & depth varies from 1.6 m to 2.2 m., in this section.

- This stretch has residential buildings and commercial establishments on either side of the channel.

- Large quantity of sewage flow, earth, silt deposition and garbage dump is noticed inside the drain.
- Masonry sidewall have been constructed all along the channel on either side. The condition of the side walls is in good to moderate condition.

- Utility lines laid across SWD is also noticed at many places in Bismillahanagar.

- Large number of sewer outlets directly discharging into SWD is observed in this reach.

- Cavities and minor cracks are observed in the drain wall at many places in this reach.

- Minor cracks and cavities in the drain wall are noticed for a height of about 1.0 m. from the drain bed.

2.6.4.7 Krishnappa Garden Drain: (K207)

(Bairasandra Extn. to Bannerghatta Road), (Chainage length of about 1,225 m.)

This section of the drain starts from a place near Bairasandra Extn. and confluences with main drain near Bannerghatta Road. As per the preliminary investigations made by the consultants, it was noticed that localities surrounding L.I.C colony, Bairasandra Extn., part of Tilaknagar and Krishnappa Garden forms part of contributory area for this section.

- This reach of drain is open drain except at few places near Krishnappa garden.

- The width of drainage channel is about 1.5 m to 6.0 m & depth varies from 1.2 m to 1.8 m., in this section.

- This stretch has residential buildings, commercial establishments and vacant lands on either side of the channel.

- Large quantity of sewage flow, earth, silt deposition and garbage dump is noticed inside the drain.

- Masonry sidewall have been constructed all along the channel on either side,. except for a few length near fire service college. The condition of the side walls is in good to moderate condition.
- Cavities and minor cracks are observed in the drain wall at many places in this reach.

- Minor cracks and cavities in the drain wall are noticed for a height of about 0.5 m. from the drain bed.

2.6.4.8 Law College Drain: (K208)

(Tilaknagar to Krishnappa Garden), (Chainage length of about 425.00 m.)

This section of the drain starts from a place near Tilaknagar police station and confluences with main drain near Krishnappa Garden. As per the preliminary investigations made by the consultants, it was noticed that localities surrounding part of Tilaknagar, canara bank colony and Krishnappa Garden forms part of contributory area for this section.

- This reach of drain is almost covered with BS slabs.

- The width of drainage channel is about 1.5 m to 4.0 m & depth varies from 1.6 m to 2.2 m., in this section.

- This stretch has residential buildings and commercial establishments on either side of the channel.

- Large quantity of sewage flow, silt deposition and garbage dump is noticed inside the drain.

- Masonry sidewall have been constructed all along the channel on either side. The condition of the side walls is in good condition.

- The drain reach near canara bank apartments is covered with RCC slab.

2.6.4.9 J.P. Nagar Drain: (K209)

(Jayanagar 4th Block to C.S.B. Junction), (Chainage length of about 9,500.00 m.)

This section of the drain starts from a place near Jayanagar 4th block and flows by the side of Madivala tank and joins Tavarekere valley primary drain near central silk board. As per the preliminary investigations made by the consultants, it was noticed that localities surrounding Jayanagar 4th block, Sarakki layout, J.P. Nagar, Dollars colony and also Kodichikkanahalli, N.G.R. Layout and Hosur road adjoining areas in Bommanahalli CMC area forms part of contributory area for this section.

- The width of drainage channel is about 3.0 m. To 12.0 m. & depth varies from 1.2 m to 2.2 m., in this section.

- This stretch has residential buildings, slum areas, tank bund and few open lands on either side of the channel.

- Secondary drain from Puttenahalli (K210) joins this drain near Dollars colony.

- Large quantity of sewage flow, silt deposition and garbage dump is noticed inside the drain.

- Masonry sidewall have been constructed all along the channel on either side i.e, upto

Dollars colony and further it is in natural condition. The condition of the side walls is in good condition.

- Existing drain near Sarakki layout 4th Phase temple is taking a sharp bend, which intern causes backflow of water in the upstream

- Cavities and minor cracks are observed in the drain wall at many places in this reach.

- Minor cracks and cavities in the drain wall are noticed for a height of about 1.0 m. from the drain bed.

- Drain bed is in natural condition.

- Existing drain reach near Pride apartment upto Bannerghatta road is in natural condition and also width is very less, which requires widening.

- Existing drain reach near Ranka apartment is covered, which needs to be opened and widened.

- Large number of Manholes has been constructed inside storm drain.

- Alignment of drain needs to be altered at many places.

- Large quantity of industrial effluent is being discharged into storm drain from Bommanahalli CMC area.

- Over flow weir of Madivala tank near KAS officers colony is connected to this secondary storm drain.

- Large quantity of raw sewage is being directly discharged into storm drain from the adjoining slum area near N.G. R. layout in Bommanahalli CMC area.

- Storm drain flows inside an industrial premises near N.G. R. Layout and further connects with road side drain at Hosur road.

2.6.4.10 Puttenahalli Drain: (K210)

(Puttenahalli to Dollars colony), (Chainage length of about 1,700.00 m.)

This section of the drain starts from a place near Sarakki layout and flows by the side of Madivala tank and joins Tavarekere valley primary drain near central silk board. As per the preliminary investigations made by the consultants, it was noticed that localities surrounding Sarakki layout, J.P. Nagar, Dollars colony and also Kodichikkanahalli, N.G.R. Layout and Hosur road adjoining areas in Bommanahalli CMC area forms part of contributory area for this section.

- The width of drainage channel is about 1.6 m. To 3.0 m. & depth varies from 1.4 m to 2.0 m., in this section.

- This stretch has residential buildings and few open lands on either side of the channel.

- Large quantity of sewage flow, silt deposition and garbage dump is noticed inside the drain.

- Masonry sidewall have been constructed all along the channel on either side. The condition of the side walls is in moderate condition.

- Cavities and minor cracks are observed in the drain wall at many places in this reach.

- Minor cracks and cavities in the drain wall are noticed for a height of about 1.0 m. from the drain bed.

- Drain bed is in natural condition.

2.7 Condition Survey of Cross Drains :

During reconnaissance survey, the existing cross drains constructed across both primary and secondary drains has been assessed for its structural and hydrological conditions. The details of these existing cross drains like type of structure, type of slab, abutment/piers, service lines near the structure, condition of parapet wall etc., have been collected and enclosed in Volume II of this report.

2.8 OBSERVATIONS DURING SITE INVESTIGATION OF LOW LYING AREAS IN KORAMANGALA VALLEY:

During reconnaissance survey of Koramangala valley, a detailed assessment of site condition, reason for flooding and possible mitigative measures to overcome the flooding problems in low lying areas have been identified and the same is discussed in the subsequent sections.

The list of critical low lying areas identified in Koramangala valley is as mentioned in Table 2.3 and same is depicted in Figure 2.4.

TABLE 2.3 List of Critical Low Lying Areas in Koramangala Valley

Sl.No.	Location	Valley	BMP Division
1.	Sudhamanagar	Koramangala Main Valley	East
2.	Shanti Nagar	Koramangala Main Valley	East
3.	Sampangiram Nagar	Koramangala Main Valley	East
4.	Wilson Garden	Koramangala Main Valley	South
5.	Siddapura	Koramangala Main Valley	South
6.	Laxman Rao Slum	Koramangala Main Valley	East
7.	Ejipura	Koramangala Main Valley	East
8.	S.T. Bed, Koramangala	Koramangala Main Valley	East
9.	L.I.C. Colony	Tavarekere Valley	South
10.	Bismillahnagar	Tavarekere Valley	South
11.	BTM Layout Dollars	Tavarekere Valley	South

2.8.1 Journalist Colony & Sudhamanagar

Journalist Colony & Sudhamanagar areas are situated in Koramangala main valley. Koramangala main valley primary storm drain (K100) and another secondary storm drain (K112) which starts from Paravathipura flows through Journalist colony & Kalasipalya and cause localised flooding problem in these regions for the reasons mentioned below.

Reasons for flooding:

77°34'19"E 77°35'19"E 77°36'19"E 77°37'19"E 77°38'19"E 77°39'19"E 77°40'19"E 77°41'19"E

12°59'7"N 12°58'7"N 12°57'7"N 12°56'7"N 12°55'7"N 12°54'7"N

1,300 650 0 1,300 2,600 3,900 5,200 Meters

GAYATRINAGAR (8)
BASHYAM NAGAR (24)
PULIKESHINAGAR (91)
BHARATHINAGAR (80)
BENNIGANAHALLI (84)
VASANTANAGAR (78)
SARVAGNANAGAR (85)
SRI RAMA MANDIR (22)
SEVASHRAMA (26)
SHIVAJINAGAR (79)
Ulsoor Tank
ULSOOR (81)
HOYSALANAGAR (82)
SRI CV RAMAN NAGAR (83)
RAMACHANDRAPURA (25)
GANDHINAGAR (27)
SAMPANGIRAMANAGAR (77)
Sampangiramnagar
BINNYPET (31)
COTTONPET (29)
CHIKPET (28)
Vrishabhavathi Valley
RICHMOND TOWN (76)
JOGPALYA (75)
Challaghatta Valley
K.R.Market Area
SKR MARKET (30)
JEEVANBIMANAGAR (74)
JAGAJIVANRAMNAGAR (44)
DHARMARAYASWAMI TEMPLE (47)
DOMLUR (72)
Sudhamnagar
CHAMARAJPET (46)
SUDHAMNAGAR (48)
AUSTIN TOWN (71)
Journalist Colony
SHANTINAGAR (70)
Koramangala Valley
NEELASANDRA (69)
Wilson Garden
Kempambudi Tank
KEMPEGOWDA NAGAR (49)
AIRPORT (73)
Pothullappa Garden
MAVALLI (61)
VISWESVARAPURAM (50)
HANUMANTHANAGAR (52)
Arekempanahalli
HOMBEGOWDANAGAR (62)
Koramangala Slum
SRINAGAR (53)
KORAMANGALA (67)
BASAVANAGUDI (51)
EJIPURA (68)
Ejipura
SRINIVASANAGAR (54)
YEDIYUR (59)
PATTABHIRAMANAGAR (60)
LAKKASANDRA (63)
Krishnappa Garden
Jayanagar (LIC Colony)
Bellandur Tank
Kathriguppe Valley
GANESHAMANDIRA (56)
JAYANAGAR (58)
GURRAPPANAPALYA (64)
Bismillanagar
MADIVALA (66)
Agara Tank
Marenahalli
Tavarekere Valley
BTM Layout (Someshwara Colony)
BTM LAYOUT (65)
PADMANABHANAGAR (55)
JP NAGAR (57)
Madivala Tank

N W E S

Legend

- Drains

Rail / Road

- Arterial Road
- Major Road
- Minor Road
- Rail
- Low Lying Areas

Koramangala Valley

- Koramangala Valley
- Tavarekere Valley
- Main Valley
- Sub Valley
- Water Bodies

DATE	No.	REVISION	DRAWN	CHECKED	APPROVED

STUP Consultants P. Ltd.
REGISTERED OFFICE: 1004-5 RAHEJA CHAMBERS, NARIMAN POINT, MUMBAI - 400021

OFFICE OF ORIGIN: BANGALORE

OWNER: BANGALORE MAHANAGARA PALIKE

DATE: 16/05/2003

CLIENT:

DRAWN: MNS

PROJECT: RE-MODELLING OF PRIMARY AND SECONDARY STORM WATER DRAINS IN BANGALORE CITY

PREPARED:

CHECKED:

TITLE: Low Lying Areas Prone for Flodding in Koramangala Valley

APPROVED:

Fig. No. .

REV

JOB No. 1495

SCALE: AS SPECIFIED

- Due to large scale encroachment, natural alignment of existing primary & secondary storm drain has been altered.

- Foundation / Floor level of residential buildings at few places in these layouts is much below the existing drain bed level.

- Cross drainage's constructed across secondary SWD near Journalist colony main road are all having inadequate vent sizes.

- Large number of utility crossings are noticed near the culvert locations.
- Existing primary drain bed slope from J.C. Road upto Lalbagh Road is almost flat.

- Number of commercial buildings constructed over SWD near J.C. Road is causing hindrance for maintenance of SWD.

- Public toilet blocks constructed over SWD (without proper drainage arrangement) between J.C. Road & Lalbagh Road is causing serious problem in that region and their support structures are obstructing free flow of water.

- Improper drainage facilities.

- Large quantity of vegetal growth is noticed inside the existing storm drain near Lalbagh road.

- Large quantity of sewage flow is noticed inside the existing storm drain.

- Large quantity of debris and garbage dump is noticed at many places inside the existing SWD.

- Culvert/bridge constructed across Koramangala main valley primary SWD (opposite to KSRTC Bhavan) near K.H. Double Road is having very inadequate vent size causing back flow of water.

2.8.2 Akkithimanahalli, Near Shanthinagar:

Akkithimanahalli is situated near Shanthinagar in Koramangala main valley. Koramangala main valley secondary storm drain (K114) flows through this locality and due to reasons mentioned below, it is causing localised flooding problems in this region,

Reasons for Flooding

- This reach of drain is almost covered with RCC slab and also not many openings/provisions made in the slab for the surface water to enter into the drain.
- Large number of manholes that have been constructed inside the storm drain for a height of about 1.2 m. from the bed level is drastically obstructing the flow.
- Large quantity of silt/earth is noticed inside the drain.
- Existing tertiary drain in this locality are inadequate and not functioning upto the required level.
- Large quantity of silt is observed inside the drain near the church area.
- The width of the drain is reduced at few places.

2.8.3 Sampangiramnagar, Near Raja Ram Mohan Roy Extension

Sampangiramnagar is situated near Mission Road in Koramangala main valley. Koramangala main valley secondary storm drain (K109) flows through this locality and due to reasons mentioned below, it is causing localised flooding problems in this region,

Reasons for Flooding

- Drain reach near this locality is almost covered.

- Foundation / Floor level of residential buildings in this layout is much below the drain bed level.

- Existing tertiary drain in this locality are inadequate and not functioning upto the required level.

- The alignment of the drain at nearly two location is taking a 90 degrees turn, which intern is reducing the flow velocity and consequently resulting in flooding on the upstream side.

- The size of the tertiary drain coming from Sampangiramnagar, 4th main road and joining the secondary drain (K109) at back side of Bangalore oncology hospital is very insufficient, which intern causing localised flooding problems in adjoining residential area.

2.8.4 Siddapura & Wilson Garden

Siddapura & Wilson garden area are situated in Koramangala main valley. A secondary storm water drain (K108) starting from Siddapura flows through Someshwarapura, Siddapura, Wilson garden and Hombegowdanagar before confluencing with Koramangala valley primary storm drain (K100) near NGO's Colony.

This stretch has residential buildings and horticulture nurseries on either side of the channel. Due to improper drainage arrangement and also for other reasons mentioned below these localities gets inundated with water even for minimum intensity of rainfall.

Reasons for flooding:

- Natural course of existing SWD alignment has been changed due to encroachment / construction of residential building.

•Improper drainage arrangement.

•Floor level of residential buildings are below the SWD drain HFL, and also in some cases even below the drain bed level.

•Most of the tertiary drains / road side L - shaped drains are not connected to secondary drain.

•Under ground sewerage system is not extended for the entire locality.

•In most of the locations, the tertiary drain bed level is much below the bed level of the secondary drain.

•Due to encroachment, the width of secondary SWD drain has been reduced near Marigowda road.

•Large quantity of solid waste stacked adjacent to SWD by the horticulture nursery owners finds its way into storm drain.

•Due to silt deposition, garbage dump and sewage flow, the carrying capacity of the existing storm drain is reduced.

•Tertiary drains laid in bylanes are inadequate to cater for both sewage and runoff water.

2.8.5 Lakshman Rao Slum

Lakshman Rao slum is situated near Adugodi in Koramangala main valley. Dense hutment development is noticed on either side of the drain. Due to various reasons mentioned below, the above referred primary drain before joining Bellandur tank is posing serious flooding problems in these localities.

•Due to large scale encroachment, natural alignment of existing primary storm drain has been altered inside the slum area

- Foundation / Floor level of hutments / residential buildings in this layout is much below the existing drain bed level.

- Existing storm drain is in natural condition without any side walls.

- Large quantity of silt and garbage dumps are noticed inside the drain.

- Large quantity of raw sewage is being directly discharged into storm drain.

- Sewerage system is not extended for the entire locality.

- Due to dense development of hutments, maintenance of drains in highly impossible in this reach.

- Existing primary drain width has been drastically reduced inside the slum area.

- Existing primary drain bed slope from Hosur bridge upto Bellandur tank is almost flat.

2.8.6 Ejipura, Koramangala & S.T. Bed Area

Koramangala, Ejipura & S.T. Bed areas are situated in Koramangala main valley. These localities comprises of dense residential buildings and commercial establishments on either side of the drain. Due to various reasons mentioned below, the above referred primary drain before joining Bellandur tank is posing serious flooding problems in these localities.

Reasons for flooding:

- Due to large scale encroachment, natural alignment of existing primary storm drain has been altered inside National Games Complex.

- Foundation / Floor level of residential buildings in this layout is much below the existing drain bed level.

- Existing primary drain width from Viveknagar bridge upto Bellandur tank has been drastically reduced from 22 m. to 9 m.

- Existing primary drain bed slope from Viveknagar bridge upto Bellandur tank is almost flat.

- Large Nos. of RCC columns constructed inside the storm drain near National games village is obstructing free flow of water.

- Nos. of approach bridges constructed and utility crossing laid across existing SWD by apartment owners in Koramangala layout is obstructing free flow of water.
- Improper drainage facilities.

- Large quantity of sewage flow is noticed in the existing storm drain including sewage discharge from National Games Complex.

- Large quantity of debris and garbage dump is noticed at many places inside the SWD.

- At some places drain does not have side walls and is in natural condition which intern reduces the velocity of flow in the drain.

- Ashwini Layout, S.T. Bed etc., are at a level lower than the drain HFL. The inadequate drain overflows in to these areas and the storm water from these area does not get drained when the primary drain is flowing full.

2.8.7 L.I.C. Colony, Near Krishnappa Garden

L.I.C. Colony is situated near Jayanagar 3rd Block in Tavarekere valley. Tavarekere valley secondary storm drain (K207) flows through this locality and due to reasons mentioned below, it is causing localised flooding problems in this region,

Reasons for Flooding

- Existing drain reach in this locality is almost covered and also in some places the road formation level is equal or lower than the drain bed level, which intern causes backflow of water from the drains onto the road surface and cause localised flooding problems in front of residential buildings.

•Drain reach near fire service college is in natural condition and also it is not properly linked with Tavarekere valley main drain. Which intern is causing stagnation of water and causing heading up of water upstream.

•Large quantity of earth has been dumped and natural alignment of drain has been altered to form a new residential layout, near fire service college.

•Drain width is drastically reduced near the joining point of this secondary drain and primary drain.

2.8.8 Bismillahanagar & Maruthinagar, Near Tavarekere

Bismillahanagar & Maruthinagar is situated in Tavarekere valley. Wherein Tavarekere valley primary storm drain (K200) flows through this locality. The topography of this area is sloping from North-West towards South -East. About 15% length of the drain is passing through open area and balance 85% length of the drain is passing through thickly populated area and dense built residential area and due to reasons mentioned below, it is causing localised flooding problems in this region,

Reasons for Flooding

•Natural alignment of storm drain has been altered in this region.

•Foundation / Floor level of residential buildings in this layout is much below the drain bed level.

•The alignment of the drain at nearly two location is taking a 90 degrees turn, which intern is reducing the flow velocity and consequently resulting in localised flooding in the region.

•The width of storm water drain is very inadequate, since it is drastically reduced to 1.5 m. from 4.5 m near Bismillahnagar.

- The existing storm water drain has been encroached and houses have been constructed by residents.

- The existing culverts constructed across storm water drain in Bismilla Nagar and Balaji Nagar is obstructing free flow.

- All the road side drains and ground profiles are sloping towards the Bismillah nagar and Balajinagar forms valley and the bed slope downstream is not adequate.

- Large quantity of raw sewage is being discharged into the storm drain in this locality.

- Large quantity of garbage and solidwaste materials is being dumped into storm drain by the residents.

2.8.9 B.T.M. Layout – Dollars Scheme Colony, Near Central Silk Board

B.T.M. Layout – Dollars Scheme Colony is situated in Tavarekere valley. Wherein Tavarekere valley primary storm drain (K200) flows through this locality and due to reasons mentioned below, it is causing localised flooding problems in this region,

Reasons for Flooding

- Foundation / Floor level of residential buildings in this layout is much below the drain bed level.

- Large quantity of raw sewage is being observed in the storm drain.

- Large quantity of garbage and solidwaste materials is being dumped into storm drain by the residents.

- The drain width is reduced near central silk board training centre.

- The culvert constructed at central silk board junction is having a very inadequate vent size thereby reducing the carrying capacity of the drain.

- Existing tertiary drain in this locality are inadequate and not functioning upto the required level.

2.9 Existing Operation and Maintenance Practice

During the recent years BMP has undertaken reconstruction of drain walls and cross drains at some strategic locations to overcome the present flooding situations and also during the last two years BMP has undertaken a large scale program of desilting of storm water drains and solid waste management.

BMP has set up Emergency squads with truck mounted pumping arrangements, to be available round the clock. For each zone, emergency telephone connections have been setup to overcome any eventuality.

BMP has also taken up projects like improvements of conservancies, foot paths, rejuvenation of parks, Swacha Bangalore and Nirmala Bangalore etc., this intern has reduced the risk of accumulation of silt and solid waste at tertiary drain level to a certain extent and also intern enhances the aesthetic appearance of the city.

2.10 Quantity and Quality of Sewage

The watershed area within the city is having the major problem of domestic sewage and sullage getting into storm water drains contributing to the pollution of the Bellandur lake. Indiscriminate dumping of solidwaste in the storm water drains is yet another cause for the pollution of the Bellandur lake.

The dry weather flow of sewage flow in Koramangala and Tavarekere valley is as mentioned in the table below Table:

Results of Dry Weather Flow Measurements in Open Drains

Name of Valley	Min flow (MLD.)	Avg. Flow (MLD.)	Max. Flow (MLD.)
Koramangala Valley	33.78	54.11	67.99
Tavarekere Valley	52.42	66.18	80.58

Source: M/s. Pai Enron Technologies systems limited Bangalore.

Concentration of Pollutants in Dry Weather Flow Drains

Parameters	Bellandur tank	Agara tank
BOD_5	388	381
SS	896	624
DO	Nil	Nil

CHAPTER 3

STORM WATER DRAINAGE SYSTEM DESIGN AND ANALYSIS

3.1 INTRODUCTION:

Application of concepts and methodologies of drainage design requires establishment of design parameters of the system considered for the design. Such parameters specifies the system performance with regard to various inputs. While the design concepts and methodologies are fairly general, design parameters are site specific. Depending on the design objectives and the availability of supporting data, different design parameters may apply to each region, location and project. Various parameters that are considered and analysed are discussed here under:

3.2 DESIGN CRITERIA:

These include planning horizon, design period, catchment physical parameters, process parameters and meteorological parameters.

3.2.1 PLANNING HORIZON:

Ideally planning of storm drainage works may be implemented in two levels – planning for short term and the long term. Planning for short term considers the proposed development plans for immediate mitigative measure. Information pertaining to development plan includes population trends, comprehensive land use and zoning plan, location of future roads, airports, and industrial area which may affect the drainage design as well as jurisdictional division and financial arrangement. The long term planning process reflects the ultimate development anticipated over a period of time which may be as long as 25 to 50 years. But, these may not be feasible for well developed cities, to accommodate higher size drains in already developed layouts. Therefore, one best alternative approach is to backfit the drain capacity with respect to the prevailing site conditions and arrive at the suitable return period, which is acceptable to the implementing agency.

3.2.2 DESIGN PERIOD:

Planning horizon reflects the envisaged land use projected for a certain number of years, the design period of drainage system indicates the expected levels of protection against such phenomena as flooding, health hazard or deterioration in the quality of receiving waters. Besides the desired level of protection, the design period depends on construction cost and damage (losses) resulting from system failures. The planning horizon may be linked to the longest design life of structures under design. Thus, while there is only one planning horizon for a drainage area, the design period may differ for the individual system components.

The TOR specifies that the acceptable design standards commensurate with the anticipated runoff volume in the next 20 years be determined in Phase-I. Thus, it is considered that the adequacy of the existing primary and secondary storm drains be studied, for the anticipated runoff rate over the next 20 years.

But, after consecutive discussions with BMP and also based on prevailing site conditions, it was decided by BMP and agreed, that inorder to incur minimum construction cost, minimum land acquisition and to avoid large scale distraction of properties adjoining to drains, it was decided to consider five year return period.

3.2.3 PHYSICAL PARAMETERS OF CATCHMENT:

Base maps showing the project area, topographical details like contour, water courses, tanks, wooded areas, rocky outcrops, marshes, etc., details of existing and proposed land uses, existing and proposed drains for establishing the study area drainage boundaries, general drainage pattern in these areas, surface slopes and total catchment area are developed. The catchment area is divided into pervious and impervious areas. In addition, the existing drainage channels in the catchment need to be characterized in terms of the cross sections, slopes, lengths, and linkages. The extent of development of the catchment has significant bearing on the runoff calculations.

3.2.4 PROCESS PARAMETERS:

These include infiltration rates, depression storage, roughness of transport elements and runoff coefficient. Generally, these parameters will be considered together as a lumped aggregate parameter.

3.2.5 METEOROLOGICAL DATA:

Important input for runoff computation is rainfall data. Rainfall data processing may be carried out by many approaches. Some of the methods are as listed and explained here under,

1. CPHEEO MANUAL
2. CALIFORNIA METHOD OF RANKING
3. GUMBEL'S DISTRIBUTION METHOD
4. LOG – PEARSON TYPE III DISTRIBUTION

3.2.5.1 RAIN FALL ANALYSIS USING CPHEEO METHOD:

The rainfall data, for the period of past 25 years (i.e., from 1976 to 2001) has been collected from IMD. And analysis for calculating the frequency of storms for the stated intensities and duration has been computed and the same is tabulated.

From the tabulated values, storm occurrences for the different years has been computed and time intensity values for these frequencies has been obtained by interpolating the values for storms occurring once a year, once in 2 years, once in 5 years, once in 10 years and once in 20 years.

Using log-log sheet, a graph has been plotted using the values of intensity (i), and duration (t) from the above tabulated values for calculating the storm occurrences for different return periods i.e., once a year, once in 2 years, once in 5 years, once in 10 years and once in 20 years respectively. From the best fit line, values of 'a' & 'n' are obtained. Further the same is substituted in the equation below.

$$i = \frac{a}{t^n}$$

where, i = intensity of rainfall in mm/hr

t = duration of storm in minutes

a,b,n = constants as appropriate

After substituting values of 'a' and 'n', different values of " i " for a various values of " t " are calculated and tabulated. A curve is plotted using an ordinary graph paper.

Another graph of runoff coefficients (c) v/s duration time (t) is plotted as per the values given in Horner's table (Table 3.3, Pg. No. 45 of CPHEEO Manuel).

3.2.5.2 RAIN FALL ANALYSIS USING RANKING METHOD:

The rainfall data for a period of 25 years is collected from Indian Meteorological Department (IMD). From the rainfall data, intensity of highest rainfall is considered in that particular duration and year which is arranged in descending order and the rank is assigned with a rank one to the highest value, a rank of two to the next highest value and so on. Whenever a particular value occurs more then once, all the values should have the same rank as they are equal. Further, recurrence interval or frequency corresponding to each rank can be calculated using a formula

$$N = T \times m$$

Where 'm' is the number of times, given rain is equalled or exceeded and is known as the ranking of the storm or ranking number

Extracting rainfall of various duration for desired frequency, further calculation of rainfall intensity in mm/hour has been done.

Using log-log sheet, graphs have been plotted using the values of intensity (i), and duration (t) from the above tabulated values for calculating the storm occurrences for different return periods i.e., once a year, once in 2 years, once in 5 years, once in 10 years and once in 20 years respectively. From the best fit curve, values of 'a' &'n' are obtained. Further, the same are substituted in the equation below.

$$i = \frac{a}{t^n}$$

where, i = intensity of rainfall in mm/hr

t = duration of storm in minutes

a,b,n = constants as appropriate

After substituting values of 'a' & 'n' different values of 'i' for a various values of 't' are calculated and tabulated. A curve is plotted using an ordinary graph paper.

3.2.5.3 RAIN FALL ANALYSIS USING GUMBEL'S DISTRIBUTION METHOD:

The rainfall data for a period of 25 years is collected from IMD and the highest rainfall intensity in that particular duration and year is considered and it is arranged in a sequential order. For each duration, the mean and standard deviation are calculated. Subsequently, the amount of rainfall for various duration and return period is calculated using the below equation.

$$X_T = X + K S_x$$

Where, X is the mean.

Sx is the standard deviation of the sample of extreme rainfall.

X_T is the rainfall amount which is equalled or exceeded on an average once in 'T' years.

K is the frequency factor which can be expressed in terms of the return period 'T' and the number of years of record 'N',
The value of 'K' can be obtained from standard table.

By substituting the values of 'X', 'Sx' and 'K'. The value of 'K' can be obtained from standard table (from S.K Garg, Table 10.6) for N = 25 and return periods varying from 1 to 20 years.

Amount of rainfall obtained will be tabulated and further the same is converted into rainfall intensities and tabulated.

Using log-log sheet, a graph is plotted using the values of intensity (i), and duration (t) from the above tabulated values for calculating the storm occurrences for different return periods i.e., once a year, once in 2 years, once in 5 years, once in 10 years and once in 20 years. From the best fit curve, values of 'a' & 'n' are obtained. Further the same is substituted in the equation below.

$$i = \frac{a}{t^n}$$

where, i = intensity of rainfall in mm/hr

t = duration of storm in minutes

a,b,n = constants as appropriate

After substituting values of 'a' & 'n', different values of 'i' for various values of 't' are calculated and tabulated, a graph is plotted on an ordinary graph sheet.

Values obtained from the above three methods are compared with other design parameters which is suitable for the present site conditions and that method is adopted for computing storm water runoff.

3.2.6 STRUCTURAL DESIGN PARAMETERS :

Parameters and standards considered for design of sub structures, super structures and cross drainage works are as follows;

1.The structures are categorized as per Table-5B of IRC : 21-2000. Since the materials used are RCC, PCC and Stone masonry and in case of bridges total length is generally less than 60 m. In case the total length of the bridge is more than 60 m. or any innovative design approach is adopted the same is categorized as per Table - 5A of IRC : 21-2000.

2.For design purposes the condition of exposure is considered as SEVERE. Since the structures are in contact with untreated sewage and drainage effluent.

3.The following materials are proposed to be used in the structures.

i.Minimum Grades of Concretes used are as below

- M15 - In levelling course below RCC, PCC & Stone masonry foundations, pile caps, approach slabs and in footpath fillings.
- M20 - In PCC structural elements like retaining walls & abutments

- M25 - In kerbs, hand rail, and posts, approach slab, retaining walls, piers, pile caps and abutments.
- M35 - In crash barriers, super structures, box culverts & piles etc.
- Maximum water cement ratio shall be 0.45.

ii. Grade of steel to be used is Fe 415.

iii. Course rubble stone masonry for bridge works such as abutments.

iv. Random rubble stone masonry for retaining structures other than bridge abutments.

v. CM 1:3 for stone masonry.

vi. PVC pipes for weep holes in retaining walls and provision for service lines in superstructure.

vii. Elastomeric bearings for beam and slab type superstructure.

viii. Compression seal expansion joint for joints along longitudinal direction in carriage way portion of superstructure.

ix. PVC water bar type expansion joint for superstructures with beam and slab arrangement.

x. Premoulded bitumen filling joint for solid slab type superstructures covering full depth.

xi. Premoulded bitumen filling joint for retaining walls.

xii. Asphalted concrete wearing coat over mastic asphalt.

xiii. Back filling behind abutments, returns and retaining walls shall be with granular materials with soil as per Appendix-6 of IRC : 78-2000.

xiv. GI drainage spouts as per drawings.

4. Minimum dimensional requirements:

i. Levelling course - 100 mm. thick below RCC / PCC foundations.
- 300 mm. thick below stone masonry foundations on soil base.
- 150 mm. thick below stone masonry foundations on rock base
- 150 mm. thick below approach slabs.

ii. Walls - 200 mm. thick for RCC / PCC walls.
- 500 mm. thick for stone masonry walls.

iii. Wearing coat on deck slabs shall be 50 mm. thick asphalted concrete in two layers of 25 mm. each over 6 mm. thick mastic asphalt. Thickness of asphalted concrete shall be varied suitably to achieve the slopes for camber or super elevation.

iv. Normal camber considered is 2.5 %.

v. Weep holes with PVC pipes (100 mm. dia. in RCC and 150 mm. dia. in stone masonry) shall be used in retaining structures including abutments and retaining walls. The spacing of weep holes shall be 1.0 m. in either direction in staggered way, with lowest at about 150 mm. above the low water level or ground level which ever is higher. (MOST Spec. : 2706).

5. Loading :

Density of PCC	=	2.2 t/m^3
RCC	=	2.4 t/m^3
Stone masonry	=	2.2 t/m^3
Back filling	=	2.0 t/m^3

i. Load due to wearing coat = 0.2 t/m^2

ii. Load due to crash barrier = 0.8 t/m On each side.

iii. Load due to hand rail and kerb = 0.95 t/m On each side.

iv. Load due to services in footpath = 0.1 t/m On each side.

v. Foot path live load = 0.5 t/m^2 On each side.

vi. Vehicle live loads are as per clause 207.4, Table-2 of IRC:6-2000 for different carriage ways.

vii. Load due to water current as per clause 213 of IRC : 6 -2000.

viii. Live load surcharge is 1.2 m height of back fill.

ix. Buoyancy force as per clause 216 of IRC : 6-2000.

x. One span dislodged condition is not considered in the case of slab bridges not provided with bearings. (As per clause 221.1 of IRC:6-2000.)

xi. Seismic forces are not considered as the structures are located in Seismic Zone-1. (As per clause 222.1 of IRC : 6-2000.)

6.Miscellaneous details :

i. Bridges or culverts with out footpath are provided with crash barrier / Hand rail.

ii. Bridges or culverts with footpath are provided with hand rails as per SD/202 of MOST STD drawing with or with out crash barrier at the edge of carriage way.

iii. Drainage spouts in the superstructure of the bridge or culverts are as per SD/205 of MOST STD drawing.

3.3 CATCHMENT ANALYSIS:

To study the hydrological conditions and drainage characteristics of Koramangala valley catchment area, the following analysis procedure has been adopted

- Identification of ridge line and demarcation of catchment boundary.
- Demarcation of primary and secondary valleys.
- Demarcation of entire catchment into micro/sub catchments.
- Identification of flow regions within micro catchments.
- Codification of flow regions.
- Characterisation of the entire catchment in terms of landuse categories.
- Identification of open and closed reach of drains.
- Assignment of the degree of imperviousness to rainfall for the above categories.
- Computation of weighted average imperviousness for each of the flow region.

The ridge lines of Koramangala valley catchment area are demarcated based on the available 10 m. interval elevation contour information in the survey of India 1:20,000 scale topo map for Bangalore city. On which the valley lines and the local ridge lines are identified to demarcate the sub catchments and flow regions. These details prepared on 1: 20000 scale map are digitized to generate a vector layer in Arcview GIS as line coverage, as well as polygons coverage. After the transformation of the coverage with reference to the map used for digitization, various attribute details on length of arcs and area of polygons are analyzed to obtain the length both primary and secondary drains and area of catchment, sub catchment and micro catchment and the same is also indicated in Figure 3.1 & 3.2.

Further, to calculate the inlet time and time of concentration the sub/micro catchments are segmented into different flow regions based on terrain slope and other aspect derived from contour information. The area details of the micro catchments codes, flow regions, land use characteristics in Koramangala main valley and Tavarekere valley are provided in Table – 3.1 to Table - 3.4.

Table 3.1 KORAMANGALA MAIN VALLEY MICRO CATCHMENT CODE

Sl. No.	Micro Catchment Code	Area (Ha.)
1	A 1	123.14
2	A 2	217.19
3	A 3	90.40
4	A 4	209.15
5	A 5	256.56
6	A 6	96.76
7	A 7	179.95
8	A 8	351.90
9	A 9	88.33
10	A 10	142.87
11	A 11	78.71
12	A 12	156.84
13	A 13	193.39
14	A 14	11.33
15	A 15	60.24
16	A 16	63.83
17	A 17	212.14
18	A 18	100.98
19	A 19	72.44
20	A 20	44.42
21	A 21	121.01
22	A 22	218.91
23	A 23	81.44
24	A 24	195.22
25	A 25	181.51
	TOTAL	**3547.67**

Table 3.2 KORAMANGALA MAIN VALLEY FLOW REGION CODE

Sl.No.	Flow Region Code	Area (ha.)
1	A1 (a)	41.19
2.	A1 (b)	81.95
3.	A2	217.19
4.	A3	90.40
5.	A4	209.15
6.	A5 (a)	57.71
7.	A5 (b)	198.83
8.	A6 (a)	72.10
9.	A6 (b)	24.61
10.	A7	179.95
11.	A8 (a)	162.45
12.	A8 (b)	189.46
13.	A9	88.33
14.	A10	142.87
15.	A11	78.71
16.	A12	156.84
17.	A13	193.39
18.	A14	
19.	A15	60.24
20.	A16	63.83
21.	A17(a)	115.81
22.	A17(b)	22.33
23	A17(c)	73.00
24	A18(a)	41.00
25	A18(b)	59.97
26	A19	72.44
27	A20	44.42
28	A21(a)	18.85
29	A21(b)	13.84

30	A21(c)	16.61
31	A21(d)	25.71
32	A21(e)	46.00
33	A22(a)	149.88
34	A22(b)	69.03
35	A23(a)	34.76
36	A23(b)	46.68
37	A24(a)	161.30
38	A24(b)	33.92
39	A25(a)	81.73
40	A25(b)	99.77
	TOTAL	**3547.57**

Table 3.3 TAVAREKERE VALLEY MICRO CATCHMENT CODE

Sl.No.	Micro Catchment Code	Area (ha.)
1.	A 1	49.43
2.	A 2	138.81
3.	A 3	18.77
4.	A 4	21.30
5.	A 5	43.21
6.	A 6	65.79
7.	A 7	43.46
8	A 8	40.74
9	A 9	45.33
10	A 10	34.79
11	A 11	49.70
12	A 12	428.33
13	A 13	129.22
14	A 14	65.02
15	A 15	66.86
16	A 16	81.22
17	A 17	103.45
18	A 18	105.49
19	A 19	140.76

20	A 20	113.78
21	A 21	168.80
22	A 22	69.83
23	A 23	262.89
24	A 24	186.32
25	A 25	71.97
26	A 26	88.20
27	A 27	56.98
	TOTAL	**2690.43**

Table 3.4 TAVAREKERE VALLEY FLOW REGION CODE

Sl.No.	Flow Region Code	Area (ha.)
1.	A 1 (a)	19.66
2.	A 1 (b)	29.77
3.	A 2 (a)	35.18
4.	A 2 (b)	18.28
5.	A 2 (c)	26.19
6.	A 2 (d)	59.16
7.	A 3	18.77
8.	A 4	21.30
9.	A 5	43.21
10.	A 6	65.79
11	A 7	43.46
12	A 8	40.74
13	A 9	45.33
14	A 10	34.79
15	A 11	49.70
16	A 12 (a)	35.75
17	A 12 (b)	252.25
18	A 12 (c)	140.33
19	A 13	129.22
20	A 14 (a)	46.84
21	A 14 (b)	18.18
22	A 15 (a)	23.86
23	A 15 (b)	43.00
24	A 16	81.22
25	A 17	103.45
26	A 18 (a)	59.47

27	A 18	46.02
28	A 19	140.76
29	A 20 (a)	33.34
30	A 20 (b)	80.44
31	A 21 (a)	72.06
32	A 21 (b)	96.74
33	A 22	69.83
34	A 23 (a)	163.59
35	A 23 (b)	99.30
36	A 24 (a)	163.42
37	A 24 (b)	22.90
38	A 25 (a)	34.38
39	A 25 (b)	37.59
40	A 26 (a)	40.60
41	A 26 (b)	47.60
42	A 27	56.98
	TOTAL	**2690.43**

Using digital image processing technique and also by visual interpretation, satellite image is used to analyze the catchments and categorise the same for various landuse categories as listed below and further at strategic locations the processed results are cross verified at site and accordingly range of percent imperviousness is assigned for each category.

1. Highly / Dense built up area with sparse vegetal cover
2. Dense built up area with medium / thick vegetal cover
3. Built up area with more open space as well as fairly dense vegetal cover
4. Open space with no vegetal cover / Open space with scrubs and other vegetation
5. Parks
6. Water bodies

Further, in order to compute the weighted average percent imperviousness for each, the highest runoff percent imperviousness assigned is 80 - 95 % for the land where settlement density is very high (>90%) and all roads are paved. The lowest runoff percent imperviousness assigned is 5 -20 % for parks with medium dense vegetation. The details of area and assigned percent imperviousness is shown in Table - 3.5.& 3.6.

In order to compute the weighted average percent imperviousness for each flow

77°34'19"E 77°35'19"E 77°36'19"E 77°37'19"E 77°38'19"E 77°39'19"E 77°40'19"E 77°41'19"E

12°59'7"N 12°58'7"N 12°57'7"N 12°56'7"N 12°55'7"N 12°54'7"N

1,300 650 0 1,300 2,600 3,900 5,200 Meters

BASHYAM NAGAR (24)
GAYATRINAGAR (8)
PULIKESHINAGAR (85)
BENNIGANAHALLI (84)
BHARATHINAGAR (80)
VASANTANAGAR (78)
SARVAGNANAGAR (85)
OLD MADRAS ROAD
SHIVAJINAGAR (79)
Ulsoor Tank
ULSOOR (81)
HOYSALANAGAR (82)
SRI CV RAMAN NAGAR (83)
SEVASHRAMA (26)
GANDHINAGAR (27)
RAMACHANDRAPURA (25)
SAMPANGIRAMANAGAR (77)
A2 217.19 Ha.
A4 209.153 Ha.
BINNYPET (31)
A1(a) 41.186 Ha.
CHIKPET (28)
COTTONPET (29)
RICHMOND TOWN (76)
JOGPALYA (75)
SKR MARKET (30)
A3 90.403 Ha.
A5(b) 198.831 Ha.
A8(b) 189.457 Ha.
JEEVANBIMANAGAR (74)
A1(b) 81.953 Ha.
DHARMARAYASWAMI TEMPLE (47)
A5(a) 57.705 Ha.
A8(a) 162.447 Ha.
DOMLUR (72)
AIRPORT ROAD
CHAMARAJPET (46)
A7 179.953 Ha.
SUDHAMNAGAR (48)
A9 88.334 Ha.
AUSTIN TOWN (71)
A25(b) 99.77 Ha.
A6(a) 72.152 Ha.
SHANTINAGAR (70)
A24(b) 33.92 Ha.
NEELASANDRA (69)
Kempambudi Tank
A24(a) 161.298 Ha.
A6(b) 24.609 Ha.
AIRPORT (73)
KEMPEGOWDA NAGAR (49)
A10 142.869 Ha.
A25(a) 81.734 Ha.
MAVALLI (61)
A22(b) 69.034 Ha.
A21(a) 18.853 Ha.
A20 50.178 Ha.
A19 66.681 Ha.
A18(b) 100.976 Ha.
HANUMANTHANAGAR (52)
VISWESVARAPURAM (50)
A22(a) 149.876 Ha.
A21(e) 46.001 Ha.
A21(b) 18.841 Ha.
A18(a) 100.976 Ha.
A11 78.709 Ha.
SRINAGAR (53)
0 Ha.
HOMBEGOWDANAGAR (62)
A23(a) 34.762 Ha.
KORAMANGALA (67)
A21(d) 25.711 Ha.
A21(c) 16.608 Ha.
A17(c) 73.003 Ha.
BASAVANAGUDI (51)
A23(b) 46.678 Ha.
EJIPURA (68)
A12 156.841 Ha.
A17(b) 22.325 Ha.
SRINIVASANAGAR (54)
PATTABHIRAMANAGAR (60)
YEDIYUR (59)
LAKKASANDRA (63)
A17(a) 115.812 Ha.
A13 193.386 Ha.
A16 63.832 Ha.
Bellandur Tank
A14 11.327 Ha.
A15 60.24 Ha.
SARJAPUR ROAD
GANESHAMANDIRA (56)
JAYANAGAR (58)
GURRAPPANAPALYA (64)
MADIVALA (66)
Agara Tank
BTM LAYOUT (65)
PADMANABHANAGAR (55)
JP NAGAR (57)
Madivala Tank
HOSUR ROAD

K112 K110 K109 K113 K108 K107 K1 K103 K104 K100A K111 K102 K101 K207 K208 K206 K205 K204 K2 K201 K203 K202 K209

Legend

- Drains
- Ridge
- Water Bodies

Rail / Road

- Arterial Road
- Major Road
- Minor Road
- Rail
- Main Valley
- Sub Valley

DATE	No.	REVISION	DRAWN	CHECKED	APPROVED

STUP Consultants P. Ltd.
REGISTERED OFFICE: 1004-5 RAHEJA CHAMBERS, NARIMAN POINT, MUMBAI - 400021

OFFICE OF ORIGIN: BANGALORE

OWNER: BANGALORE MAHANAGARA PALIKE

DATE: 16/05/2003

CLIENT:

DRAWN: MNS

PROJECT: RE-MODELLING OF PRIMARY AND SECONDARY STORM WATER DRAINS IN BANGALORE CITY

PREPARED:

CHECKED:

TITLE: Koramangala Valley, Sub Catchments in Koramangala Main Valley

APPROVED:

Fig. No. .

REV

JOB No. 1495

SCALE: AS SPECIFIED

77°34'19"E 77°35'19"E 77°36'19"E 77°37'19"E 77°38'19"E 77°39'19"E 77°40'19"E 77°41'19"E

12°59'7"N 12°58'7"N 12°57'7"N 12°56'7"N 12°55'7"N 12°54'7"N

1,300 650 0 1,300 2,600 3,900 5,200 Meters

BASHYAM NAGAR (24)
GAYATRINAGAR (8)
PULIKESHINAGAR (91)
BHARATHINAGAR (80)
BENNIGANAHALLI (84)
VASANTANAGAR (78)
SARVAGNANAGAR (85)
OLD MADRAS ROAD
SHIVAJINAGAR (79)
Ulsoor Tank
ULSOOR (81)
HOYSALANAGAR (82)
SRI CV RAMAN NAGAR (83)
SEVASHRAMA (26)
GANDHINAGAR (27)
RAMACHANDRAPURA (25)
SAMPANGIRAMANAGAR (77)
BINNYPET (31)
COTTONPET (29)
CHIKPET (28)
RICHMOND TOWN (76)
JOGPALYA (75)
SKR MARKET (30)
JEEVANBIMANAGAR (74)
DHARMARAYASWAMI TEMPLE (47)
DOMLUR (72)
AIRPORT ROAD
CHAMARAJPET (46)
SUDHAMNAGAR (48)
AUSTIN TOWN (71)
SHANTINAGAR (70)
NEELASANDRA (69)
Kempambudi Tank
KEMPEGOWDA NAGAR (49)
AIRPORT (73)
MAVALLI (61)
VISWESVARAPURAM (50)
HANUMANTHANAGAR (52)
HOMBEGOWDANAGAR (62)
SRINAGAR (53)
KORAMANGALA (67)
BASAVANAGUDI (51)
EJIPURA (68)
SRINIVASANAGAR (54)
YEDIYUR (59)
LAKKASANDRA (63)
PATTABHIRAMANAGAR (60)
Bellandur Tank
SARJAPUR ROAD
GANESHAMANDIRA (56)
MADIVALA (66)
JAYANAGAR (58)
GURRAPPANAPALYA (64)
Agara Tank
BTM LAYOUT (65)
PADMANABHANAGAR (55)
JP NAGAR (57)
Madivala Tank
HOSUR ROAD

K1 K100A K101 K102 K103 K104 K105 K106 K107 K108 K109 K110 K111 K112 K113
K201 K202 K203 K204 K205 K206 K207 K208 K209
K2

A1(a) 19.66 Ha.
A1(b) 29.768 Ha.
A2(a) 35.814 Ha.
A2(b) 18.278 Ha.
A2(c) 26.187 Ha.
A2(d) 59.162 Ha.
A3 18.772 Ha.
A4 21.299 Ha.
0.001 Ha.
A5 43.212 Ha.
A6 65.791 Ha.
A7 43.462 Ha.
A8 40.739 Ha.
A9 45.329 Ha.
A10 34.785 Ha.
A11 49.702 Ha.
A12(a) 35.748 Ha.
A12(b) 252.246 Ha.
A12(c) 140.334 Ha.
A13 129.218 Ha.
A14(a) 46.834 Ha.
A14(b) 18.178 Ha.
A15(a) 23.859 Ha.
A15(b) 43.011 Ha.
A16 81.216 Ha.
A17 103.45 Ha.
A18(a) 59.471 Ha.
A18(b) 46.022 Ha.
A19 140.764 Ha.
A20(a) 33.34 Ha.
A20(b) 80.44 Ha.
A21(a) 72.061 Ha.
A21(b) 96.735 Ha.
A22 117.104 Ha.
A23(a) 116.363 Ha.
A23(b) 99.302 Ha.
A24(a) 163.415 Ha.
A24(b) 22.902 Ha.
25(a) 71.967 Ha.
25(b) 71.967 Ha.
26(a) 88.197 Ha.
26(b) 88.197 Ha.
27 56.978 Ha.

