Bruhath Bengaluru Mahanagara Palike

Narashima Raja Square

Bengaluru

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

Hebbal Valley

Feasibility & Detailed Project Report

Volume – I

December 2006

STUP Consultants P. Limited

VOLUME I

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 four major valleys namely Vrishabhavathy, Koramangala, Challaghatta and Hebbal valley with total length of primary and secondary drains is more than 240 Km. Challaghatta main valley originates from palace ground in Jayamahal and join Bellandur lake. Hebbal main valley starts from Matadahalli and joins Nagavara 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, Commercial establishments, residential accommodations to meet the demands of the rising population has resulted in :

i) Increased pavement area & Rapid change in landuse pattern

ii) Developments of land inside the buffer storage areas and tanks

iii) Encroachments into the storm water drain

iv) Uncontrolled discharge of sewage & effluents inside the storm water drain

v) Constructions activities noticed inside the channel to facilitate for other utilities/service lines.

Bangalore Mahanagara Palike, agency responsible for the maintenance of the city's infrastructure has taken up the project of remodeling the entire storm water drains 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 four valleys :

i. Vrishabhavathy Valley
ii. Koramangala Valley
iii. Challaghatta Valley
iv. Hebbal Valley

II) Detailed scope of services includes;

- 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 for inviting tenders and evaluating Bids
- Project management and Quality assurance
- Training for BMP staff

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

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

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 / 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 are 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 catchment 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 mentioned 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 drains for allowing surface water to enter the drain and also with openings at regular intervals for routine maintenance of the system.

2. Closing of all side openings made to the drain walls for draining out surface water into the main drain, i.e., where the drain wall top is higher than the ground level/road level and construct side drains leading off storm water to the down stream end.

3. Provision of rehabilitation works like cavity filling, plastering & pointing to inside surface of existing stone masonry drain walls.

4. Provision of drain bed 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. Construction of embankment, providing stone revetment, bed protection, and service road formation where sufficient land is available.

8. Construction of new/byepass drains to reduce the load on the existing drains.

9. Construction 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 all the valleys. 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 surface water to down stream of drain.

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

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

14. Widening of drain & Construction of new drain near Outer ring road & Yogeshnagar Hebbal Main Valley (H100).

15. Widening of drain & Construction of new drain near Sanjeevappa garden, Devinagar, Maruthinagar & Bhadarappa layout in Hebbal Main Valley – I (H200).

16. Widening of drain & Construction of new drain near Hennur & Raja canal sewage treatment plant in Hebbal Minor Valley – I (H300).

17. Widening of drain & Construction of new drain near Nanjappa garden, Muniswamy layout & Chalkere in Hebbal Minor Valley – II (H400).

18. Reconstruction of Outer ring road bridge, Yogeshnagar bridge in H100, New BEL road bridge, R.M.V. Extn. bridges, Bupasandra main road culvert in H200, Hennur main road culvert, Banaswadi main road culvert, Gedalahalli main road bridge in H300.

19. Construction of new bridge near TATA nagar & Hebbal inlet weir, Balajinagar.

20. 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.

21. Encourage rain water harvesting in institutions, public parks, open grounds, 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 serious health hazards

The inadequate size of the drains, which is causes flooding of low lying areas such as Anandanagar, MSR layout, Chamundinagar, Bhuvaneshwarinagar, H.M.T. layout, Brindavannagar, Tannirhalli, Sanjeevappa garden, Maruthinagar, Badarappa layout, Shampura, Kadugondanahalli, Nagavara main road, Arabic college etc, causing threatening the life and properties of the people residing in these region, inconvenience to vehicular & pedestrian movement

Therefore, to minimize flooding, comprehensive proposals for both immediate and long term are prepared for entire Hebbal valley.

Cost Estimation:

For implementation of the various strategic actions, recommendations and proposals a detailed cost estimation has been prepared, and financial projection is as shown below;

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.,	15,938.24
2	Cost for Remodeling of Bridges / Culverts constructed across Primary & Secondary Storm Water Drains.	1,311.96
3	Cost for shifting utility lines, footpath improvement works, barricading, traffic diversion, strengthening of diversion routes etc.	862.51
4	Construction of Detention Ponds / Retarding Basins	174.00
5	Construction of Wells with pumping arrangement in low lying areas	400.00
6	Procurement of desilting machine	45.00
7	Miscellaneous and rounding off	0.02
8	Advisory, Project Management & Establishment charges. (1.5 % of Item 1 to 7)	280.98
	TOTAL	**19,012.71**
9	Annual Operation & Maintenance Cost (1.0 % of Item 1 to 7)	187.32

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

CHAPTER - 1

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 souls, 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 / retarding basins. 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 direction and set priorities on existing drainage system rehabilitation needs, and to explore the potential options, considering future hydraulic design requirements, for drainage system rehabilitation and other technical services for remodelling the existing drainage system 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 main 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 report forms the feasibility study for Hebbal 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 drains.