N W E S

Legend

- Drains
- Ridge
- Water Bodies

Rail / Road

- Arterial Road
- Major Road
- Minor Road
- Rail
- Main Valley
- Sub Valley

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PROJECT: RE-MODELLING OF PRIMARY AND SECONDARY STORM WATER DRAINS IN BANGALORE CITY

PREPARED:

CHECKED:

TITLE: Koramangala Valley, Sub Catchments in Tavarekere Valley

APPROVED:

Fig. No. .

REV

JOB No. 1495

SCALE: AS SPECIFIED

region, intersection of flow region boundaries with settlement density boundaries is done. A composite plans for Koramangala main valley and Tavarekere valley are generated by incorporating the drainage lines, ridge lines, flow region boundaries and the landuse and land cover categories and the same is indicated in Figure 3.3.

The weighted average percent imperviousness (IW) for each flow region is computed and is given by

$$IW = \frac{I_1 A_1 + I_2 A_2 + I_3 A_3 + I_4 A_4 \ldots\ldots}{A_1 + A_2 + A_3 + A_4 \ldots\ldots}.$$

where, I_1 , I_2 , I_3 , I_4 are assigned imperviousness (%) for each of the land cover category within the flow region and A_1 , A_2, A_3, A_4 are the corresponding areas.

TABLE 3.5 KORAMANGALA VALLEY LAND COVER CHARACTERISTICS

Sl.No.	Land Cover Characteristics	Area (ha)	Assigned % Imperviousness
1.	Highly / Dense built up area with sparse vegetal cover	1524.02	75 – 90
2.	Dense built up area with medium / thick vegetal cover	740.22	65 – 80
3.	Built up area with more open space as well as fairly dense vegetal cover	247.13	45 – 60
4.	Open space with no vegetal cover / Open space with scrubs and other vegetation	266.12	10 – 25
5	Parks	755.20	05 – 20
6	Water Bodies	14.96	--
	Total	**3547.63**	

Table 3.6 TAVAREKERE VALLEY LAND COVER CHARACTERISTICS

Sl.No.	Land Cover Characteristics	Area (ha)	Assigned % Imperviousness
1.	Highly / Dense built up area with sparse vegetal cover	420.59	75 – 90
2.	Dense built up area with medium / thick vegetal cover	1077.13	65 – 80
3.	Built up area with more open space as well as fairly dense vegetal cover	539.30	45 – 60

4.	Open space with no vegetal cover / Open space with scrubs and other vegetation	419.38	10 – 25
5	Parks	105.35	05 – 20
6	Water Bodies	128.68	--
	Total	**2690.43**	

3.4 DESIGN PROCEDURE:

3.4.1 GENERAL:

Having understood the site conditions and terms of reference it is proposed to adopt the approach philosophy of which revolves around 4 cardinal points viz.:

1. Understanding the project requirements and the accomplishment of the overall objective of the project.

2. Appreciation of the various factors that help or hinder the overall objective of the project both from the review of available documents and a field visit to support the overall objective.

3. Ensuring ways and means of assuring quality of the contract deliverables taking into considerations the factors – efficiency of function, economy of implementation, ease of construction and recognising the link of designs-operations interactions.

4. Ensuring quality assurance in the materials and methods of execution including modern methods of construction for early completion of the works.

And also review of available data through site appreciation leads us to formulate the

77°34'19"E 77°35'19"E 77°36'19"E 77°37'19"E 77°38'19"E 77°39'19"E 77°40'19"E 77°41'19"E

12°59'7"N 12°58'7"N 12°57'7"N 12°56'7"N 12°55'7"N 12°54'7"N

1,300 650 0 1,300 2,600 3,900 5,200 Meters

Ulsoor Valley

Vrishabhavathi Valley

Challaghatta Valley

Koramangala Valley

Kathriguppe Valley

Tavarekere Valley

BASHYAM NAGAR (24)
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SKR MARKET (30)
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SUDHAMNAGAR (48)
SHANTINAGAR (70)
AUSTIN TOWN (71)
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AIRPORT (73)
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VISWESVARAPURAM (50)
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BTM LAYOUT (65)
Madivala Tank
HOSUR ROAD

K112 K109 K113 K110 K108 K111 K104 K102 K101 K100A K103 K1 K2 K201 K202 K203 K206 K207 K209

N W E S

Legend

- Drains
- Ridge
- Water Bodies

Rail / Road

- Arterial Road
- Major Road
- Minor Road
- Rail
- Main Valley
- Sub Valley

LandUse

- Dense Builtup Area
- Medium Builtup Area
- Open Space with Vegitation
- Open Space No Vegitation
- Parks / Vegitation
- Water Bodies
- Industrial Areas

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PROJECT: RE-MODELLING OF PRIMARY AND SECONDARY STORM WATER DRAINS IN BANGALORE CITY

PREPARED:

CHECKED:

TITLE: Koramangala Valley Land Use Map

APPROVED:

Fig. No. . | REV | JOB No. 1495 | SCALE: AS SPECIFIED

method of working to ensure:

•High degree of professional standards in designing the components.
•Clear detailing that will facilitate working and
•Quality assurance in the contract deliverables.
•Quality assurance in execution of contract.

In order to accomplish these objectives, following issues need to be addressed, as applicable for each of the three stages of the project Viz. Feasibility report, Detailed Project Report and Construction Supervision.

3.4.2 STORM WATER RUNOFF:

The storm water run off is the balance of rain water precipitation on the ground which flows in drains after a part of storm water getting infiltration into the soil, retention in surface depressions and evaporated. The rate of storm water run off to be used for design of storm sewers is complex to evaluate accurately. The rate of precipitation which causes the runoff is highly variable from place to place even within a smaller region of the City. The rainfall recording stations from which the intensity of precipitation and duration of rain fall is obtained for the design of storm water drains in many instances are remotely located from the area where the storm water drain has to be designed. The geological formation of the sub-surface will also be varying and estimations of these losses are complex. Numerous empirical runoff formulae had been used for estimation of storm water runoff. Some of the methods adopted are:

1.1.Rational method (Lloyd-Davis method evolved in the United Kingdom).

1.2.Hydrographs (Over-land Flow) method.

1.3.Inlet Method.

1.4.Unit Hydrograph method.

Out of the above methods, the rational method is widely used throughout the World. More than 90% of the Engineering offices through out the United States have confirmed in a questionnaire in the year 1956 with the rational method of design has

given satisfactory results for urban drainage areas. The Ministry of Urban Development, Government of India, New Delhi, Central Public Health and Environmental Engineering Organization, has also recommended the estimation of storm water runoff by rational method.

3.4.2.1. RATIONAL METHOD:

The entire precipitation over the drainage district does not reach the storm water drains. The characteristics of the drainage district such as imperviousness, topography including depressions and water pockets, shape of the drainage basin and duration of the precipitation determine the function of the precipitation, which will reach the drain. This fraction known as the coefficient of runoff needs to be determined for each drainage district. The runoff reaching the drain is given by the expression,

$$Q = 10\ C\ i\ A$$

Where, 'Q' is the runoff in m^3/hr;

'C' is the coefficient of runoff;

'i' is the intensity of rainfall in mm/hr. and

'A' is the area of drainage district in hectares.

3.4.3. STORM FREQUENCY:

Urban storm drains are generally designed based on the concept of the design storm of a selected return period. In general the selection of the design event return period is affected by the design life of structures involved, construction cost and damage cost resulting from the system failure. Drainage structures are typically characterized by long design life and so the ideal design period should be one for which the total annual drainage costs, defined as the sum of annual construction and drainage failure costs are minimal.

While the foregoing may be true for major system, urban storm drainage system being minor system does not warrant a detailed analysis of construction and failure costs. But must evaluate acceptable risk caused by the failure of the system, depending on whether it is a major or minor drainage system.

Major drainage system comprises natural streams and valleys as well as man made

elements such as swales, channels, and ponds. The system should accommodate runoff from infrequent storms with long return periods. Damage caused by the failure of a major drainage system and the associated risks are loss of agricultural yield, damage to properties and even loss of life. Minor drainage system consists of swales, streets gutters, catch basis, storm sewers and surface and subsurface detention facilities. The minor system, designed to convey runoff from frequent storms with return periods i.e. from one to two years, primarily reduces the frequency of inconvenience caused by storm water ponding to both pedestrians and motorists. The consequences of failure of minor drainage are often insignificant provided the connected major drainage system is properly functioning.

Thus the selection of design return period for urban storm drain depends on the importance of area to be drained. Commercial and industrial areas have to be subjected to less frequent flooding. Manual on Sewerage and Sewage Treatment by the Ministry of Urban Development recommend the following:

- Residential area and Peripheral areas Twice a year
- Central and high priced areas Once a year
- Commercial and high period areas Once in two years.

3.4.4 INTENSITY OF PRECIPITATION:

The intensity of rainfall decreases with duration. Analysis of the observed data on intensity duration of rainfall of past records over a. period of years in the area is necessary to arrive at a fair estimate of intensity - duration for given frequencies. The longer record available, the more dependable is the forecast. In Indian conditions, intensity of rainfall adopted in design is usually in the range of 12 mm./hr. to 20 mm./hr. Rainfall data over a period of 25 years is collected and considered.

Frequency of storms of intensities 10 mm./hr to 120 mm./hr. for duration of 5 min. to 120 min. are tabulated, and the number of storms that had occurred for the stated intensities and duration for the desired frequency of storms (once in a year and once in two years) are considered.

The relationship between intensity and duration of storm may be expressed by a suitable, mathematical formula, several forms of which are available. The following two equations are commonly used.

$$i)\ i = \frac{a}{t^{n}}$$

$$ii)\ i = \frac{a}{t + b}$$

where, i = intensity of rainfall in mm/hr

t = duration of storm in minutes

a,b,n = constants as appropriate

The available data on 'i' and 't' are plotted and the values of the intensity (i) can be determined for any given time of consideration, (t_c).

3.4.5. TIME OF CONCENTRATION:

It is the time required for the rain water to flow over the ground surface from the farthest point of the drainage basin to reach the nodal point i.e., under consideration. Time of concentration (t_c) is equal to inlet time (t) plus the time of flow in the drain (t). The inlet time is dependent on the distance of the farthest point in the drainage basin to the inlet of the drain, the shape, characteristics and topography of the basin may generally vary. The time of flow is determined by the length of SWD and the velocity of flow in the SWD. It is to be computed for each length of SWD to be designed.

3.4.6. COEFFICIENT OF RUNOFF:

The portion of rainfall which finds its way to the drain is dependent on the imperviousness and the shape of tributary area, apart from the duration of storm.

1) Imperviousness:

The percent imperviousness of the drainage area can be obtained from the records of a particular district. In absence of such data, the following may ranges may serve as a guide.

Type of Area	**Percentage of Imperviousness**

Commercial and industrial area	70 to 90
Residential area:	
•High density	60 to 75
•Low density	35 to 60
Parks and undeveloped areas	10 to 20

The weighted average imperviousness of drainage basin for the flow concentrating at a point may be estimated using

$$I = (A_1I_1+A_2I_2+ .....) / (A1+ A2+.....)$$

Where, A_1, A_2 = Drainage areas tributary to the section under consideration

I_1, I_2 = Imperviousness respective areas and

I = Weighted average imperviousness of the total drainage basin.

3.4.7. TRIBUTARY AREA:

For each length of storm sewer, the drainage area should be indicated clearly on the map and measured. The boundaries of each tributary are dependent on topography, land use, nature of development and shape of the drainage basins. The incremental area may be indicated separately on the compilation sheet and the total area computed.

3.4.8. DURATION OF STORM:

The concept of design storm is developed to account for the time varying rainfall input as against the constant intensity design rainfalls. The assumption made in this concept is that the return period of the calculated runoff event is identical to the design storm.

For selected return period, the design storm is characterized by the duration, total amount of rainfall, the maximum rainfall intensity of a certain short duration, the timing of peak intensity and temporal storm rainfall distribution.

Continuously long light rain saturates the soil and produces higher coefficient than that of heavy rainfall for shorter duration. But intermittent rains in the same area causes

lesser saturation in the latter case. Runoff from an area is significantly influenced by the saturation of the surface near the point of concentration, rather than the flow from the distant area. The runoff coefficient of a larger area has to be adjusted by dividing the area into zones of concentration and by suitably decreasing the coefficient with the distance of the zones.

3.4.9. COMPUTATION OF RUNOFF COEFFICIENTS:

The weighted average runoff coefficients for rectangular areas of length four times the width as well as for sector shaped areas with varying percentages of impervious surface, for different times of concentration are given in Table 3.7. Although these are applicable to particular shape of areas, they also apply in a general way to the areas which are usually encountered in practice. Errors due to difference in shape of drainage are within the limits of accuracy of the rational method and of the assumption on which it is based.

TABLE – 3.7 Table of CPHEEO Manual - Runoff Coefficient

Duration t, minutes	10	20	30	45	60	75	90	100	120	135	150	185
Weighted average coefficients												
1. Sector concentrating in stated time												
a) Impervious	.525	.588	.642	.700	.740	.711	.795	.813	.828	.840	.850	.865
b)60% impervious	.365	.427	.477	.531	.569	.598	.622	.641	.656	670	.682	.701
c)40% Impervious	.285	.346	.395	.446	.482	.512	.535	.554	.571	.585	.597	.618
d) Pervious	.125	.185	.230	.312	.312	.330	.362	.382	.399	.414	.429	.454
2. Rectangle (length = 4 x width) Concentrating in stated time												
a) Impervious	.550	.648	.711	.768	.808	.837	.856	.869	.879	.887	.892	.903
b)50% Impervious	.350	.442	.499	.551	.590	.618	.639	.657	.671	.683	.694	.713

c)30% Impervious	.269	.360	.414	.464	.502	.530	.552	.572	.588	.601	.614	.636
d) Pervious	.149	.236	.287	.334	.371	.398	.422	.445	.463	.479	.49	.522

3.5. HYDRAULICS OF STORM DRAIN:

Flow capacity of open channels is calculated for each stretch of drain, of different bed slope using Manning's formula.

$$V = [(l/n)] \times [R^{2/3} S^{1/2}]$$

The Mannings co-efficient 'n' for various drain surfaces are Masonry with;

a.Neat cement plaster	0.013
b.Sand and cement plaster	0.015
c.Concrete, steel troweled	0.014
d.Concrete, wood troweled	0.015
e.Brick in good condition	0.017
f.Masonry in bad condition	0.020

Stone work;	(a) Smooth, dressed ashlar	0.015
	(b) Rubble set in cement	0.017
	(c) Fine, well packed gravel	0.020

Earth;	(a) Regular surface in good condition	0.020
	(b) In-ordinary condition	0.025
	(c) With stones and weeds	0.030
	(d) In poor condition	0.035
	(e) Partially obstructed with debris or weeds	0.050

3.5.1 RATIONAL METHOD:

The Rational method is based on the following assumptions :

1)The peak rate of runoff at any point is a direct function of the average rainfall intensity during the time of concentration to that point.

2)The frequency of the peak discharge is the same as the frequency of the average rainfall intensity. The time of concentration is the time required for the runoff to become established and flow from the most remote part of the drainage area to the point under design.

The later assumption applies to the part most remote in time, not necessarily in distance. In the rational method, average intensities have no time sequence relation to the actual rainfall pattern during the storm. The intensity duration curve used in this method is not a time sequence curve of precipitation.

The determination of values for the coefficient of runoff is difficult because this factor must represent many variables, including infiltration, ground slope, ground cover, surface and depression storage, antecedent precipitation and soil moisture, shape of drainage area, overland flow velocity, etc.

AREA:

The area of tributary to any point under consideration in a storm-sewer system must be determined.

Boundaries of the drainage area may be established by field surveys or from suitable maps or aerial photographs.

The complete drainage area is subdivided into sub-catchments and further into micro catchments for each tributary upto the point of inlet. This requires a preliminary layout of the system and tentative location of inlet point. Rearrangement of the system layout or of inlet location often is indicated as the design process proceeds. This requires reorganisation of component parts of the main drainage area to conform to the system layout and inlet scheme finally adopted.

3.5.2RAINFALL:

(a) Rainfall intensity factor, Determination of rainfall intensity, 'i' for storm-sewer design involves consideration of the following factor:

1.Average frequency of occurrence

2.Intensity - duration characteristic of rainfall for selected average frequency of occurrence.

3.Time of concentration.

b) Rainfall frequency: The average frequency of rainfall occurrence used for design determines the degree of protection afforded by a given storm drain system. This protection should be consistent with the amount of damage prevented. But in practice, cost-benefit studies usually are not conducted for the ordinary urban storm drainage project. Judgement supported by records of performance in other similar areas is usually basis of selected frequency.

The range of rainfall frequency used in engineering practices is as follows:

1)For storm drains in residential areas, 2 to 15 years with 5 year most commonly reported.

2)For storm drains in commercial and high value areas, 10 to 50 years, depending on economic justifications.

3)For flood protection works, 50 years or more

In the analysis of point rainfall intensity-duration data, there are two approaches, the annual duration and partial-duration series. In the annual duration series, for each duration selected, the heaviest rainfall that occurred in each year is listed, with no tabulation of lesser intensities during the same calendar year, even though some of them might be greater than rainfall intensities that occurred in other years of record. The first of these methods gives the probability of occurrence that the maximum rainfall in anyone year for a specified duration will equal or exceed in given intensity. In the other treatment of the data, partial duration series, all rainfall intensities above a practical minimum for each duration for the entire period of record are included. The second method gives the frequency or the number of occurrences in a given period of time that a rainfall of given intensity and duration will be equal or exceeded.

Sherman has injected the concept of "extended duration" which has been used widely

and is recommended for developing rainfall intensity frequency data. In this method, if the total precipitation in a storm is sufficient to show significant average rates for periods longer than the actual duration of the rainfall, such storms are included in the data compilations as multiple events as though they had continued for the longer times. For example, a rainfall amount for an actual 50 min storm would be listed not only as a 50-min storm with its corresponding intensity, but also as a 60-min or 90-min, or longer duration storm with a corresponding lesser intensity.

Table - Empirical Factors for Converting Annual-Duration Series to Partial-Duration Series

Return Period (Years)	Multiplier
2	1.14
5	1.04
10	1.01

Time of Concentration - An estimate of the time of concentration to the point under consideration is made so that the average rainfall rate may be determined. For urban storm sewer the time of concentration consists of the inlet time plus the time of flow in the sewer from the most remote inlet to the point under consideration.

Time of flow in the sewer may be estimated closely from the hydraulic properties of the conduit. Inlet time is the overland flow time for runoff to reach established surface drainage channels such as street gutters and ditches and travel through them to the point of inlet.

Inlet time will vary with surface slope, nature of surplus cover, and length of path of surface flow, as well with the variables influenced by antecedent rainfall intensity and duration such as infiltration capacity.

3.5.3 RUNOFF COEFFICIENTS:

General Considerations.- The run coefficient, 'C' is the variable in rational method, which is least susceptible to precise determination. Its use in the formula implies a fixed ratio for any given drainage area, whereas, in reality, the coefficient accounts for

abstractions or losses between rainfall and runoff which may vary for a given drainage area as influenced by differing climatological and seasonal conditions.

These losses, together. with their order of magnitude as observed by various investigators include:

1)Interception by vegetation. This is not usually significant in urban drainage but may range from 0.01 to 0.5 in. (0.03 to 0.13 cm.) in forest areas, depending on type of cover.

2)Infiltration into permeable soils. The ability of a soil to absorb water and percolate it to deeper groundwater is affected by certain events before and during a given storm, such as compaction of the surface, in-washing of finer sediments, and swelling of clays or colloidal soils. The Hydrology Handbook gives the following range of value of infiltration capacity. !f various types of bare soils after 1 hr. of continuous rainfall.

Soil Group	Infiltration (In./hr.)
High (sandy, open structured)	0.50 to 1.00
Intermediate (loam)	0.10 to 0.50
Low (clay, dense structured)	0.01 to 0.10

Note: In. x 2.54 = cm.

The hand book also notes the profound influence of ground cover showing that bare-soil infiltration capacity can be increased from 3 to 7.5 times with good permanent forest or grass cover, ranging down. to little or no increase with poor row crops. Antecedent precipitation also affects soil infiltration capacity, but few quantitative data are available to evaluate this factor.

Retention in Surface Depressions.- The excess rainfall fills depressions essentially present in all surfaces. Retention in forest litter may be as much as 0.3 in. (0.08 cm.): in good pasture, 0.2 in. (0.05 cm.): and in smooth cultivated land, 0.05 to 0.10 in. (0.13 to 0:3 cm.). In urban areas of moderate grade, recent gauging shows retention to be

about 0.05 in. (0.13 cm.) for impervious surfaces. Retention has been assumed to be 0.10 in. (0.3 cm) for surfaces such as lawns and normal urban pervious surfaces.

Evaporation and Transpiration - These are of little significance for the short rainfall duration encountered in urban storm drainage design.

Average Coefficients.- The use of average coefficients for various surface types, which are assumed not to vary through the duration of the storm is common.

The range of coefficient, classified with respect to the general character of the tributary area reported in use is :

Description of Area	**Runoff coefficients**
Business	
Down Town	0.70 to 0.95
Neighbourhood	0.50 to 0.70
Residential	
Single Family	0.30 to 0.50
Multi-Units, detached	0.40 to 0.60
Multi-Units, attached	0.60 to 0.75
Residential (Suburban)	0.25 to 0.40
Apartment	0.50 to 0.70
Industrial	
Light	0.50 to 0.80
Heavy	0.60 to 0.90
Parks, Cemeteries	0.10 to 0.25
Playgrounds	0.20 to 0.35
Railroad yards	0.20 to 0.35
Unimproved lands	0.10 to 0.30

It often is desirable to develop a composite runoff coefficient based on the percentage of different types of surface in the drainage area. This procedure often is applied to typical "sample" blocks as a guide to selection of reasonable values of the coefficient for an entire area. Coefficients with respect to surface type currently in use are:

Character of Surface	Runoff Coefficients
Pavement	
Asphaltic and Concrete	0.70 to 0.95
Brick	0.70 to 0.85
Roofs	0.75 to 0.95
Lawns, sandy soil	
Flat, 2 percent	0.05 to 0.10
Average, 2 to 7 percent	0.10 to 0.15
Steep, 7 percent	0.15 to 0.20
Lawns, heavy soil	
Flat, 2 percent	0.13 to 0.17
Average, 2 to 7 percent	0.18 to 0.22
Steep, 7 percent	0.25 to 0.35

The coefficient in these two tabulations are applicable for storms of 5 to 10 years frequencies. Less frequent, higher intensity storms will require the use of higher coefficients because infiltration and other losses have a proportionally smaller effect on runoff. The coefficient based on the assumption that the designs storm does not occur when the ground surface is frozen.

3.6. APPLICATION OF RATIONAL METHOD:

After the items discussed in the proceeding sections have been determined or estimated, a tentative arrangement of the proposed system including the location of inlets is made to permit division of the whole drainage area into sub districts tributary to sections of the storm sewer system.

Coefficients are selected or estimated which are appropriate for the land use and development expected at the end of the period of design.

Rainfall frequency consistent with degree of protection desired is selected and intensity-duration curves for the locality are developed from available rainfall records or from such other data as may be available (6).

Many designers find it convenient to reduce the rainfall – intensity relationship to a family of curves of runoff for rainfall intensities of selected frequencies. Such curves indicate the product of the runoff coefficient and average rain intensity (18). Other designers suggest weighing the size of the areas to reflect the variation imperviousness of individual sub areas from the average imperviousness of the project area. The weighted area size then is applied to the runoff curve developed for the average degree of imperviousness.

3.7 PROCESSING OF RAINFALL DATA:

Estimation of storm run-off depends on many factors and is difficult to evaluate accurately. It however demands a study of rainfall data for the past few years with regard to intensity and duration of each spell etc. Indian Meteorological Department, (IMD) Bangalore was contacted to furnish the rainfall data and they made available rainfall data i.e. intensity and duration at 15 minutes intervals for the years 1976 to 2001 (25 years) and it was possible to carry out the analysis of the frequency of storms of stated intensities and durations. In general there are two approaches in the analysis of rainfall intensity - duration data viz., (1) Annual - duration. series and (2) Partial - duration series. In partial - duration series, all rainfall intensities above a practical minimum for each duration for the entire period of record are included and hence this series is adopted for the analysis with the concept of "extended duration" as recommended by American Society of Civil Engineers manual. Due to practical limitations IMD have not been able to give the amount of spells less than 15 minutes for longer duration of rainfalls i.e. for 5 and 10 minutes durations, having higher intensities. As this is an essential data, corresponding higher intensity rainfall for lesser duration of 5 and 10 minutes was computed, from the available heaviest rainfall. in 15 minutes. The occurrence values thus arrived at are plotted on a graph paper against the time duration for various intensities of rainfall viz. 15 mm/hr to 240 mm/hr., are plotted on graphs, and the line of best fit is drawn for each curve of Occurrence vs. Duration. From these lines of best fit marked in the graphs of each intensities, the frequency of storms for different stated duration are finally derived.

Table – 3.8 gives the analysis of the frequency of storms of stated intensities and duration during the past 25 years.

Table 3.9 Time intensity values of storms

Intensity (i) mm/hr.	Duration (t) in minutes				
	One year storm (i.e. 25 times)	Two year storm (i.e. 12.5 times)	Five year storm (i.e. 5 times)	Ten year storm (i.e. 2.5 times)	Twenty year storm (i.e.1.25 times)
15	123.75	202.50	-	-	-
20	101.25	155.63	202.50	-	-
25	65.63	106.88	165.00	217.50	236.25
30	51.00	77.50	120.00	187.50	206.25
35	39.38	69.38	112.50	157.50	176.25
40	30.00	57.50	97.50	127.50	146.25
50	23.75	55.86	75.00	108.75	118.13
60	-	34.39	67.50	92.50	98.75
70	-	16.00	30.00	48.75	58.13
80	-	-	24.00	37.50	51.63
90	-	-	18.75	28.00	41.25
100	-	-	-	18.75	28.13
120	-	-	-	-	-

The time intensity values for these frequencies are obtained by interpolation and given in Table 3.9, for storm occurring once a year, once in 2 year, once in 5 year, once in 10 year & once in 20 years.

A graph (Fig. 3.4 to 3.8) is plotted using the values of 'i' and 't' from Table-3.9 for once a year, once in two years and once in five years storms on a log-log paper. As per central Public Health and Environmental Engineering organisation (CPHEEO) manual guidelines, once a year frequency of storm is considered for central and comparatively high priced areas, for commercial areas once in two years frequency of storm is to be considered. In addition once in five years, ten year and twenty year frequency is also considered for checking, the adequacy of culverts and the adequacy of drain reach near flood prone areas.

The generalised formula adopted for intensity and duration is :

$$i = \frac{a}{t^n} \quad \text{------}$$

Where, i = intensity of rainfall in mm/hr

t = duration of storm in minutes

a,b,n = constants as appropriate

From the line of best fit marked in the graph (Fig. 3.4 to 3.8) the values of 'a' and 'n' are found out for one, two, five, ten and twenty year storms. From the plotted best fit line, values of 'a' and 'n' are obtained:

(i) a = 414.25 and n = 0.673 for storm once a year.
(ii) a = 511.91 and n = 0.6399 for storm once in two years,
(iii) a = 570.75 and n = 0.5987 for storm once in five years.
(iv) a = 568.72 and n = 0.5476 for storm once in ten years.
(v) a = 976.47 and n = 0.6442 for storm once in twenty years.

Now using the above equation and substituting, the values of 'a' and 'n' , different values of 'i' for various values of 't' are calculated and tabulated in Table 3.10.

TABLE – 3.10

Duration "t" in minutes	**Intensity (i) = a / t^n (mm/hour)**				
	One year storm	Two year storm	Five year storm	Ten year storm	Twenty year storm
	(i.e. 25 times)	(i.e. 12.5 times)	(i.e. 5 times)	(i.e. 2.5 times)	(i.e. 1.25 times)
	a = 414.25	a = 511.91	a = 570.75	a = 568.72	a = 976.47
	n = 0.673	n = 0.6399	n = 0.5989	n = 0.5474	n = 0.6442
5	140.23	182.78	217.69	235.66	346.24
10	87.96	117.30	143.73	161.25	221.54
15	66.95	90.49	112.74	129.15	170.62
20	55.17	75.28	94.90	110.34	141.75
25	47.47	65.26	83.03	97.65	122.77
30	41.99	58.07	74.44	88.37	109.17
45	31.96	44.80	58.39	70.78	84.07
60	26.34	37.27	49.15	60.47	69.85
75	22.66	32.31	43.00	53.52	60.50
90	20.05	28.75	38.55	48.43	53.79
105	18.07	26.05	35.15	44.51	48.71
120	16.52	23.92	32.45	41.38	44.69
135	15.26	22.18	30.24	38.79	41.43
150	14.22	20.74	28.39	36.62	38.71
165	13.33	19.51	26.82	34.76	36.40
180	12.57	18.45	25.45	33.14	34.42
195	11.91	17.53	24.26	31.72	32.69
210	11.33	16.72	23.21	30.46	31.17
225	10.82	16.00	22.27	29.33	29.81
240	10.36	15.35	21.43	28.31	28.60

A curve is plotted on an ordinary graph paper (Fig 3.9) and from this graph or from log-log paper (Fig. 3.4 to 3.8), value of intensity of storm for any given duration can be worked out for return period of one, two, five, ten and twenty years. .

Another graph (Fig.3.10), run-off coefficient 'c' vs duration time 't' is plotted as per : values given in Homer's table (Table 3.3, Pg. No. 45 of CPHEEO Manuel).

3.8 COMPUTATION OF STORM WATER RUN-OFF:

Quantity of storm water run-off is calculated using the rational formula:

$$Q = 10\ C.\ i\ .\ A.$$

Where, Q = run-off in m3/hr
c. = coefficient of run-off
i. = intensity of rainfall in mm/hr
A = area of drainage segment in hectares

Coefficient of run-off (c) is arrived at by interpolation of values given in Homer's table with respect to time of concentration (t_c) and for weighted imperviousness. Refer Graph (Fig. 3.10).

As per CPHEEO guide lines, the inlet time which depends on the distance of the farthest point in the drainage basin to the inlet drain, the shape, characteristics and topography of the basin and this may generally vary from 5 to 20 minutes. The inlet time in the present case will be the time taken for the storm water to flow through a network of roadside drains (roads parallel to the main drain and perpendicular to the main drain) till it reaches either a secondary drain or a primary drain. The range of velocities obtained for the secondary/primary drains considering the ground slope and the drain sections as per the existing uncleaned / silted condition of drain, works out to 0.5 to 4.5 m/sec. The mean velocity of flow in the primary drain for 0 to 1000 m distance for clean condition of drain and silted up condition of drain is found to be 5.2 m/sec and 3.4 m/sec respectively. Keeping this velocities in view, a velocity of flow of 1.2 m/sec for terrain and maximum of 5.2 m/sec in drain was chosen to estimate the time of flow (considering cleaned drain with moderate siltation / vegetation).

To arrive at a realistic time of concentration, surface flow velocity of rainwater is taken as 5.1 m/sec as stated above and the time of flow from the farthest point of the contributory area is worked out, The inlet time varying from 5 to 20 minutes depending on various factors**.** The time thus derived are used to compute design run-off of each segment.

The weighted imperviousness of the drainage area segment-wise, was worked out as stated in earlier section. Due to non-availability of 0.5 m. or 1.0 m. contour map, the entire tributary area has been divided into various segments with respect to the ridge line and flow patterns, using the area map developed from the satellite imagery.

The identification of roadside drains / feeder drains leading to primary or secondary drains and adequacy check of such drains is not under the scope of work. However, multiple number of small drains existing in reality by the side of roads in each segment of catchment area (to be drained into main valley) is assumed to be replaced by centrally placed storm drain.

Intensity of rainfall (i) is arrived from the Graphs (Fig. 3.4 to 3.8 or 3.9) with respect to time of concentration (t_c).

Area of each drainage segment for the entire watershed area has been arrived from the micro catchment area map enclosed in Section 3.3 of this chapter.

Quantity of storm water run-off, worked out segment-wise are furnished for Koramangala main valley and Tavarekere valley in Table 4.1 & 4.2 is as enclosed in the section 4.2 of Chapter - 4 in this report.

CHAPTER - 4

REVIEW OF ASSESSMENT AND RECOMMENDATIONS ON EXISTING STORM WATER DRAINAGE SYSTEM

4.1 INTRODUCTION:

This chapter on review of assessment has been prepared to identify the reasons for the failure of the system components, during the recent years. Depending on the nature and extent of the system failure, the approach for improving the carrying capacity and rehabilitation methodologies vary accordingly. Therefore a generic groupings of approach and methodologies in achieving the objective and proper functionality of the system for different applications are needed.

To identify and prioritise rehabilitation needs, a systematic approach in planning and investigation of most problematic areas is much needed and this will intern involve, establishment of guidelines to observe the system performance and levels of service offered etc., from which decisions can be consistently based.

As the implementation of a systematic approach to planning and investigation involve significant resource commitments, both in personnel and financial terms, it is proposed that the BMP progressively improve towards achieving this long-term objective.

Further, Improvements to the existing storm drainage system, which is serving the core area is considered to be on priority for five key reasons:

- To rectify current localised flooding problems in the critical low lying areas.
- To cope with additional areas being included into the BMP administered area.
- To improve and extend the security of services in vulnerable areas of the current BMP administered area.
- To improve and protect the quality of environmental attributes including aesthetic appearance of city's environs.
- To minimise cost implication on operation and maintenance of the system.

4.2 REPORT ON ADEQUACY ANALYSIS OF EXISTING SYSTEM:

An assessment of the existing system for its adequacy has been made using computer

modelling. The adequacy of the existing system has been analysed and correlated for different year return periods.

Further, these analysis results have been once again correlated with the situation and specific site condition to verify the accuracy of the results and to suggest the strategic improvements required at that particular location.

The focus of this section is solely on

•Storm drains
•Cross drains

➢**Storm Water Drains:**

The total catchment area of the Koramangala valley is 3548 Ha. The localities which contribute and the existing condition of these drains is detailed in Section 2.3 & Section 2.6 of Chapter 2.

Cross section data of the existing drains at every 25 m. apart was collected and computer models & spread sheets were developed to analyse for their carrying capacity. The analysis has been done for different year return periods. The calculations and results of these analysis is enclosed in Table 4.1 A(existing unclean condition) 4.1 B (existing clean condition) & 4.1 C (Proposed clean condition) for storm drains in Koramangala main valley & Table 4.2 A (existing unclean condition) 4.2 B (existing clean condition) & 4.2 C (Proposed clean condition) for storm drains in Tavarekere valley.

These tables show the discharge (Q) in the existing drain at that particular chainage. The procedure adopted to work out the required data are furnished below.

1.Drain bed levels on either side of the existing drain differ marginally and hence the average of these levels are considered for computation.

2.Drain wall top levels of the existing drain also differ and hence the lower wall level /

lowest ground level heights are considered for the depth of the drain.

3.Free board is taken as 300 mm. for one and two year storms and 100 mm. for five, ten & twenty year storms.

4.Coefficient of roughness (n) considered as 0.035 for unclean conditions and 0.025 for clean conditions respectively for the analysis of existing drains and 0.02 – 0.025 for remodelled drain.

5.Design runoff (Q required) are worked out for respective chainages based on the runoff calculated segment wise.

From the analysis and the assessment carried out, following outcomes are highlighted (Existing unclean condition):

➔Koramangala Main Valley:

- Near Upparpete, Chickpete, Akkipete & Culthanpete area the existing storm drain is having a larger catchment area, more paved, less time of concentration, drain depth and width is very less, gentle slope is available, severely silted, max. obstructions and also drain walls are in moderate condition. Hence the drain capacity is adequate only for one year return period.

- Near Avenue Road, K. R. Market, Kalasipalya & Bamboo bazar the existing storm drain is having a larger catchment area, more paved, less time of concentration, drain depth and width is very less, shallow depth, moderate bed slope is available, silted, bed is in natural condition, number of obstructions and also drain walls are in moderate condition. The drain capacity is adequate only for one year return period.

- Near J.C. Road, Sudhamanagar & Journalist Colony the existing storm drain is having a larger and dense built up catchment area, less time of concentration, drain width is comparatively less, shallow depth, very flat bed slope is available, silted, bed is in natural condition, max. obstructions and also drain walls are in

moderate condition. The drain capacity in this stretch is very inadequate.

- Near Lalbagh Road, Sampanigiramnagar, Annipura & K.H. Road the existing storm drain is having a larger and dense built up catchment area, less time of concentration, sufficient drain width and depth, moderate bed slope is available, silted, bed is in natural condition, min. obstructions and also drain walls are in moderate condition. The drain capacity is adequate for two year return period.

- Near K.S.R.T.C. Bus Depot & Wilson Garden area the existing storm drain is having a wider catchment area, less time of concentration, sufficient drain width and depth except near 9th Cross Wilson Garden, very flat bed slope is available, silted, bed is in natural condition, min. obstructions and also drain walls are in moderate condition. The drain is adequate for only one year return period.

- Near Vinayakanagar & Pothalappa Garden the existing storm drain is having a comparatively wider and dense builtup catchment area, less time of concentration, sufficient drain width and depth except at few places width gets reduced, very flat bed slope is available, silted, bed is in natural condition, min. obstructions and also drain walls are in moderate condition. The drain capacity is very inadequate.

- Near Hosur Road, Adugodi the existing storm drain is having a lesser catchment area, less paved area, more time of concentration, sufficient drain width and depth, moderate bed slope is available, silted, bed is in natural condition, max. obstructions, and also drain walls are in moderate condition. The drain capacity is adequate for two year return period.

- Near L.R. Nagar Slum the existing storm drain is having a wider catchment area, less paved, more time of concentration, drain width and depth is drastically reduced at few location, moderate bed slope is available, silted, and also drain is in natural condition, min. obstructions. The drain capacity is adequate for one year return period.

- Near National Games Village the existing storm drain is having a wider catchment

area, less paved area, more time of concentration, drain width and depth is drastically reduced, moderate bed slope is available, silted, and also drain is in natural condition, min. obstructions. The drain capacity is very inadequate.

- Near Ring Road the existing storm drain is having a wider catchment area, more paved area, less time of concentration, drain width and depth is drastically reduced, moderate bed slope is available, silted, and also drain is in natural condition, min. obstructions. The drain capacity is very inadequate.

- Near Koramangala Layout the existing storm drain is having a wider catchment area, more paved area, less time of concentration, drain width and depth is drastically reduced, very flat bed slope is available, silted, and also drain walls are in moderate condition, max. obstructions. The drain capacity is very inadequate.

- Near S.T. Bed Layout & Jakkasandra the existing storm drain is having a wider catchment area, more paved area, less time of concentration, drain width and depth is drastically reduced, very flat bed slope is available, silted, and also drain walls are in moderate condition, max. obstructions. The drain capacity is very inadequate.

➔Tavarekere Valley:

- Near NIMHANS hospital the existing storm drain is having a smaller catchment area, more open space, more time of concentration, sufficient drain width and depth, good bed slope is available, moderately silted, bed is in natural condition, few obstructions. The drain capacity is adequate for twenty year return period.
- Near Fire service college the existing storm drain is having a smaller catchment area, less time of concentration, drain width and depth is reduced, moderate bed slope is available, silted, bed is in natural condition, few obstructions and also drain walls are in good condition. The drain capacity is adequate for only one year return period.

- Near Bismillahanagar the existing storm drain is having a comparatively larger and dense builtup catchment area, less time of concentration, drain width and depth is drastically reduced at few places, moderate bed slope is available, silted, bed

is in natural condition, more obstructions and also drain walls are in moderate condition. The drain capacity is very inadequate.

- Near Tavarekere & Chikka Madivala the existing storm drain is having a moderately larger and dense builtup catchment area, less time of concentration, sufficient drain width and depth, flat bed slope, silted, bed is in natural condition, few obstructions and also drain walls are in moderate condition. The drain capacity is adequate for two year return period.

- Near central silk board the existing storm drain is having a moderately larger catchment area, less time of concentration, drain width and depth is slightly reduced, moderate bed slope is available, silted, bed is in natural condition, max. obstructions and also drain walls are in moderate condition. The drain capacity is adequate for one year return period.

- Near H.S.R. layout the existing storm drain is having a larger catchment area, less time of concentration, drain width and depth is reduced at few places, very flat bed slope, silted, bed is in natural condition, less obstructions and also drain walls are in moderate condition. The drain capacity is adequate for two year return period.

- Near Agara tank the existing storm drain is having a larger catchment area with more open space, more time of concentration, sufficient drain width and depth, moderate bed slope, silted, bed is in natural condition, less obstructions and also drain walls are in good condition. The drain capacity is adequate for two year return period.

- Near J.P. Nagar the existing storm drain is having a larger catchment area with more open space, more time of concentration, sufficient drain width and depth, moderate bed slope, silted, bed is in natural condition, less obstructions and also drain walls are in moderate condition. The drain capacity is adequate for two year return period.

- Near Madivala Tank the existing storm drain is having a larger catchment area with more open space, more time of concentration, drain width and depth is

drastically reduced, moderate bed slope, silted, drain is in natural condition. The drain capacity is inadequate.

➢**Cross Drains:**

Existing culverts based on their structural conditions, no. of vents, no. of utilities laid across SWD at the culvert location which in turn causing obstruction for free flow of water were identified during reconnaissance survey and further analysed for their carrying capacity.

Table 4.3 & 4.4 shows the carrying capacity (Q) near the culverts along with all other data required to derive the same. The procedure adopted to workout the required data are furnished below:

1.Adequacy check is carried out under clean condition only, since the drains on either side of the culvert are presumed to be free of silt and vegetation to achieve optimum carrying capacity.

2.Dimensions shown in the table is the existing dimensions and the vent way considered is actually collected from site, and accordingly vent way has been worked out.

3.Bed levels at culvert location could not be measured due to flow of water. The bed slope in the direction of flow is assumed as 1 in 500 (0.002), which may produce a reasonable velocity of flow through the vent way to prevent deposition of silt and scouring action.

4.Free board is taken as 0.1 m. for one, two, five,ten & twenty year storms.

5.The percentage area reduction at the vent way of the culvert with reference to the upstream side drain area are worked out for reference and guidance.

6.Coefficient of roughness(n) is considered as 0.02 (Clean condition) & 0.035 (Unclean condition).

7.Design runoff are worked out based on the runoff calculated for the drain segment

both upstream and down stream side (near the culvert locations) for the length of about 100 m.

The remarks column of these tables, indicates the existing culvert which are inadequate to carry the design runoff and such culverts are found to be very few. The culverts which are considered to be inadequate were jointly site inspected with BMP officials and various options were explored to increase the carrying capacity before deciding for remodelling.

The existing culvert in Koramangala main valley & Tavarekere valley which are considered to be inadequate are listed in Table – 4.5

The inspection details of these existing culverts/bridges is enclosed in Volume 2 - Condition Survey.

Based on the assessment, 20 culverts which were in moderate condition and drastically obstructing the flow, has been shortlisted and considered for reconstruction. Out of 20 culverts 2 culverts i.e., near Austin town & J.P. Nagar Dollars Colony are newely proposed, based on BMP requirements and also for about 6 culverts, rehabilitation works like provision of hand rails etc., has been proposed.

The detailed designs and estimates of these culverts / bridges is enclosed in Volume 3 and relevant drawings in Volume 4. The list of culverts / bridges proposed for reconstruction is as listed below and the same is depicted in Figure 4.1.

Table - 4.5 List of Culverts / Bridges Considered for Reconstruction in Koramangala Valley

Sl. No.	Culvert No.	Chainage (m.)	Location	Remarks
Koramangala Valley Primary Storm Drain (K100) :				
1	KMC - 6	3500	Kengal Hanumanthaiah Road	Ex. Culvert/Bridge considered for remodelling
2	KMC – 9	4950	Bannerughatta Road, Near Vinayakanagar	Ex. Culvert/Bridge considered for remodelling
Austin Town Secondary Storm Drain (K103) :				
1	KMS-7 C3	1690	Airport Road (Palm grove Road)	Ex. Culvert/Bridge considered for remodelling
2	KMS-7 C7	2316	Old Race Course Road	Ex. Culvert/Bridge considered for remodelling
3	N - 1	2765	Austin Town, near BDA / Mecon Qtrs.	Proposed New Bridge
Kalasipalya Secondary Storm Drain (K112) :				
1	KMS-1 C1	175	Mavalli Tank Bund Road	Ex. Culvert/Bridge considered for remodelling
2	KMS-1 C3	450	Journalist Colony, 5th Cross Road	Ex. Culvert/Bridge considered for remodelling
3	KMS-1 C4	525	Journalist Colony, 4th Cross Road	Ex. Culvert/Bridge considered for remodelling
4	KMS-1 C5	575	Journalist Colony, 3rd Cross Road	Ex. Culvert/Bridge considered for remodelling
5	KMS-1 C6	635	Journalist Colony, 2nd Cross Road	Ex. Culvert/Bridge considered for remodelling
6	KMS-1 C7	700	Journalist Colony, 1st Cross Road	Ex. Culvert/Bridge considered for remodelling
Tavarekere Valley Primary Storm Drain (K200) :				
1	KMC-2 C7	2015	Bismillahanagar	Ex. Culvert/Bridge considered for remodelling
2	KMC-2 C17	3225	Maruthinagar, Near Madivala	Ex. Culvert/Bridge considered for remodelling
Madivala Secondary Storm Drain (K204) :				
1	KM2S4- C1	0	Near Madivala	Ex. Culvert/Bridge considered for remodelling
2	KM2S4- C2	214	Near B.T.M. Layout	Ex. Culvert/Bridge considered for remodelling
3	KM2S4- C3	260	35th Main Road, Near B.T.M. Layout	Ex. Culvert/Bridge considered for remodelling
4	KM2S4- C4	410	38th Main Road, Near B.T.M. Layout	Ex. Culvert/Bridge considered for remodelling
Tavarekere Secondary Storm Drain (K205) :				
1	KM2S3- C2	175	Tavarekere	Ex. Culvert/Bridge considered for remodelling
Guruppanapalya Secondary Storm Drain (K206) :				
1	KM2S2- C5	1119	Near Bapujinagar	Ex. Culvert/Bridge considered for remodelling
J.P. Nagar Secondary Storm Drain (K209) :				
1	N -2	1775	3rd Cross, J.P. Nagar Dollars Colony	Proposed New Bridge

Table - 4.6 List of Culverts / Bridges Considered for Providing Rehabilitation in Koramangala Valley

Improvements to Existing Culverts / Bridges				
Sl. No.	**Culvert No.**	**Chainage (m.)**	**Location**	**Remarks**
Koramangala Valley Primary Storm Drain (K100) :				
1	KMC - 5	3030	2nd Cross, Sudhamanagar	Provision of handrails / Parapet wall
Tavarekere Valley Primary Storm Drain (K200):				
1	KMC2-C8	2075	Bismillahanagar	Provision of handrails / Parapet wall
2	KMC2-C9	2109	Bismillahanagar	Provision of handrails / Parapet wall
3	KMC2-C10	2126	Bismillahanagar	Provision of handrails / Parapet wall
4	KMC2-C11	2163	Bismillahanagar	Provision of handrails / Parapet wall
5	KMC2-C12	2188	Bismillahanagar	Provision of handrails / Parapet wall
Guruppanapalya Secondary Storm Drain (K206) :				
1	KM2S2- C2	525	Near Bapujinagar	Provision of handrails / Parapet wall
2	KM2S2- C3	-	Near Bapujinagar	Provision of handrails / Parapet wall

4.3 STRATEGIC ACTIONS AND RECOMMENDATIONS:

➢KORAMANGALA MAIN VALLEY:

•The existing drain near Upparpet, Akkipet, Mamulpet, & Sulthanpet upto K.R. Market is almost covered, which needs to be opened at regular intervals, desilted and steel gratings has to be provided at all the road crossings.

•Tertiary drains at some strategic locations i.e., near Upparpet, Akkipet, Mamulpet, & Sulthanpet upto K.R. Market needs to be desilted and regarded to match with the new drain bed level.

•Since, the existing drain passes through dense built up and highly commercial area, large quantity of solid waste that is noticed inside the drain needs to be cleaned very frequently.

•The covered reach of drain needs to be opened, desilted and widened near Sourastrapete.

•The drain reach near N.R. Road needs to be desilted and steel gratings to be provided at regular interval.

- Large quantity of sewage i.e., discharged from commercial establishments near Kalasipalya needs to be stopped immediately.

- Existing tertiary drain network in Bamboo bazar area needs to be desilted and remodeled to match the new drain bed level.

- The existing drain reach near Kalasipalya (Bamboo bazar) needs to widened and new wall to be constructed.

- All openings made to the drain wall needs to be closed in this region to avoid back flow of water.

- Large number of utility lines noticed under the stair case of commercial building near 1st Main J.C. Road needs to be relocated.

- The drain reach near J.C. Road is totally covered, which needs to be opened at regular interval and desilted.

- Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management near Kalasipalya, J.C. Road & Sudhamanagar.

- The public toilet block noticed near Sudhamanagar needs to be relocated.

- Existing tertiary drain network in Sudhamanagar area needs to be desilted and remodeled to match the new drain bed level.

- The vent way of the existing culvert across Lalbagh road needs to be desilted.

- The existing drain reach near Annipura needs to widened and new wall to be constructed on right hand side.

- All openings made to the drain wall needs to be closed in this region to avoid back flow of water.

- The utility lines noticed near K.H. Road culvert location to be relocated and also the existing culvert with multiple spans needs to be reconstructed with single span.