•To suggest modifications to the main and secondary 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 of bridges across Storm Water Drains which are hindrances to the carrying capacity of drain.

1.4 REPORT OBJECTIVES:

This report provides, details of existing storm water drains in Hebbal 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 Hebbal Valley.

•Strategies to be follow 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	Project Report.
VOLUME II	Drain Alignment Plan, Longitudinal Section, Cross Section & General Arrangement Drawings for Hebbal 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 management and Quality assurance

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 remodelling 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.

This report is presented for Phase - 1 and Phase -2 works of Hebbal Valley.

1.7 PREAMBLE TO INCEPTION REPORT:

Reference is made to the inception report, which identifies the different valleys and conditions of existing storm drains, new drains (i.e., not considered in TOR) and low lying areas in different drainage zones in this report. The details from previous data, recommendation made during past initiatives, current approach, methodology, design procedure and work plan adopted for preparation of detailed project report, narrated in detail.

CHAPTER - 2

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.

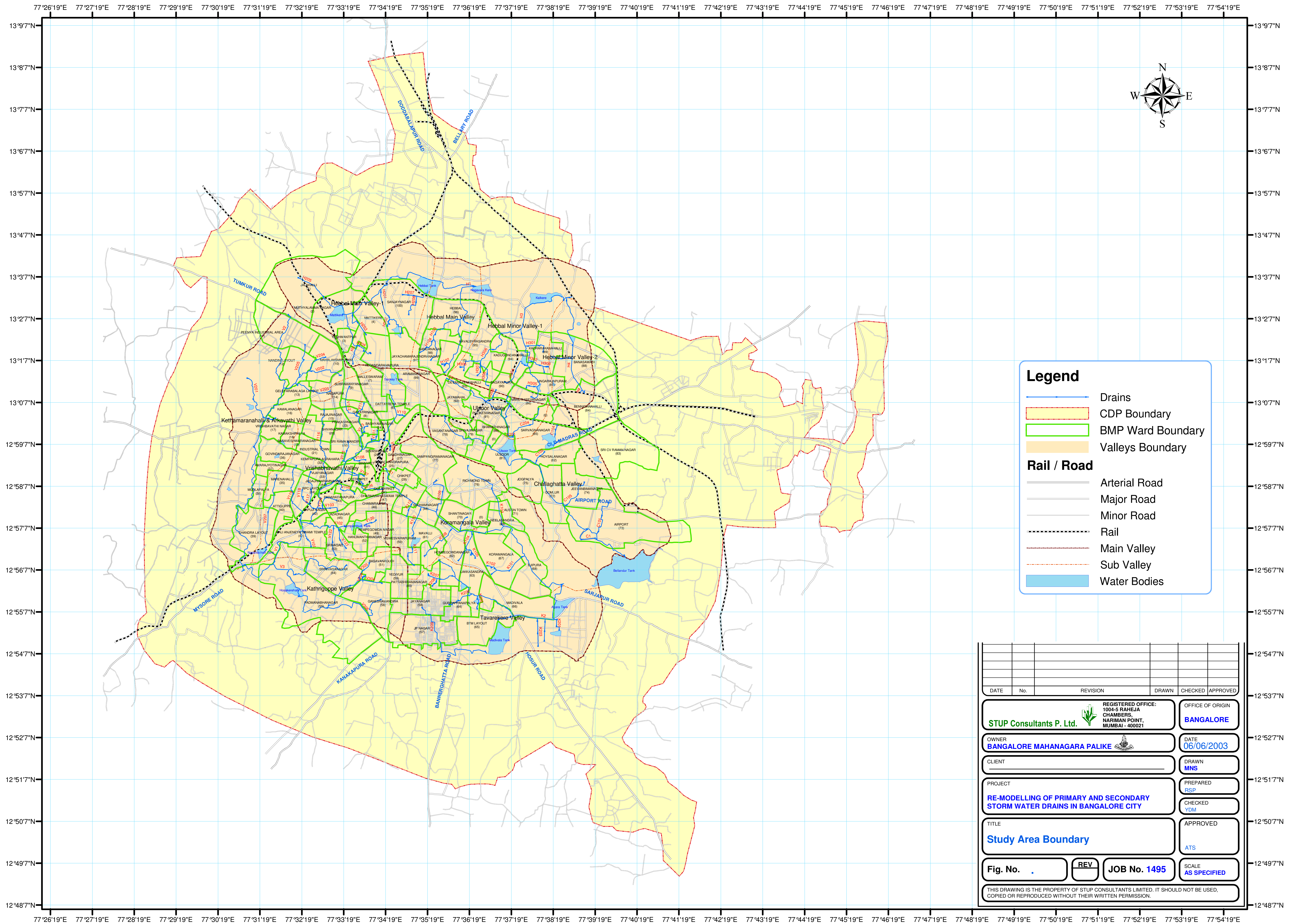
The study concerned with tertiary drains and their level of services offered is outside the current scope.

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, 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 to


Legend
Drains
CDP Boundary
BMP Ward Boundary
Valleys Boundary
Rail / Road
Arterial Road
Major Road
Minor Road
Rail
Main Valley
Sub Valley
Water Bodies
TUMKUR ROAD
DODDABALAPUR ROAD
BELLARY ROAD
OLD MADRAS ROAD
AIRPORT ROAD
SARJAPUR ROAD
HOSUR ROAD
BANNERGHATTA ROAD
KANAKAPURA ROAD
MYSORE ROAD
Hebbal Main Valley
Hebbal Minor Valley-1
Hebbal Minor Valley-2
Kethamaranahalli & Arkavathi Valley
Vrishabhavathi Valley
Ulsoor Valley
Challaghatta Valley
Koramangala Valley
Kathriguppe Valley
Tavarekere Valley
Bellandur Tank
Madivala Tank
Hebbal Tank
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BANGALORE
OWNER
BANGALORE MAHANAGARA PALIKE
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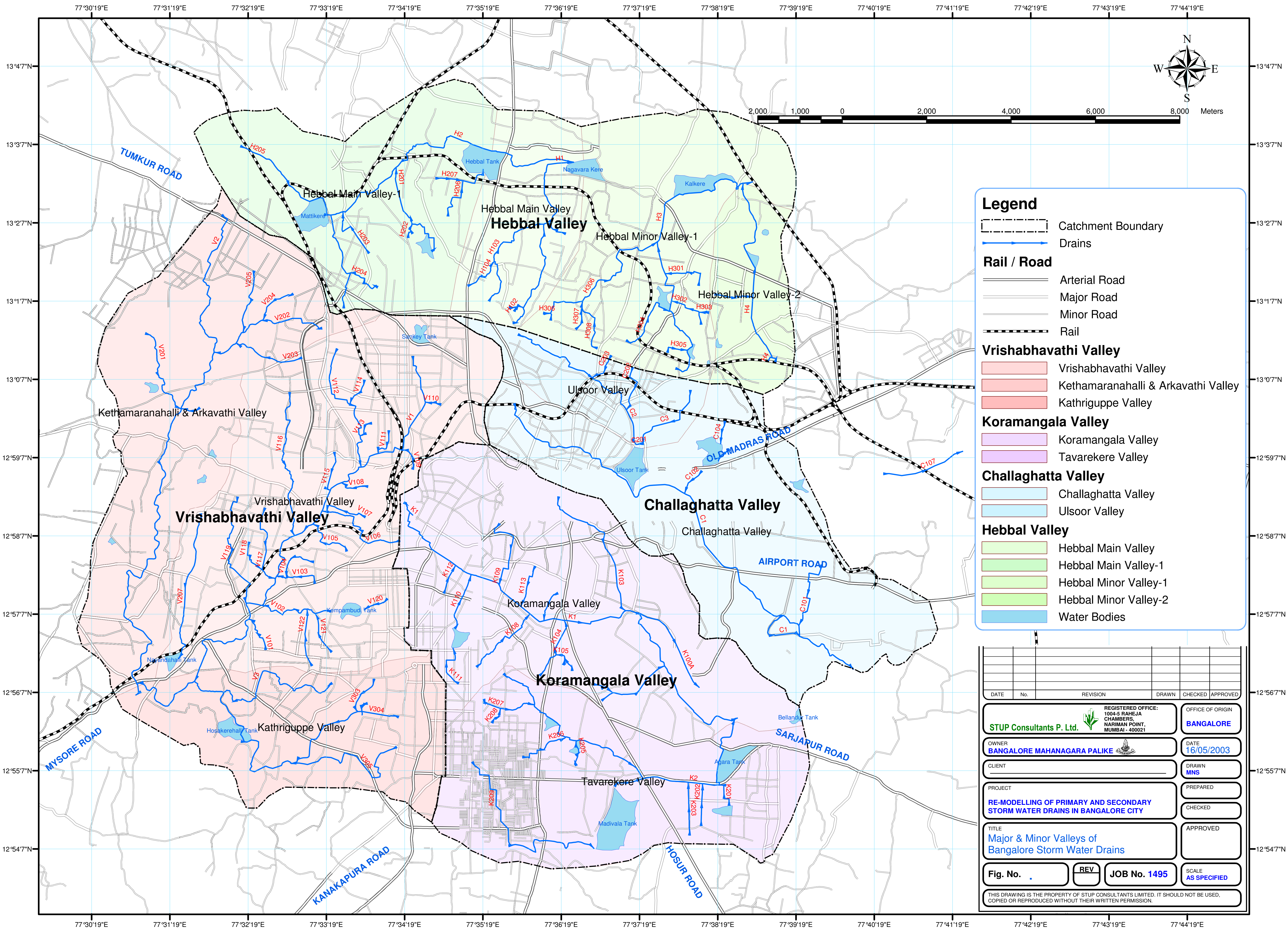
the North-East. All these valleys lie to the east, lie outside the tributary areas of the major valleys and drain independently. The catchment boundaries of major and minor valleys are shown in Figure 2.2.