- Large quantity of silt accumulation and vegetation growth noticed near K.S.R.T.C. workshop needs to be cleaned.

- Sewerage system and solid waste management system in this area needs to be improved.

- Rehabilitation works to the drain walls, to be provided near Vinayakanagar.

- Existing tertiary drain network in Vinayakanagar & Pothalappa garden area needs to be desilted and remodeled to match with the new drain bed level.

- The existing culverts with multiple spans constructed across storm drain at Bannerghatta road needs to be reconstructed.

- Caution boards and sign boards needs to be displayed near Vinayakanagar & Pothalappa garden to create awareness among people about storm drain and its management.

- The existing service road on right hand side has been encroached and residential buildings have been constructed near Hosur Road, which needs to be cleared and service road to be restored for maintenance of drain.

- Service lines noticed near the Hosur Road & Bannerghatta Road culvert locations needs to be relocated.

- Solid waste management in this region needs to be improved.

- All openings made to the drain wall needs to be closed in this region to avoid back flow of water.

- The drain reach near Lakshman Rao Nagar slum is in natural condition, it needs to be widened, alignment of drain to be slightly altered and stone pitching to be provided on both sides.

- The sewage flow noticed from adjoining Annepalya layout & L.R. Nagar slum needs to be stopped immediately.

- The drain reach i.e., down stream of Viveknagar bridge is in natural condition, it needs to be widened, alignment of drain to be slightly altered and new wall to be constructed on both sides.

- The sewage flow noticed from adjoining Ejipura layout & Indira Gandhi slum needs to be stopped immediately.

- The covered reach of drain behind National Games Village needs to be desilted.

- The drain reach on left side, behind National Games Village is in natural condition, it needs to be widened and new wall to be constructed.

- The drain reach behind BMTC Bus depot is in natural condition, it needs to be widened, alignment of drain to be slightly altered and new walls to be constructed on both sides.

- The drain reach behind Everest High School upto Inner Ring Road is in natural condition, it needs to be widened, alignment of drain to be slightly altered and new walls to be constructed on both sides.

- The drain reach down stream of Inner Ring Road is in natural condition, it needs to be widened and new walls to be constructed on both sides.

- Existing tertiary drain network in Ejipura, S.T. Bed, Koramangala Layout & Jakkasandra area needs to be desilted and remodeled to match the new drain bed level.

- The drain reach near ST bed layout needs to be desilted and minor rehabilitation works to the drain wall to be provided.

- Approach bridges constructed by private apartment owners with multiple spans need to be replaced with single span.

•Service lines laid across storm drain by private apartment needs to be relocated.

•From Koramanagala Layout, the existing drain to be widened, alignment needs to be slightly altered upto Bellandur tank and stone revetment has to be provided.

•Encroachment / Development of land near the tank bed needs to be prevented.

•Provision for future drain requirement and also for service roads needs to be demarcated.

➢**KORAMANGALA MAIN VALLEY SECONDARY STORM DRAINS:**

➢**Koramangala Layout - I drain - K101:**

•The existing closed drain near Koramangala Layout needs to opened at regular interval, desilt and steel gratings needs to be provided at regular intervals.

•Existing drain reach near Ejipura church road bridge needs to be widened and new wall to be constructed on right side.

•Minor rehabilitation works needs to be provided at open drain locations.

•Existing tertiary drain network needs to desilted and regraded to match with the new drain bed level.

➢**Koramangala Layout - 2 drain - K102:**

•The existing closed drain near Jyothi Nivas college needs to opened at regular interval, desilt and steel gratings needs to be provided at regular intervals.

•Minor rehabilitation works needs to be provided at open drain locations.

•Existing tertiary drain network needs to desilted and regraded to match with the new drain bed level.

➢**Austin Town drain – K103:**

•The existing closed drain near Shoppers stop commercial complex needs to opened at regular interval, desilt and steel gratings needs to be provided at regular intervals.

•Drain reach near Kendriya Vidayalaya needs to be widened on right hand side and new wall to be constructed.

•Existing culvert constructed across SWD near Victoria road needs to be replaced with single span culvert.

•The existing closed drain noticed near Palm grove road, Austin town needs to opened at regular interval, desilt and steel gratings needs to be provided at regular intervals.

•Drain reach near K.P.T.C.L office needs to be widened on left side and new wall to be constructed.

•After drain desilting drain bed protection needs to be provided for full length & width.

•Existing sewer pipe line and manholes noticed near Rose garden needs to be lowered.

•Openings made to the drain walls needs to be closed.

•Existing tertiary drain network needs to desilted and regraded to match with the new drain bed level.

•Minor rehabilitation works to be attended and bed protection to be provided.

➢**Laksandra drain – K104:**

•Existing drain needs to be widened on left side and new wall to be constructed near Pukraj layout.

•The existing closed drain near MICO factory complex needs to opened at regular interval, desilt and steel gratings needs to be provided at regular intervals.

•Drain reach near N.D.R.I. needs to be widened on left side and new wall to be constructed.

•After drain desilting drain bed protection needs to be provided for full length & width.

•Openings made to the drain walls needs to be closed.

•Existing tertiary drain network needs to desilted and regraded to match with the new drain bed level.

•Minor rehabilitation works to be attended and bed protection to be provided.

➢**Lakshamma garden drain – K107:**

•The existing closed drain near Langford town needs to opened at regular interval, desilt and steel gratings needs to be provided at regular intervals.

•Existing tertiary drain network needs to desilted and regraded to match with the new drain bed level.

➢**Siddapura drain – K108:**

•Dumping of vegetation droppings near Someshwara nagar by private horticulture nursery's needs to be prevented immediately.

•Drain reach near Marigowda layout needs to be widened on right side and new wall to be constructed.

•The existing closed drain near Hombegowdanagar girls high school needs to opened at regular interval, desilt and steel gratings needs to be provided at regular intervals.

•Drain reach near Wilson garden needs to be widened on right side and new wall to be constructed and further it needs to be covered by RCC slab..

•After drain desilting drain bed protection needs to be provided for full length & width.

•Openings made to the drain walls needs to be closed.

•Existing tertiary drain network needs to desilted and regraded to match with the new drain bed level.

•Minor rehabilitation works to be attended.

•Utility lines noticed near Wilson garden needs to be relocated.

•Sewerage system needs to extended to entire locality near Venkatareddy layout.

➢**Raja Ram Roy Extn. drain – K109:**

•Existing drain needs to be widened on both side and new wall to be constructed near Sampangiramnagar.

•The existing closed drain near Bangalore Institute of Oncology needs to opened at regular interval, desilt and steel gratings needs to be provided at regular intervals.

•Openings made to the drain walls needs to be closed.

•Existing tertiary drain network needs to desilted and regraded to match with the new drain bed level.

➢**Lalbagh Secondary drain – K110:**

•Existing drain needs to be widened on left side and new wall to be constructed near labour commissioners office at Sudhamanagar.

•The existing closed drain near Hosur Road needs to opened at regular interval, desilt and steel gratings needs to be provided at regular intervals.

•After drain desilting drain bed protection needs to be provided for full length & width.

•Openings made to the drain walls needs to be closed.

•Existing tertiary drain network needs to desilted and regraded to match with the new drain bed level.

•Minor rehabilitation works to be attended.

➢**Jayanagar Secondary drain – K111:**

•The existing closed drain near Vijaya College & R.V. Road needs to opened at regular interval, desilt and steel gratings needs to be provided at regular intervals.

•Existing tertiary drain network needs to desilted and regraded to match with the new drain bed level.

➢**Kalasipalya Secondary drain – K112:**

•Existing drain reach needs to desilted.

•Utility lines noticed at the culvert location near Kalasipalya cross roads & A.M. Road needs to relocated.

•Existing culvert noticed near Kalasipalya cross roads & A.M. Road needs to replaced with single span box culverts.

•After drain desilting drain bed protection needs to be provided for full length & width.

•Openings made to the drain walls needs to be closed.

•Existing tertiary drain network needs to desilted and regraded to match with the new drain bed level.

•Minor rehabilitation works to be attended.

➢**Rajendranagar Secondary drain – K113:**

•Existing drain reach needs to desilted.

•Drain reach near Muneshwara temple which is natural condition needs to widened on both sides and new wall to be constructed on both sides.

•After drain desilting drain bed protection needs to be provided for full length & width.

•Openings made to the drain walls needs to be closed.

•Existing tertiary drain network needs to desilted and regraded to match with the new drain bed level.

•Minor rehabilitation works to be attended.

➢**Akkithimmanahalli Secondary drain – K114:**

•Existing covered drain reach needs to opened at regular interval and desilted. Further steel grating needs to be provided at regular interval

•Manholes constructed inside the drain needs to be relocated.

•After drain desilting drain bed protection needs to be provided for full length & width.

•Openings made to the drain walls needs to be closed.

•Existing tertiary drain network needs to desilted and regraded to match with the new drain bed level.

•Minor rehabilitation works to be attended.

➢**TAVAREKERE VALLEY:**

•Drain reach near Bairasandra & Mundukar fire service college needs to be desilted and widened.

•Dumping of debris inside the storm drain needs to be avoided.

•Sewer pipelines and manholes that are constructed inside the drainage channel near Saduguntepalya needs to be relocated.

- Drain reach near Bismillahanagar is in natural condition, at few locations new wall to be constructed on both side.

- New RCC box drain has to be constructed at Saduguntepalya upto Bismillahanagar and which act as a bypass drain.

- Existing tertiary drain network in Bismillahanagar area needs to be desilted and remodeled to match with the new drain bed level.

- Drain width near Lakshmi theater is very narrow, it needs to be widened and new wall to be constructed.

- Drain width near Tavarekere is very narrow, it needs to be widened and new wall to be constructed.

- Liquid wastes that is being directly discharged into storm drains from dyeing industries in Tavarekere needs to be prevented.

- Caution boards and sign boards needs to be displayed near Bismillahanagar & Tavarekere area to create awareness among people about storm drain and its management.

- Solid waste management in this region needs to be improved.

- K.P.T.C.L. transformer that is installed near Lakshmi theater needs to be relocated and drain has to be widened.
- Parapet walls to be constructed for the existing culverts near Bismillahanagar.

- The drain reach near KPN travels depot in Kuvempunagar area is very inadequate, and it needs to be widened and new wall to be constructed.

- Solidwaste management system near Maruthinagar, Chikka Madivala needs to be improved.

- Existing sewerage system in Bismillahanagar and its adjoining areas has to be

extended to the entire locality and also it has to be ensured that all the houses are connected to the system.

•The existing bridge near central silk board junction flyover opposite to WIPRO needs to be remodelled.

•Minor rehabilitation works to be provided to the existing drain wall near HSR layout.

•The drain reach near HSR layout needs to be desilted.

•The drain reach near Jakasandra (beyond Sarjapur road) is in natural condition, it needs to be widened and alignment of drain needs to be slightly altered upto Bellandur tank.

➢**TAVAREKERE VALLEY SECONDARY STORM DRAINS:**

➢**Vanaganahalli Secondary drain – K201:**

•Existing drain reach needs to desilted.

•Large quantity of vegetal growth noticed inside storm drain near HSR layout needs to be cleared immediately.

•After drain desilting drain bed protection needs to be provided for full length & width.

•Openings made to the drain walls needs to be closed.

•Existing tertiary drain network needs to desilted and regraded to match with the new drain bed level.

•Minor rehabilitation works to be attended.

➢**Yellukunte Secondary drain – K202:**

•Existing drain reach needs to desilted.

•After drain desilting drain bed protection needs to be provided for full length & width.

•Openings made to the drain walls needs to be closed.

•Existing tertiary drain network needs to desilted and regraded to match with the new drain bed level.

•Minor rehabilitation works to be attended.

➢**H.S.R. Layout Secondary drain – K203:**

•Existing drain reach needs to desilted.

•Drain width needs to be widened on left side near H.S.R. Layot sector VI.

•After drain desilting drain bed protection needs to be provided for full length & width.

•Openings made to the drain walls needs to be closed.

•Existing tertiary drain network needs to desilted and regraded to match with the new drain bed level.

•Minor rehabilitation works to be attended.

➢**Madivala Secondary drain – K204:**

•Existing drain reach needs to desilted.

•RCC hume pipe culverts noticed near B.T.M. layout bus stop needs to be replaced with single span RCC box culvert.

•After drain desilting drain bed protection needs to be provided for full length & width.

•Openings made to the drain walls needs to be closed.

•Existing tertiary drain network needs to desilted and regraded to match with the new

drain bed level.

•Minor rehabilitation works to be attended.

➢**Tavarekere Secondary drain – K205:**

•Existing drain reach needs to desilted.

•After drain desilting drain bed protection needs to be provided for full length & width.

•Openings made to the drain walls needs to be closed.

•Existing tertiary drain network needs to desilted and regraded to match with the new drain bed level.

•Minor rehabilitation works to be attended.

➢**Guruppanapalya Secondary drain – K206:**

•Existing drain reach needs to desilted.

•Drain reach near Urs colony needs to be widened on right side and new wall to be constructed.

•After drain desilting drain bed protection needs to be provided for full length & width.

•Openings made to the drain walls needs to be closed.

•Existing tertiary drain network needs to desilted and regraded to match with the new drain bed level.

•Minor rehabilitation works to be attended.

➢**Krishnappa Garden Secondary drain – K207:**

•Existing drain reach needs to desilted.

•Existing covered drain near Krishnappa garden needs to be opened at regular interval, desilted and steel grating needs to be provided at regular interval.

•After drain desilting drain bed protection needs to be provided for full length & width.

•Drain reach near Bairasandra tank is in natural condition, drain alignment to be slightly altered and widened on left side and new wall to be constructed on both side.

•Existing tertiary drain network needs to desilted and regraded to match with the new drain bed level.

•Minor rehabilitation works to be attended.

➢**Law college Secondary drain – K208:**

•Existing drain reach needs to desilted.

•After drain desilting drain bed protection needs to be provided for full length & width.

•Openings made to the drain walls near Tilaknagar needs to be closed.

•Existing tertiary drain network needs to desilted and regraded to match with the new drain bed level.

•Minor rehabilitation works to be attended.

➢**J.P. Nagar Secondary drain – K209:**

•Existing drain reach needs to desilted.

•After drain desilting drain bed protection needs to be provided for full length & width.

•Openings made to the drain walls needs to be closed.

•Existing tertiary drain network needs to desilted and regraded to match with the new drain bed level.

•Minor rehabilitation works to be attended.

•Dense vegetation growth noticed near Madivala tank bed needs to cleared immediately.

•Drain reach near Madivala tank, Kodichikkanahalli, Bannerghatta road is in natural condition needs to be widened on both sides and stone revetment needs to be provided on both sides.

•Service road needs to be formed.

•Sewerage system needs to be extended for the entire locality near NGR layout in C.M.C. Area.

•Drain reach near Rupena Agrahara needs to be altered and new wall to be constructed on both side.

•Drain reach adjoining NH 7 needs to widened and new wall to be constructed on right side.

➢**Puttanahalli Secondary drain – K210:**

•Existing drain reach needs to desilted.

•Large quantity of vegetal growth noticed inside storm drain near J.P. nagar needs to be cleared immediately.

•After drain desilting drain bed protection needs to be provided for full length & width.

•Openings made to the drain walls needs to be closed.

•Existing tertiary drain network needs to desilted and regraded to match with the new drain bed level.

•Minor rehabilitation works to be attended.

4.4 MITIGATIVE MEASURES FOR LOW LYING AREAS:

4.4.1 L.I.C. Colony & Krishnappa Garden

Mitigative Measures

- Road side drain water from Krishnappa garden needs to be collected on eastern side of R.B.I. Colony and then be rerouted through Byrasandra tank (Forest area covered drain).

- Drain wall needs to be constructed for the portion of drain, which is in natural condition to channelise the flow of water, with proper bed protection.

- Large quantity of debris noticed inside the water coarse area near the tank needs to be removed for easy flow of water

- The drain reach near the joining point of K207 and K2 is to be widened by acquiring land from Fire Service Training College.

4.4.2 Sampangiramnagar :

Mitigative Measures

- In the covered reach of drain, prefabricated steel gratings and inspection opening needs to be installed at regular interval for surface runoff water to enter into storm drain & desilting.

- The alignment of existing should be slightly altered, drain should be re-routed and an RCC box drain needs to be constructed through Ist Cross Srinivas Colony, which intern avoids the 90 degrees turning noticed near the residential building and also the the existing drain near Sampangiram Nagar 4th Main width becomes adequate

to cater for upstream flow.

4.4.3 Shanthinagar:

Mitigative Measures

- The existing sewer line noticed to be re-routed & manhole to be lowered upto the bed level.
- Supporting arrangement for covered drains to be investigated and intermediate supports, if any, should be dismantled and covering slabs to be supported only on drain side walls.
- In the covered reach of drain, prefabricated steel gratings and inspection opening needs to be installed at regular interval for surface runoff water to enter into storm drain & desilting.
- Portion of existing drain needs to be re-routed at Lakshmi Road bridge location towards the 4th cross and further it has to be taken in 4th cross road, by widening the existing road side drain upto B.M.T.C. compound wall, and further the existing drain needs to be desilted upto primary drain location.

4.4.4 Bismillahanagar:

Mitigative Measures

- The vent size of existing culverts constructed across storm drain near Bismillahnagar and Balajinagar to be improved.
- The drain width should be increased by demolishing unauthorized constructions.
- Bed protection to be provided for the entire length of drain in this region for smooth flow of water.
- RCC box drain should be constructed in front of christ school to divert peak runoff

water.

4.4.5 BTM Layout & Dollars Colony, Near Central Silk Board:

Mitigative Measures

- The existing culvert at central silk board junction across the ring road and Hosur road needs to be remodeled.

- Bypass drain directly connecting to the drain on H.S.R. Layout side ring road should be constructed, which will intern reduce the risk of overflow of drain into Dollars colony layout.

- A peripheral drain of length of around 800 m along the 20th Main Road, BTM layout shall be constructed to prevent the outside water entering the area.

- Emergency squad, equipped with truck mounted pumping arrangement and standby power generator should be readily made available during rainy season, to evacuate the water from the intake well / lowest point and discharge it to outside main drain.

4.4.6 Siddapura & Wilson Garden (Ward No. 61)

Mitigative Measures:

- The covered portion of existing SWD from Hombegowdanagar girls junior college upto a location where this secondary storm drain (K108) joins Koramangala valley primary storm drain (K100) near Wilson garden needs to be desilted and widened.

- The alternative option of re routing the drain by constructing RCC box drain in Wilson garden upto secondary storm drain.

- Garbage and debris dump noticed inside the drain near Venkatareddy layout needs to be cleared and further, the drain reach which are in natural condition inside the bylanes needs to be replaced with RCC drain with proper gradient and accordingly regrade all other road side drains in this layout and connect it to existing secondary

storm drain (K108).

- The concerned authority should extend the existing sewerage system to the entire locality to prevent entry of sewage into existing SWD.

- Stacking of solid waste by horticulture nursery owners adjacent to storm drain needs to be prevented immediately, if not during heavy storms it gets carried into SWD and causes blockages and pose serious problems further down stream.

- Caution boards/display boards has to be installed to educate and create public awareness regarding storm water and storm drain management.

- Emergency squad, equipped with truck mounted pumping arrangement and standby power generator should be readily made available during rainy season, to evacuate the water from the intake well / lowest point and discharge it to outside main drain.

4.4.7 Journalist Colony & Sudhamanagar (Ward No. 48)

Mitigative Measures:

- The existing secondary storm water drain (K112) starting from Parvathipura and further flowing through Journalist colony needs to be desilted.

- The culverts constructed across storm drain (K112) near Mavali tank bund road, A. M. Road, 1st to 5th Cross road Kalasipalyam extension needs to be remodelled to provide access for free flow of water.

- Utility crossing laid across storm drain near A.M. Road, 4th Cross Kalasipalya extn. needs to be relocated to avoid accumulation of solid wastes obstructing free flow of water.

- The condition of the bridge constructed across J.C. Road is very old and also with multiple spans. It needs to be opened at regular interval and desilt

- The reach of storm drain, below the commercial establishments (Pooja Marketing),

near J.C. Road needs to be desilted.

- The community toilet block constructed over storm drain (near Nala Road) needs to be relocated & proper drainage arrangement has to be provided to prevent raw sewage entering storm drain. Further, the support structures of this toilet block is obstructing free flow of water, which requires to be relocated in order to provide access for free flow of water.

- Large quantity of vegetal growth noticed near Lalbagh road (Culvert) needs to be cleared immediately in order to improve the carrying capacity of Kormangala valley primary storm drain.

- The existing culvert constructed across storm drain near K.H. Double road needs to be remodelled and further the utility lines located at this location needs to be relocated in order to provide access for free flow of water in Koramangala valley primary drain.

- Garbage and solid waste noticed in the secondary storm drain (K109) from Mission Road upto Sudhamanagar needs to be desilted and further unauthorised constructions over storm drain needs to be cleared, in order to provide free access for schedule maintenance of storm drain.

- Avoid laying of utility lines across/inside the storm drain.

- Caution boards/display boards needs to be installed to educate and create public awareness regarding storm water and storm drain management.

- Plug all openings in the drain walls and create separate tertiary drain to lead off the storm water to down stream.

4.4.8 Ejipura, Koramangala & S.T. Bed Area (Ward No. 67 & 68)

Mitigative Measures:

In order to minimise the flooding problems the following measures are proposed to achieve long term advantages.

Phase I :

- Initially the existing curved drain shall from chainage 8175m to 8225m shall be straightened.
- At places where the drain walls do not exists, wall to be constructed.
- Wherever possible the drain shall be widened from down steam end.
- All obstructions like private bridges from chainage 9625 to 10150 obstructing the waterway in the drain shall be remove.
- From chainage 10250m the drain out let shall be provided with bell mouth and a Kucha drain shall be dug upto Bellandur lake from the bellmouth outlet.
- Drain shall be cleared of all debris, solid waste and the sane shall be maintained.

Phase II

Even after carrying out the Phase I activity the drain sizes are inadequate to carry the storm water from upstream. Therefore alternate routes were studied to carry the additional storm flow. One route identified and surveyed is taking a diversion after the Ejipura bridge at chainage 6925m.In this proposal it is suggested to construct covered RCC box drain of size 6.0m x 3.0m with openings at regular interval for maintenance in Ejipura main road for a length of 750m and further down it is proposed to continue with open channel in the Defence land for a length of 1800m before finally discharge into the Bellandur lake through Marshy land. For the purpose the Defence land needs to be acquired. The drain needs to cross the inner ring road with a box drain. Due to the restriction in road width of Ejipura main road the drain size to be restricted to maximum of 6.0m even though higher size is possible in Defence land.

The details of the proposed alignment of drain is enclosed in drawing SK – 01.

Phase III :

Due to restriction in drain width along Ejipura main road to achieve higher return period a separate drain of size 6.0m x 3.0m is also proposed from chainage 5800m in Laksmanrao slum off Audugodi. It is proposed to take the drain through Bangalore Nandini Dairy farm, Rajendranagar slum, along Koramangala 80 feet road after crossing the inner ring road at chainage to S.T. Bed and through the Marshy land to Bellundur lake. At chainage 9500m of the existing drain the vacant land on either sides of the drain need to be acquired for taking the drain from 80 feet road to S.T.Bed. At

chainage 9500m of the existing drain, the proposed drain intersects the existing drain and the flow gets divided through the existing drain and the proposed drain. The total box drain length is around 3500m. From this point in marshy land till Bellandur lake drain can be in open Kucha condition.

This drain will intercept storm water from entire Koramangala area, reducing the load on the existing drain and prevent flooding in 80 feet road. For the purpose suitable gratings, inspection covers and access for cleaning the drain are proposed at regular intervals.

Even after carrying out the above recommendations the places which are below HFL of the drain will have some flooding problem due to non draining of the area. But the flooding problem will get reduced as the overflow from the main drain gets reduced. At the same time by providing additional drains in Defence land and in Koramangala 80 feet road will prevent the outside water entering these areas. Along with the above improvement activities the following are need to be considered.

In general, the following few best storm drain management practices need to be adopted to achieve the objective of storm drainage system in this region.

- The concerned authority should extend the existing sewerage system to the entire locality to prevent entry of sewage into existing SWD.
- Debris and garbage dump noticed inside the existing storm drain has to be cleared immediately before monsoon.
- Avoid developmental activities below HFL of SWD.
- Prevent stacking/dumping of building materials near the storm drain
- Nos. of approach bridges constructed and utility crossings laid across existing SWD by apartment owners in Koramangala layout has to be immediately removed/relocated to provide access for free flow of water.
- Do not allow stacking the desilted materials on the drain edge and convey it immediately from the site to the specified dumping site.
- Prevent any unauthorised construction near/inside the designated water carriageway.

- Avoid laying of utility lines across/inside the storm drain.

- Caution boards/display boards needs to be installed to educate and create public awareness regarding storm water and storm drain management.

- Emergency squads have to be formed before monsoon to provide necessary assistance to flood affected people during heavy storms.

4.5 BEST MANAGEMENT PRACTICES:

- Implement pollution prevention methods.

- Designate and implement minimum best management practices to protect water quality.

- Implement a maintenance schedule for all structural controls designed to reduce pollutant discharges and the storm water conveyance system, to include:

  - Inspection & removal of waste between May 1st and Sept. 30th .
  - Additional cleaning between October 1st and April 30th .
  - Records of cleaning and waste removal quantity.
  - Proper waste disposal.

- Measures to eliminate discharges during maintenance & cleaning.

- Limit infiltration from sanitary sewer to storm drains through routine maintenance.

- Implement an Educational Program for all pertinent target audiences.

- Inspect and clean catch basins and keep appropriate records.

- Remove trash and debris from open channels and properly dispose of these materials to prevent them from being washed into receiving waters.

- Report prohibited non-storm water discharges observed during the course of normal daily activities so they can be investigated, contained and cleaned up or eliminated.

- Review maintenance activities to verify that appropriate storm water maintenance practices are being utilized.

- Educate employees for pollution prevention techniques.

- Inspect and clean as needed all inlets/catch basins at least once every other year (at least 50% of the entire system inspected and cleaned each year)

- Inspect and clean as needed all inlets/catch basins in known problem areas at least once a year.

- Inspect and clean as needed all storm drain lines in known problem areas at least once a year.

- Inspect and clean as needed sumps and debris racks at pump stations, detention basins, drainage ditches and debris basins throughout the year.

- Cleaning activities may occur on a year round basis, however, known problem areas shall be targeted prior to the rainy season.

- Inspect and clean as needed all storm drain facilities that have been affected by emergency response activities.

- Additional cleanings shall be conducted as necessary during the non rainy season (Oct. 1st through April 30th).

- Slide and Embankment Repair of Channels

To improve the section of the drain and to minimize the flooding problems in low lying areas, various drain improvement methods suggested are (Refer Table 4.6 for Analysis results):-

1.Increase the carrying capacity of existing tertiary drains.

2.Provision of cut off drain (bypass drains) around the low lying area to prevent

adjoining area water entering into the low lying area and construction of sump for pumping out water at a location closer to the main drains (downstream end) and also it should be located in such a way that it should be easily accessible by vehicles that are mounted with pump.

3.The improvement shall be taken up from the down stream of the valley. If remodeling works are commenced from upstream side, situation at the downstream end may get further aggravated.

4.Set-up a vigilance squad to prevent debris dumping, encroachment of drains, local obstruction, such as, pipe crossing, construction inside the drain, any discharges other than storm water.

Encourage rain water harvesting in institutions, public parks, open grounds, etc.,

Table 4.1 Showing Adequacy Analysis Results for Koramangala Main Valley - Existing Hydraulic Flow Conditions

Sl.No.	Description	Drain Reach		Chainage (m)		Catchment Area A (Ha.)	Type	Average Velocity V m/sec	Discharges (Q in m^3/sec)					Existing Av.Drain Depth D in m.	Area required for drain (A in m^2)					Existing Av. Drain Width W(m.)	Required Drain Width (m)					Remarks				
		From	To	From	To				1year	2year	5year	10year	20year		1year	2year	5year	10year	20year		1year	2year	5year	10year	20year	1year	2year	5year	10year	20year
1	K100	Upparpete	Avenue Road	0	1500	123.24	Pri.	1.6	6.82	9.46	12.19	14.56	17.78	1.6	4.26	5.92	7.62	9.1	11.11	3	2.66	3.7	4.76	5.69	6.95	AD	IA	IA	IA	IA
2	K100	Avenue Road	1 st Main J.C. Road	1500	2225	440.11	Pri.	2.42	24.81	34.46	44.4	53.07	64.74	1.96	10.25	14.24	18.35	21.93	26.75	5.66	5.23	7.26	9.36	11.19	13.65	AD	IA	IA	IA	IA
3	K100	1 st Main J.C. Road	Lalbagh Road	2225	2650	735.81	Pri.	1.75	36.28	50.5	65.25	78.25	94.85	2.39	20.73	28.86	37.29	44.71	54.2	7.84	8.67	12.07	15.6	18.71	22.68	IA	IA	IA	IA	IA
4	K100	Lalbagh Road	K.H. Road	2650	3350	1012.45	Pri.	2.28	40.36	56.21	72.7	87.28	105.57	2.4	17.7	24.66	31.89	38.28	46.3	11	7.37	10.27	13.29	15.95	19.29	AD	AD	IA	IA	IA
5	K100	K.H. Road	9 th Cross Wilson Garden Road	3350	4350	1269.49	Pri.	1.89	48.85	68.17	88.37	106.41	127.99	2.1	25.84	36.07	46.75	56.3	67.72	12.5	12.31	17.18	22.26	26.81	32.25	AD	IA	IA	IA	IA
6	K100	9 th Cross Wilson Garden Road	Vinayaka Nagar	4350	4700	1458.04	Pri.	1.57	48.85	68.17	88.37	106.41	127.99	1.7	31.11	43.42	56.28	67.78	81.53	12.5	18.3	25.54	33.11	39.87	47.96	IA	IA	IA	IA	IA
7	K100	Vinayaka Nagar	Hosur Road	4700	5200	1554.66	Pri.	2.24	54.02	75.32	97.52	117.27	141.43	1.95	24.12	33.62	43.54	52.35	63.14	20	12.37	17.24	22.33	26.85	32.38	AD	AD	IA	IA	IA
8	K100	Hosur Road	Rose Garden	5200	6600	1963.58	Pri.	1.89	65.47	91.54	118.93	143.63	171.83	1.76	34.64	48.43	62.92	76	90.91	21	19.68	27.52	35.75	43.18	51.66	AD	IA	IA	IA	IA
9	K100	Rose Garden	Vivek Nagar Bridge	6600	7050	2463.8	Pri.	2.17	71.68	100.36	130.64	158.15	188.36	2.5	33.03	46.25	60.2	72.88	86.8	15	13.21	18.5	24.08	29.15	34.72	AD	IA	IA	IA	IA
10	K100	Vivek Nagar Bridge	Ejipura Church Road Bridge	7050	8400	2647.67	Pri.	2	77.31	108.4	141.35	171.5	203.4	2.1	38.65	54.2	70.67	85.75	101.7	12	18.41	25.81	33.65	40.83	48.43	IA	IA	IA	IA	IA
11	K100	Ejipura Church Road Bridge	1 st Cross Koramangala / S.T. Bed	8400	9100	2922.64	Pri.	1.7	81.91	114.97	150.12	182.46	215.7	1.77	48.18	67.63	88.3	107.33	126.88	11.5	27.22	38.21	49.89	60.64	71.68	IA	IA	IA	IA	IA
12	K100	1 st Cross Koramangala / S.T. Bed	Bellandur Tank	9100	10900	3151.06	Pri.	1.8	88.22	124.01	162.21	197.62	232.62	2.02	49.01	68.89	90.12	109.79	129.23	13	24.26	34.11	44.61	54.35	63.98	IA	IA	IA	IA	IA
13	K101	Hosur Road	Koramangala Slum	0	2000	132.33	Sec.	2.14	8.53	11.77	15.03	17.77	22.13	1.68	3.99	5.5	7.02	8.3	10.34	3.32	2.37	3.27	4.18	4.94	6.16	AD	AD	IA	IA	IA
14	K103	M.G. Road	Neelasandra	0	3400	351.91	Sec.	1.99	16.39	23.06	30.19	36.81	43.25	1.27	8.24	11.59	15.17	18.5	21.73	11	6.48	9.12	11.95	14.56	17.11	AD	AD	IA	IA	IA
15	K108	Jayanagar 1 st Block	Wilson Garden	0	1925	188.55	Sec.	1.79	8.72	12.19	15.85	19.15	22.88	1.26	4.87	6.81	8.85	10.7	12.78	3.1	3.86	5.41	7.03	8.49	10.15	IA	IA	IA	IA	IA

16	K109	Kanteerava Stadium	R.R.M.Roy Extn.	0	2000	75.49	Sec.	1.43	4.27	5.95	7.7	9.24	11.17	1.64	2.98	4.16	5.38	6.46	7.81	3.5	1.82	2.54	3.28	3.94	3.94	AD	AD	AD	IA	IA
17	K110	Hosur Road	Sudhama Nagar	0	625	105.2	Sec.	1.45	5.18	7.14	9.11	10.74	13.42	1.4	3.57	4.92	6.28	7.41	9.26	1.8	2.55	3.52	4.49	5.29	6.61	IA	IA	IA	IA	IA
18	K112	Paravathipura	Kumbaragundi	0	715	81.73	Sec.	1.83	5.65	7.76	9.84	11.54	14.6	1.77	3.09	4.24	5.38	6.31	7.98	3.92	1.75	2.39	3.04	3.56	4.51	AD	AD	AD	AD	IA
19	K113	Royal Parikrama Centre near Koramangala 8 th Block	Koramangala Main Valley Primary drain (Behind Akhila Karnataka Animal Rehabilitation Centre)	0	2225	122.64	Sec.	2	5.62	7.86	10.22	12.35	14.75	1.6	2.81	3.93	5.11	6.18	7.37	4.2	1.75	2.46	3.19	3.86	4.61	AD	AD	AD	AD	IA

Land Use Analysis for Koramangala Main Valley – Existing Hydraulic Flow Conditions

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of builtup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m³/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m²					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
K100	0	1500	A1(a)	41.19	35.01	6.18	66.75	11.2	0.02	1.5	1.6	15.63	6.67	33.49	0.513	38.99	54.12	69.69	83.20	101.69	2.29	3.18	4.09	4.88	5.97											
			A1(b)	81.95	69.65	12.30	66.74	11.2	0.01	1.2	1.6	15.63	6.94	33.77	0.513	38.78	53.84	69.34	82.83	101.15	4.53	6.29	8.1	9.67	11.81												
			Total	**123.14**							1.6										**6.82**	**9.46**	**12.19**	**14.56**	**17.78**	3.00	1.60	**4.26**	**5.92**	**7.62**	**9.10**	**11.11**	**2.66**	**3.70**	**4.76**	**5.69**	**6.95**
K100	1500	2225	A2	217.2	189.6	27.60	68.01	11.02	0.01	1.2	2.42	15.32	7.64	33.98	0.521	38.62	53.63	69.09	82.55	100.75	12.15	16.87	21.73	25.96	31.69											
			A25 (b)	99.77	99.77	0.00	75	10	0.01	1.2	2.42	15.32	9.72	35.05	0.558	37.82	52.58	67.82	81.16	98.77	5.85	8.13	10.48	12.54	15.26												
				316.97																	**17.99**	**24.99**	**32.21**	**38.51**	**46.95**											
			Total	**440.11**							2.42										**24.81**	**34.46**	**44.4**	**53.07**	**64.74**	5.66	1.96	**10.25**	**14.24**	**18.35**	**21.93**	**26.75**	**5.23**	**7.26**	**9.36**	**11.19**	**13.65**
K112	0	715	A25 (a)	81.73	81.73	0	75	10	0.01	1.2	1.83	6.51	6.94	23.46	0.503	49.55	67.98	86.26	101.12	127.92	5.65	7.76	9.84	11.54	14.6											
			Total	**81.73**							1.83										**5.65**	**7.76**	**9.84**	**11.54**	**14.6**	3.92	1.77	**3.09**	**4.24**	**5.38**	**6.31**	**7.98**	**1.75**	**2.39**	**3.04**	**3.56**	**4.51**
K100	2225	2650	A3	90.4	87.19	3.21	73.05	10.28	0.02	1.5	1.75	25.24	4.44	39.97	0.564	34.62	48.34	62.69	75.53	90.75	4.9	6.85	8.88	10.7	12.85											
			A4	123.57	123.57	0.00	75	10	0.01	1.2	1.75	25.24	8.33	43.57	0.586	32.66	45.74	59.53	72.04	85.84	6.57	9.2	11.97	14.49	17.26												
				213.97																	**11.47**	**16.04**	**20.85**	**25.18**	**30.11**											
			Total	**735.81**							1.75										**36.28**	**50.5**	**65.25**	**78.25**	**94.85**	7.84	2.39	**20.73**	**28.86**	**37.29**	**44.71**	**54.20**	**8.67**	**12.07**	**15.60**	**18.71**	**22.68**
K111	0	950	A23(a)	34.76	29.16	5.6	66.14	11.29	0.01	1.2	1.4	11.31	4.86	27.46	0.487	44.57	61.46	78.49	92.76	115.57	2.09	2.89	3.69	4.36	5.43											
			A23(b)	46.68	46.68	0	75	10	0.02	1.2	1.4	11.31	7.64	28.95	0.529	43.01	59.42	76.05	90.12	111.71	2.95	4.07	5.22	6.18	7.66												
			Total	**81.44**							1.4										**5.04**	**6.96**	**8.9**	**10.54**	**13.09**											
K110	0	625	A24(a1)	71.32	14.68	56.64	31.32	16.35	0.01	1.2	1.45	7.18	2.5	26.04	0.339	46.19	63.58	81.03	95.50	119.60	3.1	4.27	5.44	6.41	8.02											
			A24(b)	33.88	30.58	3.3	69.64	10.78	0.01	1.2	1.45	7.18	9.72	27.69	0.499	44.32	61.14	78.11	92.34	114.96	2.08	2.87	3.67	4.34	5.4												
				105.2							1.45										**5.18**	**7.14**	**9.11**	**10.74**	**13.42**	1.80	1.40	**3.57**	**4.92**	**6.28**	**7.41**	**9.26**	**2.55**	**3.52**	**4.49**	**5.29**	**6.61**
			Total	**922.45**							1.45										**10.23**	**14.1**	**18.01**	**21.28**	**26.52**											

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of bulitup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m^3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m^2					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
											2.28										**40.36**	**56.21**	**72.7**	**87.28**	**105.57**	11.00	2.40	**17.70**	**24.66**	**31.89**	**38.28**	**46.30**	**7.37**	**10.27**	**13.29**	**15.95**	**19.29**
K100	2650	3350	A24(a2)	90	60	30	56.67	12.67	0.01	1.2	2.28	20.1	12.5	45.27	0.512	31.84	44.63	58.18	70.55	83.75	**4.08**	**5.71**	**7.45**	**9.03**	**10.72**												
K109	0	2000	A5 (a)	57.71	57.71	0	75	10	0.02	1.5	1.43	23.31	3.33	36.64	0.561	36.70	51.10	66.03	79.21	95.97	3.3	4.6	5.94	7.13	8.64												
			A5 (b2)	17.78	15	2.78	66.4	11.25	0.01	1.2	1.43	23.31	6.94	41.51	0.579	33.75	47.18	61.29	73.99	88.57	0.97	1.35	1.75	2.12	2.53												
			Total	**75.49**							1.43										**4.27**	**5.95**	**7.7**	**9.24**	**11.17**	3.50	1.64	**2.98**	**4.16**	**5.38**	**6.46**	**7.81**	**1.82**	**2.54**	**3.28**	**3.94**	**4.76**
																					40.36	**56.21**	**72.7**	**87.28**	**105.57**												
K100	3350	4350	A5 (b1)	181.55	156.55	25	67.43	11.1	0.01	1.2	1.89	25.13	15.28	51.51	0.577	29.18	41.09	53.85	65.74	77.06	8.49	11.96	15.67	19.13	22.42												
			Total	**1269.49**							1.89										**48.85**	**68.17**	**88.37**	**106.41**	**127.99**	12.50	2.10	**25.84**	**36.07**	**46.75**	**56.30**	**67.72**	**12.31**	**17.18**	**22.26**	**26.81**	**32.25**
K108	0	1925	A22 (a)	119.51	80	39.51	56.82	12.64	0.01	1.2	1.79	17.92	10.42	40.99	0.496	34.04	47.56	61.75	74.50	89.29	5.61	7.83	10.17	12.27	14.71												
			A22 (b)	69.04	44.31	24.73	55.3	12.87	0.01	1.2	1.79	17.92	13.89	44.68	0.505	32.12	45.01	58.64	71.06	84.46	3.11	4.36	5.68	6.88	8.18												
				188.55							1.79										**8.72**	**12.19**	**15.85**	**19.15**	**22.88**	3.10	1.26	**4.87**	**6.81**	**8.85**	**10.70**	**12.78**	**3.86**	**5.41**	**7.03**	**8.49**	**10.15**
K100	4350	4700		**1458.04**					-	-	1.57	3.72	-	55.23							**48.85**	**68.17**	**88.37**	**106.41**	**127.99**	12.50	1.70	**31.11**	**43.42**	**56.28**	**67.78**	**81.53**	**18.30**	**25.54**	**33.11**	**39.87**	**47.96**
K107	0	750	A6 (a)	72.02	53	19.02	60.47	12.11	0.02	1.5	1.5	8.33	7.78	28.22	0.467	43.75	60.39	77.21	91.38	113.55	4.09	5.65	7.22	8.54	10.61												
			A6 (b)	24.6	9.6	15	41.46	14.88	0.01	1.2	1.5	8.33	11.11	34.32	0.413	38.35	53.28	68.67	82.10	100.10	1.08	1.5	1.94	2.32	2.82												
			Total	**96.62**							1.5										**5.17**	**7.15**	**9.15**	**10.86**	**13.44**	4.00	1.50	**3.45**	**4.77**	**6.10**	**7.24**	**8.96**	**2.30**	**3.18**	**4.07**	**4.83**	**5.97**
K100	4700	5200	**Total**	**1554.66**							2.24	3.72		58.95							**54.02**	**75.32**	**97.52**	**117.27**	**141.43**	20.00	1.95	**24.12**	**33.62**	**43.54**	**52.35**	**63.14**	**12.37**	**17.24**	**22.33**	**26.85**	**32.38**
K104	0	1700	A21 (a)	18.86	9.22	9.64	46.89	14.09	0.01	1.2	1.8	15.74	5.56	35.39	0.437	37.58	52.25	67.43	80.74	98.15	0.86	1.2	1.54	1.85	2.25												
			A21 (b)	13.84	13.84	0	75	10	0.01	1.2	1.8	15.74	8.33	34.07	0.554	38.54	53.53	68.97	82.42	100.57	0.82	1.14	1.47	1.76	2.14												
			A21 (c)	7.7	3.89	3.81	47.79	13.96	0.02	1.5	1.8	15.74	11.11	40.81	0.458	34.14	47.69	61.91	74.67	89.54	0.33	0.47	0.61	0.73	0.88												

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of bulitup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m^3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m^2					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
			A21 (d)	25.71	25.71	0	75	10	0.01	1.2	1.8	15.74	15.28	41.02	0.579	34.02	47.54	61.72	74.47	89.24	1.41	1.97	2.55	3.08	3.69												
			A21 (e)	46	46	0	75	10	0.01	1.2	1.8	15.74	16.67	42.41	0.583	33.27	46.54	60.50	73.12	87.35	2.48	3.46	4.5	5.44	6.5												
			Total	**112.11**							1.8										**5.9**	**8.23**	**10.68**	**12.86**	**15.46**	3.00	2.00	**3.28**	**4.57**	**5.93**	**7.14**	**8.59**	**1.64**	**2.29**	**2.97**	**3.57**	**4.29**
																					54.02	**75.32**	**97.52**	**117.27**	**141.43**											
K100	5200	6600	A7	179.95	119.61	60.34	56.56	12.68	0.01	1.2	1.89	38.58	9.03	60.29	0.550	26.25	37.15	49.01	60.31	69.63	7.22	10.21	13.47	16.58	19.14											
			A20 (a)	44.42	17.9	26.52	42.16	14.78	0.01	1.2	1.89	38.58	9.03	62.38	0.491	25.66	36.35	48.01	59.19	68.12	1.55	2.2	2.91	3.58	4.12												
			A19 (a)	72.44	40.3	32.14	50.6	13.55	0.02	1.5	1.89	38.58	11.11	63.24	0.525	25.42	36.04	47.62	58.75	67.52	2.68	3.8	5.03	6.2	7.13												
			Total	**296.81**																	**11.45**	**16.22**	**21.41**	**26.36**	**30.39**											
			Total	**1963.58**							1.89										**65.47**	**91.54**	**118.93**	**143.63**	**171.83**	21.00	1.76	**34.64**	**48.43**	**62.92**	**76.00**	**90.91**	**19.68**	**27.52**	**35.75**	**43.18**	**51.66**
K103	0	3400	A8 (a)	162.45	116.43	46.02	59.42	12.27	0.02	1.5	1.99	28.48	6.67	47.41	0.531	30.86	43.33	56.59	68.79	81.30	7.4	10.39	13.57	16.49	19.49											
			A 8(b)	189.46	176.26	13.2	71.17	10.56	0.01	1.2	1.99	28.48	13.89	52.92	0.596	28.66	40.39	52.99	64.77	75.73	8.99	12.67	16.62	20.32	23.76												
				351.91							1.99										**16.39**	**23.06**	**30.19**	**36.81**	**43.25**	11.00	1.27	**8.24**	**11.59**	**15.17**	**18.50**	**21.73**	**6.48**	**9.12**	**11.95**	**14.56**	**17.11**
																					65.47	**91.54**	**118.93**	**143.63**	**171.83**											
K100	6600	7050	A9	88.33	88.33	0	75	10	0.01	1.2	2.17	33.79	25	68.79	0.631	24.02	34.15	45.28	56.11	63.96	3.72	5.28	7.01	8.68	9.9											
			A 18 (b)	59.98	59.98	0	75	10	0.01	1.2	2.17	33.79	26.39	70.18	0.631	23.70	33.71	44.74	55.50	63.14	2.49	3.54	4.7	5.83	6.64												
			Total	148.31																	6.21	8.83	11.71	14.52	16.53											
			Total	**2463.8**							2.17										**71.68**	**100.36**	**130.64**	**158.15**	**188.36**	15.00	2.50	**33.03**	**46.25**	**60.20**	**72.88**	**86.80**	**13.21**	**18.50**	**24.08**	**29.15**	**34.72**
K100	7050	8400	A10	142.87	40.74	102.13	35.68	15.72	0.01	1.2	2	47.92	13.89	77.52	0.461	22.17	31.63	42.16	52.56	59.22	4.05	5.78	7.71	9.61	10.83											

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of bulitup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m^3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m^2					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
			A18 (a)	41	41	0	75	10	0.01	1.2	2	47.92	20.83	78.75	0.631	21.93	31.32	41.76	52.11	58.63	1.58	2.25	3	3.74	4.21												
			Total	**183.87**																	**5.63**	**8.03**	**10.71**	**13.35**	**15.04**											
			Total	**2647.67**							2										**77.31**	**108.4**	**141.35**	**171.5**	**203.4**	12.00	2.10	**38.65**	**54.20**	**70.67**	**85.75**	**101.70**	**18.41**	**25.81**	**33.65**	**40.83**	**48.43**
K101	0	350	A17 (b)	22.33	22.33	0	75	10	0.01	1.2	2.5	2.47	4.17	16.63	0.462	62.45	84.70	105.97	122.05	159.63	1.79	2.43	3.04	3.5	4.58											
																					1.79	**2.43**	**3.04**	**3.5**	**4.58**											
K101	350	2000	A17 (a)	60	60	0	75	10	0.02	1.5	2.14	12.85	6.67	29.52	0.534	42.45	58.68	75.17	89.16	110.32	3.78	5.22	6.69	7.94	9.82											
			A17 (c)	50	58	0	75	10	0.01	1.2	2.14	12.66	11.11	33.77	0.550	38.78	53.84	69.35	82.83	101.16	2.96	4.12	5.3	6.33	7.73											
			Total	**132.33**							2.14										**6.74**	**9.34**	**11.99**	**14.27**	**17.55**											
											2.14										**8.53**	**11.77**	**15.03**	**17.77**	**22.13**	3.32	1.68	**3.99**	**5.50**	**7.02**	**8.30**	**10.34**	**2.37**	**3.27**	**4.18**	**4.94**	**6.16**
K100	8400	9100	A11	78.8	38.8	40	47.08	14.06	0.01	1.2	1.7	56.37	9.72	80.16	0.51	21.67	30.96	41.32	51.60	57.96	2.43	3.47	4.63	5.78	6.49											
			A16	63.84	48	15.84	61.35	11.98	0.01	1.2	1.7	56.37	13.19	81.55	0.571	21.42	30.62	40.90	51.12	57.32	2.17	3.1	4.14	5.18	5.81											
			Total	**142.64**							1.7										**4.6**	**6.57**	**8.77**	**10.96**	**12.3**											
			Total	**2922.64**							1.7										**81.91**	**114.97**	**150.12**	**182.46**	**215.7**	11.50	1.77	**48.18**	**67.63**	**88.30**	**107.33**	**126.88**	**27.22**	**38.21**	**49.89**	**60.64**	**71.68**
K100	9100	10900	A12	156.84	46.84	110	36.43	15.61	0.03	1.5	1.8	60.65	7.78	84.04	0.47	20.99	30.04	40.17	50.29	56.22	4.25	6.09	8.14	10.19	11.39											
			A14	11.32	11.32	0	75	10	0.01	1.2	1.8	60.65	16.67	87.31	0.631	20.46	29.32	39.26	49.24	54.85	0.41	0.58	0.78	0.98	1.09											
			A15	60.24	25	35.24	42.83	14.68	0.01	1.2	1.8	60.65	13.89	89.22	0.49	20.17	28.91	38.75	48.67	54.1	1.66	2.37	3.18	3.99	4.44											
			Total	**228.4**							1.8										**6.31**	**9.04**	**12.1**	**15.16**	**16.92**											
			Total	**3151.04**							1.8										**88.22**	**124.01**	**162.21**	**197.62**	**232.62**	13.00	2.02	**49.01**	**68.89**	**90.12**	**109.79**	**129.23**	**24.26**	**34.11**	**44.61**	**54.35**	**63.98**
K113	0	2225	A	66.8	38.8	28	51.95	13.35	0.01	1.2	2	18.54	9.72	41.62	0.48	33.69	47.10	61.19	73.88	88.41	2.99	4.18	5.43	6.56	7.85											
			A	55.84	40	15.84	59.4	12.27	0.01	1.2	2	18.54	13.19	44.01	0.522	32.45	45.45	59.18	71.65	85.29	2.63	3.68	4.79	5.8	6.9											
			Total	**122.64**							2										**5.62**	**7.86**	**10.22**	**12.35**	**14.75**	4.20	1.60	**2.81**	**3.93**	**5.11**	**6.18**	**7.37**	**1.75**	**2.46**	**3.19**	**3.86**	**4.61**