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	13,250	
	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 – I		Near Mysore lamps works	Hebbal lake	2,590	9,000	
	b) Hebbal Minor Valley – I		Near Jaibharathnagar	Kalkere lake	1,529	7,375	
	c) Hebbal Minor Valley – II		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.


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
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N S E W
Hebbal Valley
Hebbal Main Valley
Hebbal Main Valley-1
Hebbal Minor Valley-1
Hebbal Minor Valley-2
Vrishabhavathi Valley
Kethamaranahalli & Arkavathi Valley
Kathriguppe Valley
Ulsoor Valley
Challaghatta Valley
Koramangala Valley
Tavarekere Valley
Hebbal Tank
Nagavara Kere
Kalkere
Mattikere
Sankey Tank
Ulsoor Tank
Kempambudi Tank
Nayandahalli Tank
Hosakerehalli Tank
Madivala Tank
Agara Tank
Bellandur Tank
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OLD MADRAS ROAD
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2.3 DESCRIPTION OF HEBBAL VALLEY:

2.3.1 Hebbal Valley:

The Hebbal valley comprises of four sub catchments i.e., Hebbal Main valley, Hebbal Main valley - I, Hebbal Minor Valley - I and Hebbal Minor valley - II.

Hebbal main valley (H100) starts from Venkateshwara swamy temple near R.K. Theatre and runs through Hanumanthappa Layout, Muninanjappa block, Rathanamma Layout, Chamundinagar, Kanakanagar main road, Sunrise colony, Nagenahalli main road, Outer Ring Road and ends at Nagavara Tank.