Table Showing Adequacy Analysis Results for Koramangala Main Valley - For Improved Hydraulic Flow Conditions

Sl.No.	Description	Drain Reach		Chainage (m)		Catchment Area A (Ha.)	Type	Average Velocity V m/sec	Discharges (Q in m^3/sec)					Av.Drain D in m.	Area required for drain (A in m^2)					Proposing Av. Drain Width W(m.)	Required Drain Width (m)					Remarks				
		From	To	From	To				1year	2year	5year	10year	20year	Proposing Depth	1year	2year	5year	10year	20year		1year	2year	5year	10year	20year	1year	2year	5year	10year	20year
1	K100	Upparpete	Avenue Road	0	1500	123.24	Pri.	2.4	6.82	9.46	12.19	14.56	17.78	1.8	2.84	3.94	5.08	6.07	7.41	3.5	1.58	2.19	2.82	3.37	4.12	AD	AD	AD	AD	IA
2	K100	Avenue Road	1 st Main J.C. Road	1500	2225	440.11	Pri.	3.3	24.81	34.46	44.4	53.07	64.74	2.2	7.52	10.44	13.46	16.08	19.62	8.5	3.42	4.75	6.12	7.31	8.92	AD	AD	AD	AD	IA
3	K100	1 st Main J.C. Road	Lalbagh Road	2225	2650	735.81	Pri.	3.2	36.28	50.5	65.25	78.25	94.85	2.4	11.34	15.78	20.39	24.45	29.64	10	4.72	6.58	8.5	10.19	12.35	AD	AD	AD	IA	IA
4	K100	Lalbagh Road	K.H. Road	2650	3350	1012.45	Pri.	3.7	40.36	56.21	72.7	87.28	105.57	2.4	10.91	15.19	19.65	23.59	28.53	11	4.54	6.33	8.19	9.83	11.89	AD	AD	AD	AD	IA
5	K100	K.H. Road	9 th Cross Wilson Garden Road	3350	4350	1269.49	Pri.	3	48.85	68.17	88.37	106.41	127.99	2.4	16.28	22.72	29.46	35.47	42.66	12.5	6.78	9.47	12.27	14.78	17.78	AD	AD	AD	IA	IA
6	K100	9 th Cross Wilson Garden Road	Vinayaka Nagar	4350	4700	1458.04	Pri.	2.7	48.85	68.17	88.37	106.41	127.99	2.1	18.09	25.25	32.73	39.41	47.41	12.5	8.61	12.02	15.58	18.77	22.57	AD	AD	IA	IA	IA
7	K100	Vinayaka Nagar	Hosur Road	4700	5200	1554.66	Pri.	3.93	54.02	75.32	97.52	117.27	141.43	2.4	13.75	19.16	24.81	29.84	35.99	20	5.73	7.99	10.34	12.43	14.99	AD	AD	AD	AD	AD
8	K100	Hosur Road	Rose Garden	5200	6600	1963.58	Pri.	3	65.47	91.54	118.93	143.63	171.83	3	21.82	30.51	39.64	47.88	57.28	22.5	7.27	10.17	13.21	15.96	19.09	AD	AD	AD	AD	AD
9	K100	Rose Garden	Vivek Nagar Bridge	6600	7050	2463.8	Pri.	3.8	71.68	100.36	130.64	158.15	188.36	3	18.86	26.41	34.38	41.62	49.57	24	6.29	8.8	11.46	13.87	16.52	AD	AD	AD	AD	AD
10	K100	Vivek Nagar Bridge	Ejipura Church Road Bridge	7050	8400	2647.67	Pri.	3.3	77.31	108.4	141.35	171.5	203.4	3	23.43	32.85	42.83	51.97	61.64	16	7.81	10.95	14.28	17.32	20.55	AD	AD	AD	IA	IA
11	K100	Ejipura Church Road Bridge	1 st Cross Koramangala / S.T. Bed	8400	9100	2922.64	Pri.	3.75	81.91	114.97	150.12	182.46	215.7	3	21.84	30.66	40.03	48.66	57.52	18	7.28	10.22	13.34	16.22	19.17	AD	AD	AD	AD	IA
12	K100	1 st Cross Koramangala / S.T. Bed	Bellandur Tank	9100	10900	3151.06	Pri.	3.7	88.22	124.01	162.22	197.62	232.62	2.8	23.84	33.52	43.84	53.41	62.87	14	8.52	11.97	15.66	19.08	22.45	AD	AD	IA	IA	IA
13	K101	Hosur Road	Koramangala Slum	0	2000	132.33	Sec.	3.75	8.53	11.77	15.03	17.77	22.13	1.8	2.28	3.14	4.01	4.74	5.9	3.8	1.26	1.74	2.23	2.63	3.28	AD	AD	AD	AD	AD
14	K103	M.G. Road	Neelasandra	0	3375	351.91	Sec.	3.85	16.43	23.12	30.26	36.89	43.36	1.8	4.27	6	7.86	9.58	11.26	11	2.37	3.34	4.37	5.32	6.26	AD	AD	AD	AD	AD
15	K108	Jayanagar 1 st Block	Wilson Garden	0	1925	188.55	Sec.	1.79	8.72	12.19	15.85	19.15	22.88	1.26	4.87	6.81	8.85	10.7	12.78	3.1	3.86	5.41	7.03	8.49	10.15	IA	IA	IA	IA	IA
16	K109	Kanteerava Stadium	R.R.M.Roy Extn.	0	1975	75.49	Sec.	3	4.29	5.98	7.73	9.28	11.23	1.8	1.43	1.99	2.58	3.09	3.74	3.5	0.79	1.11	1.43	1.72	2.08	AD	AD	AD	AD	AD
17	K110	Hosur Road	Sudhama Nagar	0	625	105.2	Sec.	1.45	9.69	13.43	17.26	20.55	25.24	1.6	6.68	9.26	11.9	14.17	17.41	6	4.18	5.79	7.44	8.86	10.88	AD	AD	IA	IA	IA

Sl.No.	Description	Drain Reach		Chainage (m)		Catchment Area A (Ha.)	Type	Average Velocity V m/sec	Discharges (Q in m^3/sec)					Proposing Av.Drain Depth D in m.	Area required for drain (A in m^2)					Proposing Av. Drain Width W(m.)	Required Drain Width (m)					Remarks				
		From	To	From	To				1year	2year	5year	10year	20year		1year	2year	5year	10year	20year		1year	2year	5year	10year	20year	1year	2year	5year	10year	20year
18	K112	Paravathipura	Kumbaragundi	0	715	81.73	Sec.	2.4	5.65	7.76	9.84	11.54	14.6	1.9	2.36	3.23	4.1	4.81	6.08	3.92	1.24	1.7	2.16	2.53	3.2	AD	AD	AD	AD	AD

Land Use Analysis for Koramangala Main Valley Storm Water Drain Clean Condition

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of bulitup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m³/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m²					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
K100	0	1500	A1(a)	41.19	35.01	6.18	66.75	11.2	0.02	1.5	1.6	15.63	6.67	33.49	0.513	38.99	54.12	69.69	83.20	101.69	2.29	3.18	4.09	4.88	5.97											
			A1(b)	81.95	69.65	12.30	66.74	11.2	0.01	1.2	1.6	15.63	6.94	33.77	0.513	38.78	53.84	69.34	82.83	101.15	4.53	6.29	8.1	9.67	11.81											
			Total	**123.14**							1.6										**6.82**	**9.46**	**12.19**	**14.56**	**17.78**	3.00	1.60	**4.26**	**5.92**	**7.62**	**9.10**	**11.11**	**2.66**	**3.70**	**4.76**	**5.69**	**6.95**
K100	1500	2225	A2	217.2	189.6	27.60	68.01	11.02	0.01	1.2	2.42	15.32	7.64	33.98	0.521	38.62	53.63	69.09	82.55	100.75	12.15	16.87	21.73	25.96	31.69											
			A25 (b)	99.77	99.77	0.00	75	10	0.01	1.2	2.42	15.32	9.72	35.05	0.558	37.82	52.58	67.82	81.16	98.77	5.85	8.13	10.48	12.54	15.26											
				316.97																	**17.99**	**24.99**	**32.21**	**38.51**	**46.95**											
			Total	**440.11**							2.42										**24.81**	**34.46**	**44.4**	**53.07**	**64.74**	5.66	1.96	**10.25**	**14.24**	**18.35**	**21.93**	**26.75**	**5.23**	**7.26**	**9.36**	**11.19**	**13.65**
K112	0	715	A25 (a)	81.73	81.73	0	75	10	0.01	1.2	1.83	6.51	6.94	23.46	0.503	49.55	67.98	86.26	101.12	127.92	5.65	7.76	9.84	11.54	14.6											
			Total	**81.73**							1.83										**5.65**	**7.76**	**9.84**	**11.54**	**14.6**	3.92	1.77	**3.09**	**4.24**	**5.38**	**6.31**	**7.98**	**1.75**	**2.39**	**3.04**	**3.56**	**4.51**
K100	2225	2650	A3	90.4	87.19	3.21	73.05	10.28	0.02	1.5	1.75	25.24	4.44	39.97	0.564	34.62	48.34	62.69	75.53	90.75	4.9	6.85	8.88	10.7	12.85											
			A4	123.57	123.57	0.00	75	10	0.01	1.2	1.75	25.24	8.33	43.57	0.586	32.66	45.74	59.53	72.04	85.84	6.57	9.2	11.97	14.49	17.26											
				213.97																	**11.47**	**16.04**	**20.85**	**25.18**	**30.11**											
			Total	**735.81**							1.75										**36.28**	**50.5**	**65.25**	**78.25**	**94.85**	7.84	2.39	**20.73**	**28.86**	**37.29**	**44.71**	**54.20**	**8.67**	**12.07**	**15.60**	**18.71**	**22.68**
K110	0	1000	A23(a)	34.76	29.16	5.6	66.14	11.29	0.01	1.2	1.4	11.9	4.86	28.05	0.492	43.93	60.62	77.49	91.68	113.99	2.09	2.88	3.68	4.35	5.41											
			A23(b)	46.68	46.68	0	75	10	0.02	1.2	1.4	11.9	7.64	29.54	0.534	42.43	58.65	75.13	89.12	110.25	2.94	4.06	5.2	6.17	7.64											
			Total	**81.44**							1.4										**5.02**	**6.94**	**8.88**	**10.53**	**13.05**	4.00	1.50	**3.59**	**4.96**	**6.35**	**7.52**	**9.32**	**2.39**	**3.31**	**4.23**	**5.01**	**6.21**
K110	1000	2375	A24(a1)	71.32	14.68	56.64	31.32	16.35	0.01	1.2	1.45	15.8	2.5	34.66	0.371	38.10	52.95	68.27	81.66	99.48	2.8	3.89	5.02	6.01	7.32											
			A24(b)	33.88	30.58	3.3	69.64	10.78	0.01	1.2	1.45	15.8	9.72	36.31	0.536	36.93	51.40	66.40	79.61	96.54	1.86	2.59	3.35	4.02	4.87											
				105.2																	**4.67**	**6.49**	**8.37**	**10.02**	**12.19**											
			Total	**922.45**							1.45										**9.69**	**13.43**	**17.26**	**20.55**	**25.24**	6.00	1.60	**6.68**	**9.26**	**11.90**	**14.17**	**17.41**	**4.18**	**5.79**	**7.44**	**8.86**	**10.88**

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of builtup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m^3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m^2					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
											2.28										**40.36**	**56.21**	**72.7**	**87.28**	**105.57**	11.00	2.40	**17.70**	**24.66**	**31.89**	**38.28**	**46.30**	**7.37**	**10.27**	**13.29**	**15.95**	**19.29**
K100	2650	3350	A24(a2)	90	60	30	56.67	12.67	0.01	1.2	2.28	20.1	12.5	45.27	0.512	31.84	44.63	58.18	70.55	83.75	**4.08**	**5.71**	**7.45**	**9.03**	**10.72**												
K109	0	1975	A5 (a)	57.71	57.71	0	75	10	0.02	1.5	1.43	23.02	3.33	36.35	0.561	36.90	51.36	66.35	79.55	96.46	3.32	4.62	5.97	7.16	8.68												
			A5 (b2)	17.78	15	2.78	66.4	11.25	0.01	1.2	1.43	23.02	6.94	41.21	0.579	33.91	47.39	61.55	74.27	88.97	0.97	1.36	1.76	2.12	2.55												
			Total	**75.49**							1.43										**4.29**	**5.98**	**7.73**	**9.28**	**11.23**	3.50	1.64	**3.00**	**4.18**	**5.41**	**6.49**	**7.85**	**1.83**	**2.55**	**3.30**	**3.96**	**4.79**
																					40.36	**56.21**	**72.7**	**87.28**	**105.57**												
K100	3350	4350	A5 (b1)	181.55	156.55	25	67.43	11.1	0.01	1.2	1.89	25.13	15.28	51.51	0.577	29.18	41.09	53.85	65.74	77.06	8.49	11.96	15.67	19.13	22.42												
			Total	**1269.49**							1.89										**48.85**	**68.17**	**88.37**	**106.41**	**127.99**	12.50	2.10	**25.84**	**36.07**	**46.75**	**56.30**	**67.72**	**12.31**	**17.18**	**22.26**	**26.81**	**32.25**
K108	0	1925	A22 (a)	119.51	80	39.51	56.82	12.64	0.01	1.2	1.79	17.92	10.42	40.99	0.496	34.04	47.56	61.75	74.50	89.29	5.61	7.83	10.17	12.27	14.71												
			A22 (b)	69.04	44.31	24.73	55.3	12.87	0.01	1.2	1.79	17.92	13.89	44.68	0.505	32.12	45.01	58.64	71.06	84.46	3.11	4.36	5.68	6.88	8.18												
				188.55							1.79										**8.72**	**12.19**	**15.85**	**19.15**	**22.88**	3.10	1.26	**4.87**	**6.81**	**8.85**	**10.70**	**12.78**	**3.86**	**5.41**	**7.03**	**8.49**	**10.15**
K100	4350	4700		**1458.04**					-	-	1.57	3.72	-	55.23							**48.85**	**68.17**	**88.37**	**106.41**	**127.99**	12.50	1.70	**31.11**	**43.42**	**56.28**	**67.78**	**81.53**	**18.30**	**25.54**	**33.11**	**39.87**	**47.96**
K107	0	750	A6 (a)	72.02	53	19.02	60.47	12.11	0.02	1.5	1.5	8.33	7.78	28.22	0.467	43.75	60.39	77.21	91.38	113.55	4.09	5.65	7.22	8.54	10.61												
			A6 (b)	24.6	9.6	15	41.46	14.88	0.01	1.2	1.5	8.33	11.11	34.32	0.413	38.35	53.28	68.67	82.10	100.10	1.08	1.5	1.94	2.32	2.82												
			Total	**96.62**							1.5										**5.17**	**7.15**	**9.15**	**10.86**	**13.44**	4.00	1.50	**3.45**	**4.77**	**6.10**	**7.24**	**8.96**	**2.30**	**3.18**	**4.07**	**4.83**	**5.97**
K100	4700	5200	**Total**	**1554.66**							2.24	3.72		58.95							**54.02**	**75.32**	**97.52**	**117.27**	**141.43**	20.00	1.95	**24.12**	**33.62**	**43.54**	**52.35**	**63.14**	**12.37**	**17.24**	**22.33**	**26.85**	**32.38**
K104	0	1400	A21 (a)	18.86	9.22	9.64	46.89	14.09	0.01	1.2	1.8	2.31	5.56	21.96	0.375	51.80	70.91	89.73	104.83	133.47	1.02	1.39	1.76	2.06	2.62												
			A21 (b)	13.84	13.84	0	75	10	0.01	1.2	1.8	4.63	8.33	22.96	0.497	50.27	68.91	87.36	102.30	129.68	0.96	1.32	1.67	1.96	2.48												
			A21 (c)	7.7	3.89	3.81	47.79	13.96	0.02	1.5	1.8	3.24	11.11	28.31	0.414	43.66	60.27	77.07	91.22	113.32	0.39	0.53	0.68	0.81	1												

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of builtup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m^3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m^2					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
			A21 (d)	25.71	25.71	0	75	10	0.01	1.2	1.8	8.8	15.28	34.07	0.554	38.54	53.53	68.97	82.42	100.57	1.53	2.12	2.73	3.26	3.98												
			A21 (e)	46	46	0	75	10	0.01	1.2	1.8	6.94	19.44	36.39	0.561	36.87	51.33	66.31	79.51	96.40	2.64	3.68	4.76	5.7	6.91												
			Total	**112.11**							1.8										**6.54**	**9.04**	**11.6**	**13.79**	**17**	3.00	2.00	**3.63**	**5.02**	**6.45**	**7.66**	**9.44**	**1.82**	**2.51**	**3.22**	**3.83**	**4.72**
																					54.02	**75.32**	**97.52**	**117.27**	**141.43**											
K100	5200	6600	A7	179.95	119.61	60.34	56.56	12.68	0.01	1.2	1.89	38.58	9.03	60.29	0.550	26.25	37.15	49.01	60.31	69.63	7.22	10.21	13.47	16.58	19.14											
			A20 (a)	44.42	17.9	26.52	42.16	14.78	0.01	1.2	1.89	38.58	9.03	62.38	0.491	25.66	36.35	48.01	59.19	68.12	1.55	2.2	2.91	3.58	4.12												
			A19 (a)	72.44	40.3	32.14	50.6	13.55	0.02	1.5	1.89	38.58	11.11	63.24	0.525	25.42	36.04	47.62	58.75	67.52	2.68	3.8	5.03	6.2	7.13												
			Total	**296.81**																	**11.45**	**16.22**	**21.41**	**26.36**	**30.39**											
			Total	**1963.58**							1.89										**65.47**	**91.54**	**118.93**	**143.63**	**171.83**	21.00	1.76	**34.64**	**48.43**	**62.92**	**76.00**	**90.91**	**19.68**	**27.52**	**35.75**	**43.18**	**51.66**
K103	0	3375	A8 (a)	162.45	116.43	46.02	59.42	12.27	0.02	1.5	1.99	28.27	6.67	47.2	0.531	30.95	43.46	56.74	68.96	81.53	7.42	10.42	13.6	16.53	19.54											
			A 8(b)	189.46	176.26	13.2	71.17	10.56	0.01	1.2	1.99	28.27	13.89	52.71	0.596	28.74	40.49	53.11	64.91	75.93	9.02	12.7	16.66	20.37	23.82												
				351.91							1.99										**16.43**	**23.12**	**30.26**	**36.89**	**43.36**	11.00	1.27	**8.26**	**11.62**	**15.21**	**18.54**	**21.79**	**6.50**	**9.15**	**11.97**	**14.60**	**17.16**
																					65.47	**91.54**	**118.93**	**143.63**	**171.83**											
K100	6600	7050	A9	88.33	88.33	0	75	10	0.01	1.2	2.17	33.79	25	68.79	0.631	24.02	34.15	45.28	56.11	63.96	3.72	5.28	7.01	8.68	9.9											
			A 18 (b)	59.98	59.98	0	75	10	0.01	1.2	2.17	33.79	26.39	70.18	0.631	23.70	33.71	44.74	55.50	63.14	2.49	3.54	4.7	5.83	6.64												
			Total	148.31																	6.21	8.83	11.71	14.52	16.53											
			Total	**2463.8**							2.17										**71.68**	**100.36**	**130.64**	**158.15**	**188.36**	15.00	2.50	**33.03**	**46.25**	**60.20**	**72.88**	**86.80**	**13.21**	**18.50**	**24.08**	**29.15**	**34.72**
K100	7050	8400	A10	142.87	40.74	102.13	35.68	15.72	0.01	1.2	2	47.92	13.89	77.52	0.461	22.17	31.63	42.16	52.56	59.22	4.05	5.78	7.71	9.61	10.83											
			A18 (a)	41	41	0	75	10	0.01	1.2	2	47.92	20.83	78.75	0.631	21.93	31.32	41.76	52.11	58.63	1.58	2.25	3	3.74	4.21												
			Total	**183.87**																	**5.63**	**8.03**	**10.71**	**13.35**	**15.04**											
			Total	**2647.67**							2										**77.31**	**108.4**	**141.35**	**171.5**	**203.4**	12.00	2.10	**38.65**	**54.20**	**70.67**	**85.75**	**101.70**	**18.41**	**25.81**	**33.65**	**40.83**	**48.43**

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of bulitup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m^3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m^2					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
K101	0	350	A17 (b)	22.33	22.33	0	75	10	0.01	1.2	2.5	2.47	4.17	16.63	0.462	62.45	84.70	105.97	122.05	159.63	1.79	2.43	3.04	3.5	4.58											
																					1.79	**2.43**	**3.04**	**3.5**	**4.58**											
K101	350	2000	A17 (a)	60	60	0	75	10	0.02	1.5	2.14	12.85	6.67	29.52	0.534	42.45	58.68	75.17	89.16	110.32	3.78	5.22	6.69	7.94	9.82											
			A17 (c)	50	58	0	75	10	0.01	1.2	2.14	12.66	11.11	33.77	0.550	38.78	53.84	69.35	82.83	101.16	2.96	4.12	5.3	6.33	7.73											
			Total	**132.33**							2.14										**6.74**	**9.34**	**11.99**	**14.27**	**17.55**											
											2.14										**8.53**	**11.77**	**15.03**	**17.77**	**22.13**	3.32	1.68	**3.99**	**5.50**	**7.02**	**8.30**	**10.34**	**2.37**	**3.27**	**4.18**	**4.94**	**6.16**
K100	8400	9100	A11	78.8	38.8	40	47.08	14.06	0.01	1.2	1.7	56.37	9.72	80.16	0.51	21.67	30.96	41.32	51.60	57.96	2.43	3.47	4.63	5.78	6.49											
			A16	63.84	48	15.84	61.35	11.98	0.01	1.2	1.7	56.37	13.19	81.55	0.571	21.42	30.62	40.90	51.12	57.32	2.17	3.1	4.14	5.18	5.81											
			Total	**142.64**							1.7										**4.6**	**6.57**	**8.77**	**10.96**	**12.3**											
			Total	**2922.64**							1.7										**81.91**	**114.97**	**150.12**	**182.46**	**215.7**	11.50	1.77	**48.18**	**67.63**	**88.30**	**107.33**	**126.88**	**27.22**	**38.21**	**49.89**	**60.64**	**71.68**
K100	9100	10900	A12	156.84	46.84	110	36.43	15.61	0.03	1.5	1.8	60.65	7.78	84.04	0.47	20.99	30.04	40.17	50.29	56.22	4.25	6.09	8.14	10.19	11.39											
			A14	11.34	11.34	0	75	10	0.01	1.2	1.8	60.65	16.67	87.31	0.631	20.46	29.32	39.26	49.24	54.85	0.41	0.58	0.78	0.98	1.09											
			A15	60.24	25	35.24	42.83	14.68	0.01	1.2	1.8	60.65	13.89	89.22	0.49	20.17	28.91	38.75	48.67	54.1	1.66	2.37	3.18	3.99	4.44											
			Total	228.42							1.8										**6.31**	**9.04**	**12.1**	**15.16**	**16.92**											
			Total	**3151.06**							1.8										**88.22**	**124.01**	**162.22**	**197.62**	**232.62**	13.00	2.02	**49.01**	**68.89**	**90.12**	**109.79**	**129.23**	**24.26**	**34.11**	**44.61**	**54.35**	**63.98**

Table Showing Adequacy Analysis Results for Tavarekere Valley - Existing Hydraulic Flow Conditions

Sl.No.	Description	Drain Reach		Chainage (m)		Catchment Area A (Ha.)	Type	Average Velocity V m/sec	Discharges (Q in m^3/sec)					Existing Av.Drain Depth D in m.	Area required for drain (A in m^2)					Existing Av. Drain Width (W in m.)	Required Drain Width (m)					Remarks				
		From	To	From	To				1year	2year	5year	10year	20year		1year	2year	5year	10year	20year		1year	2year	5year	10year	20year	1year	2year	5year	10year	20year
1	K200	Nimhans Hospital	Mundkar Fire service college	0	1075	49.43	Pri.	3.42	2.59	3.58	4.58	5.42	6.72	1.5	0.76	1.05	1.34	1.59	1.97	3.5	0.5	0.7	0.89	1.06	1.31	AD	AD	AD	AD	AD
2	K200	Mundkar Fire service college	Tank Bund Road, Near Bismillahanagar	1075	1850	87.42	Pri.	2.8	16.8	23.12	29.44	34.67	43.48	1.51	6	8.26	10.51	12.38	15.53	4.05	3.97	5.47	6.96	8.2	10.28	AD	IA	IA	IA	IA
3	K200	Tank Bund Road, Near Bismillahanagar	Lakshmi theater, near Bismillahanagar	1850	2250	348.68	Pri.	2.4	18.07	24.88	31.73	37.43	46.8	1.61	7.53	10.37	13.22	15.59	19.5	3.77	4.68	6.44	8.21	9.69	12.11	IA	IA	IA	IA	IA
4	K200	Lakshmi theater, near Bismillahanagar	Tavarekare Main Road	2250	2500	489.27	Pri.	2.21	19.97	27.55	35.2	41.62	51.8	1.87	9.04	12.47	15.93	18.83	23.44	6.24	4.83	6.67	8.52	10.07	12.54	AD	IA	IA	IA	IA
5	K200	Tavarekare Main Road	CSB Jr., Near Hosur Road	2500	4350	758.01	Pri.	1.65	25.87	35.83	46.02	54.8	67.34	2.03	15.68	21.72	27.89	33.21	40.81	8.28	7.72	10.7	13.74	16.36	20.1	AD	IA	IA	IA	IA
6	K200	CSB Jr., Near Hosur Road	HSRlayout Sector –VII, 5th Main Road	4350	5450	945.67	Pri.	1.82	31.52	43.82	56.54	67.71	82.31	2.14	17.32	24.07	31.06	37.2	45.22	12.37	8.09	11.25	14.52	17.38	21.13	AD	AD	IA	IA	IA
7	K200	HSRlayout Sector –VII, 5th Main Road	HSRlayout Sector –VII, 9th Main Road	5450	5800	1143.74	Pri.	1.3	33.61	46.78	60.46	72.54	87.87	1.76	25.85	35.99	46.51	55.8	67.59	14	14.69	20.45	26.42	31.7	38.4	IA	IA	IA	IA	IA
8	K200	HSRlayout Sector –VII, 9th Main Road	HSRlayout Sector –VII, 14th Main Road (Agara Tank)	5800	6075	1208.76	Pri.	1.76	37.26	51.83	66.93	80.23	97.36	1.96	21.17	29.45	38.03	45.58	55.32	14	10.8	15.03	19.4	23.26	28.22	AD	IA	IA	IA	IA
9	K200	HSRlayout Sector –VII, 14th Main Road (Agara Tank)	Bellandur Tank	6075	7625	1763.86	Pri.	1.8	49.84	69.78	90.85	110.05	130.96	2	27.69	38.77	50.47	61.14	72.76	20	13.84	19.38	25.24	30.57	36.38	AD	AD	IA	IA	IA
10	K201	Vanganahalli	Near Agara Tank	0	1350	137.93	Sec.	1.68	6.83	9.53	12.35	14.87	17.89	1.62	4.06	5.67	7.35	8.85	10.65	3.66	2.51	3.5	4.54	5.46	6.57	AD	AD	IA	IA	IA
11	K202	Yellukunte	Venkatapura	0	950	65.02	Sec.	1.36	3.65	5.05	6.47	7.68	9.49	1.64	2.68	3.71	4.76	5.65	6.98	2.8	1.64	2.26	2.9	3.45	4.25	AD	AD	IA	IA	IA
12	K203	Crompton Greeves	Outer Ring Road	0	1200	148.08	Sec.	1.12	7.2	10.03	12.96	15.55	18.84	1.19	6.43	8.95	11.58	13.89	16.82	2.26	5.4	7.53	9.73	11.67	14.13	IA	IA	IA	IA	IA
13	K204	Near Madivala Tank	Hosur Road	0	705	95.05	Sec.	2.26	4.74	6.57	8.42	10.01	12.34	1.33	2.1	2.9	3.73	4.43	5.46	3.5	1.58	2.18	2.8	3.33	4.11	AD	AD	AD	AD	IA

Table Showing Adequacy Analysis Results for Tavarekere Valley - Existing Hydraulic Flow Conditions

Sl.No.	Description	Drain Reach		Chainage (m)		Catchment Area A (Ha.)	Type	Average Velocity V m/sec	Discharges (Q in m^3/sec)					Existing Av.Drain Depth D in m.	Area required for drain (A in m^2)					Existing Av. Drain Width (W in m.)	Required Drain Width (m)					Remarks				
		From	To	From	To				1year	2year	5year	10year	20year		1year	2year	5year	10year	20year		1year	2year	5year	10year	20year	1year	2year	5year	10year	20year
14	K205	Muddaramnagar	Bismillahanagar	0	525	66.15	Sec.	3	6.38	8.81	11.28	13.36	16.57	1.3	2.13	2.94	3.76	4.45	5.52	3.8	1.64	2.29	2.93	3.47	4.31	AD	AD	AD	AD	IA
15	K206	Tayappanahalli	Bovi Colony	0	1245	94.8	Sec.	2.1	4.51	6.25	8.02	9.54	11.74	2	2.15	2.98	3.82	4.54	5.59	4.4	1.07	1.49	1.91	2.27	2.8	AD	AD	AD	AD	AD
16	K207	Bairasandra Extn.	Baivasandra Extention	0	425	61.35	Sec.	2.33	3.44	4.73	6.01	7.05	8.9	1.7	1.48	2.03	2.58	3.03	3.82	2	0.87	1.19	1.52	1.78	2.25	AD	AD	AD	AD	IA
17	K207	Baivasandra Extention	Bannerghatta Road	425	1225	178.62	Sec.	2.1	10.24	14.04	17.81	20.86	26.42	1.56	4.87	6.68	8.48	9.93	12.58	4.5	3.12	4.29	5.44	6.37	8.06	AD	AD	IA	IA	IA
18	K208	Tilaknagar	Krishnappa Garden	0	425	77.44	Sec.	1.95	4.47	6.12	7.72	9	11.51	2	2.29	3.14	3.96	4.62	5.9	3	1.15	1.57	1.98	2.31	2.95	AD	AD	AD	AD	AD
19	K209	Jaya Nagar 4th Block	J.P. Nagar 2nd Club Shopping Complex	0	1500	230.85	Sec.	2.9	13.96	19.19	24.41	28.7	36.1	1.9	4.81	6.62	8.42	9.9	12.45	4	2.53	3.48	4.43	5.21	6.55	AD	AD	IA	IA	IA
20	K209	Jaya Nagar 4th Block	J.P. Nagar 2nd Club Shopping Complex	1500	2825	323.6	Sec.	3.5	19.57	26.92	34.29	40.38	50.64	1.9	5.59	7.69	9.8	11.54	14.47	6.5	2.94	4.05	5.16	6.07	7.61	AD	AD	AD	AD	IA
21	K209	J.P. Nagar 2nd Club Shopping Complex	Ring Road	2825	4500	496	Sec.	2.5	28.76	39.68	50.71	59.99	74.61	2.1	11.5	15.87	20.28	24	29.84	8	5.48	7.56	9.66	11.43	14.21	AD	AD	IA	IA	IA
22	K209	Ring Road	Anthappa Layout	4500	6000	627.96	Sec.	1.2	34.3	47.51	61.03	72.66	89.3	1.4	28.58	39.59	50.86	60.55	74.41	10	20.42	28.28	36.33	43.25	53.15	IA	IA	IA	IA	IA
23	K209	Anthappa Layout	Madivala Tank	6000	8250	716.14	Sec.	0.9	38.11	52.89	68.12	81.38	99.38	1.5	42.34	58.77	75.69	90.42	110.42	8.5	28.23	39.18	50.46	60.28	73.62	IA	IA	IA	IA	IA
24	K210	J.P.Nagar, Puttenhalli	Sarakki Layout	0	1700	120	Sec.	1.8	6.76	9.37	12.05	14.37	17.61	1.8	3.76	5.21	6.7	7.98	9.79	2.2	2.09	2.89	3.72	4.43	5.44	AD	IA	IA	IA	IA

Land Use Analysis for Tavarekere Valley – Existing Hydraulic Flow Conditions

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of bulitup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m^3/sec.				Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m^2					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)		(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
K200	0	1075	A1(a)	19.66	10	9.66	47.98	13.93	0.02	1.5	3.42	5.24	8.89	28.06	0.414	43.93	60.61	77.48	91.67	113.98	0.99	1.37	1.75	2.58												
			A1(b)	29.77	19.02	10.75	55.14	12.89	0.01	1.2	3.42	5.24	11.11	29.24	0.452	42.72	59.04	75.59	89.63	110.99	1.6	2.21	2.82	4.15												
			Total	**49.43**							3.42										**2.59**	**3.58**	**4.58**	**6.72**	3.5	1.5	**0.8**	**1.0**	**1.3**	**1.6**	**2.0**	**0.5**	**0.7**	**0.9**	**1.1**	**1.3**
K207	0	425	A2(a)	35.16	12.16	23.00	39.02	15.23	0.02	1.5	2.33	3.04	4.44	22.72	0.352	50.63	69.38	87.93	102.90	130.58	1.74	2.38	3.02	4.49												
			A2(c)	26.19	26.19	0.00	75	10	0.01	1.2	2.33	3.04	12.5	25.54	0.501	46.80	64.37	81.97	96.51	121.10	1.71	2.35	2.99	4.41												
			Total	**61.35**							2.33										**3.44**	**4.73**	**6.01**	**8.9**	2	1.7	**1.5**	**2.0**	**2.6**	**3.0**	**3.8**	**0.9**	**1.2**	**1.5**	**1.8**	**2.2**
K208	0	425	A2(b)	18.28	14	4.28	62.12	11.87	0.01	1.2	1.95	3.63	3.47	18.98	0.42	57.15	77.85	97.93	113.55	146.63	1.23	1.67	2.1	3.14												
			A2(d)	59.16	30	29.16	47.89	13.94	0.01	1.2	1.95	3.63	4.17	21.74	0.379	52.15	71.36	90.27	105.40	134.33	3.25	4.45	5.62	8.37												
			Total	**77.44**							1.95										**4.47**	**6.12**	**7.72**	**11.51**	3	2	**2.3**	**3.1**	**4.0**	**4.6**	**5.9**	**1.1**	**1.6**	**2.0**	**2.3**	**3.0**
K207	425	1225	A22	39.83	29.83	10.00	61.19	12.01	0.01	1.2	2.1	6.35	8.33	26.69	0.461	45.43	62.58	79.84	94.21	117.70	**2.32**	**3.19**	**4.07**	**6.01**												
			Total	**178.62**							2.1										**10.24**	**14.04**	**17.81**	**26.42**	4.5	1.56	**4.9**	**6.7**	**8.5**	**9.9**	**12.6**	**3.1**	**4.3**	**5.4**	**6.4**	**8.1**
K200	1075	1850	A3	18.77	5	13.77	34.65	15.87	0.02	1.5	2.8	11.01	2.22	29.1	0.365	42.86	59.21	75.80	89.85	111.32	0.82	1.13	1.44	2.12												
			A4	21.3	10	11.3	45.82	14.24	0.01	1.2	2.8	11.01	4.17	29.42	0.41	42.54	58.80	75.31	89.32	110.54	1.03	1.43	1.83	2.69												
			A22	47.35	17.62	29.73	40.47	15.02	0.02	1.5	2.8	11.01	5.56	31.59	0.4	40.56	56.19	72.17	85.91	105.60	2.13	2.94	3.78	5.53												
			Total	**87.42**							2.8										**3.98**	**5.5**	**7.06**	**10.34**												
			Total	**315.47**							2.8										**16.8**	**23.12**	**29.44**	**43.48**	4.05	1.51	**6**	**8.26**	**10.51**	**12.38**	**15.53**	**3.97**	**5.47**	**6.96**	**8.2**	**10.28**
K200	1850	2250	A5	33.21	8.21	25	33.6	16.02	0.01	1.2	2.4	15.63	8.33	39.98	0.396	34.61	48.32	62.68	75.52	90.73	1.27	1.77	2.29	3.32												
			Total	**348.68**							2.4										**18.07**	**24.88**	**31.73**	**46.8**	3.77	1.61	**7.53**	**10.37**	**13.22**	**15.59**	**19.5**	**4.68**	**6.44**	**8.21**	**9.69**	**12.11**
K206	0	1245	A21(a)	42.06	22.06	20	48.85	13.8	0.02	1.5	2.1	9.88	5.56	29.24	0.423	42.72	59.03	75.59	89.62	110.99	2.11	2.92	3.74	5.49												

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of builtup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m^3/sec.				Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m^2					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)		(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
			A21(b)	52.74	22.74	30	43.71	14.55	0.01	1.2	2.1	9.88	8.33	32.76	0.414	39.57	54.89	70.61	84.21	103.14	2.4	3.33	4.28	6.26												
			Total	**94.8**							2.1										**4.51**	**6.25**	**8.02**	**11.74**	4.4	2	**2.1**	**3.0**	**3.8**	**4.5**	**5.6**	**1.1**	**1.5**	**1.9**	**2.3**	**2.8**
K200	2250	2500	A6	**45.79**	20	25.79	44.02	14.51	0.01	1.2	2.21	18.85	9.72	43.08	0.46	32.91	46.07	59.93	72.49	86.47	1.91	2.67	3.47	5.01											
			Total	**489.27**							2.21										**19.97**	**27.55**	**35.2**	**51.8**	6.24	1.87	**9.04**	**12.47**	**15.93**	**18.83**	**23.44**	**4.83**	**6.67**	**8.52**	**10.07**	**12.54**
K205	0	525	A20(a)	33.3	28	5.3	66.25	11.27	0.02	1.5	3	2.92	13.33	27.52	0.49	44.50	61.37	78.38	92.64	115.4	2	2.76	3.53	5.2											
			A20(b)	80.41	54.78	25.63	57.47	12.55	0.01	1.2	3	2.92	13.89	29.36	0.460	42.61	58.89	75.41	89.43	110.71	4.38	6.05	7.75	11.38												
			Total	**113.71**							3										**6.38**	**8.81**	**11.28**	**16.57**	3.8	1.3	**2.1**	**2.9**	**3.8**	**4.5**	**5.5**	**1.6**	**2.3**	**2.9**	**3.4**	**4.2**
K200	2500	4350	A7	33.53	10	23.53	36.4	15.61	0.01	1.2	1.65	18.69	11.11	45.41	0.428	31.77	44.54	58.07	70.43	83.58	1.27	1.77	2.31	3.33											
			A8	40.74	14.84	25.9	40.03	15.09	0.01	1.2	1.65	18.69	13.89	47.66	0.45	30.75	43.19	56.41	68.59	81.02	1.57	2.2	2.88	4.13												
			A19	80.76	30.76	50	40.95	14.95	0.01	1.2	1.65	18.69	16.67	50.31	0.46	29.65	41.72	54.62	66.59	78.25	3.06	4.31	5.64	8.07												
			Total	**155.03**							1.65										**5.89**	**8.28**	**10.83**	**15.54**												
			Total	**758.01**							1.65										**25.87**	**35.83**	**46.02**	**67.34**	8.28	2.03	**15.7**	**21.7**	**27.9**	**33.2**	**40.8**	**7.7**	**10.7**	**13.7**	**16.4**	**20.1**
K204	0	705	A18 (a)	49	20	29	42.45	14.73	0.02	1.5	2.26	5.2	8.89	28.82	0.393	43.14	59.58	76.24	90.33	112.02	2.31	3.19	4.08	6											
			A 18 (b)	46.05	33	13.05	59.41	12.27	0.01	1.2	2.26	5.2	15.28	32.74	0.480	39.59	54.91	70.64	84.24	103.18	2.43	3.37	4.34	6.34												
			Total	**95.05**							2.26										**4.74**	**6.57**	**8.42**	**12.34**	3.5	1.33	**2.1**	**2.9**	**3.7**	**4.4**	**5.5**	**1.6**	**2.2**	**2.8**	**3.3**	**4.1**
K200	4350	5450	A10	34.49	25	9.49	59.87	12.2	0.01	1.2	1.82	32.97	11.11	56.28	0.55	27.50	38.83	51.07	62.63	72.79	1.46	2.06	2.71	3.86											
			A9	45.33	34.9	10.43	62.35	11.84	0.01	1.2	1.82	32.97	12.5	57.31	0.57	27.16	38.38	50.52	62.01	71.95	1.95	2.75	3.62	5.15												
			A17	58.12	32.12	26	50.4	13.58	0.01	1.2	1.82	32.97	12.5	59.05	0.522	26.62	37.65	49.62	61.00	70.58	2.24	3.18	4.18	5.95												
			Total	**92.61**							1.82										**5.65**	**7.99**	**10.51**	**14.97**												
			Total	**945.67**							1.82										**31.52**	**43.82**	**56.54**	**82.31**	12.37	2.14	**17.3**	**24.1**	**31.1**	**37.2**	**45.2**	**8.1**	**11.2**	**14.5**	**17.4**	**21.1**

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of builtup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m^3/sec.				Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m^2					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)		(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
K203	0	1200	A15(a)	23.86	18	5.86	61.49	11.96	0.01	1.2	1.12	17.86	5.56	35.38	0.5	37.58	52.26	67.44	80.75	98.17	1.24	1.73	2.23	3.25												
			A15(b)	43	27.5	15.5	55.17	12.88	0.01	1.2	1.12	17.86	5.56	36.3	0.48	36.94	51.41	66.41	79.62	96.56	2.11	2.93	3.79	5.51												
			A16	81.22	50	31.22	53.86	13.08	0.02	1.5	1.12	17.86	6.67	37.6	0.47	36.07	50.26	65.02	78.1	94.39	3.85	5.36	6.94	10.08												
			Total	**148.08**							1.12										**7.2**	**10.03**	**12.96**	**18.84**	2.26	1.19	**6.4**	**9.0**	**11.6**	**13.9**	**16.8**	**5.4**	**7.5**	**9.7**	**11.7**	**14.1**
K200	5450	5800	A11	49.99	41.38	8.61	65.53	11.38	0.01	1.2	1.3	45.51	5.56	62.45	0.588	25.64	36.33	47.99	59.16	68.08	**2.09**	**2.97**	**3.92**	**5.56**												
			Total	**1143.74**							1.3			62.45							**33.61**	**46.78**	**60.46**	**87.87**	14	1.76	**25.9**	**36.0**	**46.5**	**55.8**	**67.6**	**14.7**	**20.4**	**26.4**	**31.7**	**38.4**
K202	0	950	A14(a)	46.84	32.57	14.27	58.24	12.44	0.01	1.2	1.36	11.64	5.56	29.63	0.464	42.34	58.53	74.99	88.97	110.03	2.56	3.53	4.53	6.65												
			A14(b)	18.18	18.18	0	75	10	0.01	1.2	1.36	11.64	9.72	31.36	0.531	40.75	56.44	72.48	86.25	106.09	1.09	1.51	1.94	2.84												
			Total	**65.02**							1.36										**3.65**	**5.05**	**6.47**	**9.49**	2.8	1.64	**2.7**	**3.7**	**4.8**	**5.7**	**7.0**	**1.6**	**2.3**	**2.9**	**3.4**	**4.3**
K200	5800	6075	**Total**	**1208.76**							1.76	3.37		65.82							**37.26**	**51.83**	**66.93**	**97.36**	14	1.96	**21.2**	**29.4**	**38.0**	**45.6**	**55.3**	**10.8**	**15.0**	**19.4**	**23.3**	**28.2**
K201	0	1350	A12(c)	137.93	102	35.93	60.67	12.08	0.01	1.2	1.68	13.39	13.89	39.37	0.51	34.97	48.81	63.26	76.16	91.64	6.83	9.53	12.35	17.89	3.66	1.62	**4.1**	**5.7**	**7.3**	**8.8**	**10.6**	**2.5**	**3.5**	**4.5**	**5.5**	**6.6**
K200	6075	7625	A12(b)	252.2	88.3	163.9	39.26	15.2	0.01	1.2	1.8	49.77	11.11	76.08	0.478	22.45	32.02	42.63	53.10	59.94	7.51	10.72	14.27	20.06												
			A13	129.22	54.22	75	43.08	14.64	0.01	1.2	1.8	49.77	15.28	79.69	0.495	21.76	31.08	41.47	51.77	58.18	3.86	5.52	7.36	10.33												
			A12(a)	35.75	25.02	10.73	58.49	12.4	0.01	1.2	1.8	49.77	18.06	80.23	0.56	21.66	30.95	41.3	51.58	57.93	1.2	1.72	2.29	3.21												
			Total	**417.17**																	**12.58**	**17.95**	**23.92**	**33.61**											
			Total	**1763.86**							1.8										**49.84**	**69.78**	**90.85**	**130.96**	20	2	**27.7**	**38.8**	**50.5**	**61.1**	**72.8**	**13.8**	**19.4**	**25.2**	**30.6**	**36.4**
K209	0	1500	A23(a)	134.11	95.79	38.32	59.28	12.29	0.02	1.5	2.9	8.62	3.33	24.24	0.443	48.47	66.56	84.58	99.31	125.24	8	10.98	13.95	20.66												
			A23(b)	66.74	56.25	10.49	66.36	11.26	0.02	1.5	2.9	8.62	5.56	25.43	0.476	46.93	64.55	82.18	96.73	121.42	4.14	5.7	7.26	10.72												
			A22	30	25.4	4.6	66.57	11.23	0.01	1.2	2.9	8.62	6.94	26.79	0.482	45.31	62.43	79.66	94.02	117.42	1.82	2.51	3.2	4.71												
			Total	**230.85**							2.9										**13.96**	**19.19**	**24.41**	**36.1**	4	1.9	**4.8**	**6.6**	**8.4**	**9.9**	**12.4**	**2.5**	**3.5**	**4.4**	**5.2**	**6.6**

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of builtup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m^3/sec.				Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m^2					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)		(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
K209	1500	2825	A23(a)	29.47	26.9	2.57	70.2	10.7	0.02	1.5	3.5	9.52	6.67	26.89	0.498	45.20	62.29	79.48	93.83	117.15	1.84	2.54	3.24	4.78												
			A23(b)	32.56	28.15	4.41	67.55	11.08	0.01	1.2	3.5	9.52	6.94	27.55	0.491	44.47	61.33	78.33	92.59	115.32	1.97	2.72	3.48	5.12												
			A24(a)	30.72	25.12	5.6	64.97	11.46	0.01	1.2	3.5	9.52	7.64	28.62	0.484	43.34	59.85	76.57	90.68	112.53	1.79	2.47	3.16	4.64												
			Total	**92.75**							3.5										**5.61**	**7.73**	**9.88**	**14.54**												
			Total	**323.6**							3.5										**19.57**	**26.92**	**34.29**	**50.64**	6.5	1.9	**5.6**	**7.7**	**9.8**	**11.5**	**14.5**	**2.9**	**4.0**	**5.2**	**6.1**	**7.6**
K210	0	1700	A24(a)	120	102.26	17.74	66.87	11.18	0.02	1.5	1.8	15.74	5.56	32.48	0.509	39.81	55.20	70.98	84.62	103.73	6.76	9.37	12.05	17.61												
			Total	**120**							1.8										**6.76**	**9.37**	**12.05**	**17.61**	2.2	1.8	**3.8**	**5.2**	**6.7**	**8.0**	**9.8**	**2.1**	**2.9**	**3.7**	**4.4**	**5.4**
K209	2825	4500	A24(b)	22.9	18	4.9	63.23	11.71	0.01	1.2	2.5	16.67	6.94	35.32	0.51	37.62	52.31	67.50	80.82	98.27	1.22	1.69	2.18	3.17												
			A24(a)	29.5	10	19.5	38.64	15.29	0.01	1.2	2.5	16.67	5.56	37.51	0.41	36.13	50.34	65.12	78.20	94.53	1.22	1.69	2.19	3.18												
			Total	**52.4**							2.5										2.43	3.38	4.37	6.35												
			Total	**496**							2.5										**28.76**	**39.68**	**50.71**	**74.61**	8	2.1	**11.5**	**15.9**	**20.3**	**24.0**	**29.8**	**5.5**	**7.6**	**9.7**	**11.4**	**14.2**
K209	4500	6000	A25(a)	34.37	20	14.37	52	13.34	0.02	1.5	1.2	34.72	8.89	56.96	0.52	27.28	38.53	50.71	62.22	72.23	1.37	1.93	2.54	3.62												
			A25(b)	37.59	25	12.59	56.58	12.68	0.01	1.2	1.2	34.72	12.5	59.9	0.55	26.37	37.31	49.20	60.52	69.93	1.51	2.13	2.81	4												
			A19	60	51.45	8.55	67.16	11.14	0.02	1.5	1.2	34.72	11.11	56.97	0.59	27.27	38.52	50.70	62.21	72.22	2.67	3.78	4.97	7.08												
			Total	**131.96**							1.2										5.55	7.84	10.32	14.69												
			Total	**627.96**							1.2										**34.3**	**47.51**	**61.03**	**89.3**	10	1.4	**28.6**	**39.6**	**50.9**	**60.6**	**74.4**	**20.4**	**28.3**	**36.3**	**43.3**	**53.2**
K209	6000	8250	A26(a)	40.58	33.68	6.9	65.65	11.36	0.01	1.2	0.9	37.04	9.72	58.12	0.584	26.91	38.04	50.09	61.53	71.30	1.77	2.5	3.3	4.69												
			A26(b)	47.6	38.55	9.05	64.54	11.52	0.01	1.2	0.9	37.04	11.11	59.67	0.582	26.44	37.40	49.31	60.65	70.10	2.03	2.88	3.79	5.39												
			Total	**88.18**							0.9										3.8	5.38	7.09	10.08												
			Total	**716.14**							0.9										**38.11**	**52.89**	**68.12**	**99.38**	8.5	1.5	**42.3**	**58.8**	**75.7**	**90.4**	**110.4**	**28.2**	**39.2**	**50.5**	**60.3**	**73.6**

Table Showing Adequacy Analysis Results for Tavarekere Valley - For Improved Hydraulic Flow Conditions

Sl.No.	Description	Drain Reach		Chainage (m)		Catchment Area A (Ha.)	Type	Average Velocity V m/sec	Discharges (Q in m^3/sec)					Existing Av.Drain Depth D in m.	Area required for drain (A in m^2)					Existing Av. Drain Width (W in m.)	Required Drain Width (m)					Remarks				
		From	To	From	To				1year	2year	5year	10year	20year		1year	2year	5year	10year	20year		1year	2year	5year	10year	20year	1year	2year	5year	10year	20year
1	K200	Nimhans Hospital	Mundkar Fire service college	0	1075	49.43	Pri.	5.29	2.59	3.58	4.58	5.42	6.72	1.5	0.49	0.68	0.86	1.02	1.27	3.5	0.33	0.45	0.58	0.68	0.85	AD	AD	AD	AD	AD
2	K200	Mundkar Fire service college	Tank Bund Road, Near Bismillahanagar	1075	1850	87.42	Pri.	3.7	16.84	23.17	29.51	34.75	43.59	1.6	4.55	6.26	7.98	9.39	11.78	4.05	2.85	3.91	4.98	5.87	7.36	AD	AD	IA	IA	IA
3	K200	Tank Bund Road, Near Bismillahanagar	Lakshmi theater, near Bismillahanagar	1850	2250	348.68	Pri.	4.35	18.11	24.94	31.8	37.51	46.91	1.8	4.17	5.74	7.32	8.63	10.79	4.1	2.31	3.19	4.06	4.79	5.99	AD	AD	AD	IA	IA
4	K200	Lakshmi theater, near Bismillahanagar	Tavarekare Main Road	2250	2500	489.27	Pri.	3.71	20.01	27.61	35.27	41.71	51.91	2	5.39	7.43	9.5	11.23	13.98	7	2.69	3.72	4.75	5.62	6.99	AD	AD	AD	AD	AD
5	K200	Tavarekare Main Road	CSB Jr., Near Hosur Road	2500	4350	758.01	Pri.	3.59	25.91	35.89	46.1	54.88	67.45	2.4	7.22	10	12.84	15.29	18.79	10.5	3.01	4.17	5.35	6.37	7.83	AD	AD	AD	AD	AD
6	K200	CSB Jr., Near Hosur Road	HSRlayout Sector –VII, 5th Main Road	4350	5450	945.67	Pri.	3.36	31.56	43.87	56.61	67.79	82.42	2.2	9.4	13.07	16.86	20.2	24.55	12.37	4.27	5.94	7.67	9.18	11.16	AD	AD	AD	AD	AD
7	K200	HSRlayout Sector –VII, 5th Main Road	HSRlayout Sector –VII, 9th Main Road	5450	5800	1143.74	Pri.	2.4	33.65	46.84	60.53	72.63	87.98	1.9	14.02	19.51	25.21	30.25	36.65	14	7.38	10.27	13.27	15.92	19.29	AD	AD	AD	IA	IA
8	K200	HSRlayout Sector –VII, 9th Main Road	HSRlayout Sector –VII, 14th Main Road (Agara Tank)	5800	6075	1208.76	Pri.	3.14	37.33	51.92	67.05	80.37	97.53	2	11.9	16.56	21.38	25.63	31.11	14	5.95	8.28	10.69	12.82	15.55	AD	AD	AD	AD	IA
9	K200	HSRlayout Sector –VII, 14th Main Road (Agara Tank)	Bellandur Tank	6075	7625	1763.86	Pri.	2.38	49.91	69.87	90.97	110.19	131.14	2.2	20.97	29.36	38.23	46.3	55.1	24	9.53	13.35	17.38	21.05	25.05	AD	AD	AD	AD	IA
10	K201	Vanganahalli	Near Agara Tank	0	1350	137.93	Sec.	2.56	6.83	9.53	12.35	14.87	17.89	1.7	2.66	3.72	4.82	5.8	6.98	3.8	1.57	2.19	2.83	3.41	4.1	AD	AD	AD	AD	IA
11	K202	Yellukunte	Venkatapura	0	950	65.02	Sec.	2.15	3.67	5.08	6.52	7.74	9.55	1.7	1.71	2.36	3.03	3.6	4.44	2.8	1.01	1.39	1.78	2.12	2.61	AD	AD	AD	AD	AD
12	K203	Crompton Greeves	Outer Ring Road	0	1200	148.08	Sec.	2.2	7.2	10.03	12.96	15.55	18.84	1.4	3.28	4.57	5.9	7.08	8.58	4	2.34	3.26	4.22	5.06	6.13	AD	AD	IA	IA	IA
13	K204	Near Madivala Tank	Hosur Road	0	705	95.05	Sec.	3.19	4.74	6.57	8.42	10.01	12.34	1.4	1.49	2.06	2.64	3.14	3.87	3.5	1.06	1.47	1.89	2.25	2.77	AD	AD	AD	AD	AD
14	K205	Muddaramnagar	Bismillahanagar	0	525	66.15	Sec.	5.45	6.38	8.81	11.28	13.36	16.57	1.3	1.17	1.62	2.07	2.45	3.04	3.8	0.9	2.29	2.93	3.47	4.31	AD	AD	AD	AD	IA

Table Showing Adequacy Analysis Results for Tavarekere Valley - For Improved Hydraulic Flow Conditions

Sl.No.	Description	Drain Reach		Chainage (m)		Catchment Area A (Ha.)	Type	Average Velocity V m/sec	Discharges (Q in m^3/sec)					Existing Av.Drain Depth D in m.	Area required for drain (A in m^2)					Existing Av. Drain Width (W in m.)	Required Drain Width (m)					Remarks				
		From	To	From	To				1year	2year	5year	10year	20year		1year	2year	5year	10year	20year		1year	2year	5year	10year	20year	1year	2year	5year	10year	20year
15	K206	Tayappanahalli	Bovi Colony	0	1245	94.8	Sec.	4.36	4.51	6.25	8.02	9.54	11.74	2	1.03	1.43	1.84	2.19	2.69	4.4	0.52	0.72	0.92	1.09	1.35	AD	AD	AD	AD	AD
16	K207	Bairasandra Extn.	Baivasandra Extention	0	425	61.35	Sec.	3.98	3.49	4.79	6.08	7.14	9.01	1.7	0.88	1.2	1.53	1.79	2.26	2	0.51	0.71	0.9	1.05	1.33	AD	AD	AD	AD	AD
17	K207	Baivasandra Extention	Bannerghatta Road	425	1225	178.62	Sec.	4.27	10.28	14.1	17.88	20.95	26.53	1.6	2.41	3.3	4.19	4.91	6.22	6	1.51	2.07	2.62	3.07	3.89	AD	AD	AD	AD	AD
18	K208	Tilaknagar	Krishnappa Garden	0	425	77.44	Sec.	3.79	4.47	6.12	7.72	9	11.51	2	1.18	1.61	2.04	2.37	3.04	3	0.59	0.81	1.02	1.19	1.52	AD	AD	AD	AD	AD
19	K209	Jaya Nagar 4th Block	J.P. Nagar 2nd Club Shopping Complex	0	1500	230.85	Sec.	3.33	13.96	19.19	24.41	28.7	36.1	1.9	4.19	5.76	7.32	8.61	10.83	4	2.2	3.03	3.85	4.53	5.7	AD	AD	AD	IA	IA
20	K209	Jaya Nagar 4th Block	J.P. Nagar 2nd Club Shopping Complex	1500	2825	323.6	Sec.	3.92	19.57	26.92	34.29	40.38	50.64	1.9	4.99	6.86	8.74	10.3	12.91	6.5	2.63	3.61	4.6	5.42	6.8	AD	AD	AD	AD	IA
21	K209	J.P. Nagar 2nd Club Shopping Complex	Ring Road	2825	4500	496	Sec.	3.73	28.76	39.68	50.71	59.99	74.61	2.2	7.71	10.64	13.6	16.09	20.01	11	3.5	4.84	6.18	7.31	9.09	AD	AD	AD	AD	AD
22	K209	Ring Road	Anthappa Layout	4500	6000	627.96	Sec.	1.5	34.3	47.51	61.03	72.66	89.3	1.4	22.85	31.65	40.65	48.4	59.48	10	16.32	22.61	29.04	34.57	42.49	IA	IA	IA	IA	IA
23	K209	Anthappa Layout	Madivala Tank	6000	8250	716.14	Sec.	0.87	38.11	52.89	68.12	81.38	99.38	1.5	43.57	60.47	77.88	93.04	113.63	8.5	29.04	40.32	51.92	62.03	75.75	IA	IA	IA	IA	IA
24	K210	J.P.Nagar, Puttenhalli	Sarakki Layout	0	1700	120	Sec.	2.49	6.76	9.37	12.05	14.37	17.61	1.8	2.72	3.77	4.85	5.78	7.08	2.2	1.51	2.09	2.69	3.21	3.93	AD	AD	IA	IA	IA

Land Use Analysis for Tavarekere Valley – Hydraulic Flow Conditions Clean Condition

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of bulitup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m^3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m^2					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)		(For 10 Year)	(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
K200	0	1075	A1(a)	19.66	10	9.66	47.98	13.93	0.02	1.5	3.42	5.24	8.89	28.06	0.414	43.93	60.61	77.48	91.67	113.98	0.99	1.37	1.75	2.07	2.58												
			A1(b)	29.77	19.02	10.75	55.14	12.89	0.01	1.2	3.42	5.24	11.11	29.24	0.452	42.72	59.04	75.59	89.63	110.99	1.6	2.21	2.82	3.35	4.15												
			Total	**49.43**							3.42										**2.59**	**3.58**	**4.58**	**5.42**	**6.72**	3.5	1.5	**0.8**	**1.0**	**1.3**	**1.6**	**2.0**	**0.5**	**0.7**	**0.9**	**1.1**	**1.3**
K207	0	425	A2(a)	35.16	12.16	23.00	39.02	15.23	0.02	1.5	2.33	3.04	4.44	22.72	0.352	50.63	69.38	87.93	102.90	130.58	1.74	2.38	3.02	3.54	4.49												
			A2(c)	26.19	26.19	0.00	75	10	0.01	1.2	2.33	3.04	12.5	25.54	0.513	46.80	64.37	81.97	96.51	121.10	1.75	2.4	3.06	3.6	4.52												
			Total	**61.35**							2.33										**3.49**	**4.79**	**6.08**	**7.14**	**9.01**	2	1.7	**1.5**	**2.1**	**2.6**	**3.1**	**3.9**	**0.9**	**1.2**	**1.5**	**1.8**	**2.3**
K208	0	425	A2(b)	18.28	14	4.28	62.12	11.87	0.01	1.2	1.95	3.63	3.47	18.98	0.42	57.15	77.85	97.93	113.55	146.63	1.23	1.67	2.1	2.43	3.14												
			A2(d)	59.16	30	29.16	47.89	13.94	0.01	1.2	1.95	3.63	4.17	21.74	0.379	52.15	71.36	90.27	105.40	134.33	3.25	4.45	5.62	6.57	8.37												
			Total	**77.44**							1.95										**4.47**	**6.12**	**7.72**	**9**	**11.51**	3	2	**2.3**	**3.1**	**4.0**	**4.6**	**5.9**	**1.1**	**1.6**	**2.0**	**2.3**	**3.0**
K207	425	1225	A22	39.83	29.83	10.00	61.19	12.01	0.01	1.2	2.1	6.35	8.33	26.69	0.461	45.43	62.58	79.84	94.21	117.70	**2.32**	**3.19**	**4.07**	**4.81**	**6.01**												
			Total	**178.62**							2.1										**10.28**	**14.1**	**17.88**	**20.95**	**26.53**	4.5	1.56	**4.9**	**6.7**	**8.5**	**10.0**	**12.6**	**3.1**	**4.3**	**5.5**	**6.4**	**8.1**
K200	1075	1850	A3	18.77	5	13.77	34.65	15.87	0.02	1.5	2.8	11.01	2.22	29.1	0.365	42.86	59.21	75.80	89.85	111.32	0.82	1.13	1.44	1.71	2.12												
			A4	21.3	10	11.3	45.82	14.24	0.01	1.2	2.8	11.01	4.17	29.42	0.41	42.54	58.80	75.31	89.32	110.54	1.03	1.43	1.83	2.17	2.69												
			A22	47.35	17.62	29.73	40.47	15.02	0.02	1.5	2.8	11.01	5.56	31.59	0.4	40.56	56.19	72.17	85.91	105.60	2.13	2.94	3.78	4.5	5.53												
			Total	**87.42**							2.8										**3.98**	**5.5**	**7.06**	**8.38**	**10.34**												
			Total	**315.47**							2.8										**16.84**	**23.17**	**29.51**	**34.75**	**43.59**	4.05	1.51	**6.02**	**8.28**	**10.54**	**12.41**	**15.57**	**3.98**	**5.48**	**6.98**	**8.22**	**10.31**
K200	1850	2250	A5	33.21	8.21	25	33.6	16.02	0.01	1.2	2.4	15.63	8.33	39.98	0.396	34.61	48.32	62.68	75.52	90.73	1.27	1.77	2.29	2.76	3.32												
			Total	**348.68**							2.4										**18.11**	**24.94**	**31.8**	**37.51**	**46.91**	3.77	1.61	**7.55**	**10.39**	**13.25**	**15.63**	**19.54**	**4.69**	**6.45**	**8.23**	**9.71**	**12.14**
K206	0	1245	A21(a)	42.06	22.06	20	48.85	13.8	0.02	1.5	2.1	9.88	5.56	29.24	0.423	42.72	59.03	75.59	89.62	110.99	2.11	2.92	3.74	4.43	5.49												
			A21(b)	52.74	22.74	30	43.71	14.55	0.01	1.2	2.1	9.88	8.33	32.76	0.414	39.57	54.89	70.61	84.21	103.14	2.4	3.33	4.28	5.11	6.26												

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of bulitup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m^3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m^2					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)		(For 10 Year)	(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
			Total	**94.8**							2.1										**4.51**	**6.25**	**8.02**	**9.54**	**11.74**	4.4	2	**2.1**	**3.0**	**3.8**	**4.5**	**5.6**	**1.1**	**1.5**	**1.9**	**2.3**	**2.8**
K200	2250	2500	A6	**45.79**	20	25.79	44.02	14.51	0.01	1.2	2.21	18.85	9.72	43.08	0.46	32.91	46.07	59.93	72.49	86.47	1.91	2.67	3.47	4.2	5.01												
			Total	**489.27**							2.21										**20.01**	**27.61**	**35.27**	**41.71**	**51.91**	6.24	1.87	**9.06**	**12.49**	**15.96**	**18.87**	**23.49**	**4.84**	**6.68**	**8.53**	**10.09**	**12.56**
K205	0	525	A20(a)	33.3	28	5.3	66.25	11.27	0.02	1.5	3	2.92	13.33	27.52	0.49	44.50	61.37	78.38	92.64	115.4	2	2.76	3.53	4.17	5.2												
			A20(b)	80.41	54.78	25.63	57.47	12.55	0.01	1.2	3	2.92	13.89	29.36	0.460	42.61	58.89	75.41	89.43	110.71	4.38	6.05	7.75	9.19	11.38												
			Total	**113.71**							3										**6.38**	**8.81**	**11.28**	**13.36**	**16.57**	3.8	1.3	**2.1**	**2.9**	**3.8**	**4.5**	**5.5**	**1.6**	**2.3**	**2.9**	**3.4**	**4.2**
K200	2500	4350	A7	33.53	10	23.53	36.4	15.61	0.01	1.2	1.65	18.69	11.11	45.41	0.428	31.77	44.54	58.07	70.43	83.58	1.27	1.77	2.31	2.8	3.33												
			A8	40.74	14.84	25.9	40.03	15.09	0.01	1.2	1.65	18.69	13.89	47.66	0.45	30.75	43.19	56.41	68.59	81.02	1.57	2.2	2.88	3.5	4.13												
			A19	80.76	30.76	50	40.95	14.95	0.01	1.2	1.65	18.69	16.67	50.31	0.46	29.65	41.72	54.62	66.59	78.25	3.06	4.31	5.64	6.87	8.07												
			Total	**155.03**							1.65										**5.89**	**8.28**	**10.83**	**13.18**	**15.54**												
			Total	**758.01**							1.65										**25.91**	**35.89**	**46.1**	**54.88**	**67.45**	8.28	2.03	**15.7**	**21.8**	**27.9**	**33.3**	**40.9**	**7.7**	**10.7**	**13.8**	**16.4**	**20.1**
K204	0	705	A18 (a)	49	20	29	42.45	14.73	0.02	1.5	2.26	5.2	8.89	28.82	0.393	43.14	59.58	76.24	90.33	112.02	2.31	3.19	4.08	4.84	6												
			A 18 (b)	46.05	33	13.05	59.41	12.27	0.01	1.2	2.26	5.2	15.28	32.74	0.480	39.59	54.91	70.64	84.24	103.18	2.43	3.37	4.34	5.18	6.34												
			Total	**95.05**							2.26										**4.74**	**6.57**	**8.42**	**10.01**	**12.34**	3.5	1.33	**2.1**	**2.9**	**3.7**	**4.4**	**5.5**	**1.6**	**2.2**	**2.8**	**3.3**	**4.1**
K200	4350	5450	A10	34.49	25	9.49	59.87	12.2	0.01	1.2	1.82	32.97	11.11	56.28	0.55	27.50	38.83	51.07	62.63	72.79	1.46	2.06	2.71	3.32	3.86												
			A9	45.33	34.9	10.43	62.35	11.84	0.01	1.2	1.82	32.97	12.5	57.31	0.57	27.16	38.38	50.52	62.01	71.95	1.95	2.75	3.62	4.44	5.15												
			A17	58.12	32.12	26	50.4	13.58	0.01	1.2	1.82	32.97	12.5	59.05	0.522	26.62	37.65	49.62	61.00	70.58	2.24	3.18	4.18	5.14	5.95												
			Total	**92.61**							1.82										**5.65**	**7.99**	**10.51**	**12.91**	**14.97**												
			Total	**945.67**							1.82										**31.56**	**43.87**	**56.61**	**67.79**	**82.42**	12.37	2.14	**17.3**	**24.1**	**31.1**	**37.2**	**45.3**	**8.1**	**11.3**	**14.5**	**17.4**	**21.2**
K203	0	1200	A15(a)	23.86	18	5.86	61.49	11.96	0.01	1.2	1.12	17.86	5.56	35.38	0.5	37.58	52.26	67.44	80.75	98.17	1.24	1.73	2.23	2.67	3.25												
			A15(b)	43	27.5	15.5	55.17	12.88	0.01	1.2	1.12	17.86	5.56	36.3	0.48	36.94	51.41	66.41	79.62	96.56	2.11	2.93	3.79	4.55	5.51												

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of bulitup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m^3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m^2					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)		(For 10 Year)	(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
			A16	81.22	50	31.22	53.86	13.08	0.02	1.5	1.12	17.86	6.67	37.6	0.47	36.07	50.26	65.02	78.1	94.39	3.85	5.36	6.94	8.34	10.08													
			Total	**148.08**							1.12										**7.2**	**10.03**	**12.96**	**15.55**	**18.84**	2.26	1.19	**6.4**	**9.0**	**11.6**	**13.9**	**16.8**	**5.4**	**7.5**	**9.7**	**11.7**	**14.1**
K200	5450	5800	A11	49.99	41.38	8.61	65.53	11.38	0.01	1.2	1.3	45.51	5.56	62.45	0.588	25.64	36.33	47.99	59.16	68.08	**2.09**	**2.97**	**3.92**	**4.83**	**5.56**											
			Total	**1143.74**							1.3			62.45							**33.65**	**46.84**	**60.53**	**72.63**	**87.98**	14	1.76	**25.9**	**36.0**	**46.6**	**55.9**	**67.7**	**14.7**	**20.5**	**26.5**	**31.7**	**38.5**
K202	0	950	A14(a)	46.84	32.57	14.27	58.24	12.44	0.01	1.2	1.36	11.64	5.56	29.63	0.464	42.34	58.53	74.99	88.97	110.03	2.56	3.53	4.53	5.37	6.65											
			A14(b)	18.18	18.18	0	75	10	0.01	1.2	1.36	11.64	9.72	31.36	0.543	40.75	56.44	72.48	86.25	106.09	1.12	1.55	1.99	2.37	2.91												
			Total	**65.02**							1.36										**3.67**	**5.08**	**6.52**	**7.74**	**9.55**	2.8	1.64	**2.7**	**3.7**	**4.8**	**5.7**	**7.0**	**1.6**	**2.3**	**2.9**	**3.5**	**4.3**
K200	5800	6075	**Total**	**1208.76**							1.76	3.37		65.82							**37.33**	**51.92**	**67.05**	**80.37**	**97.53**	14	1.96	**21.2**	**29.5**	**38.1**	**45.7**	**55.4**	**10.8**	**15.1**	**19.4**	**23.3**	**28.3**
K201	0	1350	A12(c)	137.93	102	35.93	60.67	12.08	0.01	1.2	1.68	13.39	13.89	39.37	0.51	34.97	48.81	63.26	76.16	91.64	6.83	9.53	12.35	14.87	17.89	3.66	1.62	**4.1**	**5.7**	**7.3**	**8.8**	**10.6**	**2.5**	**3.5**	**4.5**	**5.5**	**6.6**
K200	6075	7625	A12(b)	252.2	88.3	163.9	39.26	15.2	0.01	1.2	1.8	49.77	11.11	76.08	0.478	22.45	32.02	42.63	53.10	59.94	7.51	10.72	14.27	17.77	20.06											
			A13	129.22	54.22	75	43.08	14.64	0.01	1.2	1.8	49.77	15.28	79.69	0.495	21.76	31.08	41.47	51.77	58.18	3.86	5.52	7.36	9.19	10.33												
			A12(a)	35.75	25.02	10.73	58.49	12.4	0.01	1.2	1.8	49.77	18.06	80.23	0.56	21.66	30.95	41.3	51.58	57.93	1.2	1.72	2.29	2.86	3.21												
			Total	**417.17**																	**12.58**	**17.95**	**23.92**	**29.83**	**33.61**											
			Total	**1763.86**							1.8										**49.91**	**69.87**	**90.97**	**110.19**	**131.14**	20	2	**27.7**	**38.8**	**50.5**	**61.2**	**72.9**	**13.9**	**19.4**	**25.3**	**30.6**	**36.4**
K209	0	1500	A23(a)	134.11	95.79	38.32	59.28	12.29	0.02	1.5	2.9	8.62	3.33	24.24	0.443	48.47	66.56	84.58	99.31	125.24	8	10.98	13.95	16.38	20.66											
			A23(b)	66.74	56.25	10.49	66.36	11.26	0.02	1.5	2.9	8.62	5.56	25.43	0.476	46.93	64.55	82.18	96.73	121.42	4.14	5.7	7.26	8.54	10.72												
			A22	30	25.4	4.6	66.57	11.23	0.01	1.2	2.9	8.62	6.94	26.79	0.482	45.31	62.43	79.66	94.02	117.42	1.82	2.51	3.2	3.77	4.71												
			Total	**230.85**							2.9										**13.96**	**19.19**	**24.41**	**28.7**	**36.1**	4	1.9	**4.8**	**6.6**	**8.4**	**9.9**	**12.4**	**2.5**	**3.5**	**4.4**	**5.2**	**6.6**
K209	1500	2825	A23(a)	29.47	26.9	2.57	70.2	10.7	0.02	1.5	3.5	9.52	6.67	26.89	0.498	45.20	62.29	79.48	93.83	117.15	1.84	2.54	3.24	3.82	4.78											
			A23(b)	32.56	28.15	4.41	67.55	11.08	0.01	1.2	3.5	9.52	6.94	27.55	0.491	44.47	61.33	78.33	92.59	115.32	1.97	2.72	3.48	4.11	5.12												
			A24(a)	30.72	25.12	5.6	64.97	11.46	0.01	1.2	3.5	9.52	7.64	28.62	0.484	43.34	59.85	76.57	90.68	112.53	1.79	2.47	3.16	3.74	4.64												

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of bulitup and paved areas (Ha.)	Area of parks and open space, etc. (Ha.)	Weighted Imperviousness (%)	Inlet Time in minutes	Slope of terain	Average Velocity in m/sec.		Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour					Quantity (Q)= 10 C.i A m^3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m^2					Width required for drain in m				
	from	to								For terain	For Drain					(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)		(For 10 Year)	(For 20 Year)			(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)	(For 1 Year)	(For 2 Year)	(For 5 Year)	(For 10 Year)	(For 20 Year)
			Total	**92.75**							3.5										**5.61**	**7.73**	**9.88**	**11.68**	**14.54**													
			Total	**323.6**							3.5										**19.57**	**26.92**	**34.29**	**40.38**	**50.64**	6.5	1.9	**5.6**	**7.7**	**9.8**	**11.5**	**14.5**	**2.9**	**4.0**	**5.2**	**6.1**	**7.6**
K210	0	1700	A24(a)	120	102.26	17.74	66.87	11.18	0.02	1.5	1.8	15.74	5.56	32.48	0.509	39.81	55.20	70.98	84.62	103.73	6.76	9.37	12.05	14.37	17.61													
			Total	**120**							1.8										**6.76**	**9.37**	**12.05**	**14.37**	**17.61**	2.2	1.8	**3.8**	**5.2**	**6.7**	**8.0**	**9.8**	**2.1**	**2.9**	**3.7**	**4.4**	**5.4**
K209	2825	4500	A24(b)	22.9	18	4.9	63.23	11.71	0.01	1.2	2.5	16.67	6.94	35.32	0.51	37.62	52.31	67.50	80.82	98.27	1.22	1.69	2.18	2.61	3.17													
			A24(a)	29.5	10	19.5	38.64	15.29	0.01	1.2	2.5	16.67	5.56	37.51	0.41	36.13	50.34	65.12	78.20	94.53	1.22	1.69	2.19	2.63	3.18												
			Total	**52.4**							2.5										2.43	3.38	4.37	5.24	6.35												
			Total	**496**							2.5										**28.76**	**39.68**	**50.71**	**59.99**	**74.61**	8	2.1	**11.5**	**15.9**	**20.3**	**24.0**	**29.8**	**5.5**	**7.6**	**9.7**	**11.4**	**14.2**
K209	4500	6000	A25(a)	34.37	20	14.37	52	13.34	0.02	1.5	1.2	34.72	8.89	56.96	0.52	27.28	38.53	50.71	62.22	72.23	1.37	1.93	2.54	3.11	3.62													
			A25(b)	37.59	25	12.59	56.58	12.68	0.01	1.2	1.2	34.72	12.5	59.9	0.55	26.37	37.31	49.20	60.52	69.93	1.51	2.13	2.81	3.46	4												
			A19	60	51.45	8.55	67.16	11.14	0.02	1.5	1.2	34.72	11.11	56.97	0.59	27.27	38.52	50.70	62.21	72.22	2.67	3.78	4.97	6.1	7.08												
			Total	**131.96**							1.2										5.55	7.84	10.32	12.67	14.69												
			Total	**627.96**							1.2										**34.3**	**47.51**	**61.03**	**72.66**	**89.3**	10	1.4	**28.6**	**39.6**	**50.9**	**60.6**	**74.4**	**20.4**	**28.3**	**36.3**	**43.3**	**53.2**
K209	6000	8250	A26(a)	40.58	33.68	6.9	65.65	11.36	0.01	1.2	0.9	37.04	9.72	58.12	0.584	26.91	38.04	50.09	61.53	71.30	1.77	2.5	3.3	4.05	4.69													
			A26(b)	47.6	38.55	9.05	64.54	11.52	0.01	1.2	0.9	37.04	11.11	59.67	0.582	26.44	37.40	49.31	60.65	70.10	2.03	2.88	3.79	4.67	5.39												
			Total	**88.18**							0.9										3.8	5.38	7.09	8.72	10.08												
			Total	**716.14**							0.9										**38.11**	**52.89**	**68.12**	**81.38**	**99.38**	8.5	1.5	**42.3**	**58.8**	**75.7**	**90.4**	**110.4**	**28.2**	**39.2**	**50.5**	**60.3**	**73.6**

Table 4. 3 Showing Check for Adequacy of Existing Culverts with measured Site Slopes - Koramangala Valley (K1)

(UnClean Condition) (with freeboard 100mm)

Sl.No.	Culvert No.	Chainage	Vent	Span Length	Vertical Clearance of the Culvert	Slope	(Di) (D- 0.1)	A= (B x Di)	U.S.D Area (Da)	(Da – A)/Da x 100	WP = (B+2Di)	R = A / P	(n)	$V = (1/n) R^{2/3} S^{0.5}$	Q = A x V	Q total	Discharge ($Q_{Reqd.}$)					Remarks					Required Width (B)				
																	1year	2year	5year	10year	20year	1year	2year	5year	10year	20year	1year	2year	5year	10year	20year
	K103	(m)	No.	(B) m	(D) m	(S)	(D- 0.1) m	(m^2)	(m^2)	%	(m)	(m)		(m/s)	(Cumec)	(Cumec)	(Cumec)	(Cumec)	(Cumec)	(Cumec)	(Cumec)										
1	KMS7-C3	Airport Road, Palm Grove Road @ 1690	1	1.300	1.500	0.0060	1.400	1.820			4.100	0.444	0.030	1.502	2.735																
			2	1.300	1.500	0.0060	1.400	1.820			4.100	0.444	0.030	1.502	2.735																
			3	1.300	1.500	0.0060	1.400	1.820			4.100	0.444	0.030	1.502	2.735																
				3.9			1.400	5.460	8.700	37.241				1.502		8.204	9.72	14.31	17.90	21.81	25.65	IA	IA	IA	IA	IA	4.62	6.8	8.51	10.37	12.19
2	KMS7-C7	Old Race Coarse Road @ 2316	1	2.200	1.200	0.0020	1.100	2.420			4.400	0.550	0.030	1.001	2.422																
			2	2.200	1.200	0.0020	1.100	2.420			4.400	0.550	0.030	1.001	2.422																
			3	2.200	1.200	0.0020	1.100	2.420			4.400	0.550	0.030	1.001	2.422																
				6.6			1.100	7.260	9.520	23.739				1.001		7.265	12.21	17.57	22.48	27.41	32.22	IA	IA	IA	IA	IA	11.09	15.96	20.43	24.9	29.27

Table 4.4 Showing Check for Adequacy of Existing Culverts with measured Site Slopes - Tavarakere Valley (K2)

(UnClean Condition) (with freeboard 100mm)

Sl.No.	Culvert No.	Chainage	Vent	Span Length	Vertical Clearance of the Culvert	Slope	(Di) (D- 0.1)	A= (B x Di)	U.S.D Area (Da)	(Da – A)/Da x 100	WP = (B+2Di)	R = A / P	(n)	$V = (1/n) R^{2/3} S^{0.5}$	Q = A x V	Q total	Discharge ($Q_{Reqd.}$)					Remarks					Required Width (B)				
																	1year	2year	5year	10year	20year	1year	2year	5year	10year	20year	1year	2year	5year	10year	20year
	K200	(m)	No.	(B) m	(D) m	(S)	(D- 0.1) m	(m^2)	(m^2)	%	(m)	(m)		(m/s)	(Cumec)	(Cumec)	(Cumec)	(Cumec)	(Cumec)	(Cumec)	(Cumec)										
1	KMC2-C7	Mosque Road, Bismillaha Nagar @2015	1	4.000	1.000	0.0080	0.900	3.600			5.800	0.621	0.033	1.972	7.100																
				4.000			0.900	3.600	7.18	49.86				1.972		7.100	17.40	23.95	30.51	35.96	45.04	IA	IA	IA	IA	IA	9.80	13.49	17.19	20.26	25.38
2	KMC2-C17	Maruthi Nagar main road, New extension, madivala @3225	1	2.340	1.300	0.0030	1.200	2.808			4.740	0.592	0.020	1.932	5.424																
			2	2.680	1.300	0.0030	1.200	3.216			5.080	0.633	0.020	2.019	6.494																
				5.020			1.200	6.024	14.28	57.82				2.019		11.918	22.37	30.92	39.60	46.98	58.13	IA	IA	IA	IA	IA	9.23	12.76	16.34	19.39	23.99
	K204																														
3	KM2S4-C2	BTM Layout / Ring Road @ 214	1	0.900	-	0.0100	-	0.636			2.829	0.225	0.011	3.363	2.140													Diameter of the Pipe				
			3	2.7				1.909	5.71	66.56				3.363		6.421	3.16	4.38	5.62	6.68	8.23	AD	AD	AD	IA	IA	0.63	0.74	0.84	0.92	1.02
4	KM2S4-C3	35th Main Road, BTM Layout @ 260	1	0.900	-	0.0030	-	0.636			2.829	0.225	0.011	1.842	1.172													Diameter of the Pipe				
			3	2.7				1.909	4.05	52.86				1.842		3.517	3.48	4.81	6.18	7.34	9.05	AD	IA	IA	IA	IA	0.90	1.05	1.19	1.30	1.44

Sl.No.	Culvert No.	Chainage	Vent	Span Length	Vertical Clearance of the Culvert	Slope	(Di) (D- 0.1)	A= (B x Di)	U.S.D Area (Da)	(Da – A)/Da x 100	WP = (B+2Di)	R = A / P	(n)	$V = (1/n) R^{2/3} S^{0.5}$	Q = A x V	Q total	Discharge ($Q_{Reqd.}$)					Remarks					Required Width (B)				
																	1year	2year	5year	10year	20year	1year	2year	5year	10year	20year	1year	2year	5year	10year	20year
	K200	(m)	No.	(B) m	(D) m	(S)	(D- 0.1) m	(m^2)	(m^2)	%	(m)	(m)		(m/s)	(Cumec)	(Cumec)	(Cumec)	(Cumec)	(Cumec)	(Cumec)	(Cumec)										
5	KM2S4-C4	38th Main Road, BTM Layout @ 410	1	0.900	-	0.0050	-	0.636			2.829	0.225	0.011	2.378	1.513												Diameter of the Pipe				
			3	2.7				1.909	3.18	39.96				2.378		4.540	4.43	6.13	7.86	9.35	11.52	AD	IA	IA	IA	IA	0.89	1.05	1.18	1.29	1.43
	K206																														
6	KM2S2-C5	Bapujinagar @1119	1	4.100	1.200	0.0028	1.100	4.510			6.300	0.716	0.030	1.412	6.366																
				4.100			1.100	4.510	13.47	66.52				1.412		6.366	3.47	4.81	6.17	7.33	9.04	AD	AD	AD	IA	IA	2.24	3.10	3.97	4.72	5.82

CHAPTER - 5

ENVIRONMENTAL AND SOCIAL IMPACT

5.1 INTRODUCTION:

This chapter provides a strategic framework to ensure that existing storm drainage system in Bangalore is managed in a reliable, affordable, sustainable and environmentally friendly manner, which is most essential for success of any project. But from the existing management practices followed by the stakeholders and also with the prevailing site conditions, it appears that, along with the resources required to achieve the recommended targets, strategies and actions, they also needs to adopt best storm drain management practices, improvised construction and construction supervision techniques, strengthened organisational setup, major legislative changes, coordination with other stakeholders, public awareness campaigns including their participation to minimise the adverse implications on storm drain functionality and storm drain management practice in the city.

5.2 ENVIRONMENTAL CONDITIONS:

Open parks, major waterways and water bodies that exists in a city like Bangalore can be a significant amenity for flood protection. But in recent times, due to lack of planning and rapid changes in the landuse, these amenities have been largely ignored to a great extent by various stakeholders, service providers and the public in general. In the recent history, there has been no comprehension of the need to provide for storm water drainage system to service urban development beyond the sub-divisional level of tertiary drains. As a consequence, the primary and secondary drainage systems in the core (BMP) administered area have developed on an adhoc basis and now they have reached a saturation level and not in a position to provide security to the low lying areas during most needed situations. Further, there are many evidence that in areas outside the BMP administered region, the development authorities do not enforce and adopt even rudimentary practices for planning, construction and maintenance of primary and secondary drains and also they lack of resources and technical expertise to adopt best storm drain management practices.

Significantly, what is seen over a period of time is that, number of lakes that were existing in BMRDA area have been filled up and converted into residential layouts. These lake areas otherwise would have acted as flood buffer zone. The tank beds, and its adjoining areas being the lowest point in the valley, even for small intensity of rainfall they are always prone for flooding, to prevent flooding in such areas. It requires, construction of new drains or expensive mechanical means. Therefore inorder to avert such expensive recurring problems. At this juncture, it is very much essential to create awareness among public, public representatives and all concerned about the consequences of encroaching tank areas. Restoration of tanks areas need to be taken on priority, which intern reduce the runoff and flooding problems in some of the adjoining low lying areas to a certain extent.

Koramangala valley is one such valley which suffers from all the above reasons. As mentioned earlier in the Chapter 2, storm drains in Koramangala valley flows through dense residential and commercial areas of the city. Since the drain is flowing through dense residential and commercial areas in the initial reaches, the natural coarse of the drain is altered at many places due to encroachments and also inappropriate planning by the landuse planners. Further, the carrying capacity is also drastically reduced due to dumping of construction debris, municipal solid wastes and also discharging raw sewage into the drains by the commercial establishments like restaurants, lodges, marriage halls, slum areas etc. thereby distracting the visual aesthetic amenity of waterway, causing siltation problems, inconvenience to the surrounding localities and threatening the health aspects of the communities residing in the close proximity of the waterway.

The main valley is silted up and blocked with solid wastes and utility crossings in the upper reaches and is plagued by siltation and sewage disposal in the middle reaches and encroachment and misuse in lower reaches. The end result is environmentally most polluting, flooding and nuisance value being high.

Although in many drainage basins, under ground sewerage system has been provided, there are still large quantities of raw and partially treated sewage flowing in the urban drains and waterways. This is caused by a combination of wastes discharged from unsewered premises, lateral / sub main sewers not connected to the trunk sewers, and effluent from trunk sewers which are under capacitated due

to siltation or due to increased sewage from higher than planned development densities. Koramangala was formed by BDA in the early eighties and has grown very rapidly since then. It is a major link between the prestigious software parks at Whitefield and the Electronic city. It is the centre of the axis of Software Belt. Hence the land value in Koramangala has shot up very high in recent years and development is very rapid. The areas adjoining Koramangala are Ejipura and Srinivagalu. These two areas are relatively old hamlet areas now becoming part of the urban development. But unfortunately both these areas are not covered with sewerage system. And all the waste generated from these localities are being discharged into storm drains.

Further, the drainage channel flows through dense commercial areas, wherein large numbers of shops and public toilet blocks have been constructed over the drain. Even though the sewer lines exists, the sewer out lets from the public toilets are not connected to the sewerage system and they are discharging raw sewage directly into storm drains and also due to lack of timely maintenance of chocked sewer pipelines, manholes, under capacity sewer pipelines, and lack of sewer connectivity, raw sewage is being allowed to enter into storm drain thereby distracting the visual aesthetic amenity of waterway, making place favorable for mosquito breading, causing substantial inconvenience to the surrounding locality resident, pedestrians and vehicular movement and also the slaughter houses located near the drains are also threatening the health aspects of the communities residing close to the waterway.

Since the topography of the terrain is sloping towards the drain and also due to improper solid waste collection and conveyance arrangement all the solid waste generated from the commercial establishments and the greasy liquid waste from service stations, find their way into the storm drain, further all the floating materials gets clogged with the utility lines laid across storm drains and culverts locations obstructing free flow of water and causing localized flooding problems and intern pose substantial damage to both life and property.

Due to lack of sediment erosion control measures and devices, large quantity of silt is being accumulated inside the drain thereby causing siltation, ponding of water and intern making places favorable for mosquito breading.

The more extensive tertiary drains that exists are the key elements of the urban drainage system, but due to deficiencies in designs and maintenance practice, the existing tertiary drains are not serving upto the intended level of service during most needed hour of service.

Further down the stream near the receiving water body, new layouts that are formed are recently developed. But since the land value is very high, widening of drains is restricted and also the existing tertiary drains, due to deficiencies in design and maintenance practices they are not functioning upto the intended level of services during large storms and causing localised flooding problems.

Further, another significant cause of frequent flooding of low-lying areas is due to large accumulation of sediments and vegetal growth that reduce the carrying capacity of the drains. Further, improper solid waste collection and conveyance system and lack of understanding the impact of casual litter disposal inside the drains are significant factors contributing to the high waste volumes found in drains. Similarly, erosion control practices in construction sites, public parklands, private gardens and on the medians and verges of roads are not sufficient to control large silt loads reaching the main drains. These factors, combined with infrequent clearance of drains by concerned authorities, occasionally lead to unsanitary conditions in drains and further aggregate the already aggravated situation.

5.2.1 Relationships between Solid Waste and Drainage

Until recent times, the relationship between solid waste materials and drainage system and its impact on the environmental attributes was not considered to be significant due to various reasons, even though the responsibility for both drainage and solid waste management in the core area lies with BMP and outer periphery areas with CMC/TMC.

As observed during reconnaissance survey, disposal of bio degradable and non degradable material dumps into the drains were of a common practice all along the drain and intern factors that were influenced to affect the functionality of the system

were also noted and few factors that were noted are as explained in brief here under,

The disposals of house hold garbage, street sweepings and construction debris into drains near Akkipete, B.V.K. Iyengar Road, Avenue Road, K.R. Market, Bamboo Bazar, Kalasipalya, J.C. Road, Sudhamanagar, Journalist colony, Sampangiramnagar, Siddapura, Wilson garden and L.R. Nagar areas in Koramangala main valley and Krishnappa garden, Bismillanagar, Tavarekere, Bajajinagar, Bapujinagar, Guruppanapalya, Madivala and Someshwara colony in Tavarekere valley is affecting free flow of water, reducing the aesthetic appearance, reducing the quality of environmental attributes in that region. Apart from affecting the flow, solid wastes have particular impact on the smaller tertiary drains, often obstructing flow completely, and causing short term localized flooding that can be especially dangerous to both pedestrians and vehicular movement. Further to improve the situation in that region improvised method of solid waste collection and conveyance system, community awareness campaigns in these regions is most essential.

5.2.2 Conflicts between Sewers and Drains:

At present there are some trunk sewers laid within drainage channels. Problems that arise from sewers in drainage channels are numerous and include:

- capacity reduction of drains due to manholes;
- restrictions on channel augmentation options;
- ready opportunities to relieve excess sewage into channels;
- need for parallel programming and close coordination, where rehabilitation of either service is proposed;
- difficult access for sewer maintenance;
- lack of access to sewers under lined inverts and cross drainage culverts
- potential damage to the system from drain assets; and
- poor construction due to difficult access and flow diversion problems.

Benefits are few and include:

- no need for separate sewer easement; and

• relatively low excavation cost due to shallow depth.

All the above problems mentioned outweigh the benefits accrued in the Koramangala valley and therefore urgent efforts are required to cleanse the entire system.

5.2.3 Impacts of Poor Storm Water Drainage System:

The importance of adequate storm water and wastewater drainage, in tandem with sufficient water supply, cannot be over emphasised, if full health benefits from provision of services are to be derived. Inadequate drainage causes inconvenience and losses to both life and property varying in nature ranging from:

•Inundation of houses and establishments on the floodplains, caused by large scale "valley" flooding from overflow of primary and secondary drains.

•local area inundation and water stagnation in residential areas, caused by "local" drainage deficiencies and run-off from adjacent local catchments as in K.R. Market area, Sudhamanagar, Journalist colony, Arekempanahalli, Wilson garden, Pothalappa Garden, Koramangala, Austin town, Ejipura and S.T. Bed area in Koramangala Main Valley.

Bismillahanagar, Krishnappa Garden, LIC Colony, Guruppanapalya, Dollars Colony, and Madivala in Tavarekere valley.

•Causes extensive damage to infrastructure works and intern reduces the aesthetic appearance of the city and reduces the land value cost adjacent to drains etc.

•Having high solid waste and sewage concentrations, the flood waters which inundate dwellings and their curtilages create particularly very objectionable conditions in Bangalore.

•The frequency and duration of flooding is relatively high in some of the locations, occurring usually during the south west monsoon period. Whilst valley flooding occurs several times per year in down stream areas. Under these latter

conditions, poor drainage causes water stagnation and creates the surrounding area favorable for mosquitoes breeding and intern leads to unsanitary conditions. Even the water quality in some of the borewells that are dug adjacent to storm drains are polluted.

•Out of the 360 officially recognized slums in Bangalore, only 30 percent have underground sewerage services. Hence, the major portion of the wastewater generated from such slums will be discharged via the storm water system causing very unhygienic conditions.

5.3 ENVIRONMENTAL MANAGEMENT PLAN:

The proposed activities arising from this chapter are strategic in nature, and as such, the detailed investigations required have not been performed. Consequently the environmental assessment of the proposed activities addresses generic environmental impacts and mitigation measures only.

Recommendations:

- Prepare a comprehensive management plan which is acceptable and affordable by the community.

- Prepare a risk assessment plan and risk management plan.

- Prepare a construction and maintenance schedule to ensure effective functionality of the system.

- Implement an effective, improvised solid waste collection and conveyance system.

- Ground water quality analysis to be carried out periodically and the analysed results should be compared with past records and accordingly action to be framed.

- Large scale green belt development activity to be taken up and encouraged all along the channel and also in open lands to improve the aesthetic value of the city environs.

- Prepare a strategic plan for development of land in low lying areas.

- Municipal authorities should be more vigilant on the contractors responsible for disposal of solid wastes generated from the market yards, slums and densely populated areas.

- There should be stringent penalty on commercial establishments, dyeing industries, hospitals lying in the catchment area, that are disposing off their liquid/solid waste in the valley in an inappropriate manner.

- There should be a ban on the construction of public toilets on the banks of the waterway.

- Service station / garages should not be allowed to dispose the greasy effluent into the drain.

- There should be a strict vigil on slaughter houses and dyeing industries, which are discharging their liquid waste directly into drains and they should be instructed to dispose of their waste in a secured manner.

- Horticulture gardens and nurseries situated along the banks of the valleys should be cordoned off from the valley and should dispose the vegetative waste separately outside as a landfill and not to discard in the drain.

- There should be no UGD inlet into the drain from slums and other residential areas.

- Silt traps and silt barriers must be constructed along the drain at strategic locations to reduce silt load at downstream of the valley.

- Municipal authorities should encourage public and private sector enterprises for usage of recycled water and adopt rain water harvesting techniques in open lands etc.

- Create awareness among the public, regarding importance of the system functionality.
- Detention ponds for recharging ground water and to minimise fine silt transportation should be constructed along the strategic vantage locations in the valley. Few locations where such ponds could be created/constructed apart from existing parks maintained by BMP are as listed below and the same is depicted in Figure 5.1.

Table 5.1 List of Locations For Construction of Detention Ponds

1. Victoria Hospital Area
2. Lalbagh Botanical Garden
3. NIMHANS Hospital Campus
4. Dharmaram College Campus
5. Christ College Grounds
6. St. Johns Hospital Campus
7. Reserved Forest Area, near Doresanipalya
8. K.S.R.P. Quarters, near Madivala
9. MICO Factory, near Hosur Road - Koramangala
10. Bangalore Milk Dairy
11. MICO Factory, near Adugodi
12. National Dairy Research Institute, near Adugodi
13. K.S.R.T.C. Area, near Shanthinagar
14. AEC College, near Ejipura
15. Bangalore Military School, near Velleara Jn.
16. Cubbon Park Area
17. Central College Campus, near K.R. Circle
18. Maharanis College Campus
19. Bangalore Turf Club Area
20. Controller of Defence Accounts Office Premises, near Airport Road
21. Hindu Burial Ground, near Lang Ford Town
22. M.N. Krishna Rao Park, near Basavanagudi
23. Police Quarters, near Adugodi
24. Bangalore City Corporation Premises
25. Private Nursery's, near Siddapura

5.4 SOCIAL IMPACTS:

Baseline data together with data on social and environmental impact of flooding has been collected during reconnaissance survey to ascertain the level of service offered by the existing drainage system at various locations in the BMP, BDA and BMA administered areas.

The Baseline survey provided the following statistics on the incidence, nature and possible cause of flooding:

•7% of the household in B.M.P. area, reported that they faced instances of flooding.

•10% of households of lower socio-economic status reported that they had faced flooding in the past decade-instances of flooding had been more common in the central part of the city.

•Of the house holds that had experienced flooding, 72% reported such occurrences in the last one year, 15% had experienced flooding in the year 1999, 7% during the period 1995 to 1998, while 2% reported that they had experienced flooding prior to 1995.

•Of the households that had experienced flooding, a majority said that the effects had lasted for one to three days, while 3 % said they had extended beyond a week.

•Two thirds of the households ascribed the reasons for flooding to blockages in the sewerage system, 12% to ingress of rain water into the house, while 11% said that it had been caused by a blocked drains or gutter.

•Lower income households and those living in the slums were more vulnerable to flooding caused by blocked drains; and

•All households reported damage to assets and loss of workdays on account of such flooding.

- Few households from the conurbation and green belt areas reported that their houses had been flooded in the recent past, suggesting the high density of houses and lack of planned development have contributed to the problem of improper drainage in the corporation area.

- Out of 360 officially recognized slum in Bangalore, only 30% have underground sewerage services. Hence, in the majority of slums wastewater must be discharged via. the storm water system, during flooding instances due to water stagnation, it provides a breeding ground for mosquitoes and leads to generally unsanitary conditions and health hazards.

Details on the areas affected, the frequency of flooding, the impacts and the cause of flooding would all be relevant for an effective management of the drainage system, but such records are not kept. But, during reconnaissance survey such information's were collected from public as first hand information and were considered during the evaluation of analysis results to improve the existing situation.

CHAPTER - 6

COST ESTIMATION

6.1 INTRODUCTION

All development projects shall aim to make the best use of available financial, physical, and institutional resources.

This is especially true for upgrading work, for which the available resources are usually limited in relation to the total need. It is therefore very much important to minimise the cost at which services are provided while ensuring that agreed minimum standards are achieved. In the mean while, it is also important to ensure that cost, both capital cost and recurrent are affordable to the organization and also as well as agreeable to all the beneficiaries.

6.2 COSTS:

The costs considered when appraising remodeling proposals, fall into two basic categories, capital costs and recurrent costs.

Capital cost are the costs incurred at the beginning of the project between its inception and its completion on the ground. Further the capital cost include,

- the cost of planning and designing the work,
- construction costs,
- supervision costs, and
- overheads.

Recurrent costs are the cost incurred after execution of the project for its routine maintenance and operations.

6.3 COST ESTIMATE:

Based on the techno-economical proposals indicated to BMP in the feasibility report and further, after obtaining the concurrence for the acceptance of all the proposals, the works envisaged in the entire Koramangala Valley has been sliced into three packages, which are as follows,

Package – (K1VD-I) : Koramangala Main Valley - K100
(From Ch. 0.00 m. upto 6,600.00 m.)
[From Majestic Area upto Infant Jesus Church, near Viveknagar]

Package – (K1VD-II) : Koramangala Main Valley - K100
(From Ch. 6,600.00 m. upto 12,000.00 m.)
[From Infant Jesus Church, near Viveknagar upto Bellandur Tank]

Package – (K2VD-III): Tavarekere Valley - K200
(From Ch. 0.00 m. upto 7,625.00 m.)
[From Bairasandra Extn. upto Bellandur Tank]

The works envisaged in Koramangala valley primary and secondary storm drains and also which are grouped under each package is as listed below in the Table 6.1 to Table 6.8. and the same is depicted in Figure 6.1.

77°34'19"E 77°35'19"E 77°36'19"E 77°37'19"E 77°38'19"E 77°39'19"E 77°40'19"E 77°41'19"E

12°59'7"N 12°58'7"N 12°57'7"N 12°56'7"N 12°55'7"N 12°54'7"N

0 700 1,400 2,800 4,200 5,600 Meters

N W E S

Package - I

Package - II

Package - III

Vrishabhavathi Valley

Ulsoor Valley

Challaghatta Valley

Koramangala Valley

Kathriguppe Valley

Tavarekere Valley

OLD MADRAS ROAD

AIRPORT ROAD

SARJAPUR ROAD

HOSUR ROAD

Ulsoor Tank

Kempambudi Tank

Madivala Tank

Agara Tank

Belandur Tank

Legend

- Addl Drains
- Drains
- Water Bodies

Rail / Road

- Arterial Road
- Major Road
- Minor Road
- Rail

DATE	No.	REVISION	DRAWN	CHECKED	APPROVED

STUP Consultants P. Ltd.

REGISTERED OFFICE: 1004-5 RAHEJA CHAMBERS, NARIMAN POINT, MUMBAI - 400021

OFFICE OF ORIGIN: BANGALORE

OWNER: BANGALORE MAHANAGARA PALIKE

DATE: 21/10/2003

CLIENT:

DRAWN: MNS

PROJECT: RE-MODELLING OF PRIMARY AND SECONDARY STORM WATER DRAINS IN BANGALORE CITY

PREPARED: RSP

CHECKED: YDM

TITLE: Location Plan - Proposed RCC Drains in Koramangala Valley

APPROVED: ATS

Fig. No. .

REV

JOB No. 1495

SCALE: AS SPECIFIED

TABLE 6.1 Details of Primary and Secondary Storm Drains of Koramangala Main Valley Considered for Remodeling in Package – (K1VD - I)

(From Chainage 0.00 m. upto 6,600.00 m.)

Sl. No.	Drain ID	Name	Type	Start	End	Length (Mts.)
Koramangala Main Valley (K1):						
1	K100	Koramangala	Pri.	Near Upparpet Area	Infant Jesus Church near Viveknagar	6,600
2	K103	Austin Town	Sec.	M.G.Road	Neelasandra	3,400
3	K104	Laksandra	Sec.	Sampangiramnagar	Annepalya	1,700
4	K107	Lakshmanna Garden	Sec.	Langford Town	Jalakanteshwarapur	770
5	K108	Siddapura	Sec.	Jayanagar I st. Block	Wilson Garden	1,925
6	K109	R.R.M. Roy Extn.	Sec.	Kanteerava Stadium	Sudhamanagar	2,000
7	K110	Lalbagh	Sec.	Lalbagh tank	J.C.Road	625
8	K111	Jayanagar	Sec.	Jayanagar 3rd Block	Lalbagh tank	950
9	K112	Kalasipalya	Sec.	Paravathipura	Kumbaragundi	715
10	K114	Akkithimanahalli	Sec.	DivyaSree Chamber	KSRTC Training Centre	1,100
Total Length of Primary Drain						**6,600**
Total Length of Secondary Drains						**13,185**

TABLE 6.2 Details of Culverts / Bridges constructed across Primary and Secondary Storm Water Drains in Koramangala Main Valley Considered for Remodeling in - Package – (K1VD – I)

Sl. No.	Culvert No.	Chainage (m.)	Location	Remarks
Austin Town Secondary Storm Drain (K103) :				
1	KMS-7 C3	1,690	Airport Road (Palm grove Road)	Ex. Culvert/Bridge considered for remodelling
2	KMS-7 C7	2,316	Old Race Course Road	Ex. Culvert/Bridge considered for remodelling
List of Culverts / Bridges Considered for Providing Rehabilitation in Package – I (KVD – I)				
Improvements to Existing Culverts / Bridges				
Koramangala Valley Primary Storm Drain (K100) :				
1	KMC - 5	3,030	2 nd Cross, Sudhamanagar	Provision of handrails / Parapet wall

Table 6.3 Details of New Drains Proposed for construction in Koramangala Main Valley Package – (K1VD – I)

Sl. No.	Drain ID	Name	Type	Start	End	Length (Mts.)
Koramangala Main Valley (K1):						
1	K115	Shanthi nagar	Sec.	Lakshmiamma Garden	KSRTC Training Centre	750
2	K116	RRM Roy	Sec.	Srinivas Colony near Bangalore Institute of Oncology	RRM Roy Extn.	400
3	K117	Wilson Garden	Sec.	Mari Gowda Road near Hombe Gowda nagar	Wilson Garden near Siddaiah Road	400
					Total Length of New Drains	**1,550**

TABLE 6.4 Details of Primary and Secondary Storm Drains of Koramangala Main Valley Considered for Remodeling in Package – (K1VD - II)

(From Chainage 6,600.00 m. upto 12,000.00 m.)

Sl. No.	Drain ID	Name	Type	Start	End	Length (Mts.)
Koramangala Main Valley (K1):						
1	K100	Koramangala	Pri.	Infant Jesus Church near Viveknagar	Location near Bellandur Tank	5,400
2	K101	Koramangala layout (1)	Sec.	Hosur Road	Koramangala Slum	2,000
3	K102	Koramangala layout (2)	Sec.	Hosur Road	Jyothi Nivas College	300
4	K113	Rajendranagar	Sec.	Royal Parikrama Centre Near Koramanagala 8th Block	Koramanagala Main Valley (Behind Akhila Karanataka Animal Rehab. Centre)	2,225
					Total Length of Primary Drain	**5,400**
					Total Length of Secondary Drains	**4,525**

Table 6.5 Details of New Drains Proposed for construction in Koramangala Main Valley Package – (K1VD – II)

Sl. No.	Drain ID	Name	Type	Start	End	Length (Mts.)
Koramangala Main Valley (K1):						
1.	K118	Koramangala Layout	Pri.	Koramangala 5 th Block, 5 th Cross	Koramangala 7th Main Road	1,800
					Total Length of New Drains	**1,800**

TABLE 6.6 Details of Primary and Secondary Storm Drains of Tavarekere Valley Considered for Remodeling in Package – (K2VD - III)

(From Chainage 0.00 m. upto 7,625.00 m.)

Sl. No.	Drain ID	Name	Type	Start	End	Length (Mts.)
Tavarekere Valley (K2):						
1	K200	Tavarekere Valley	Pri.	Bairasandra near NIMHANS Hospital	Location near Bellundur Tank	7,625
2	K201	Vanganahalli	Sec.	Vanganahalli	Near Agara Tank	1,350
3	K202	Yellukunte	Sec.	Yelukunte	Venkatapura	950
4	K203	H.S.R Layout	Sec.	Crompton Greaves	Outer Ring Road	1,200
5	K204	Madivala	Sec.	Near Madivala Tank	Hosur Road	705
6	K205	Tavarekere	Sec.	Mudduramanagar	Bismillahanagar	525
7	K206	Guruppanapalya	Sec.	Tayappanahalli	Bovi Colony	1,245
8	K207	Krishnappa Garden	Sec.	Bairasandra Extn.	Bannerghatta Road	1,225
9	K208	Canara Bank Colony/ Law College	Sec.	Tilaknagar	Krishnappa Garden	425
10	K209	J. P. Nagar	Sec.	Jayanagar 4th Block	Madivala Tank	8,250
11	K210	Puttenahalli	Sec.	J.P.Nagar, Puttenahalli	Sarakki Layout	1,700
					Total Length of Primary Drain	**7,625**
					Total Length of Secondary Drains	**17,575**

TABLE 6.7 Details of Culverts / Bridges Constructed across Primary and Secondary Storm Water Drains in Tavarekere Valley Considered for Remodeling in Package – (K2VD – III)

Sl. No.	Culvert No.	Chainage (m.)	Location	Remarks
Tavarekere Valley Primary Storm Drain (K200) :				
1	KMC-2 C7	2015	Bismillahanagar	Ex. Culvert/Bridge considered for remodelling
2	KMC-2 C17	3225	Maruthinagar, Near Madivala	Ex. Culvert/Bridge considered for remodelling
Madivala Secondary Storm Drain (K204) :				
1	KM2S4- C1	0	Near Madivala	Ex. Culvert/Bridge considered for remodelling
2	KM2S4- C2	214	Near B.T.M. Layout	Ex. Culvert/Bridge considered for remodelling
3	KM2S4- C3	260	35th Main Road, Near B.T.M. Layout	Ex. Culvert/Bridge considered for remodelling
4	KM2S4- C4	410	38th Main Road, Near B.T.M. Layout	Ex. Culvert/Bridge considered for remodelling
Tavarekere Secondary Storm Drain (K205) :				
1	KM2S3- C2	175	Tavarekere	Ex. Culvert/Bridge considered for remodelling
Guruppanapalya Secondary Storm Drain (K206) :				
1	KM2S2- C5	1119	Near Bapujinagar	Ex. Culvert/Bridge considered for remodelling
List of Culverts / Bridges Considered for Providing Rehabilitation Improvements to Existing Culverts / Bridges				
Tavarekere Valley Primary Storm Drain (K200):				
1	KMC2-C8	2075	Bismillahanagar	Provision of handrails / Parapet wall
2	KMC2-C9	2109	Bismillahanagar	Provision of handrails / Parapet wall
3	KMC2-C10	2126	Bismillahanagar	Provision of handrails / Parapet wall
4	KMC2-C11	2163	Bismillahanagar	Provision of handrails / Parapet wall
5	KMC2-C12	2188	Bismillahanagar	Provision of handrails / Parapet wall
Guruppanapalya Secondary Storm Drain (K206) :				
1	KM2S2- C2	525	Near Bapujinagar	Provision of handrails / Parapet wall
2	KM2S2- C3	-	Near Bapujinagar	Provision of handrails / Parapet wall

TABLE 6.8 Details of New Drains Proposed for Construction in Tavarekere Valley Package – (K2VD – III)

Sl. No.	Drain ID	Name	Type	Start	End	Length (Mts.)
Tavarekere Valley (K2):						
1	K211	BTM Layout	Sec.	BTM Layout 1st stage	Central Silk Board Staff Qtrs.	1,000
2	K212	Guruppanapalya -1	Sec.	Guruppanapalya	Maruthi HBS Layout	100
3	K213	Guruppanapalya - 2	Sec.	Maruthi HBS Layout	Tavarekere Main Road	500
4	K214	Bharathi nagar	Sec.	Tank Bund Road near St.Gaspar Bhavan	Brindavan Nagar	700
Total Length of New Drains						**2,300**

Detailed cost estimate has been worked out for improving the carrying capacity and rehabilitating the existing system, construction of new drains and bridges/culverts, improving the functionality and capacity of tertiary drains and other allied works to minimizing the flooding problems in low lying areas and the same is also indicated in Figure 6.1.

Wherein, rehabilitation work includes drain wall reconstruction, cavity filling, restoration of eroded stones, providing pointing and where as carrying capacity improvement work includes desilting, widening, deepening, plastering, wall raising, construction of water recharging structures and providing bed protection.

For ease of assessment, carrying capacity improvement works and rehabilitation works have been identified and assessed for every kilometer length and accordingly cost estimates have been prepared and given in Volume IV of this report. Further for better understanding work summary statements and strip plans have been prepared and enclosed in this chapter.

For assessment of cost, detailed hydraulic design, structural designs, quantity estimation and cost estimation as per current schedule of rates have been carried out

A lumpsum amount provision for temporary shifting of utilities, traffic diversion, providing improvement works like green belt development along side of storm drains etc., are made in the estimate.

Apart from the cost incurred for remodeling of storm drains, some of the costs which are not considered in the estimate and which are envisaged to be a large amount are,

- Procurement of land / acquisition cost
- Rehabilitation cost for distracted property owners
- Removal of structures & Disposal of debris
- Permanent shifting of service lines by various agencies
- Sewerage system improvement works
- Restoration of roads and cross drainages after completion of the works
- Cost incurred for asset management
- Maintenance of drains, etc.

Table 6.9 & 6.10 indicates carrying capacity improvement works & rehabilitation works for Primary storm drain in Koramangala Main Valley.

Table 6.11 & 6.12 indicates carrying capacity improvement works & rehabilitation works for Secondary storm drains in Koramangala Main Valley.

Table 6.13 & 6.14 indicates carrying capacity improvement works & rehabilitation works for Primary storm drain in Tavarekere Valley.

Table 6.15 & 6.16 indicates carrying capacity improvement works & rehabilitation works for Secondary storm drains in Tavarekere Valley.

Table 6.17 Indicates abstract of cost for remodelling of existing culverts / bridges and also construction of new bridges in Koramangala Valley.

Table 6.18 Indicates abstract of cost for construction of new drains / improving the existing tertiary drains in Koramangala Valley has been made in the estimate.

6.4 Work Programme for Koramangala Valley:

The works proposed for remodeling of storm drains in Koramangala Valley shall be taken up in a phased manner simultaneously in all the packages. Since, some of the critical issues like coordination from other agencies in several instances, community participation, acquisition of land from both government & public, shifting of major utilities, traffic diversion at several places etc., are envisaged in all the packages.

After having several discussion with senior officials of BMP and other stake holders and beneficiaries of the project. Work programme with a broader contest has been formulated keeping in view the availability of the resources, minimum distraction to the adjoining properties, to cause less inconvenience to the public, considering the environmental aspects etc., also for smooth and successful implementation of the project, which is as narrated below,

Table - 6.9 Schedule For Improving the Carrying Capacity of Existing Primary Storm Drains in Koramangala Main Valley (K100)

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Carrying Capacity Improvements Works							
					Drain Widening		Drain Desilting & Deepening		Drain Wall Raising		Bed Protection	
	From	To	From	To	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks
1	2	3	4	5	6	8	9	11	12	14	15	17
K100 – Koramangala Valley Primary Storm Drain												
1	0	1,000	Old Taragupet Main Road	A.S. Achar Street / BVK Iyengar Road	a) 500 - 1000	b) Right Side From Sowrastrapete Road upto BVK Iyengar Road. Existing covered drain to be opened and widened on right hand side. Further, new SSM wall of required height to be constructed and again covered with new RCC slab of 275 mm thick. Existing width 1.6 m widened to 4.0 m and height 1.2 m.	a) 0 - 1000	a) This reach of drain is almost covered as it needs to be opened at regular interval for desilting and it has to be desilted for about 0.4 m depth. Further, after desilting, steel grating needs to be installed at regular intervals.	-	-	a) 0 - 1000	a) After desilting drain bed need to be provided for full length & width.
2	1,000	2,000	A.S. Achar Street / BVK Iyengar Road	3rd Cross, New Bamboo Bazar Road	a) 1000 - 1500	a) Right Side From BVK Iyengar Road upto Avenue Road. Existing covered drain to be opened and widened on Right hand side and small structure on left hand side. Further, new RCC wall to be constructed and again covered with new RCC slab of 0.3 m thick upto Ch. 1400 m and also steel gratings to be provided at regular interval. Existing width: 2.5 m widened to 6.5 m & height 1.4 m	a) 1000 - 2000 b) 1800 - 2000	a) Existing drain needs to be desilted for about 0.5 m depth. b) After desilting drain bed to be deepened by about 0.5 m from N.R. Road upto 3rd cross New Bamboo Bazar Road	-	-	a) 1000 - 2000	a) After desilting drain bed needs to be provided for full length & width.
					a) 1800 - 2000	Left Side From N.R. Road upto 3rd cross, New Bamboo Bazar Road. Existing drain needs to be widened on Left hand side. Existing width : 4.5 m widened to 8.0 m & height 1.8 m						
3	2,000	3,000	3rd Cross, New Bamboo Bazar Road	2nd Cross Road, Sudhama-nagar	a) 2000 - 2275	a) Left Side 3rd Cross, New Bamboo Bazar Road upto 1st Main J.C. Road	a) 2000 - 3000	a) Existing drains needs to be desilted for about 0.4 m	a) 2000 - 2325	Right Side a) After providing rehabili-tation to the existing drain wall, it has to be raised by about 0.6 m	a) 2000 - 2325	a) After desilting bed protection reach to be provided for full length & width

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Carrying Capacity Improvements Works							
					Drain Widening		Drain Desilting & Deepening		Drain Wall Raising		Bed Protection	
	From	To	From	To	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks
1	2	3	4	5	6	8	9	11	12	14	15	17
						Existing width 5.5 m widen-ed to 10.0 m to height 2.4 m	b) 2000 - 2325	b) After desilting, drain bed to be deepened by about 0.5 m from 3rd Cross, New Bamboo Bazar Road upto 1st Main, J.C. Road		From 3rd Cross, New Bamboo Bazar Road upto 1st Main J.C. Road	b) 2425 - 3000	b) After desilting bed protection needs to be provided for full length & width
4	3,000	4,000	2nd Cross Road, Sudhama-nagar	KSRTC Bus Depot near K.H. Double Road	a) 3275 - 3475	a) Right Side 8th Cross, Annipura upto 10th Cross, Annipura. Existing drain needs to be widened on Right hand side. Existing width 8.5 m widened to 12.5 m & ht. 2.4 m	a) 3000 - 4000	a) Existing drain needs to be desilted for about 0.4 m	-	-	a) 3000 - 4000	a) After desilting bed protection needs to be provided for full length & width.
5	4,000	5,000	KSRTC Bus Depot near K.H. Double Road	Bannerghata Road near Jalakantesh-warapura	-	-	a) 4000 - 5000	Existing drain needs to be desilted for about 0.4 m. Existing width : 12.5 m	-	-	a) 4000 - 4950	a) After desilting bed protection needs to be provided for full length & width.
6	5,000	6,000	Bannerghata Road near Jalakanteshwa rapura	Muthu - Mariamma Temple near L.R. Nagar foot bridge location.	a) 5200 - 6000	a) Both Side From Hosur Road upto Muttumariamma Temple. Existing drain is in natural condition and it needs to be widened on both sides & embankment to be made with imported earth. Further, between Ch. 5650 - 5850. Slightly Drain alignment needs to be altered. Stone revetment is to be provided on both sides for full length. Existing width 14.0 m widened to 22.5 m & ht. 3.0 m	a) 5000 - 6000	Existing drain need to be desilted for about 0.4 m	-	-	a) 5000 - 6000	a) After desilting bed protection needs to be provided for full length & width.
7	6,000	7,000	Muthu - Mariamma Temple near L.R. Nagar foot bridge location	Viveknagar Bridge Location	a) 6000 - 6575	Both Sides From Muthumariamma Temple upto a location where Austin Town drain joins main drain. Existing drain is in natural condition and embankment to be made up with imported earth, and stone revetment to be provided on both sides for full length.	a) 6000 - 7000	Existing drain needs to be desilted for about 0.5 m	a) 6600 - 6900	Right Side From a location where, Austin Town drain joins primary drains upto Viveknagar bridge.	a) 6000 - 7000	a) After desilt-ing drain bed protection needs to be for full length & width.

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Carrying Capacity Improvements Works							
					Drain Widening		Drain Desilting & Deepening		Drain Wall Raising		Bed Protection	
	From	To	From	To	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks
1	2	3	4	5	6	8	9	11	12	14	15	17
						Existing width 22.5 m & ht. 3.0 m.				After providing rehabilitation works to the existing drain wall, it has to be raised by about 0.5 m		
					b) 6600 - 6900	Left Side From a location where Austin town drain joins primary drain upto Viveknagar bridge location. Existing drain needs to be widened and new wall to be constructed on left hand side. Existing widith: 12 m widened to 24.0 m & ht. 3.0 m						
8	7,000	8,000	Viveknagar Bridge Location	National Games Village	a) 7000 - 7200	Both Side Near Ejipura Main Road. (BMP Hot Mix Plant) Existing drain needs to be widened on both sides and new wall to be built on both sides.). Existing width: 7.5 m widened to 16 m & height 3.0 m	7000 - 8000	Existing drain needs to be desilted for about 0.4 m	a) 7000 - 7200	Right Side Near Ejipura Main Road. After providing rehabilitation to existing drain wall. Existing drain wall ht. Has to be raised by about 0.5 m.	a) 7000 - 7850	After desilting drain bed needs to be provided for full length & width.
					b) 7200 - 7850	Left Side Near Indira Gandhi Slum Area Existing drain needs to be widened on Left hand side. Existing width 8 m to 16 m & ht. 3.0 m			b) 7200 - 7850	Left Side Near Indira Gandhi Slum area. After providing rehabilitation to existing drain wall, it has to be raised by about 0.6 m		
9	8,000	9,000	National Games Village	Koramangala 1st Cross Road	a) 8200 - 8400	Both Side Behind Koramangala BMTC Bus Depot upto Ejipura Church Road bridge location. Existing drain alignment needs to be slightly altered & widened and new wall needs to be constructed on both side. Existing width: 7.5 m widened to 18 m ht. 2.6 m.	a) 8000 - 9000	Existing drain needs to be desilted by about 0.4 m	-	-	a) 8200 - 9000	After desilting drain bed need to be provided for full length & width.
					b) 8425 - 8500	Right Side Near Ejipura Church Road bridge location Existing drain is in natural conditon on Right hand side. It needs to be widened and stone revetment needs to be provided. Existing width: 10.5 widened to 18 m ht. 3.0 m						
					c) 8500 - 8700	Both Sides At Ashwini layout near Inner Ring Road. Existing drain is in natural conditon and embankment needs to be made with imported earth and stone revetment provided. Existing width: 9.5 m widened to 18 m ht. 3.0 m						

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Carrying Capacity Improvements Works							
					Drain Widening		Drain Desilting & Deepening		Drain Wall Raising		Bed Protection	
	From	To	From	To	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks
1	2	3	4	5	6	8	9	11	12	14	15	17
					d) 8725 - 8825 e) 8825 - 9000	d) Left Side Near Inner Ring Road Bridge location. Existing drain is in natural condition and it needs to be widened and new wall needs to be constructed on left hand side. Existing width: 11.5 m widened to 18 m ht. 2.6 m e) Left Side Near Koramangala Ist Cross Road. Existing drain needs to be widened and new wall needs to be constructed on left hand side. Existing width: 10 m widened to 18 m ht. 2.6 m						
10	9,000	10,000	Koramangala 1st Block, 1st Cross Road	Koramangala Ist Block, 8th Cross Road	a) 9600 - 9650	a) Both Sides Near SEVA Gangothri Associates. Existing drain alignment needs to be slightly altered and widened and new wall to be built on both sides. Existing width: 11 m widened to 14 m height 2.6 m.	a) 9000-10000	Existing drain needs to be desilted by 0.4 m	-	-	a) 9000 - 10000	After desilting drain bed needs to be provided for full length & width.
11	10,000	12,000	Koramangala Ist Block, 8th Cross Road	Location near Bellandur Tank	a)10,100-12,000	a) Both Side Existing drain reach is in natural condition and it has to be widened and stone revetment provided. Further, service road has to be formed on either side and guard stone at every 10 m interval to be provided. Existing width: 14 m widened to 24 m ht. 2.4 m	a)10100-12000	Existing drain needs to be desilted by about 0.6 m	-	-	a) 10,000 - 11,000	After desilting drain bed needs to be provided for full length & width.

Table - 6.10 Schedule For Providing Rehabilatation to the Existing Primary Storm Drain in Koramangala Main Valley

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Rehabilitation Works					
					Drain Wall Reconstruction		Drain Wall Restoration		Utility Shifting & Other Obstruction Removals	
	From	To	From	To	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks
1	2	3	4	5	6	8	9	11	12	14
K100 – Koramangala Valley Primary Storm Drain										
1	0	1,000	Old Taragupet Main Road	A.S. Achar Street / BVK Iyengar Road	-	-	a) 500 - 1000	Right Side From Sowrastrapete Road upto BVK Iyengar Road. After desilting, cavities to be filled, eroded stones to be restored and pointiong to be done for existing wall on Right hand side for a ht. of about 1.2 m.	-	-
2	1,000	2,000	A.S. Achar Street / BVK Iyengar Road	3rd Cross, New Bamboo Bazar Road	-	-	a) 1000 - 1500 b) 1500 - 1800 c) 1800 - 2000	a) Left Side From BVK Iyengar Road upto Avenue Road. After desilting, cavities to be filled, eroded stones to be restored and pointing to be done for existing wall in left hand side for a ht. of about 1.4 m b) Both Sides Near K.R. Market upto Avenue Road. After desilting, cavities to be filled, eroded stones to be restored and pointing to be provided for existing wall on both sides for a height of about 1.4 m. c) Right Side From N.R. Road upto New Bamboo Bazar. After desilting, cavities to be filled, eroded stones to be restored and pointing to be provided for existing wall on both sides for a height of about 1.8 m.	-	-
3	2,000	3,000	3rd Cross, New Bamboo Bazar Road	2nd Cross Road, Sudhamanagar	-	-	a) 2000 - 2325 b) 2425 - 3000	Right Side From 3rd cross, New Bamboo Bazar Road upto 1st Main, J.C. Road. After desilting, cavities to be filled, eroded stones to be restored and pointing to be donne for existing wall on Right hand side for a height of about 1.5 m. Both Sides From J.C. Road upto 2nd cross, Sudhamanagar. After desilting, cavities to be filled, eroded stones to be restored and pointing to be provided for existing wall on both side for a height of about 1.5 m	- -	- -
4	3,000	4,000	2nd Cross Road, Sudhamanagar	KSRTC Bus Depot near K.H. Double Road	a) 3000 - 3500	Both Side	a) 3000 - 3275	Both Side	a) 3000 - 3500	1 no. of 300 mm dia & 100 mm dia. C.I. Pipeline at 2.8 m height above bed level exists.

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Rehabilitation Works					
					Drain Wall Reconstruction		Drain Wall Restoration		Utility Shifting & Other Obstruction Removals	
	From	To	From	To	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks
1	2	3	4	5	6	8	9	11	12	14
					b) 3500 - 4000	Near Annipura 100 m length drain wall to be reconstructed on both sides for a height of 2.4 m. Both Sides Near KSRTC Bus Depot 50 m length Drain wall to be reconstructed on both sides for a height of 2. 4m	b) 3275 - 3475 c) 3475 - 4000	Near Sudhamanagar. After desilting, cavities to be filled, eroded stones to be restored and pointing to be done for existing wall on both side for a height of about 1.5 m Left Side Near Annipura. After desilting, cavities to be filled, eroded stones to be restored and pointing to be done for existing wall on left hand side for a height of 1.5 m. Both Side Near K.S.R.T.C. Bus Depot. After desilting, cavities to be filled, erodes stones to be restored and pointing to be done for existing wall on both side for a height of 1.5 m.	b) 3500 - 4000	1 no. of 100 mm dia electrical cable at 2 m height above bed level exists.
5	4,000	5,000	KSRTC Bus Depot near K.H. Double Road	Bannerghata Road near Jalakanteshwarapura	a) 4000 - 4500	Both Side Near K.S.R.T.C. Bus Depot. 100 m length drain wall to be reconstructed on both side for a height of 2.4 m.	a) 4000 - 5000	Both Side From K.S.R.T.C. Bus Depot upto Bannerghatta Road near Jalakanteshwarapura. After desilting, cavities to be filled, eroded stones to be restored and pointing to be done for existing drain walls on both sides for a height of 2.0 m	a) 4000 - 5000	1 no. of 900 mm dia. w/s pipe line at 3.0 m height above drain bed exists.
					b) 4500 - 5000	Right Side Near Vinayakanagar. 100 m length drain wall to be reconstructed on both sides for a height of 2.4 m				
6	5,000	6,000	Bannerghata Road near Jalakanteshwarapura	Muthu - Mariamma Temple near L.R. Nagar foot bridge location.	-	-	a) 5000 - 5200	Both Side Near Vinayakanagar. After desilting, cavities to be filled, eroded stones to be restored and pointing to be done for existing wall on both sides for a height of 2.4 m.	a) 5000 - 5500	a) 3 nos. of M.S. utility pipe & 2 nos. of cable exists near bridge location.

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Rehabilitation Works					
					Drain Wall Reconstruction		Drain Wall Restoration		Utility Shifting & Other Obstruction Removals	
	From	To	From	To	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks
1	2	3	4	5	6	8	9	11	12	14
7	6,000	7,000	Muthu - Mariamma Temple near L.R. Nagar foot bridge location.	Viveknagar Bridge Location	-	-	a) 5000 - 5200	Right Side Near Viveknagar Bridge location. After desilting, cavities to be filled, eroded stones to be restored and pointing to be done for existing wall on Right side for a height of 1.5 m	-	-
8	7,000	8,000	Viveknagar Bridge Location	National Games Village	-	-	a) 7200 - 7850	Left Side Near Indira Gandhi Slum Area. After desilting, cavitieis to be filled, eroded stones to be restored and pointing to be provided for the existing wall on left side for a height of 1.5 m.	-	-
9	8,000	9,000	National Games Village	Koramangala 1st Cross Road	-	-	a) 8425 - 8500	Left Side Near Ejipura Church Road bridge location. After desilting, cavities to be filled, eroded stones to be restored and pointing to be provided for the existing wall on left side for a height of 1.5 m.		
							b) 8700 - 9000	Both Side Near Inner Ring Road. After desilting, cavities to be filled, eroded stones to be restored and pointing to be provided for the existing wall on both side for a height of 1.5 m.		
10	9,000	10,000	Koramangala 1st Block, 1st Cross Road	Koramangala Ist Block, 8th Cross Road	9500 - 10000	Both Side 30 m length drain wall to be reconstructed on both sides for a height of 2.2 m.	a) 9000 - 9600	Both Side Near Koramangala Ist Block. After desilting, cavities to be filled, eroded stones to be restored and pointing to be provided to the existing drain wall for a height of 1.5 m.	-	-
11	10,000	12,000	Koramangala Ist Block, 8th Cross Road	Location near Bellandur Tank	-	-	-	-	-	-

Table - 6.9 Schedule For Improving the Carrying Capacity of Existing Secondary Storm Drains in Koramangala Main Valley

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Carrying Capacity Improvements Works							
					Drain Widening		Drain Desilting & Deepening		Drain Wall Raising		Bed Protection	
	From	To	From	To	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks
1	2	3	4	5	6	8	9	11	12	14	15	17
K101–Koramangala Layout(1)Secondary Storm Drain:												
1	0	1,000	Hosur Main Road	Koramangala 5th Block, 5th Cross Road	-	-	0 - 1000	This Reach of drain is almost covered and it needs to be opened at regular interval and desilted by about 0.3 m. Further, pre-fabricated steel grating needs to be provided at regular interval. Existing Average Width:3m	-	-	-	-
2	1,000	2,000	Koramangala 5th Block, 5th Cross Road	Ejipura Church Road Bridge	1800 - 2000	Right Side Koramangala 80 Feet Road upto Ejipura Church Road Bridge. Existing drain needs to be widened on right hand side. Existing width 2.75 m widened to 4.5 m & height 2.2 m	1000 - 2000	This reach of drain is almost covered (upto Ch. 1400 m). It needs to be opened at regular interval and desilted by about 0.3 m. Further, from (1400 - 2000 m) it is open drain. Existing average width: 4 m	-	-	a) 1800 - 2000	After desilting bed protection need to be provided for full lengfth & width.
K102–Koramangala Layout(2)Secondary Storm Drain:												
1	0	300	Hosur Main Road	Jyothi Niwas Womens College	-	-	0 - 300	This Reach of drain is open drain upto Ch. 200 m and further, it is closed (upto 300 m). It needs to be opened at regular interval and desilted by about 0.3 m. Further pre-fabricated steel grating needs to be provided at regular interval. Existing Width : 2.0 m	-	-	-	-
K103–Austin Town Secondary Storm Drain:												
1	0	1,000	M.G. Road	Corpn. Work Shop, near Magrath Road	-	-	0 - 1000	This Reach of drain is almost covered and it needs to be opened at regular interval and desilted by about 0.3 m. Further, pre-fabricated steel grating needs to be provided at regular interval. Existing average width: 3 m	-	-	-	
2	1,000	2,000	Corpn. Work Shop, near Magrath Road	KPTCL Office near Old Race Course Road	a) 1050 - 1700 b) 1700 - 2000	a) Left Side From Shoppers Stop Commercial Complex near Magarath Road upto Victoria Road. Existing drain needs to be widened on Left Hand Side and on right hand side near Kendriya Vidyalaya. Existing width: 3.0 m to 6.5 m & ht. 2.0 m Left Side	a) 1000 - 2000	Existing drain needs to be desilted by about 0.5 m	-	-	a) 1000 - 2000	a) After desilting drain bed needs to be provided for full length & width.

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Carrying Capacity Improvements Works							
					Drain Widening		Drain Desilting & Deepening		Drain Wall Raising		Bed Protection	
	From	To	From	To	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks
1	2	3	4	5	6	8	9	11	12	14	15	17
						From Victoria Road upto KPTCL Office. Existing drain needs to be widened on left hand side and further from Palm Grove road drain needs to be widened on right hand side upto KPTCL office. Existing width: 7.0 m to 10.0 m & ht. 2.2 m						
3	2,000	3,400	KPTCL Office near Old Race Course Road	Rose Garden near Neelasandra	-	- Existing width: 8 m	a) 2000 - 3400	Existing drain need to be desilted by about 0.4 m and further after desilting drain bed needs to be deepened by about 0.5 m	-	-	a) 2000 - 3400	After desilting drain bed needs to be provided for full length & width.
K104–Laksandra Secondary Storm Drain:												
1	0	1,700	Lalajinagar near MICO Factory	Pothalappa Garden near Annapalya	a) 800 - 900 b) 1525 - 1700	a) Left Side New MICO Layout Road near Pukraj Layout. Existing drain needs to be widened on left hand side Existing average width: 2.5 widened to 4.0 m and height 2.0 m b) Left Side Opp. NDRI. Existing drain needs to be widened on left hand side. Existing width 2.5 m widened to 5.0 m and height 2.0 m	a) 0 - 1700	Existing drain needs to be desilted by about 0.4 m. Existing Av. Width : 2.5 m	-	-	a) 150 - 900 b) 1450 - 1700	a) After desilting drain bed needs to be provided for full length & width b) After desilting drain bed needs to be provided for full length & width
K107–Lakshamma Garden Secondary Storm Drain:												
1	0	770	Langford Town	Jalakanteshwarapura	-	-	0 - 770	Existing drain needs to be desilted by about 0.4 m depth and further, from Ch. 400 upto Ch. 700 m. Existing covered drain needs to be opened at regular interval and desilted by about 0.5 m and further pre-fabricated steel grating needs to be provided at regular interval. Existing width: 4 m	-	-	-	-
K108–Siddapura Secondary Storm Drain:												
1	0	1,000	Someshwara-pura, near Jayanagar 1st Block	Venkata Reddy Layout	-	-	a) 0 - 1000	Existing covered drain from Ch.0 - 200 m needs to be opened at regular interval and desilted for about 0.3 m and further pre-fabricated steel grating needs to be provided at regular interval. Further, from Ch. 200 - 1000 m, it is open drain and it needs to be desilted by about 0.3 m and further, after desilting drain bed needs to be deepened by about 0.4 m.	-	-	a) 200 - 1000	After desilting, bed protection needs to be provided for full length & width.
2	1,000	1,925	Venkata Reddy Layout	Wilson Garden	a) 1150 - 1250	a) Both Side Near Marigowda road. Existing dran is in natural condition. It needs to be widened and new wall to be constructed on both sides.	a) 1150 - 1250	a) This reach of drain needs to be desilted by 0.4 m and further deepened by abaout 0.5 m.			a)1150 - 1250 b)1650 - 1925	After desilting, bed protection needs to be provided for full length & width. After desilting, bed protection needs to be provided for full length & width.

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Carrying Capacity Improvements Works							
					Drain Widening		Drain Desilting & Deepening		Drain Wall Raising		Bed Protection	
	From	To	From	To	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks
1	2	3	4	5	6	8	9	11	12	14	15	17
						Existing average width : 2 m widened to 3. 5 m ht. 1.6 m. Right side	b) 1250 - 1650	b) This Reach of drain is almost covered and it needs to be opened at regular interval and desilted by about 0.5 m and further, pre-fabricated steel grating needs to be provided at regular interval.				
					b) 1650 - 1925	From Wilson Garden, 10th Cross Road upto K-Valley primary drain location. Existing stone slab covered drain needs to be opened and widened on Right hand side. Further, after widening, new RCC walls to be constd. on both sides and this entire reach of drain needs to be covered with 325 mm thick RCC slab. Existing average width : 1.5 m widened to 5.0 m height 2.0 m	c) 1650 - 1925	This Reach of drain is almost covered and it needs to be opened at regular interval and desilted by about 0.5 m and further, pre-fabricated steel grating needs to be provided at regular interval.				
K109–Raja Ram Mohan Roy Extn. Secondary Storm Drain:												
1	0	1,000	Kanteerava Stadium	12th Cross, Sampangi Ramnagar	-	-	a) 0 - 1000	a) This Reach of drain is almost covered and it needs to be opened at regular interval and desilted by about 0.3 m and further pre-fabricated steel grating needs to be provided at regular intervals. Existing average width: 2m	-	-	-	-
2	1,000	2,000	12th Cross, Sampangi ramnagar	Raja Ram Mohan Roy Extn.	a) 1150 - 1300	a) Both Sides From 14th Cross, Sampan-giramnagar upto Mission Road Existing covered drain needs to be opened and widened on Right hand side and further on left hand side (From existing 1.5 m to 3.0 m). Further, RCC Box drain of size 3 x 2 needs to be constructed, at the same location.	a) 1000 - 2000	a) This Reach of drain is almost covered and it needs to be opened at regular interval and desilted by about 0.3 m and further, pre-fabricated steel grating needs to be provided at regular interval. Existing average width : 3.0 m				
					b) 1475 - 1600	b) Left Side Near Bangalore Institute of Oncology. Existing B.S. Slab covered drain needs to be opened, widened on left hand side and further, new RCC box drain of size 3 x 2 m needs to be constructed. Existing average width: 2						
K110–Lalbagh Secondary Storm Drain:												
1	0	625	Hosur Road	Sudhama Nagar	a) 525 - 625	Left Side Near Labour Commi-ssioner's office near Sudhamanagar.	a) 0 - 625	a) This reach of drain is covered upto (Ch: 0 - 100 m). It needs to be opened at regular interval and desilted. Further, from (Ch. 100 - 500 m) open drain, it needs to be desilted by about 0.4 m.	-	-	a) 100 - 525	After desilting, bed protection needs to be provided for full length & width. Existing average width : 2 m

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Carrying Capacity Improvements Works							
					Drain Widening		Drain Desilting & Deepening		Drain Wall Raising		Bed Protection	
	From	To	From	To	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks
1	2	3	4	5	6	8	9	11	12	14	15	17
						Existing drain needs to be widened on left hand side. Existting average width : 1.8 m widened to 4.0 m. ht. 1.6 m					b) 525 - 625	After desilting, bed protection needs to be provided for full length & width. Proposed average width : 4 m
K111–Jayanagar Secondary Storm Drain:												
1	0	950	South End Road, near Jayanagar 2nd Block	Lalbagh Tank	-	-	a) 0 - 950	a) This reach of drain is almost covered and it needs to be opened at regular interval and desilted by about 0.4 m and further, pre-fabricated steel gratings needs to be provided at regular interval. Existing width : 2 m	-	-	-	-
K112–Kalasipalya Secondary Storm Drain:												
1	0	715	Parvathipura	Kumbara Gundi	-	-	a) 0 - 715	a) Existing drain needs to be desilted by about 0.5 m Existing average width: 4 m	-	-	a) 0 - 715	a) After desilting drain bed needs to be provided for full length & width.

Table - 6.10 Schedule For Providing Rehabilatation to the Existing Secondary Storm Drains in Koramangala Main Valley

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Rehabilitation Works					
					Drain Wall Reconstruction		Drain Wall Restoration		Utility Shifting & Other Obstruction Removals	
	From	To	From	To	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks
1	2	3	4	5	6	8	9	11	12	14
K101 – Koramangala Layout (1) Secondary Storm Drain										
1	0	1,000	Hosur Main Road	Koramangala 5th Block, 5th Cross Road	-	-			-	-
2	1,000	2,000	Koramangala 5th Block, 5th Cross Road	Ejipura Church Road Bridge	-	-	a) 1600 - 2000	Both Side After desilting, cavities to be filled, eroded stones to be restored and pointing to be done to the existing drain wall on both sides for a height of about 0.8 m.	-	-
K102–Koramangala Layout(2)Secondary Storm Drain:										
1	0	300	Hosur Main Road	Jyothi Niwas Womens College	-	-	-	-	-	-
K103–Austin Town Secondary Storm Drain:										
1	0	1,000	M.G. Road	Corpn. Work Shop, near Magrath Road	-	-	0-1000	This Reach of drain is almost covered and it needs to be opened at regular interval and desitted by about 0.3 m. Further, fabricated steel grating needs to be provided at regular interval. Existing average width : 3 m	-	-
2	1,000	2,000	Corpn. Work Shop, near Magrath Road	KPTCL Office near Old Race Course Road	-	-	a) 1000 - 1700 b) 1700 - 2000	Left Side After desilting, cavities to be filled, eroded stones to be restored and pointing to be done to the existing drain wall on Left side for a height of about 1.5 m Right Side After desilting, cavities to be filled, eroded stones to be restored and pointing to be done to the existing drain wall on Right side for a height of about 1.5 m		
3	2,000	3,400	KPTCL Office near Old Race Course Road	Rose Garden near Neelasandra	-	-	a) 2000 - 2300	Both Side After desilting, cavities to be filled, eroded stones to be restored and pointing to be done to the existing drain wall on Both sides for a height of about 1.5 m	a) 2000 - 2500	a) 16 nos. of water supply, KPTCL & BSNL pipelines and cables exists.

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Rehabilitation Works					
					Drain Wall Reconstruction		Drain Wall Restoration		Utility Shifting & Other Obstruction Removals	
	From	To	From	To	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks
1	2	3	4	5	6	8	9	11	12	14
							b) 3200 - 3400	Both Side After desilting, cavities to be filled, eroded stones to be restored and pointing to be done to the existing drain wall on Both sides for a height of about 1.5 m	b) 2500 - 3400	a) 1 no. of 600 mm dia and 1 no. of 100 mm dia. pipeline exists.
K104–Laksandra Secondary Storm Drain:										
1	0	1,700	Lalajinagar near MICO Factory	Pothalappa Garden near Annapalya	-	-	a) 150 - 800	Both Sides After desilting, cavities to be filled, eroded stones to be restored and pointing to be done to the existing drain wall on Both sides for a height of about 1.0 m	-	-
							b) 800 - 900	Right Side After desilting, cavities to be filled, eroded stones to be restored and pointing to be done to the existing drain wall on Right side for a height of about 1.0 m		
							c) 1400 - 1700	Right Side After desilting, cavities to be filled, eroded stones to be restored and pointing to be done to the existing drain wall on Right side for a height of about 1.0 m		
K107–Lakshamma Garden Secondary Storm Drain:										
1	0	770	Langford Town	Jalakanteshwarapura	-	-	-	-	-	-
K108–Siddapura Secondary Storm Drain:										
1	0	1,000	Sonmeshwarapura near Jayanagar Ist Block	Venkata Reddy Layout	-	-	a) 200 - 1000	a) Both Side After desilting, cavities to be filled, eroded stones to be restored and pointing to be done to the existing drain wall on both sides for a height of about 1.5 m.	-	-
2	1,000	1,925	Venkata Reddy Layout	Wilson Garden	-	-	a) 1650 - 1925	a) Left Side After desilting, cavities to be filled, eroded stones to be restored and pointing to be done to the existing drain on left side for a height of about 1.5 m.	a) 1000 - 1500 a) 1500 - 1925	a) 1 no. of 300 mm dia. C I water supply pipeline line exists. b) 6 nos. of 1.2 m dia Manhole exists a) 1 no. of 150 mm dia water supply pipeline exists.

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Rehabilitation Works					
					Drain Wall Reconstruction		Drain Wall Restoration		Utility Shifting & Other Obstruction Removals	
	From	To	From	To	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks
1	2	3	4	5	6	8	9	11	12	14
K109–Raja Ram Mohan Roy Extn. Secondary Storm Drain:										
1	0	1,000	Kanteerava Stadium	12th Cross, Sampangi Ramnagar	-	-	-	-	-	-
2	1,000	2,000	12th Cross, Sampangi ramnagar	Raja Ram Mohan Roy Extn.	-	-	-	-	-	-
K110–Lalbagh Secondary Storm Drain:										
1	0	625	Hosur Road	Sudhama-nagar	-	-	a) 100 - 525	a) Both Side After desilting, cavities to be filled, eroded stones to be restored and pointing to be done to the existing drain wall on both sides for a height of about 1.0 m	-	-
K111–Jayanagar Secondary Storm Drain:										
1	0	950	South End Road, near Jayanagar 2nd Block	Lalbagh Tank	-	-	-	-	-	-
K112–Kalasipalya Secondary Storm Drain:										
1	0	715	Parvathipura	Kumbara Gundi	-	-	a) 0 - 715	Both Side After desilting, cavities to be filled, eroded stones to be restored and pointing to be done to the existing drain wall on both sides for a height of about 1.0 m.	-	-

Table 6.9 - Schedule For Improving the Carrying Capacity of Existing Secondary Storm Drains in Koramangala Main Valley

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Carrying Capacity Improvements Works							
					Drain Widening		Drain Desilting & Deepening		Drain Wall Raising		Bed Protection	
	From	To	From	To	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks
1	2	3	4	5	6	8	9	11	12	14	15	17
K113–Rajendranagar Secondary Storm Drain:												
1	0	1,000	Royal Parikrama Centre near Koramangala 8th Block	Rajendra Nagar 1st Main Road	600-900	a) Both side From Mariyamma temple upto Muneshwara temple. Existing drain is in natural condition and it needs to be widened on right hand side and new walls to be constructed for widened width on both sides. Width: 5.0 m & Height 1.6m	0 - 1000	Existing drain needs to be drilled for about 0.5 m depth.	-	-	a) 0 - 600 b) 600 - 1000	a) After drilling, drain bed needs to be provided for full length & width. Ex-Average width 3.5 m. b) After drilling, drain bed needs to be provided for full length & width. Ex-Average width 5.0 m.
2	1,000	2,225	Rajendra Nagar 1st Main Road	Koramangala Main Valley Primary drain (behind Akhila Karnataka Animal Rehabilitation Centre)	-	-	1000 - 2225	This reach of drain is almost covered and it needs to be opened at regular interval and desilted by about 0.5 m depth.	-	-	a) 1000 - 1200	a) After drilling, drain bed needs to be provided for full length & width. Ex-Average width 8.5 m.
									-	-	b) 2100 -2225	a) After drilling, drain bed needs to be provided for full length & width. Ex-Average width 9.0 m.

Table - 6.10 Schedule For Providing Rehabilatation to the Existing Secondary Storm Drains in Koramangala Main Valley

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Rehabilitation Works					
					Drain Wall Reconstruction		Drain Wall Restoration		Utility Shifting & Other Obstruction Removals	
	From	To	From	To	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks
1	2	3	4	5	6	8	9	11	12	14
K113–Rajendranagar Secondary Storm Drain:										
1	0	1,000	Royal Parikrama Centre near Koramangala 8th Block	Rajendra Nagar 1st Main Road	-	-	a) 0 - 600	**Both side:** From Parikrama Centre upto Mariamma Temple. After drilling, cavities to be filled, eroded stones to be restored and pointing to be done for existing wall on both side for a height of about 1.4 m	-	-
							b) 900 - 1000	**Both side:** From Muneshwara Temple upto Rajendranagar 1st Main road. After drilling, cavities to be filled, eroded stones to be restored and pointing to be done for existing wall on both side for a height of about 2.0 m		
2	1,000	2,000	Rajendra Nagar 1st Main Road	Koramangala Main Valley Primary drain (behind Akhila Karnataka Animal Rehabilitation Centre)	-	-	a) 1000 - 1200	**Both side:** From Rajendranagar 1st Main road upto Koramangala 80 Ft. Road. After drilling, cavities to be filled, eroded stones to be restored and pointing to be done for existing wall on both side for a height of about 2.0 m	-	-
								Both side:		
							b) 2100 - 2225	From Akhila Karnataka Animal Rehabilitation Centre. After drilling, cavities to be filled, eroded stones to be restored and pointing to be done for existing wall on both side for a height of about 2.2 m		

Table - 6.9 Schedule For Improving the Carrying Capacity of Existing Secondary Storm Drains in Tavarekere Valley

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Carrying Capacity Improvements Works							
					Drain Widening		Drain Desilting & Deepening		Drain Wall Raising		Bed Protection	
	From	To	From	To	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks
1	2	3	4	5	6	8	9	11	12	14	15	17
K 114– Akkithimmanahalli Secondary Storm Drain:												
1	0	1,100	Divyasree Chamber	KSRTC Training centre	-		0-350	This reach of drain is almost covered and it needs to be opened at regular interval and desilted by about 0.4m. Further steel grading needs to be provided at regular interval. Ex.Avg. Width:1.8 m	-	-		
					-	-	350-650	This reach of drain is almost covered and it needs to be opened at regular interval and desilted by about 0.4m.	-	-	350-650	After drilling, bed protection needs to be provided for full length & width.
					-	-	650-750	This reach of drain is almost covered and it needs to be opened at regular interval and desilted by about 0.5m.	-	-		
							750-1100	This reach of drain is almost covered and it needs to be opened at regular interval and desilted by about 0.4m.	-	-		

Table -6.10 Schedule For Providing Rehabilatation to the Existing Secondary Storm Drains in Tavarekere Valley

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Rehabilitation Works					
					Drain Wall Reconstruction		Drain Wall Restoration		Utility Shifting & Other Obstruction Removals	
	From	To	From	To	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks
1	2	3	4	5	6	8	9	11	12	14
K 114–Akkithimmanahalli Secondary Storm Drain:										
1	0	1,100	Divyasree Chamber	KSRTC Training centre	-	-	350-650	**Both side** After drilling, cavities to be filled, eroded stones to be restored and pointing to be done to the existing drains wall o both sides for a height of about 1.2 m	500-1000	6 Nos. of 1.2 m dia manhole exits.
					-	-	750-1100	**Both side** After drilling, cavities to be filled, eroded stones to be restored and pointing to be done to the existing drains wall o both sides for a height of about 1.2 m	-	-

Table - 6.9 Schedule For Improving the Carrying Capacity of Existing Primary Storm Drain in Tavarekere Main Valley (K200)

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Carrying Capacity Improvements Works							
					Drain Widening		Drain Desilting & Deepening		Drain Wall Raising		Bed Protection	
	From	To	From	To	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks
1	2	3	4	5	6	8	9	11	12	14	15	17
K200 – Tavarekere Valley Primary Storm Drain												
1	0	1,000	Sanatorium Road, Near NIMHANS Hospital	Mundkar Fire Service College near Jayanagar East Block	-	-	a) 0 - 1000	a) Existing drain needs to be desilted by about 0.4 m and further covered reach of drain from (Ch. 325 m to 750 m) needs to be opened and pre-fabricated steel grating needs to be provided at regular interval. Existing Average widht: 4 m.	-	-	a) 750 - 1000	After desilting drain bed needs to be provided for full length & width.
2	1,000	2,000	Mundkar Fire Service College near Jayanagar East Block	Tank Bund Road Near Bismilah-nagar	-	-	a) 1000 - 2000	a) Existing drain needs tobe desilted by about 0.4 m. Existing Average Width: 4 m	-	-	a) 1000 - 1225 b) 1325 - 1500 c) 1800 - 2000	After desilting drain bed needs to be provided for full length & width. After desilting drain bed needs to be provided for full length & width. After desilting drain bed needs to be provided for full length & width.
3	2,000	3,000	Tank Bund Road near Bismillanagar	Brindavan Nagar	a) 2050 - 2340 b) 2340 - 2400	a) Both Sides Near Balajinagar 19th Main Road Existing drain is in natural condition and new RCC walls needs to be constd. on both sides for a ht. of 1.8 m. b) Left Side Existing drain needs to be widened on left hand side. Existing width: 4.5 m widened to 7.5 m ht. 2.0 m	a) 2000 - 3000	a) Existing drain needs to be desilted by about 0.4 m	-	-	a) 2000 - 3000	After desilting drain bed needs to be provided for full length & width
					c) 2700 - 2900 d) 2900 - 3000	a) Left Side Near Brindavanagar Existing drain needs to be widened on left hand side and new RCC wall to be constd. Existing width: 7.5 widened to 10.5 m & ht. 2.2 m Right Side Near Brindavannagar. Existing drain needs to be widened on Right hand side and new RCC wall to be constd. Existing width: 5 m widened to 10.5 m & height 2.2 m						
4	3,000	4,000	Brindavan Nagar	36th Main Road, BTM Layout, 1st Stage	a) 3300 - 3500 b) 3525 - 3625 c) 3450 - 3550	a) Right Side Near Maruthi Nagar, Madivala Extn. (KPN Travels) Existing drain needs to be widened on Right hand side and new RCC wall to be constd. Existing width : 6 m widened to 10.5 m & height 2.4 m Right Side Near Venkateshwara Layout - Existing drain needs to be widened on Right hand side and new RCC wall to be constd. Existing width: 7.0 m widened to 10.5 m & ht. 2.4 m Left Side Near Ramaiah Garden Existing drain needs to be widened on left hand side and new RCC wall to be constd. Existing width: 5 m widened to 10.5 m & height 2.4 m	a) 3000 - 4000	a) Existing drain needs to be desilted by about 0.4 m	-	-	a) 3000 - 4000	After desilting bed protection needs to be provided for full length & width.

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Carrying Capacity Improvements Works							
					Drain Widening		Drain Desilting & Deepening		Drain Wall Raising		Bed Protection	
	From	To	From	To	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks
1	2	3	4	5	6	8	9	11	12	14	15	17
					d) 3750 - 4000	Right Side Near Madivala - Existing drain needs tobe widened on right hand side and new RCC wall to be constd. Existing width : 7 m to 10.5 m & ht. 2.4 m						
5	4,000	5,000	36th Main Road, BTM Layout, 1st Stage	Fern Hill Garden Apts. near HSR Layout	a) 4000 - 4150	Right Side Near CSB Research Centre Existing drain needs to be widened on right hand side and new RCC wall to be constd. Existing Width: 8 m to 10.5 m and height 2.4 m	a) 4000 - 5000	Existing drain needs to be desilted by about 0.4 m Existing Average Width : 9 m	-	-	a) 4000 - 5000	After desilting bed protection needs to be provided for full length & width.
6	5,000	6,000	Fern Hill Garden, Apartments near HSR Layout	HSR Layout, Sector-5 near 14th Main Road (Agara Tank)	-	-	a) 5000 - 6000	Existing drain need to be desilted by about 0.4 m Existing Average width: 14 m	-	-	a) 5000 - 6000	After desilting bed protection needs to be provided for full length & width.
7	6,000	7,600	HSR Layout, Sector-5 near 14th Main Road (Near Agara Tank)	Location near Bellandur Tank	7000 - 7600	Both Side Near Koramangala - Sarjapura Road Existing drain is in natural condition and it needs to be widened on both sides. Further, embankment to be made on both side with imported earth and dry stone revetment needs to be provided on both sides for full length and guard stones to be provided at every 10 m interval and new 7.5 m wide Service Road needs to be formed for 500 m length. Existing width: 20 m Proposed widening width: 30 m (bottom width) height 2.2 m	1) 6000 - 7000	Existing drain needs to be desilted by about 0.5 m for full length and further from Ch. 7000 m to 7600 m. After desilting, drain bed needs to be deepened by about 0.5 m. Ch. 6000 - 7000 Existing width: 15.0 m	-	-	a) 6000 - 7000	After desilting drain bed protection needs to be provided for full length and width.

Table - 6.10 Schedule For Providing Rehabilatation to the Existing Primary Storm Drain in Tavarekere Main Valley (K200)

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Rehabilitation Works					
					Drain Wall Reconstruction		Drain Wall Restoration		Utility Shifting & Other Obstruction Removals	
	From	To	From	To	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks
1	2	3	4	5	6	8	9	11	12	14
K200 – Tavarekere Valley Primary Storm Drain										
1	0	1,000	Sanatorium Road, Near NIMHANS Hospital	Mundkar Fire Service College near Jaynagar East Block	-	-	a) 750 - 1000	a) Both Side After desilting, cavities to be filled, eroded stones to be restored and pointing to be done on both sides to the existing drain wall for a height of about 0.5 m.	0 - 500	a) 8 nos. of 100 mm dia. Sewer Outlets exists - Left Side b) 10 nos. of 100 mm dia. Sewer Outlets exists - Right Side
2	1,000	2,000	Mundkar Fire Service College near Jayanagar East Block	Tank Bund Road Near Bismilahnagar	-	-	a) 1000 - 2000	a) Both Side After desilting, cavities to be filled, eroded stones to be restored and pointing to be done on both sides for the existing drain wall for a height of 0.6 m	a) 1000 - 1500 b) 1500 - 2000	a) 5 nos. of 100 mm dia. Sewer Outlets exists - Left Side b) 4 nos. of 100 mm dia. Sewer Outlets exists - Right Side a) 10 nos. of 100 mm dia sewer line exists - Left Side b) 12 nos. of 100 mm dia. sewer line exists - Right Side
3	2,000	3,000	Tank Bund Road near Bismillanagar	Brindavan Nagar	-	-	a)2340 - 2400 b)2400 - 2700 c)2700 - 2900 d)2900 - 3000	a) Right Side After desilting, cavities to be filled, eroded stones to be restored and pointing to be done on Right side for the existing drain wall for a height of 0.6 m b) Both Side After desilting, cavities to be filled, eroded stones to be restored and pointing to be done on both sides for the existing drain wall for a height of 0.6 m c) Right Side After desilting, cavities to be filled, eroded stones to be restored and pointing to be done on Right side for the existing drain wall for a height of 0.6 m d) Left Side After desilting, cavities to be filled, eroded stones to be restored and pointing to be done on Left side for the existing drain wall for a height of 0.6 m	a) 2000 - 2500	a) 10 nos. of 100 mm dia. sewer outlets exists - Left Side b) 12 nos. of 100 mm dia. sewer outlets exists - Right Side c) 4 Nos. of 1.2 m dia manholes exits.
4	3,000	4,000	Brindavan Nagar	36th Main Road, BTM Layout, 1st Stage	-	-	a) 3000 - 3300 b) 3300 - 3475	Both Sides a) After desilting, cavities to be filled, eroded stones to be restored and pointing to be done to the existing drain wall on both sides for a height of about 1.5 m. b) Left Side After desilting, cavities to be filled, eroded stones to be restored and pointing to be done to the existing drain wall on left side for a height of about 1.5 m.	a) 3000 - 3500 b) 3500 - 4000	a) 10 nos. of 100 mm dia Sewer outlets exists - Left Side b) 11 nos. of 100 mm dia Sewer outlets exists - Right Side c) 5 nos. of 100 mm dia Sewer outlets exists - Left Side d) 6 nos. of 100 mm dia Sewer outlets exists - Right Side a) 10 nos. of 100 mm dia Sewer outlets exists - Right Side

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Rehabilitation Works					
					Drain Wall Reconstruction		Drain Wall Restoration		Utility Shifting & Other Obstruction Removals	
	From	To	From	To	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks
1	2	3	4	5	6	8	9	11	12	14
										b) 10 nos. of 100 mm dia Sewer outlets exists - Left Side
							c) 3475 - 3525	Right Side After desilting, cavities to be filled, eroded stones to be restored and pointing to be done to the existing drain wall on Right side for a height of about 1.5 m.		
							d) 3525 - 3625	Left Side After desilting, cavities to be filled, eroded stones to be restored and pointing to be done to the existing drain wall on left side for a height of about 1.5 m.		
							e) 3625 - 3750	Both Sides After desilting, cavities to be filled, eroded stones to be restored and pointing to be done to the existing drain wall on both sides for a height of about 1.5 m.		
							f) 3750 - 4000	Right Side After desilting, cavities to be filled, eroded stones to be restored and pointing to be done to the existing drain wall on Right side for a height of about 1.5 m.		
5	4,000	5,000	36th Main Road, BTM Layout, 1st Stage	Fern Hill Garden Apts. near HSR Layout	-	-	a) 4000 - 4100	Right Side After desilting, cavities to be filled, eroded stones to be restored and pointing to be done on Right side to the existing drain wall for a height of 1 m.	a) 4000 - 5000	a) 16 nos. of 100 mm dia Sewer outlets exists - Left Side b) 20 nos. of 100 mm dia Sewer outlets exists - Right Side
							b) 4100 - 4350	Both Sides After desilting, cavities to be filled, and eroded stones to be restored and pointing to be done on both sides to the existing drain wall for a height of 1 m.		c) 2 no. of 1.2 m dia & 1 m height above drain bed level exists.
							c) 4450 - 5000	Both sides After desilting, cavities to be filled, and pointing to be done on both sides to the existing drain wall for a height of 1 m.		
6	5,000	6,000	Fern Hill Garden, Apartments near HSR Layout	HSR Layout, Sector-5 near 14th Main Road (Agara Tank)	a) 5500 - 6000	Both Side Near Fern Hill Garden Apartments near HSR Layout. 5 m wall to be reconstructed on both sides to a height of about 2.2 m	a)5000-6000	a) Both Sides After desilting, cavities to be filled and pointing to be done on Both sides to the existing drain wall for a height of 1.0 m	a) 5000 - 6000	a) 8 nos. of 100 mm dia. Sewer outlets exists - Left Side b) 10 nos. of 100 mm dia. Sewer outlets exists - Right Side
7	6,000	7,600	HSR Layout, Sector-5 near 14th Main Road	Location near Bellundur tank	7000-7600	Near Koramangala Sarjapura Rd.Ex-drain is in natural condition and it needs to be widened on both sides. Further, embankment to be made on both sides with imported earth and dry stones revetment needs to be provided on both sides for full length and gold stones to be provided at every 10 m interval and new 7.5 m Service Rd, needs to be formed for 500 m length.	6000 - 7000	After desilting, cavities to be filled, eroded stones to be restored and pointing to be done on both sides to the existing drain wall to a height of about 1.0 m.	6000 - 7000	1) 1 no. of 0.5 m BWSSB C.I. Sewer line exists.
			(Near Agara Tank)		Ex-Width:20 m. Pro-widening width : 30 m (Bottom) & ht. 2.2 m					2) 5 nos. of cables exists.

Table - 6. Schedule For Improving the Carrying Capacity of Existing Secondary Storm Drains in Tavarekere Main Valley

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Carrying Capacity Improvements Works							
					Drain Widening		Drain Desilting & Deepening		Drain Wall Raising		Bed Protection	
	From	To	From	To	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks
1	2	3	4	5	6	8	9	11	12	14	15	17
K201–Vanganahalli Secondary Storm Drain												
1	0	1,350	Vanganahalli	Agara Tank	a) 725 - 850	Left Side Near HBR Layour Sector - IV, 16th Cross Road. Existing drain needs to be widened on left hand side and new RCC wall to be constd. Existing width: 2.0 m 5.0 m & ht. 1.8 m	a) 0 - 1350	a) Existing drain needs to be desilted by about 0.5 m and also large quantity of vegetal growth noticed, needs to be cleared.	-	-	a) 0 - 1350	After desilting drain bed needs to be provided for fulllength & width
K202–Yellukunte Secondary Storm Drain												
1	0	950	Yellukunte	Venkatapura	-	-	a) 0 - 950	a) Existing drain needs to be desilted by about 0.5 m and also large quantity of vegetal growth noticed needs to be cleared. Existing width: 2.6 m	-	-	a) 0 - 950	After desiling drain bed needs to be provided for full length & width.
K203–HSR Layout Secondary Storm Drain												
1	0	1,200	Crompton Greaves	Outer Ring Road	a) 950 - 1200	Left Side Near HSR Layout Sector - VI Existing drain needs to be widened on Left Hand side. Existing Width: 2.5 to 7.5 m and height 1.6 m	a) 0 - 1200	a) Existing drain needs to be desilted by about 0.4 m and also large qty. of debris and vegetal growth noticed needs to be cleared. Existing Width: 2.5 m	-	-	a) 0 - 1200	After desilting drain bed needs to be provided for full length & width.
K204–Madivala Secondary Storm Drain												
1	0	705	Near Madivala Tank	Hosur Road	-	-	a) 0 - 705	a) Existing drain needs to be desilted by about 0.3 m and also large quantity of debris needs to be cleared. Existing width: 4. 5 m			a) 0 - 705	After desilting drain bed needs to be provided for full length & width.
K205– Tavarekere Secondary Storm Drain												
1	0	525	Mudduram Nagar	Bismillaha Nagar			a) 0 - 525	Existing drain needs to be desilted by about 0.3 m and Further, it needs to be deepened by about 0.5 m	-	-	a) 0 - 525	After desilting drain bed needs to be provided for full length & width
K206–Guruppanapalya Secondary Storm Drain												
1	0	1,245	Tayappana-halli	Bovi Colony	a) 275 - 475	Right Side Near URS Colony. Existing drain needs to be widened on Right hand side. Existing width: 2. 6 m to 5.0 m & ht. 1.8 m	a) 0 - 1125	Existing covered drain from (Ch. 0 - 200 m) needs to be opened at regular interval and desilted by about 0.4 m for the entire length. Further, from Ch. 200 m upto 475 m and it needs to be desilted and deepened by about 0.3 m.	-	-	a) 200 - 1245	After desilting drain bed needs to be provided for full length & width.
K207–Krishnappa Garden Secondary Storm Drain												
1	0	1,225	Bairasandra Extension	Bannerghatta Road	a) 500 - 850	Left Side	a) 0 - 1225		-	-	a) 500 - 1225	After desilting drain bed needs to be

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Carrying Capacity Improvements Works							
					Drain Widening		Drain Desilting & Deepening		Drain Wall Raising		Bed Protection	
	From	To	From	To	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks
1	2	3	4	5	6	8	9	11	12	14	15	17
						Near RBI Extn. Existing drain needs to be widened on left hand wide. Existing width: 2.6 m to 5.5 m & ht. 1.6 m.		Existing covered drain from (Ch. 0 - 500 m) needs to be opened at regular interval and desilted by about 0.5 m and Further, from Ch. 500 m upto 1225 m, it needs to be deepened by about 0.4 m				provided for full length & width
					b) 850 - 1225	<u>Left Side</u> Near lake bund road. Existing drain is in natural condition and it needs to be widened on left hand side and new wall to be constructed on both sides. Existing width: 6.0 m to 7.5 m & ht. 1.8 m						
K208– Law College Secondary Storm Drain:												
1	0	425	Tilaknagar	Krishnappa Garden	-	-	a) 0 - 425	Existing covered drain from Ch. 0 - 200 m needs to be opened at regular interval, desilted by about 0.3 m and further, from Ch. 200 m it needs to be desilted and deepened by about 0.4 m upto 425 m. Existing width: 2 m	-	-	a) 225 - 425	After desilting drain bed needs to be provided for full length & width.

Table - 6. Schedule For Providing Rehabilatation to the Existing Secondary Storm Drains in Tavarekere Main Valley

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Rehabilitation Works					
					Drain Wall Reconstruction		Drain Wall Restoration		Utility Shifting & Other Obstruction Removals	
	From	To	From	To	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks
1	2	3	4	5	6	8	9	11	12	14
K201–Vanganahalli Secondary Storm Drain										
1	0	1,350	Vanganahalli	Agara Tank	a) 0 - 500	Both Side New walls to be constructed for a length of 300 m on both sides for a height of about 1.8 m	a) 0 - 725	Both Side After desilting, cavities to be filled, eroded stones to be restored and pointing to be done on both sides to the existing wall to a height of about 0.5 m	-	-
							b) 725 - 850	Right Side After desilting, cavities to be filled, eroded stones to be restored and pointing to be done on Right sides to the existing wall to a height of about 0.5 m		
							c) 850 - 1350	Both Side After desilting, cavities to be filled, eroded stones to be restored and pointing to be done on Both sides to the existing wall to a height of about 0.5 m		
K202–Yellukunte Secondary Storm Drain										
1	0	950	Yellukunte	Venkatapura	a) 0 - 500	a) Both Side New wall to be constructed for a length of 50 m on both sides for a height of about 1.8 m.	a) 0 - 950	Both Side After desilting, cavities to be filled, eroded stones to be restored and pointing to be done on Both sides to the existing wall to a height of about 0.5 m	-	-
K203–HSR Layout Secondary Storm Drain										
1	0	1,200	Crompton Greaves	Outer Ring Road	-	-	a) 0 - 950	Both Side After desilting, cavities to be filled, eroded stones to be restored and pointing to be done on Both sides to the existing wall to a height of about 0.5 m	-	-
							b) 950 - 1200	Right Side After desilting, cavities to be filled, eroded stones to be restored and pointing to be done on Right side to the existing wall to a height of about 0.5 m		
K204–Madivala Secondary Storm Drain										
1	0	705	Near Madivala Tank	Hosur Road	-	-	a) 0 - 500	Both Side After desilting, cavities to be filled, eroded stones to be restored and pointing to be done on both sides to the existing wall to a height of about 1.0 m.	-	-

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Rehabilitation Works					
					Drain Wall Reconstruction		Drain Wall Restoration		Utility Shifting & Other Obstruction Removals	
	From	To	From	To	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks
1	2	3	4	5	6	8	9	11	12	14
K205– Tavarekere Secondary Storm Drain										
1	0	525	Mudduram Nagar	Bismillaha Nagar	-	-	a) 0 - 525	Both Sides After desilting, cavities to be filled, eroded stones to be restored and pointing to be done on both sides to the existing wall to a height of about 1.0 m.	a) 0 - 525	a) 12 nos. of 100 mm dia. sewer outlets existing on left side b) 10 nos. of 100 mm dia. sewer outlets existing on Right side
K206–Guruppanapalya Secondary Storm Drain										
1	0	1,245	Tayappana-halli	Bovi Colony	-	-	a) 275 - 475	Left Side After desilting, cavities to be filled, eroded stones to be restored and pointing to be done on Left side to the existing wall to a height of about 1.0 m.	a) 0 - 500	a) 2 nos. of 1.2 m dia. Manhole exists in the drain
							b) 475 - 1245	Both Side After desilting, cavities to be filled, eroded stones to be restored and pointing to be done on both sides to the existing wall to a height of about 1.0 m.		
K207–Krishnappa Garden Secondary Storm Drain										
1	0	1,225	Bairasandra Extension	Bannerghatta Road	-	-	a) 500 - 850	Right Sides After desilting, cavities to be filled, eroded stones to be restored and pointing to be done to the existing drain wall on Right side for a height of about 0.5 m.	-	-
							b) 850 - 1225	Right Side After desilting, cavities to be filled, eroded stones to be restored and pointing to be done to the existing drain wall on Right side for a height of about 0.5 m.		
K208– Law College Secondary Storm Drain:										
1	0	425	Tilaknagar	Krishnappa Garden	-	-	a) 200 - 425	Both Side After desilting, cavities to be filled, eroded stones to be restored and pointing to be done to the existing drain wall on Both side for a height of about 0.5 m.	-	-

Table - Schedule For Improving the Carrying Capacity of Existing Secondary Storm Drains in Tavarekere Valley

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Carrying Capacity Improvements Works							
					Drain Widening		Drain Desilting & Deepening		Drain Wall Raising		Bed Protection	
	From	To	From	To	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks
1	2	3	4	5	6	8	9	11	12	14	15	17
K 209–J.P. Nagar Secondary Storm Drain:												
1	0	1,000	1st Main Road, 4th Block, Jayanagar	Banashankari Main Road (IRR)	-		0 - 1000	Existing drain needs to be drilled by about 0.3 m, Ex-Average width 4.0 m.	-	-		
2	1,000	2,000	Banashankari Main Road (IRR)	J.P. Nagar 2nd Phase, 80 Ft. Road	-	-	1000-2000	Existing drain needs to be drilled by about 0.4 m, Ex-Average width 6.0 m.	-	-	1000-2000	After desilting, bed protection needs to be provided for full length & width.
3	2,000	3,000	J.P. Nagar 2nd Phase, 80 Ft. Road	3rd Main Road, Sarakki Dollars Colony	-	-	2000-3000	Existing drain needs to be drilled by about 0.4 m, Ex-Average width 6.0 m.	-	-	2000-3000	After desilting, bed protection needs to be provided for full length & width.
4	3,000	4,000			3550-3650	**Left side** Near Sarakki 4th Phase, 5th Cross temple. Ex-drain alignment needs to be slightly altered, widened and new wall to be constructed. Ex-Avg Width:7.5 m, Pro-widened widh: 11.0 m & Ht: 2.2 m			-	-		After desilting, bed protection needs to be provided for full length & width.
b)					3850-4000	**Both sides** Near Pride Apartment, Ex-drain is in natural condition and it needs to be widened on both sides and embankment needs to be formed with imported earth and dry stone revetment needs to be provided. Further, service road of 7.5 m wide needs to be formed on right hand side & guard stones to be provided at 10 m on both sides. Ex-Avg.width: 9.0 m Pro-widened width: 12.0 m and Height: 2.2 m	3000-4000	Existing drain needs to be drilled by about 0.5 m, Ex-Average width 10.0 m.	-	-	3000-4000	After desilting, bed protection needs to be provided for full length & width.
4	3,000	4,000	3rd Main Road, Sarakki Dollars Colony	Near Pride Apartment					-	-		
5	4,000	5,000	Near Pride Apartment	Location near Madivala tank at Kodichikkanahalli	a)4000-4150	**Both sides** Near Bannerghatta Road, Ex-drain is in natural condition and it needs to be widened on both sides and embankment needs to be formed with imported earth and dry stone revetment needs to be provided. Further, service road of 7.5 m wide needs to be formed on right hand side. Ex-Avg.width: 5.0 m Pro-widened width:12.5 m and Height: 2.2 m	4000-5200	Existing drain needs to be drilled by about 0.4 m, Ex-Average width 6.0 m.	-	-	4000-5200	After desilting, bed protection needs to be provided for full length & width.
					b)4175-4400	**Both sides** Opp. Ranka colony, Ex-covered drain needs to be opened and widened on right side and further embankment needs to be formed with imported earth and dry stone revetment needs to be provided on both sides. Ex-Avg.width: 5.0 m Pro-widened width: 12.5 m & Ht. 2.2 m						

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Carrying Capacity Improvements Works							
					Drain Widening		Drain Desilting & Deepening		Drain Wall Raising		Bed Protection	
	From	To	From	To	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks
1	2	3	4	5	6	8	9	11	12	14	15	17
					c)4400-5000	**Both sides** Opp. Mantri terrace Apartment, Ex-drain is in natural condition, drain alignment needs to be slightly altered, widened on both sides. Further, embankment needs to be made up with imported earth and dry stone revetment needs to be provided on both sides. Service road of 7.5 m wide needs to be formed on right hand side. Ex-Avg.width: 8.0 m Pro-widened width: 14.0 m & Ht. 2.2 m			-	-		
6	5,000	6,000	Location near Madivala tank at Kodichikkanahalli	Kodi chikkanahalli	5000-6000	**Both side:** Ex-drain reach is in natural condition and it needs to be widened and embankment needs to be formed on right side with imported earth. Further, dry stone revetment needs to be provided on both sides. Further, 7.5 m wide Service road needs to be formed on right side. Ex-Avg.width: 8.0 m Pro-widened width:12.5 m and Height: 2.2 m	5000-6000	Near Kodi chikkanahalli. Ex. drain needs to be desilted by about 0.5 m for the full length.	-	-	5000-6000	After desilting, bed protection needs to be provided for full length & width.
7	6,000	7,000	Kodi chikkanahalli	Lake city layout	6000-7000	**Both side:** Ex-drain reach is in natural condition. Alignment of drain needs to be slightly altered, widened and embankment needs to be formed on right side with imported earth. Further, dry stone revetment needs to be provided on both sides. Further, 7.5 m wide Service road needs to be formed on right side and guard stone to be provided at 10 m interval. Ex-Avg.width: 8.0 m Pro-widened width:14.0 m and Height: 2.2 m	6000-7000	Near Rotary Nagar. Ex. drain needs to be desikted by about 0.5 m for the full length.	-	-	6000-7000	After desilting, bed protection needs to be provided for full length & width.
8	7,000	8,000	Lake city layout	NGR layout	7000-8000	**Both side:** Ex-drain reach is in natural condition. Alignment of drain needs to be slightly altered, widened and embankment needs to be formed on right side with imported earth. Further, dry stone revetment needs to be provided on both sides. Further, 7.5 m wide Service road needs to be formed on right side and guard stone to be provided at 10 m interval. Ex-Avg.width: 8.0 m Pro-widened width:14.0 m and Height: 2.2 m	7000-8000	Near Rotary Nagar. Ex. drain needs to be desikted by about 0.5 m for the full length.	-	-	7000-8000	After desilting, bed protection needs to be provided for full length & width.

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Carrying Capacity Improvements Works							
					Drain Widening		Drain Desilting & Deepening		Drain Wall Raising		Bed Protection	
	From	To	From	To	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks
1	2	3	4	5	6	8	9	11	12	14	15	17
9	8,000	9,500	NGR layout	Bommanahalli Indl. Area	a)8000-8300	**Both side:** Ex-drain reach is in natural condition. Alignment of drain needs to be slightly altered, widened and embankment needs to be formed on right side with imported earth. Further, dry stone revetment needs to be provided on both sides. Further, 7.5 m wide Service road needs to be formed on right side and guard stone to be provided at 10 m interval. Ex-Avg.width: 8.0 m Pro-widened width:14.0 m and Height: 2.2 m	8000-9500	Near Rotary Nagar. Ex. drain needs to be desikted by about 0.5 m for the full length.	-	-	8000-9500	After desilting, bed protection needs to be provided for full length & width.
					b)8300-9000	**Both side:** Near Bommanahalli Indl. area. Ex-drain flow through industrial area, it is in natural condition, it needs to be widened on both sides and embankment needs to be formed on both sides with imported earth and dry stone revetment needs to be provided on both sides. Ex-Avg.width: 8.0 m Pro-widened width:12.5 m and Height: 2.2 m						
					c)9000-9500	**Left side:** Near Hosur main road. Ex-drain flows by the side of Hosur main road. Drain is in natural condition on left side. It needs to be widened on left side and new RCC wall to be constd on left side. Ex-Avg.width: 6.0 m Pro-widened width:12.5 m and Height: 2.2 m						
K 210–Puttenahallli Secondary Storm Drain:												
1	0	1,000	Shiva temple near sarakki lake	Ayodhya nagar, JP nagar 5th phase, Visveswaraiah circle	-		0 - 1000	Existing drain needs to be desilted by about 0.5 m, Ex-Average width 2.0 m.	-	-	0-1000	After desilting, bed protection needs to be provided for full length & width.
2	1,000	1,700	Ayodhya nagar, JP nagar 5th phase, Visveswaraiah circle	New Dollars colony, JP nagar 5th phase.	-	-	1000-1700	Existing drain needs to be drilled by about 0.4 m, Ex-Average width 6.0 m.	-	-	1000-1700	After desilting, bed protection needs to be provided for full length & width.

Table - Schedule For Providing Rehabilatation to the Existing Secondary Storm Drains in Tavarekere Valley

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Rehabilitation Works					
					Drain Wall Reconstruction		Drain Wall Restoration		Utility Shifting & Other Obstruction Removals	
	From	To	From	To	Chainage (m.)	Remarks	Chainage (m.)	Remarks	Chainage (m.)	Remarks
1	2	3	4	5	6	8	9	11	12	14
K209–J.P. Nagar Secondary Storm Drain:										
1	0	1,000	1st Main Road, 4th Block, Jayanagar	Banashankari Main road	-	-	0-1000	**Both side** After desilting, cavities to be filled, eroded stones to be restored and pointing to be provided for a height of 1.0 m	-	-
2	1,000	2,000	Banashankari Main road	J.P. Nagar 2nd Phase, 80 Ft. Road	-	-	1000-2000	**Both side** After desilting, cavities to be filled, eroded stones to be restored and pointing to be provided for a height of 1.0 m	-	-
3	2,000	3,000	J.P. Nagar 2nd Phase, 80 Ft. Road	3rd Main Road, Sarakki Dollars Colony			2000-3000	**Both side** After desilting, cavities to be filled, eroded stones to be restored and pointing to be provided for a height of 1.0 m	2500-3000	1 No. of 150 mm dia w/s pipe line.
4	3,000	4,000	3rd Main Road, Sarakki Dollars Colony	Near Pride Apartment	-	-	3000-3850	**Both side** After desilting, cavities to be filled, eroded stones to be restored and pointing to be provided for a height of 1.0 m	3000-4000	15 Nos. of 1.2 m dia. Manhole 1.2 m above drain bed level. 1 No. of 150 mm dia sewer line exists.
5	4,000	5,000	Near Pride Apartment	Location near Madivala tank at Kodichikkanahalli	-	-			4000-4500	1 No. of 150 mm dia w/s pipe line.
6	5,000	6,000	Location near Madivala tank at Kodichikkanahalli	Kodi chikkanahalli						
7	6,000	7,000	Kodi chikkanahalli	Lake city layout						
8	7,000	8,000	Lake city layout	NGR layout						
9	8,000	9,000	NGR layout	Bommanahalli Indl. Area			9000-9500	**Right side:** Near Hosur road. After desilting, cavities to be filled, eroded stones to be restored and pointing to be provided for a height of 1.5 m		
K210–Puttenahalli Secondary Storm Drain:										
1	0	1,000	Shiva temple near sarakki lake	Ayodhya nagar, JP nagar 5th phase, Visveswaraiah circle	-	-	0-1000	**Both side** After desilting, cavities to be filled, eroded stones to be restored and pointing to be provided for a height of 1.0 m	-	-
2	1,000	2,000	Ayodhya nagar, JP nagar 5th phase, Visveswaraiah circle	New Dollars colony, JP nagar 5th phase.	-	-	1000-1700	**Both side** After desilting, cavities to be filled, eroded stones to be restored and pointing to be provided for a height of 1.0 m	1000-1700	2 manholes & 1.2 m dia, 0.6 m ht. above drain bed level.

✓Brief Work Programme for Remodeling of Storm Water Drains in Koramangala Valley:

•All the works considered under remodeling project shall start simultaneously from down stream end of respective packages.

•Vegetation growth noticed inside the drain at various locations, shall be removed in all the packages.

•Shifting of service lines which are noticed all along the entire length of the drain at various locations, shall be taken up simultaneously in coordination with various agencies in all the packages.

•Stoppage of sewage and other undesirable liquid wastes entry into storm drains which are noticed over the entire length, shall be taken up simultaneously in all the packages.

•Desilting of drains, removal of debris/solid wastes etc., which are noticed over the entire length of storm drain, shall be taken up simultaneously in all the packages.

•Widening of storm drains at the critical reaches, which are identified at various locations under the project, shall be takenup simultaneously in all the packages.

•Culvert/bridges considered for remodeling under the project, at various locations shall be takenup simultaneously in all the packages.

•Construction of new drains considered for minimising the flooding problems in low lying areas which are spread over at various locations shall be takenup simultaneously in all the packages.

•Reaches of existing drain walls proposed for reconstruction/restoration under the project at various locations in the entire length of drain, shall be takenup simultaneously in all the packages.

- Providing rehabilitation works to existing drain walls and other structures considered under the project at various locations, shall be takenup simultaneously in all the packages.

- Construction of new drain wall / stone revetment in the reaches identified at various location under the project shall be takenup simultaneously in all the packages.

- Providing pointing and skin reinforcement to the entire length of existing SSM storm drain walls shall be takenup simultaneously in all the packages..

- Construction of water recharging structures and development of land along side of the drain shall be takenup simultaneously in all the packages.

- Providing bed protection to the entire length of storm drains, shall be takenup simultaneously in all the packages.

- Restoration of roads, cross drains and other infrastructure facilities, after completion of the works at various locations, shall be takenup simultaneously in all the packages.

- Providing improvements works at along side of the storm drains, shall be takenup simultaneously in all the packages.

- Periodic maintenance of storm drainage system, shall be takenup for the entire length of the drains in all the packages.

6.6 Recurrent Cost :

For maintaining the existing drains in good condition and to have maximum hydraulic carrying capacity, the drainage system has to be maintained in good condition. The general maintenance envisaged are:

1. Removal of weeds
2. Removal of silt
3. Removal of debris and garbage

4.Repair of civil structures

5.Creating public awareness

6.Maintenance of desilting equipment's

7.Manpower requirement for maintenance of the system.

Table 6.19 Indicates abstract of cost for annual operation and maintenance of the drainage system in Koramangala Valley.

Table 6.19 Abstract of Cost for Operation and Maintenance of Primary and Secondary Storm Water Drains in Koramangala Valley

Sl. No.	***Description***	***Amount (Rs. In lakhs)***	***Remarks***
1	**Operation & Maintenance**		(Cost considered is for per annum).
1.1	Establishment Charges	17.50	
1.2	Purchase & maintenance of equipments.	17.50	
1.3	Construction of new components	52.50	
1.4	Drain Desilting works	43.75	Av. Silt depth of Min. 0.3 to 0.5 m. per year
1.5	Rehabilitation works	35.00	
1.6	Staff training, community awareness etc.	8.76	
	Total	**175.01**	

Abstract of Cost
for Remodeling of Primary and Secondary Storm Water Drains, Culverts/Bridges & its appurtenant works in Koramangala Valley

Sl.No.	Description	Amount (Rs. In Lakhs)
1	Cost for Remodeling of Primary & Secondary Storm Water Drains, Construction of New Drains near low lying areas, Formation of Service Roads etc.,	10,303.32
2	Cost for Remodeling of Bridges / Culverts constructed across Primary & Secondary Storm Water Drains.	380.12
3	Cost for shifting utility lines, footpath improvement works, barricading, traffic diversion, strengthening of diversion routes etc.	534.17
4	Construction of Detention Ponds / Retarding Basins	150.00
5	Construction of Wells with pumping arrangement in low lying areas	300.00
6	Procurement of desilting machine	0.00
7	Miscellaneous and rounding off	0.02
8	1.Advisory, Project Management & Establishment Charges (1.5 % of Item 1 to 7)	175.01
	2.Sub Total	**11,842.65**
9	3.Phase – I Construction of new drain from Koramangala 80 ft. road via. Ejipura main road, ASC centre, Defence dairy farm land upto Bellandur Tank	3,129.06
10	4.Phase – II Construction of new drain along Koramangala 80 ft. road upto Jakkasandra layout	3,237.96
	5.Total (Including Phase – I Proposal)	**14,971.71**
	6.Total (Including Phase – II Proposal)	**15,080.61**
11	Annual Operation & Maintenance Cost (1.5 % of Item 1 to 7)	175.01

CHAPTER – 7

TECHNO – ECONOMIC ANALYSIS

7.1 INTRODUCTION:

Koramangala main valley originates from Majestic Area in the centre of the city and terminates at Belandur lake near the present airport and is located south east of Bangalore.. The valley is spread in around 60 sq. km out of a total area of 225 sq. km for the Bangalore city. The total population of Bangalore city as per 2001 census is 4.5 million (the municipal limits are divided into 100 wards) and around 1.0 million people live in the 22 wards of Koramangala valley area. There are 78,800 residential and 20,137 non-residential properties in the area.

Tanks in Koramangala valley

The main tank in the valley is Belandur Lake close to the present airport. The tank is highly contaminated and hazardous for public and cattle use. Major reconditioning and rejuvenation exercise should be undertaken as part of the lake development programs. To maintain the ecosystem it is essential to clean the tank as well as divert the sewage mixing with the storm water drain by laying a sewage network. Unless continuous fresh water supply is ensured for the lakes and tanks, the habitat of the water bodies would be severely affected.

The contamination in the lakes have altered the habitat for fishes, birds and other aquatic plants; foremost being the growth of dangerous weeds like water hyacinth. The problem is further complicated by the gradual siltation over the years, creating a deep layer of artificial subsoil on the lakebed. Apart from reducing the water holding capacity of the lakes, this has completely stopped the recharge of ground water.

The Valley projects when implemented would not generate additional revenue for the principal implementing agency viz. BMP. Thus, it is a social infrastructure project attempting to restore the eco-system and relieve the citizens and residents of hardships that they are currently exposed by way of polluted drains, flooding and potential danger of public health hazards. These characteristics of the project lend itself for grants, aid and soft loans. Not withstanding the above social aspects, BMP would provide appropriate support to the project by means of initial seed amount and through budget provision to support the operation and maintenance of the SWDs once constructed.

7.2 OUT COME OF THE PROJECTS:

Sustainable ecosystem for lakes, river beds and other water bodies around river valleys; prevention and management of floods in low-lying areas and livable environ for citizens and residents.

7.3 STAKE HOLDERS OF THE PROJECT:

The project is designed to address the varying requirements of the stakeholders. They are:

INTERNAL	EXTERNAL
Bangalore Mahanagara Palike (BMP)	Citizens (residents of the area)
Bangalore Water, Sewage and Sanitation Board (BWSSB)	Industries and other occupants of the area
Lake Development Authority	NGOs
City Municipal Corporations	Funding Agencies
Bangalore Development Authority (BDA)	Government of Karnataka (GOK)
Karnataka Pollution Control Board	Karnataka Urban Infrastructure Development Finance Corporation (KUIDFC)
Elected representatives	Government of India (GOI)

7.4 STAKEHOLDER REQUIREMENTS, OUTPUTS AND BENEFITS:

Residents	No flooding Odourless and free flow of drain Green environment Separation of sewage and storm water Excellent Belandur lake and tanks Financially not inconvenienced Selected owners of land will benefit from land Value appreciation
Lake Development Authority	Water entering the lakes is as per the acceptable technical standards; Visually fresh water fish should thrive in the lakes Possibility for increased tourism
Bangalore Mahanagara Palike	One major issue resolved in line with 'citizen first' approach Good branding possibility Success can be replicated in other valley projects Publish a comprehensive book Success will enhance and ensure better flow of funds for future projects
BWSSB	One major issue resolved, rehabilitation of existing sewerage system to collect, treat and dispose the treated sewage there by abating the raw sewage flow into drains and lakes

	Diversion of sewage lines from the storm water drain network enabling proper care and maintenance of the sewerage system
GOK	Rediscover Bangalore as city of gardens, lakes etc.
GOI	A template for urban development; model to empower local governments
Funding Agency	Better chance of realizing ROI; fulfilling the purpose to assist developing countries in their efforts to develop economic and social infrastructure and stabilize their economies

7.5 PROJECT OBJECTIVES:

1. To rectify current localized flooding problems in the critical low lying areas identified in the study.
2. To cope with additional areas being included into the BMP administered area in terms of expansion of the storm water drain network.
3. To prevent polluted water getting into lakes and river beds
4. Encourage rain water harvesting in institutions, public parks, open grounds, etc
5. To improve and extend the security of services in vulnerable areas of the current BMP administered area.
6. To improve and protect the quality of environmental attributes including aesthetic appearance of city's environs.
7. To minimize cost implication on operation and maintenance of the system.
8. To educate the residents and citizens to be aware of the effect of dumping solid waste and other wastes into the drains (which are open by design)
9. To educate and enforce measures to prevent industries and commercial establishments from discharging toxic and wastewater into drains, lakes and river beds
10. To design, develop and implement information architecture to capture and incorporate vector and raster data to be used by multiple agencies on a shared basis. Information architecture is designed to support sustainability.

7.6 VARIABLES AND MEASUREMENTS:

It would be essential to translate the requirements in to variables that could be subject to measurement in order to monitor the performance. The table below depicts the variables and measurements and the scale as applicable for measurement.

VARIABLE	MEASURE	METRICS
Capacity of the local body of the Government (BMP)	Capacity to carry out environment management plan; ability to enforce relevant rules or regulations	Scale 1 to 5
Flexibility to accept change in terms of new approaches to environment plans	Willingness of employees and authorities of BMP and other internal stakeholders to accept professional and outcome based approaches to maintenance of ecosystem	Scale 1 to 5
Commitment to the implementation of the project	Demonstration by allocating required resources and competencies on a timely basis; enacting office orders and other instruments to facilitate implementation	Definitive
Effort to build awareness	Including a component for education and awareness in the project cost and engaging the citizens at various levels of project formulation and implementation	Definitive
Plan quality	Clarity of scope of work and definitiveness	Scale 1 to 5
Risk of flooding	Property loss, public health hazard, damages to structures	Scale 1 to 3
Regulatory policies	Permitted land uses, density controls over land use, transfer of development rights, cluster development provisions, set back requirements, site review requirements, spatial study or impact assessment requirements, building standards for flood prone area developments, financing for mitigation	Combination
Awareness	Educational awareness, voluntary real estate disclosure, flood warning systems, posting of signs to indicate flood prone areas	Definitive
Emergency planning provisions	Evacuation provisions, sheltering provisions, emergency plan provision	Scale 1 to 3
Change interventions	Willingness to train and orient personnel to achieve common and shared objectives of the local body	Scale 1 to 5

The parameters and indicators identified above have been studied in detail while preparing the detailed project report for the valley as well to develop the risk management plan. The primary risk identified for the implementation of the storm water drain project relates to coordination among various stakeholders in terms of timely execution of individual projects and schemes in order that the overall environmental condition of the valleys is restored.

7.7 Abstract of Cost

For remodeling of primary and secondary Storm Water Drains, Culverts/Bridges & its appurtenant works in Koramangala Valley:

Sl. No.	Description	Amount (Rs. In Crores)
1	Cost for Remodeling of Primary & Secondary Storm Water Drains, Construction of New Drains near low lying areas, Formation of Service Roads etc.,	103.03
2	Cost for Remodeling of Bridges / Culverts constructed across Primary & Secondary Storm Water Drains.	3.80
3	Cost for shifting utility lines, footpath improvement works, barricading, traffic diversion, strengthening of diversion routes etc.	5.34
4	Construction of Detention Ponds / Retarding Basins	1.50
5	Construction of Wells with pumping arrangement in low lying areas	3.00
6	Procurement of desilting machine	0.00
7	Miscellaneous and rounding off	0.01
8	Advisory, Project Management & Establishment Charges (1.5 % of Item 1 to 7)	1.75
	Total	**118.43**
9	Annual Operating & Maintenance Charges	1.75

For the purpose of seeking external funding only the core capital expenditure of Rs. 118.43 crores is considered whereas the amount required for operation and maintenance would be funded by Bangalore Mahanagara Palike out of its budget allocations (internal resources).

The direct beneficiaries of the clean environment that would ensue upon implementation of the project are the residents spread over 22 wards in the city. The demographic details of them are provided herewith:

7.8 WARDS AND DEMOGRAPHICS OF KORAMANGALA VALLEY:

Description	Ward No	Ward Names	Population	Properties	
				Residential	Non-residential
Koramangala Main Valley (K100)	27	Gandhinagara	32,752	2026	2062
	28	Chikapete	31,839	2640	4376
	30	Sri. Krishna Rajendra Market	39,502	1298	768
	47	Sri. Dharmarayaswami Temple	32,829	1849	3312
	48	Sudhamanagara	42,591	1460	1841
	50	Viswesvarapura	31,899	3772	399
	61	Mavalli	39,474	1860	205
	62	Hombegowdanagara	53,648	4293	269
	67	Koramangala	45,753	1791	340
	68	Ejipura	40,856	6245	240
	69	Neelasandra	51,994	2293	96
	70	Shanthinagara	35,016	3115	260
	71	Austin Town	39,771	1968	42
	76	Richmond Town	36,474	5290	3024
	77	Sampangiramanagara	32,354	2981	783
Tavarekere Valley (K200)	57	J.P. Nagara	63,594	8848	402
	58	Jayanagara	40,113	5695	157
	60	Pattabhiramanagara	39189	4142	467
	63	Lakkasandra	48,225	3372	510
	64	Gurrappanapalya	62,919	4145	140
	65	B.T.M. Layout	51,457	5657	245
	66	Madivala	65,760	4060	199
	22 wards	**Total**	**9,58,009**	**78,800**	**20,137**

CHAPTER – 8

SUSTAINABILITY EVALUATION

8.1 LEGAL ASSESSMENT:

8.1.1 LAND ACQUISITION:

The optimal engineering solution emerging in the techno economic study would require removal of structures and houses that have sprung up along the sides of the storm water drain. There are instances where structures have been built on the side walls of the drain itself impairing scope for widening of the drains. The width of the storm water drains right through the city is greatly reduced by encroachments thus reducing the carrying capacity of the drains. There are instances of dwellings built right on top of the drains in certain areas (Yeshwantpur – beginning of Hebbal Valley drain).

Considering the prolonged process that would be necessary to enforce vacation of properties built around the storm water drain network the solution proposed avoids land acquisition on a large scale for the initiative. Where it is absolutely necessary land acquisition is envisaged considering the rehabilitation programme for people who would get displaced on account of the project implementation. The land acquisition is proposed through a process of conferring development rights (Transfer of Development Rights) by which the owner of the land who has surrendered the part of the land towards infrastructure projects would be allowed to carry out construction based on enhanced floor space index (FSI) conferred by the TDRs.

8.1.2 ENFORCEMENT MEASURES:

To deal with indiscriminate dumping of solid waste in to the storm water drains, apart from education and awareness programme, enforcement measures that act as deterrent are also required to be imposed. Based on experience in dealing with such situations it is recommended that the civic authority is empowered to deal firmly with violators of law in respect of dumping of solid waste that include construction debris, dead animals and hazardous waste material. To sustain the initiative enforcement measures are proposed against unauthorized constructions and to deal with encroachments.

Further, there are many instances of evidence that in areas outside the BMP administered region, the development authorities do not enforce and adopt even rudimentary practices for planning, construction and maintenance of primary and secondary drains and also they lack resources and technical expertise to adopt best storm drain management practices. In the new areas strict enforcement of law and procedures would discourage the citizens and commercial establishments from treating storm water drains as mere sewage drains.

8.2 ESTABLISHMENT OF INSTITUTIONAL FRAME WORK:

There are multiple agencies of the Government that are directly involved and accountable to ensure that the storm water drains in Bangalore carry only storm water and nothing else (0% impurity whether liquid waste or solid waste). The agencies are Bangalore Mahanagara Palike (BMP) who is directly responsible as the implementing agency as well as the entity vested with the construction and maintenance of the drains in the city. The other agency is Bangalore Water Supply and Sanitation Board (BWSSB) whose function is to ensure that sewage is collected and conveyed to the sewage network and that it does not mix with the storm water. The current situation, however reveals that the storm water drains in Bangalore carry much of sewage as these are either directly disposed in to the drains or they overflow from the manholes and pipes located inside the storm water drains. The third agency having a stake in the upkeep of the storm water drains is the Lake Development Authority (LDA) whose mandate is to keep the lakes on the down streams to be pollution free.

The fourth agency involved in the issue is Bangalore Development Authority (BDA) who allots and plans residential and commercial sites in and around Bangalore. When sites are allotted without considering the existence of water and sanitation networks, citizens have little choice in the disposal of waste and most often they find their way in to the storm water drains.

Institution	Primary Role	Impact on SWDs	Area of cooperation	Severity of non-cooperation/ inaction
BMP	Planning, Development, Financing, Construction, operation and maintenance	Carrying capacity, flooding, pollution of the environment	Timely execution of projects Educating the citizens on proper solid waste disposal	Medium to High
BWSSB	Collection, Conveyance and disposal of sewerage	Mixing of sewage with storm water polluting the drains, clogging, spreading odour and finally polluting the lakes and water bodies	Integrated planning and removal of sewage network components form the storm water drains	High
BDA	Land Use Planning and allotment of sites	Residents forced to discharge sewage in to SWDs where sewage networks have not been planned but construction permits given	Coordination with BMP/BWSSB to create the infrastructure in a coordinated manner while allotting sites	Medium
LDA	Upkeep of lakes and water bodies	Closing of entry points in to lakes due to polluted water entering the lakes thus making the environment around the lake unhygienic (lake itself may be pure of sewage and other contaminations)	Participate in planning and development of schemes to treat the unclean water before entry in to the lakes	Medium

To realize the outcome of 100% pure flow of storm water in the drains all the above agencies need to participate and implement plans in an integrated and coordinated manner. The Government of Karnataka represented by the Urban Development Department has constituted an inter-institutional committee with members drawn from the following to give shape to the proposal for coordination and effective management of the storm water drain initiatives:

- Commissioner, BMP – Chairman of the Committee
- Secretary, Urban Development, GOK
- Chairman, BWSSB
- Chairman, BDA
- Chairman, LDA

Another critical institutional aspect for the storm water drain projects is the need to establish a dedicated project management cell within BMP to undertake such a massive and citizen sensitive project.

8.3 RATIONALE FOR A PROJECT MANAGEMENT UNIT:

There is a need for an organization which could handle joint projects among stakeholders cutting across various government entities. Such an organization should address the needs of the city – Greater Bangalore – a Techno polis, fast emerging as an intelligent city. The informal arrangement that was started a few years back in the form of BATF (Bangalore Agenda Task Force) needs to be formalized now by establishing a new organization that would focus on delivering citizen services by concentrating on urban infrastructure planning and execution. A strategic plan for the city development in terms of urban infrastructure shall be developed by the proposed organization along with a clear road map with milestones to translate the strategy to actions.

To execute a project with multiplicity of stakeholders profound project management skills and inter-disciplinary approaches are essential. In order to effectively implement, monitor and control the schemes envisaged under the storm water drain initiative it is strongly recommended that a Project Management Unit (PMU) as an exclusive entity responsible for storm water projects be established. Funding agencies stipulate evidence of professional management skills and best practices for sanction and disbursal of funds for such of these schemes. BMP readily accepted the recommendation and it has been suggested that PMU be established as part of BMP functioning independently to carry out the storm water drain projects in accordance with JNNURM guidelines and reforms agenda agreed among the stakeholders.

It has been observed in many infrastructure project implementation schemes that cost and time overruns could have been avoided if a separate dedicated unit or cell were vested with the authority and powers to deal with the project implementation cycle. There has been a significant improvement in performance of dedicated units wherein policy, implementation and regulation are clearly isolated and delineated. It is proposed that PMU functions as an execution agency of policies framed by BMP / Government and thus focusing on deliverables in terms of performance. Weak institutional mechanism coupled with lack of application of contracting skills affect the implementation of large infrastructure schemes. Channeling right competencies required for handling such schemes is vital but found to be non-existent under bundled institutional setups created around budgetary focus for expenditure monitoring. Performance measurement in terms of timely completion and construction as per requirements and specifications, are few aspects that are not given due importance under current functioning of these institutions.

Projects executed as part of many government schemes are susceptible to delays on account of slow decision making process and sometimes by the application of bureaucratic procedures. Focused attention and clearly defined roles among implementation agencies are seldom noticed in routine schemes funded either through budgetary allocations or through external funding mechanisms. Systems of the government remain inflexible and unable to cope up and address the needs of the funding agencies and contractors to deal effectively with emerging situations, uncertainties and risks.

While establishing the PMU, its governance structure, its inter-play with various internal and external stakeholders and its role, responsibility, powers, authority and liabilities need to be defined. More importantly the framework should highlight on the organization structure, the profile and attributes of the Chief Executive Officer and outsourcing mechanisms to pool resources. The recommendation would lay the basis for the establishment and operation of the PMU as well as its future role in respect of similar large urban infrastructure projects in Bangalore city.

The likelihood of achieving the project outcomes as per the specifications and within the timeframe planned would be greatly enhanced if the PMU is mandated to design, develop, implement and oversee the operation and maintenance phases. Performance orientation and achievement of measurable goals would be the hallmark of PMU and the knowledge gained should also be gradually transferred to its contractors, outsource partners and stakeholders.

PMU should be designed and structured in such a way that it is independent and allowed to function as an autonomous unit and be part of BMP. Performance measures of PMU shall be agreed between the designated state government agency and PMU and also in consultation with major stakeholders like BMP, BWSSB, LDA, BDA, CMCs etc. PMU should be evaluated based on its efficiency and effectiveness parameters and evolve initiatives and projects that are economically viable and politically sustainable. PMU could have its resources picked up from among various constituents of the government apart from external professional pool. An organization structure that would primarily meet with the engineering and enforcement aspects of the project is developed and presented here. The administrative functions like land acquisition and arrangement of finance are to be dealt with by the inter-institutional committee recommended as part of the reforms agenda.

Organization structure of the Project Management Unit (PMU) for implementing the remodeling of storm water drain network in Bangalore City.

8.4 EDUCATION AND AWARENESS PROGRAMME:

Awareness program as a tool is designed to address issues and propagate messages relevant to segmented consumers in respect of maintaining the environment to defined standards. The messages would include the types of technology, sources (availability), behavior pattern, ways to prevent dumping of waste, significance of clean environment with respect to health and safety and impact (social & economic) of not adhering to recommended rules and procedures.

Communication in the form of scientific intervention is critical to educate the economically weaker sections of the society, policy makers from health department, local bodies in charge of maintaining the environment around the storm water drains, lakes and other water bodies. They need to be aware of the systems governing safe environment, clean air and lakes with fresh water allowing fish to thrive. Unclean environment and the resultant odour and mosquito infestation affect their livelihood and also their health. The awareness in respect of impact of letting out wastewater without treatment on the environment and personal health are equally important. The communication program aims to create awareness on the ill-effects of having unclean storm water drain and water bodies and living in the midst of polluted environment caused by letting out un-treated wastewater and solid waste in to the open. It has been established through studies that more than 60% of the diseases caused are water borne and by effectively controlling sections of the society to seek and resort to safe disposal of both solid and liquid waste substantial savings would be made in the outlays currently made by the health department to address the public-health concerns. Orientation of the society through communication is an effective tool to achieve the desired results concerning behavior of citizens. They would emulate what is told if they are convinced of the impact in their lives. Practical demonstrations with test reports and certificates from authorized agencies entwined with communications program for spreading the message would achieve the desired result. Messages propagated in the local lingua and through personalities accepted by the community would have a significant impact in terms of acceptability and remembrance.

8.5 OBJECTIVES OF THE INTERVENTION:

The segmented target groups for this program are primarily economically weaker sections of the society, policy makers from health sector, local bodies in charge of wastewater and solid waste disposal, commercial establishments in the Hebbal Valley apart from potential polluting industrial units. For them the objectives are to:

- Introduce awareness on disposal pattern of waste and environmental factors associated with water and wastewater; especially focusing on organic matter in the form of bacteria, viruses and the like.
- Develop and administer awareness programs and education material in simple forms for school children.
- For the local bodies' material containing information on availability of cost effective technologies, transportation, quality control, costs, impact on environment would be developed and disseminated.
- Structure media programs along with direct campaigns to instill the awareness program.
- Sustain the message and effective follow up with repeated contacts and innovative schemes.
- Craft slide presentations, printable handouts, posters, and short movies for effective communication. The material prepared and administered would be in local language and simple to understand.

8.6 TARGET GROUP(S) WITH LOCATION SPECIFIC INFORMATION:

Bangalore City consists of 100 wards and the total population in the four valleys is around 4,500,000. The target group for the communications program will comprise segmented sections of weaker sections, schools (primary, middle and higher), and policy makers from health sector and local bodies in charge of storm ware drains, sanitation and lake maintenance. These would be chosen from the wards of the valleys. The target audience would be graded into government and the private sector comprising the policy makers, influencers, decision makers and implementing authorities. Citizens would be targeted through a network of non-government organizations (NGOs) who have established direct contact at various levels of communities.

8.7 DURATION OF THE INTERVENTION:

It is estimated that the intervention would be completed within a period of 36 months from commencement. There would be an intensive planning and requirement analysis process in the initial three months period formulating plans for implementing the awareness and communications program. Review and monitoring activities would form part of the intervention schedule to make an effective impact of the awareness program. The intervention would be administered both during the construction (remodeling of the drains) and the operation phase.

8.8 JUSTIFICATION FOR UNDERTAKING THE PROPOSED INTERVENTION:

A large engineering project with an outlay over Rs 7000 million without an education and awareness component is not likely to produce sustainable results. One of the key assumptions of the storm ware project is that raw sewage will not enter the drains once remodeling is complete. This assumption can not be satisfied through and engineering intervention alone. People have to be educated and made aware of the importance of sustaining the eco-system in order to protect the environment. If practices that are currently in vogue continues after the remodeling the purpose of the project initiative would have been completely missed. In order to realize the core objectives the proposed intervention is viewed as absolutely necessary. A program of Rs 30 million administered over a period of 36 months is likely to protect the investments made to the tune of Rs 7000 million. Enforcement alone is not likely to result in achieving the desired results. By directly engaging the segmented citizens the likelihood of protecting the investment and the maintenance of the eco-system of Hebbal Valley would be greatly enhanced.

8.9 APPROACH & METHODOLOGY:

Basic research in terms of segmentation of communities in terms of language, income level, literacy and vocation would be conducted in the first three months to gather data which will enable development of suitable programs for spreading the awareness. It is proposed to conduct an analysis and requirement planning to identify the areas where communication channels for the segmented target groups should be established and improved. The identification process would also focus on designing the content of the communication and awareness program suited to the target groups identified in terms of simplicity, vernacular and easy to comprehend and relate to real life situations. In case of school children curriculum on environmental health dealing with aspects of safe disposal of waste and keeping the environment clean and health aspects would be designed and promoted to authorities in the educational sector. Similarly, biological effects of living in unclean and polluted environ and methods to prevent unsafe methods of disposal of waste would be packaged in program for the health sector department. Impact of use of safe environment around the storm water drains on the spending by the health department would be clearly captured and popularized. Pilot schemes with focus target groups would be developed and administered. Lessons from the pilot schemes would be analyzed and evaluated for use in subsequent interventions in other community development programs as part of the education and awareness intervention.

8.10 DESCRIPTION OF THE TARGET AREA, TARGET GROUP (S) ALONG WITH THEIR CURRENT SOCIOECONOMIC STATUS:

The target area comprises four valleys (Challaghatta, Hebbal, Koramangala & Vrishabavathi) spread over 100 municipal corporation wards. The socioeconomic conditions of people living in the target area and in the target groups are quite mixed but predominantly economically weaker sections. For the target groups and in fact for all consumers, health costs arising out of water borne diseases are proving to be a great burden and continuously rising. Problems of flooding in the low lying areas due to clogging of drains with silt and waste have been witnessed in the past. Residents, commercial establishments and industries today are unaware of the ill-effects of throwing waste and discharging sewage in to storm water drains.

8.11 RELEVANCE OF THE INTERVENTION TO THE WORK ALREADY GOING ON:

A number of NGOs today interact with communities in regard to various socio-economic issues affecting the lives of the society. The proposed program would be designed in such a way to take advantage of the existing communication channels and also the network of NGOs to effectively promote the campaign. The emphasis would be to prevention of dumping of solid waste in to the storm water drains. The current programme would be suitably intermixed with ongoing communication programmes that are underway so that the citizens do not feel another massive programme thrust on them.

8.12 UTILISATION OF THE EXPECTED OUTCOME FROM THE INTERVENTION AND ITS BENEFICIARIES:

The outcomes expected from this intervention are two fold: firstly, it is to ensure acceptance of the program by the community in terms of change in practices for disposal of waste; effectives to be measured in terms of creating and sustaining a clean and green environment around the storm ware drains in the Hebbal Valley. Opportunities for employment creation within the local community for operation and maintenance of facilities would also be explored and established.

8.13 RISK ASSESSMENT:

Internal risks come mainly from three sources: the project, the organizations involved, and the relationships among partners. Most projects suffer at least temporarily, from a deficient project structure: many are launched even though objectives are not clear, a business case had not been completed, and milestones were only vaguely defined, if defined at all. On the organizational side, lack of project control mechanisms is the factor that most impede many projects. Finally, risks associated with the relationships among partners has been the major source of concern present in all projects, lack of definition of role and responsibility as the most important problem for project implementation.

The risks associated with the storm water drain projects fall in to three categories:

- Multiple stakeholder coordination risk during execution of work
- Project risk
- Acquisition of land and removal of encroachments while widening the drains

Continuing discharge of sewerage in to the drains – BWSSB is expected to draw up plans for connecting the households that now discharge the sewerage direct to the drains. Coordination and integration of BWSSB's plans with that of BMP alone will ensure the drains carrying the storm water of acceptable quality

Indiscriminate dumping of solid waste and debris in to the drains is another aspect exposed to risk. BMP has earmarked areas in each of the wards in the city where construction debris could be dumped. The exercise has begun and once implemented would greatly reduce the amount of debris being dumped in to the storm water drains. This combined with proper education and awareness programmes would help prevention of debris getting in to the drains.

8.14 RISK MANAGEMENT:

Risk	**Stakeholders**	**Severity of risk**	**Solution**
Acquisition of land	BMP, Government of Karnataka	Medium	A combination of enforcement and rehabilitation measures is required to notify the affected people and provide alternate arrangements for living
Removal of encroachments	BMP, BDA, Government of Karnataka	Medium	Legislation followed by proper enforcement; affected people to be considered for housing under basic services to urban poor plan

Internal risks associated with storm water drain projects in the four valleys of Bangalore city with suggested measures to address the risks.

Risks associated with the project itself	***Characteristics of clients/users of the service:*** resistance to change, lack of involvement, inadequate education level, difficulties in communicating, unrealistic expectations. (to overcome BMP is seeking citizen participation through ward committees and other for a) ***Scope of the project:*** universality or specificity of the service, number of partners involved, number of clients, size of budget. (contract documentation being revamped to define the role and responsibility very clearly) ***Complexity of the project:*** especially organizational and technological complexity. (consultant would evaluate various assumptions made in the design and detailed engineering) ***Definition and structure of the project:*** unclear objectives, ill-defined specifications and functional requirements, changes in the scope or the reach of the project, difficulties in integrating data or processes. (flexibility to accommodate changes from contractors)
Organizational risks	***Lack of resources:*** uncertainty of funding, inadequate resources, lack of expertise in complex resource management. ***Project team competencies:*** lack of experience, expertise, stability, and communication skills. (it is proposed to establish a PMU with requisite skills and experience) ***Management strategy:*** inadequate or inappropriate organizational support and control, absence of a champion, lack of leadership, unavailability of tested management tools and processes. (inter-institutional committee proposed to deal with policy level decisions) ***Technological know-how:*** absence of an adequate technological infrastructure and of in-house technological competencies. (Competencies being upgraded).
Relationship risks	***Form of collaboration:*** inadequate or inappropriate type of agreement, misunderstandings regarding the content of the agreement; inappropriate selection of partners. (all contractual frameworks to define the role, responsibility and liability of various parties clearly) ***Collaborative process:*** problems occurring with coordination, communications, inertia, dependency, mistrust, lack of consensus or involvement. (change management proposed)

CHAPTER 9

FINANCIAL AND OPERATING PLAN

The storm water drain valley projects when implemented would not generate additional revenue for the principal implementing agency viz. BMP. Thus, it is a social infrastructure project attempting to restore the eco-system and relieve the citizens and residents of hardships that they are currently exposed by way of polluted drains, flooding and potential danger of public health hazards. These characteristics of the project lend itself for grants, aid and soft loans. Not withstanding the above social aspects, BMP would provide appropriate support to the project by means of initial seed amount and through budget provision to support the operation and maintenance of the SWDs once constructed.

However, BMP is examining the possibility of levying a one time collection charges from property owners in the city towards partial recovery of capital cost that is estimated for the remodeling of the storm water drains. It is under consideration to recover at the maximum 40% of the capital cost through such cess. The recovery would be made over a period of five years from the property owners. This scheme is subject to willingness and affordability criteria of the residents and the approval of the BMP council and the State Government.

The revenue accrual on account of the proposed cess is summarized below – a total collection of Rs 302.50 Crores from the years 2007-08 till 2011-12.

Storm Water Drain Cess			45.00	55.00	65.00	67.50	70.00

Estimated Capital Costs

Cost in Rs Crores

Name of Component	**Capital Cost as per DPR**	**Years**					
		2006-07	**2007-08**	**2008-09**	**2009-10**	**2010-11**	**2011-12**
Storm Water Drain Network							
Challaghatta Valley	124.83	49.93	49.93	24.97	-	-	-
Hebbal Valley	190.13	76.05	76.05	38.03	-	-	-
Koramangala Valley	118.43	47.37	47.37	23.69	-	-	-
Vrishabhavathi valley	245.54	98.22	98.22	49.11	-	-	-
Sub-total for four valleys	**678.93**	**271.57**	**271.57**	**135.79**	**0.00**	**0.00**	**0.00**

Funding pattern for Storm Water Drain Valley Projects (Rs Crores)

Funding Pattern	**Total**	**2006-07**	**2007-08**	**2008-09**
GOI Grant 35%	237.63	95.05	95.05	47.53
GOK Grant 15 %	101.84	40.74	40.74	20.37
BMP financing	339.47	135.79	135.79	67.89
Total	**678.93**	**271.57**	**271.57**	**135.79**

The funding pattern is based on the JNNURM guidelines.

The fund flow statement for BMP for the next 10 years has been developed taking into consideration the financing of major infrastructure projects under JNNURM stream and non-JNNURM stream. These projections are under review by SBI Caps who are carrying out a due diligence exercise as well as the evaluation of viability for seeking external funding (viability gap after grant funding). The viability gap is proposed to be funded by direct loans as well as tax free municipal bonds that is under active consideration of both the State and the Central governments.

The basic assumptions in the financial projections are:

The property tax collection would move from Rs 320 crores in the year 2006-07 to Rs 750 Crores in the year 2015-16; this is being achieved with reforms in the property tax collection mechanism aided by GIS system for all the 100 municipal wards of BMP. The collection efficiency is estimated to go up to 85% by the year 2015-16 (the efficiency currently is 60%).

The revenue accretion from the State Government is estimated to move up from Rs 121 Crores in the year 2006-07 to Rs 302 Crores in the year 2015-16. This is based on the devolution criteria and guidelines provided by the Urban Development Department of the Government of Karnataka

Levy of storm water drain cess as a one time fee to be collected from all property owners – 10% cess on property tax paid – this would result in revenue accretion of Rs 302.50 crores over a period of 5 years

The total capital expenditure programme envisaged by BMP under JNNURM is approximately Rs 8000 crores including the basic services to urban poor component. Out of this BMP needs to mobilize Rs 4000 crores. It is assumed that BMP would arrange for term loans to the extent of Rs 1000 crores and the balance Rs 3000 crores would be obtained through issuing a series of tax free municipal bonds

Government of Karnataka would provide guarantees for the issue of municipal bonds to the extent of viability gap identified by the financial advisor

The cost of the municipal bonds is taken as 7% per annum and the bonds would be redeemed after 7 years period

The interest rate for future loans is assumed as 7.5 % per annum

The projections show a deficit in the terminal years when the bonds get redeemed; BMP proposes to identify additional sources of revenue from the year 2008-09 to improve its financial position in order to fund capital expenditure as well as honour financial commitments

The projections based on the assumptions are as follows:

Projected Funds Flow Statement for BMP

(Rs. In Crores)

REVENUE	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
REVENUE RECEIPTS											
Tax Revenues											
Property Tax	320.00	400.00	450.00	550.00	650.00	675.00	700.00	725.00	750.00	750.00	750.00
Advertisement Taxes	15.47	16.86	18.55	20.40	22.44	24.68	27.15	29.87	32.86	36.14	39.75
Surcharge on Stamp Duty	15.00	20.00	22.00	24.20	26.62	29.28	32.21	35.43	38.97	42.87	47.16
	350.47	436.86	490.55	594.60	699.06	728.97	759.36	790.30	821.83	829.01	836.91

Non Tax Revenues											
Grants											
SFC Grants	110.00	131.00	149.00	182.00	219.00	231.00	240.00	257.00	257.00	257.00	257.00
Other Grants:	11.00										
Grants towards electricity		25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
Incentivisation		10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Twelfth Finance Commission		10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	121.00	176.00	194.00	227.00	264.00	276.00	285.00	302.00	302.00	302.00	302.00

Service Charges											
Infrastructure Cess / User charges	20.00	-	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
SWM Cess	30.00	30.00	30.00	30.00	30.00	30.00	30.00	36.00	36.00	36.00	36.00
Service chgs on Tax exempt Props	15.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
	65.00	55.00	75.00	75.00	75.00	75.00	75.00	81.00	81.00	81.00	81.00
Fees & Fines											
Building License Fees	5.25	11.60	11.60	11.60	11.60	11.60	11.60	12.76	12.76	12.76	12.76
Compounding Fees	4.50	10.00	11.00	12.10	13.31	14.64	16.11	17.72	19.49	21.44	23.58
Development Charges	3.00	8.86	9.75	10.72	11.79	12.97	14.27	15.70	17.27	18.99	20.89
Ground Rent	3.06	8.24	9.06	9.97	10.97	12.06	13.27	14.60	16.06	17.66	19.43
Road Cutting Charges	6.02	0.45	0.50	0.54	0.60	0.66	0.72	0.80	0.88	0.96	1.06
Khata Transfer & Extract fees	8.94	11.35	12.49	13.73	15.11	16.62	18.28	20.11	22.12	24.33	26.76
Hotel / Power License Fees	3.50	5.00	5.50	6.05	6.66	7.32	8.05	8.86	9.74	10.72	11.79
Fee for Quality Control	-	5.00	5.50	6.05	6.66	7.32	8.05	8.86	9.74	10.72	11.79
Others	44.94	24.86	27.35	30.08	33.09	36.40	40.04	44.04	48.45	53.29	58.62
	79.21	85.36	92.74	100.85	109.77	119.59	130.39	143.43	156.50	170.87	186.68

Receipts from Corporation Properties											
Rent from Shops /Leased	9.31	23.50	23.50	23.50	23.50	23.50	23.50	25.85	25.85	25.85	25.85
Others	1.08	0.81	0.85	0.89	0.94	0.98	1.03	1.09	1.14	1.20	1.26
	10.39	24.31	24.35	24.39	24.44	24.48	24.53	26.94	26.99	27.05	27.11
Total Revenue Receipts	**626.07**	**777.53**	**876.63**	**1,021.8**	**1,172.2**	**1,224.04**	**1,274.2**	**1,343.67**	**1,388.32**	**1,409.93**	**1,433.70**

REVENUE	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
Capital Grants											
MOU Grants	81.90	-	-	-	-	-	-	-	-	-	-
JNNURM Funds	-	434.04	902.54	929.64	666.75	603.75	457.75		-	-	-
	81.90	434.04	902.54	929.64	666.75	603.75	457.75	-	-	-	-
Long Term Loans											
Loans from Financial Institutions for JNNURM matching grants	-	108.06	224.70	231.45	166.00	150.31	113.96	-	-	-	-
Bonds for JNNURM matching grants		325.98	677.84	698.20	500.75	453.44	343.79	-	-	-	-
Loans from Financial Institutions others	545.53	396.60	-	-	-	-	-	-	-	-	-
	545.53	830.64	902.54	929.65	666.75	603.75	457.75	-	-	-	-
Others											
Improvement Charges	30.00	30.00	30.00	30.00	30.00	30.00	36.00	36.00	36.00	36.00	36.00
Bldg Deviation Regularisation	100.00	10.00	100.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Sale of Properties	16.25	21.50	21.50	21.50	21.50	21.50	21.50	21.50	21.50	21.50	21.50
	146.25	61.50	151.50	61.50	61.50	61.50	67.50	67.50	67.50	67.50	67.50

Total Capital Receipts	**773.68**	**1,326.1**	**1,956.58**	**1,920.7**	**1,395.0**	**1,269.00**	**983.00**	**67.50**	**67.50**	**67.50**	**67.50**

Other Receipts

Cesses collected on Property Tax	108.80	136.00	153.00	187.00	221.00	229.50	238.00	246.50	255.00	255.00	255.00
Storm Water Drain Cess			45.00	55.00	65.00	67.50	70.00				
Deposits, Statutory Deductions etc	52.45	62.14	143.48	143.48	143.48	143.48	143.48	20.00	20.00	20.00	20.00
	161.25	198.14	341.48	385.48	429.48	440.48	451.48	266.50	275.00	275.00	275.00
TOTAL RECEIPTS	**1,561.00**	**2,301.85**	**3,174.68**	**3,328.11**	**2,996.75**	**2,933.52**	**2,708.76**	**1,677.67**	**1,730.82**	**1,752.43**	**1,776.20**

EXPENDITURE	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
Administrative Expenses											
Salaries											
Pay of Officers	6.26	5.81	6.39	7.03	7.73	8.51	9.36	10.29	11.32	12.45	13.70
Pay of Establishment	62.37	72.74	80.01	88.02	96.82	106.50	117.15	128.86	141.75	155.92	171.52
Allowances	63.00	64.18	70.60	77.66	85.42	93.97	103.36	113.70	125.07	137.58	151.33
Pension / Gratuity	30.50	34.50	37.95	41.75	45.92	50.51	55.56	61.12	67.23	73.95	81.35
	162.13	177.23	194.95	214.45	235.89	259.48	285.43	313.97	345.37	379.91	417.90
Advertisement & Publicity	2.12	2.33	2.80	3.36	4.03	4.83	5.80	6.96	8.35	3.08	3.69
Printing & Stationery	3.25	1.58	1.74	1.91	2.10	2.31	2.54	2.80	3.08	3.39	3.73
Telephone Charges	0.84	1.19	1.25	1.31	1.38	1.45	1.52	1.59	1.67	1.76	1.85
Electricity Charges	30.54	25.60	26.88	28.22	29.64	31.12	32.67	34.31	36.02	37.82	39.71
Water Charges	4.30	2.20	2.31	2.43	2.55	2.67	2.81	2.95	3.10	3.25	3.41
Council related Expenditure	3.90	5.49	5.76	6.05	6.36	6.67	7.01	7.36	7.72	8.11	8.52
Office Infrastructure	3.98	4.61	4.84	5.08	5.34	5.60	5.88	6.18	6.49	6.81	7.15
Vehicles - M & R Cost	10.03	10.25	10.76	11.30	11.87	12.46	13.08	13.74	14.42	15.14	15.90
Other Expenses	93.63	65.66	68.95	72.40	76.02	79.82	83.81	88.00	92.40	97.02	101.87

	152.59	118.91	125.29	132.06	139.26	146.93	155.12	163.87	173.25	176.38	185.83
Welfare Activities											
18% Allocation	14.53	27.76	27.76	27.76	27.76	27.76	27.76	27.76	27.76	27.76	27.76
Backward Classes & Minority Welfare	2.58	11.35	11.35	11.35	11.35	11.35	11.35	11.35	11.35	11.35	11.35
Women Welfare	6.48	4.99	4.99	4.99	4.99	4.99	4.99	4.99	4.99	4.99	4.99
General	0.70	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
	24.29	44.90	44.90	44.90	44.90	44.90	44.90	44.90	44.90	44.90	44.90
Educational Promotion Activities											
18% allocation	2.02	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
General	3.47	7.20	7.78	7.78	7.78	7.78	7.78	7.78	7.78	7.78	7.78
Sports Activities	1.55	1.07	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.52
	7.04	8.47	9.50	9.50	9.50	9.50	9.50	9.50	9.50	9.50	9.50

Health & Sanitation

Cleaning of Garbage	40.00	50.00	52.50	55.13	57.88	60.78	63.81	67.00	70.36	73.87	77.57
Decentralised Composting	0.10	0.10	0.11	0.11	0.12	0.12	0.13	0.13	0.14	0.15	0.16
Street Dog Management	0.85	1.50	1.58	1.65	1.74	1.82	1.91	2.01	2.11	2.22	2.33
Tipping Fees	2.50	2.00	2.10	2.21	2.32	2.43	2.55	2.68	2.81	2.95	3.10
Others	3.95	15.61	16.39	17.21	18.07	18.97	19.92	20.92	21.96	23.06	24.22
	47.40	69.21	72.67	76.30	80.12	84.13	88.33	92.75	97.39	102.25	107.37
EXPENDITURE	**2005-06**	**2006-07**	**2007-08**	**2008-09**	**2009-10**	**2010-11**	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**

Financial Expenses

Interest on Loans	76.51	120.61	147.68	220.20	278.55	320.47	355.84	385.78	364.64	304.37	237.50
Interest on Municipal Bonds	-	21.00	63.00	112.00	147.00	178.50	199.50	199.50	199.50	178.50	136.50
	76.51	141.61	210.68	332.20	425.55	498.97	555.34	585.28	564.14	482.87	374.00
Total Revenue Expenditure	**469.96**	**560.33**	**657.99**	**809.42**	**935.23**	**1,043.91**	**1,138.62**	**1,210.27**	**1,234.55**	**1,195.81**	**1,139.50**

CAPITAL EXPENDITURE

Public Works											
Solid Waste Management	7.90	6.60	6.93	7.28	7.64	8.02	8.42	8.84	9.29	9.75	10.24
Engineering - Zonal	462.44	383.19	25.00	26.25	27.56	28.94	30.39	31.91	33.50	35.18	36.94
Multi Purpose Engg Divisions	33.77	29.55	20.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Projects	138.27										
Infrastructure	134.37										
Comprehensive Development Plan	43.60										
Storm Water Drain Network											
Challaghatta Valley		49.93	49.93	24.97	-	-	-	-	-	-	-
Hebbal Valley		76.05	76.05	38.03	-	-	-	-	-	-	-
Koramangala Valley		47.37	47.37	23.69	-	-	-	-	-	-	-
Vrishabhavathi valley		98.22	98.22	49.11	-	-	-	-	-	-	-
Sub-total for four valleys		**271.57**	**271.57**	**135.79**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Extension work into CMC areas		**86.00**	**106.00**	**106.00**	**106.00**	**106.00**	**-**	**-**	**-**	**-**	**-**

Environment Management											
Tanks		15.00	17.00	17.00	17.00	17.00	17.00	-	-	-	-
Parks		15.00	8.00	8.00	7.00	6.00	6.00	-	-	-	-
Incinerator, Crematorium and Abattoirs		9.00	16.00	16.00	17.00	17.00	16.00	-	-	-	-
Tree Plantation and Nurseries		1.50	1.50	1.50	1.50	1.50	1.50	-	-	-	-
Urban Renewal											
Decongestion			30.00	30.00	30.00	30.00	30.00	-	-	-	-
Development of CBD			20.00	20.00	20.00	20.00	20.00	-	-	-	-
Road Network											
Arterial and Sub arterial roads		125.00	150.00	400.00	325.00	250.00	250.00	-	-	-	-
* **Includes IT/BT, Flood damaged roads**											
Grade Separators		120.00	200.00	150.00	150.00	200.00	80.00	-	-	-	-
Pedestrian subways		5.00	15.00	15.00	15.00	15.00	10.00	-	-	-	-
Foot Over Bridges		-	5.00	5.00	5.00	5.00	5.00	-	-	-	-
Foot Path improvements		-	20.00	20.00	20.00	20.00	20.00	-	-	-	-
Internal Core Ring Road			200.00	200.00		-	-	-	-	-	-

Road Widening		120.00	180.00	180.00	110.00	110.00	100.00	-	-	-	-
Waste Management											
Scientific Land fill stations at Mandur, Mavallipura, Manavarthekaval and near Ramanagaram		-	175.00	70.00	-	-	-	-	-	-	-
Transfer stations		-	40.00	35.00	60.00	60.00	60.00	-	-	-	-
Basic Services to Urban Poor	-	100.00	350.00	450.00	450.00	350.00	300.00	-	-	-	-
Traffic Engineering Cell	14.91	43.85									
Electrical Engg	23.72	34.40	42.40	42.40	42.40	42.40	42.40	42.40	42.40	42.40	42.40
Horticulture	56.84	28.72	30.16	31.66	33.25	34.91	36.65	38.49	40.41	42.43	44.55
	915.82	**1,665.96**	**2,201.13**	**2,112.66**	**1,454.35**	**1,331.77**	**1,043.37**	**131.64**	**135.60**	**139.76**	**144.13**
Repayment of Long Term Liabilities											
Repayment of Loans to Fin Instns	70.18	112.46	160.59	216.36	257.10	280.35	289.54	207.18	146.27	108.88	78.63
Repayment of Municipal Bonds	-	-	-	-	-	-	-	-	300.00	600.00	700.00
	70.18	112.46	160.59	216.36	257.10	280.35	289.54	207.18	446.27	708.88	778.63
Total Capital Expenditure	**986.00**	**1,778.42**	**2,361.72**	**2,329.03**	**1,711.45**	**1,612.12**	**1,332.91**	**338.82**	**581.88**	**848.64**	**922.76**

Other Payments											
Repayment of Cesses - Current	27.84	36.00	114.75	140.25	165.75	172.13	178.50	184.88	191.25	191.25	191.25
Repayment of Cesses - Arrears	-	32.73	-	-	-	-	-	-	-	-	-
Repayment of Statutory Deductions / Deposits	41.52	45.48	43.04	43.04	100.43	100.43	100.43	14.00	14.00	14.00	14.00
	69.36	114.21	157.79	183.29	266.18	272.56	278.93	198.88	205.25	205.25	205.25
TOTAL PAYMENTS	**1,525.32**	**2,452.97**	**3,177.51**	**3,321.74**	**2,912.86**	**2,928.59**	**2,750.46**	**1,747.97**	**2,021.67**	**2,249.69**	**2,267.51**
Net Surplus / Deficit	**35.68**	**(151.12)**	**(2.82)**	**6.38**	**83.89**	**4.93**	**(41.70)**	**(70.30)**	**(290.85)**	**(497.26)**	**(491.31)**

CHAPTER - 10

IMPLEMENTATION PLAN

10.1 INTRODUCTION:

This chapter provides a strategic framework to ensure that the Remodeling of storm water drain project proposed for Bangalore city is managed in a reliable, affordable, sustainable and environmentally friendly manner, and which is most essential for success of any project.

But from the existing management practices followed by the stakeholders and also with the prevailing site conditions, it appears that, along with the resources required to achieve the recommended targets, strategies and actions, they also needs to adopt best storm drain management practices, improvised construction and construction supervision techniques, strengthened organizational setup, major legislative changes, coordination with other stakeholders, public awareness campaigns including their participation to minimize the adverse implications on storm drain functionality and storm drain management practice in the city.

In order to achieve the overall objectives of the project, it is very much essential to have a proper implementation programme that could ensure better control over the project cost and resources mobilized etc. BMP also proposes to have a separate project implementation unit within BMP (other than members from stake holders dept.), headed by a senior officer from the Engineering wing, Revenue wing, consortia of Technical consultants, Financial advisors, Project management consultants, co ordination committee members (other stake holders dept. members), PRO's & NGO's.

10.2 STAGES OF THE PROJECT:

The proposed project is take up in two stages and it is proposed that Stage – I activities will be carried out by external Technical Consultants and Stage – II activities shall be monitored by the design consultants and the same will be over seen by BMP.

Stage – I PREPARATION OF DETAILED PROJECT REPORT:

Phase 1: Technical, Economical and Environmental Feasibility Study of the Project of Remodeling of the Storm Water Drain System.

Phase 2: Detailed engineering design, preparation of tender documents, cost estimates for the remodeling work, Preparation of Bid document and assist BMP to entrust the work to experienced, competent and successful agency.

A brief scope of assignment to be rendered by the Technical Consultants is given below:

- Detailed topographical and geo-technical survey
- Assessment of quantity of runoff
- Adequacy analysis of existing drains
- Hydraulic and structural designs and drawings
- Cost estimation and Bill of Quantities
- Technical specifications.
- Bid Documents
- Slicing and Packaging (Phasing for Implementation)
- Assistance in Inviting and evaluating Bids
- Project management and Quality assurance

The outline methodology Phase – I & Phase- II works & activity bar chart for Stage – I works is enclosed in this chapter as Fig. 10.1, Fig. 10.2 & Fig. 10.3.

Stage – II PROJECT IMPLEMENTATION:

The works envisaged in the project are grouped into 16 packages and each package costing around Rs. 20 Crores.

The details of the works identified are narrated in detail in the previous chapters and the summary of the same is indicated packages are as mentioned in the Table 10.1. and the same is depicted in Figure no. 10.4.

Name of the Valley	Drain Length, (Km.)		Total No. of Culverts/Bridges Considered for Remodelling	Tender Package No.
	Primary	Secondary		
Koramangala Valley				
Koramangala Main Valley	12.000	17.710	12	K1VD – I, K1VD- II & K1VD- IV
Tavarekere Valley	7.650	18.825	9	K2VD - III
Challaghatta Valley				
Challaghatta Main Valley	12.000	13.400	14	C1VD - II & C1VD- III
Ulsoor Valley	4.150	4.170	9	C2VD - I
Hebbal Valley				
Hebbal Main Valley	4.425	4.800	5	H1VD- I
Hebbal Main Valley - I	9.000	10.695	6	H2VD- II
Hebbal Minor Valley - I	7.375	9.330	16	H3VD- III
Hebbal Minor Valley - II	5.000	0.950	1	H4VD- IV
Vrishabhavathi Valley				
Vrishabhavathi Main Valley	14.000	30.945	18	V1VD - I & V1VD- II
Kethmaranahalli & Arkavathi Valley	13.300	14.675	15	V2VD - III & V2VD- IV
Kathriguppe Valley	4.850	11.400	6	V3VD- V

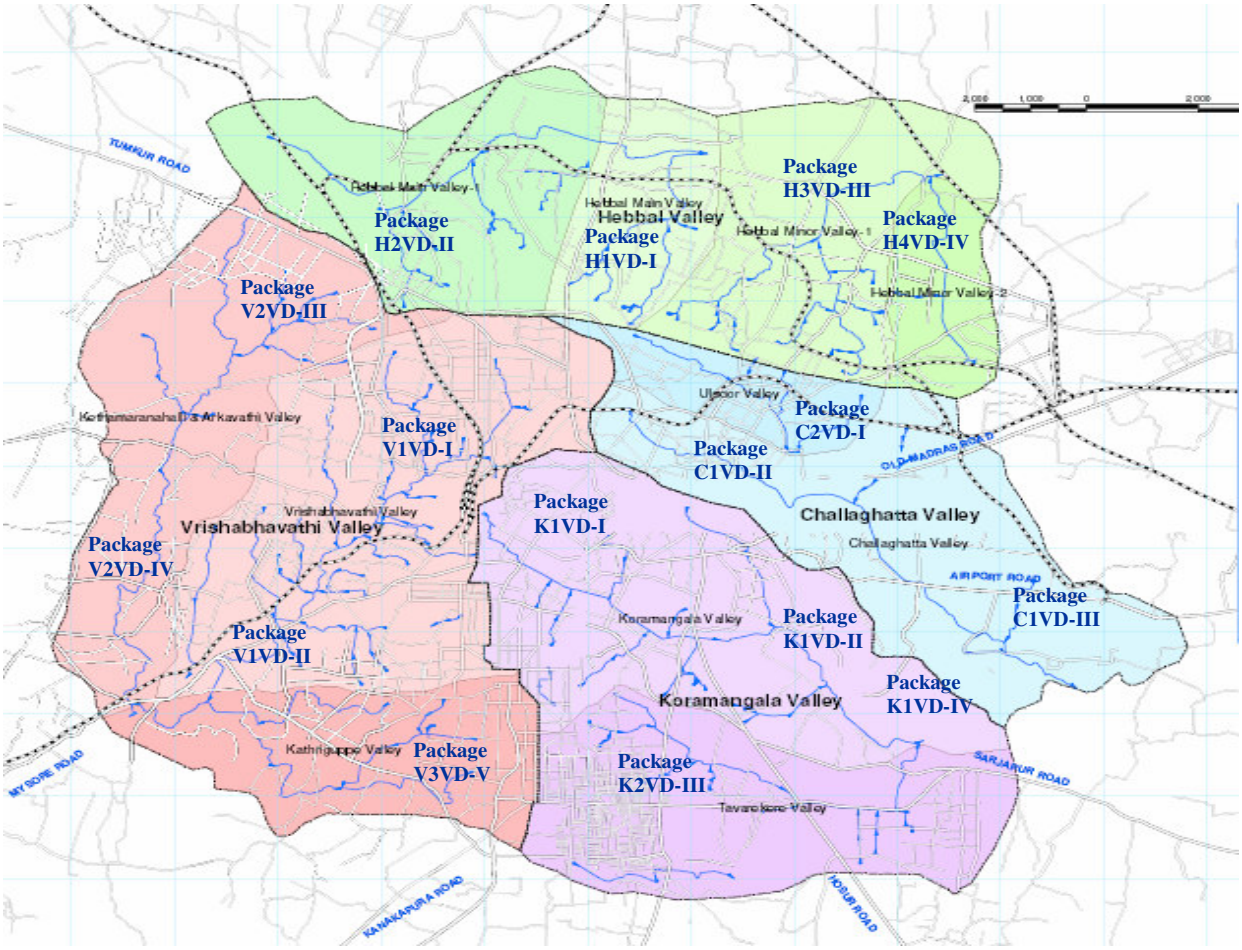

Figure 10.4 Packages Details

The site activities envisaged in all the 16 packages are classified into five categories viz'

Rehabilitation works to existing system:

I. Reconstruction of collapsed wall
II. Restoration of broken wall
III. Cavity filling, restoration of eroded stones, providing pointing to the existing drain walls etc.

Carrying capacity improvement works:

I. Widening of Drains
II. Desilting and drain deepening
III. Drain bed protection

Remodeling of existing inadequate vent way/Structurally unstable - bridges/culverts.

Removal of obstacles – pipe lines, manholes, cables etc.

Training & Community awareness campaigns.

The works proposed for remodeling of storm drains shall be taken up in a phased manner simultaneously in all the packages. Since, some of the critical issues like coordination from other agencies in several instances, community participation, acquisition of land from government & public, shifting of major utilities, traffic diversion at several places etc., are envisaged in all the packages.

After having several discussion with senior officials of BMP and other stake holders and beneficiaries of the project. Work programme with a broader contest has been formulated keeping in view the availability of the resources, minimum distraction to the adjoining properties, to cause less inconvenience to the public, considering the environmental aspects etc., also for smooth and successful implementation of the project, which is as narrated below,

Brief Work Programme for Remodeling of Storm Water Drains in Bangalore City:

- All the works considered under remodeling project shall start simultaneously from down stream end of respective packages.
- Vegetation growth noticed inside the drain at various locations shall be removed in all the packages.
- Shifting of service lines which are noticed all along the entire length of the drain at various locations, shall be taken up simultaneously in coordination with various agencies in all the packages.
- Stoppage of sewage and other undesirable liquid wastes entry into storm drains which are noticed over the entire length shall be taken up simultaneously in all the packages.
- Desilting of drains, removal of debris/solid wastes etc., which are noticed over the entire length of storm drain, shall be taken up simultaneously in all the packages.
- Widening of storm drains at the critical reaches, which are identified at various locations under the project, shall be taken up simultaneously in all the packages.
- Culvert/bridges considered for remodeling under the project, at various locations shall be taken up simultaneously in all the packages.
- Construction of new drains considered for minimizing the flooding problems in low lying areas which are spread over at various locations shall be taken up simultaneously in all the packages.
- Reaches of existing drain walls proposed for reconstruction/restoration under the project at various locations in the entire length of drain, shall be taken up simultaneously in all the packages.
- Providing rehabilitation works to existing drain walls and other structures considered under the project at various locations, shall be taken up simultaneously in all the packages.
- Construction of new drain wall / stone revetment in the reaches identified at various locations under the project shall be taken up simultaneously in all the packages.
- Providing pointing and skin reinforcement to the entire length of existing SSM storm drain walls shall be taken up simultaneously in all the packages.

- Construction of water recharging structures and development of land along side of the drain shall be taken up simultaneously in all the packages.
- Providing bed protection to the entire length of storm drains shall be taken up simultaneously in all the packages.
- Restoration of roads, cross drains and other infrastructure facilities, after completion of the works at various locations, shall be taken up simultaneously in all the packages.
- Providing improvements works at along side of the storm drains, shall be taken up simultaneously in all the packages.
- Periodic maintenance of storm drainage system shall be taken up for the entire length of the drains in all the packages.

10.3 IMPLEMENTATION PROGRAMME:

It is estimated that the work envisaged under remodeling of storm water drain project would involve period of 24 months from bidding with first six months dedicated to tender process and award of contract, which will be done as per KTTP act and 18 months for the execution of civil works.

It is proposed that BMP, the nodal agency will set up a separate implementation unit whose responsibilities would include ensuring the deployment of adequate staff, usage of quality materials, construction practices of acceptable standards and quality of works carried out, monitoring and reporting the project progress to the project monitoring agencies.

Tender specifications and construction practices are reflected in the bid document issued by BMP for its works related to construction of system components. The contractor would also adhere to the environmental regulations in practices and keep the citizens informed of the scheduled of the project underway in a periodic manner.

Detailed item wise implementation schedule for the execution of the project is enclosed in this report.