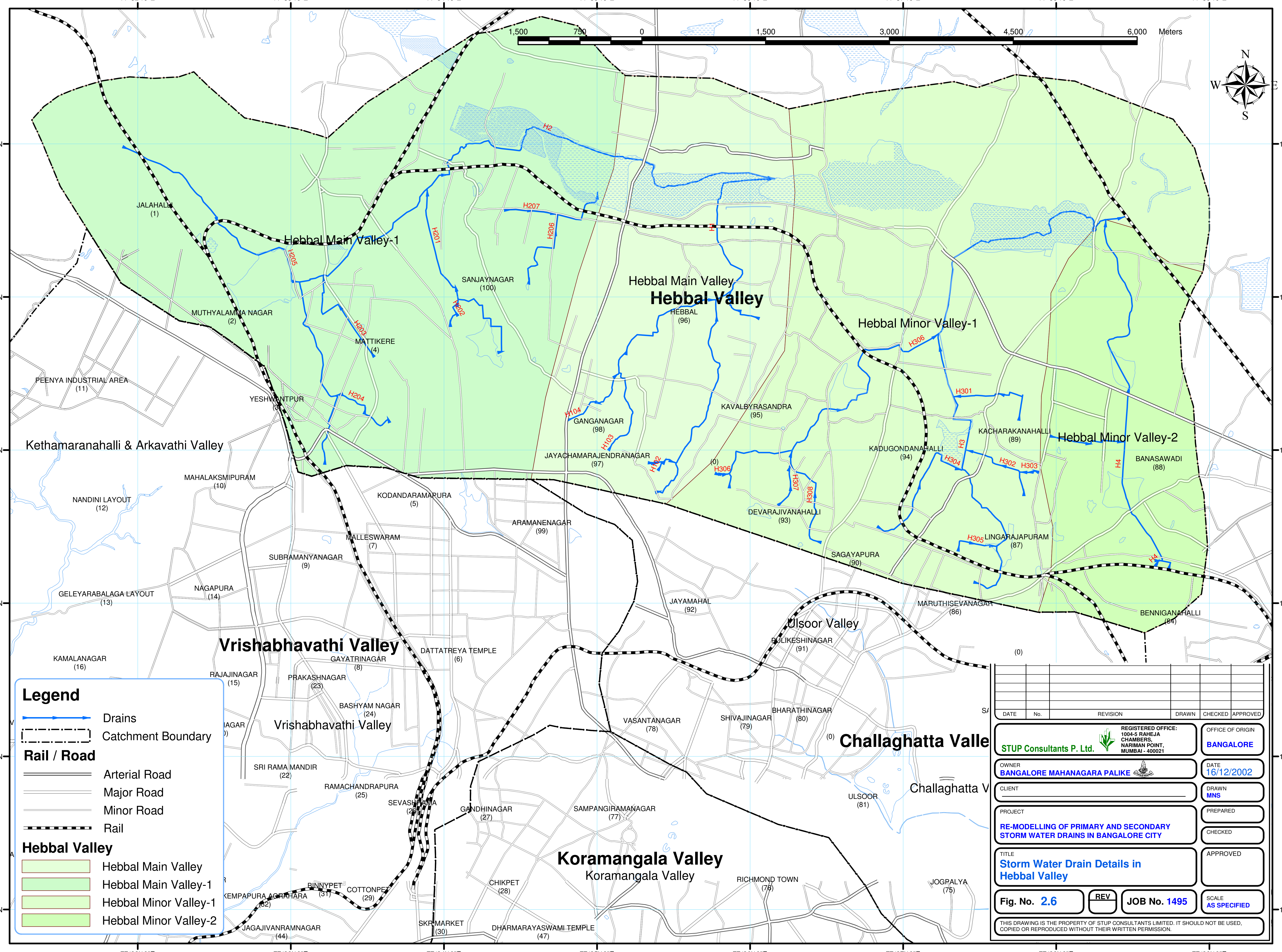
Hebbal main valley primary drain comprises of four secondary storm drains, covering the entire Hebbal main valley. The details of these drains are as mentioned in Table 2.2 and are shown in Figure 2.3.

Hebbal main valley - I (H200) starts from the Old Tumkur Road near Mysore lamp works and runs through Kamalanagar Extension, Mohan kumar road, Chowdeshwari nagar, Mathikere main road, RMV Extension, Venkatachary nagar, New B.E.L. Road, Outer Ring Road, Devinagar main road, Maruthinagar , Mottappa layout, Balaji Layout, Nagashettyhalli main road, Defence Dairy Farm, Chiranjeevi nagar, Yogesh nagar and ends at Nagavara Tank.

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

Hebbal minor valley - I (H300) starts from the Jaibharthinagar 3rd cross near Lingarajpura Railway track and runs through Muniswamy street, Kanakadasa Layout, H.B.R Layout, Yaseen nagar, Rahat Ali Layout, Outer Ring Road, Gedalahalli main road and ends at Raja Canal sewage treatment plant.

Hebbal minor valley - I primary drain comprises of Eight secondary storm drains, covering the entire Hebbal minor valley - I. The details of these drains are as mentioned in Table 2.2 and are shown in Figure 2.3.



Hebbal Valley
Hebbal Main Valley
Hebbal Main Valley-1
Hebbal Minor Valley-1
Hebbal Minor Valley-2
Kethamaranahalli & Arkavathi Valley
Vrishabhavathi Valley
Ulsoor Valley
Challaghatta Valley
Koramangala Valley
JALAHALLI (1)
MUTHYALAMMA NAGAR (2)
MATTIKERE (4)
KODANDARAMAPURA (5)
DATTATREYA TEMPLE (6)
MALLESWARAM (7)
GAYATRINAGAR (8)
SUBRAMANYANAGAR (9)
MAHALAKSMIPURAM (10)
PEENYA INDUSTRIAL AREA (11)
NANDINI LAYOUT (12)
GELEYARABALAGA LAYOUT (13)
NAGAPURA (14)
RAJAJINAGAR (15)
KAMALANAGAR (16)
SRI RAMA MANDIR (22)
PRAKASHNAGAR (23)
BASHYAM NAGAR (24)
RAMACHANDRAPURA (25)
GANDHINAGAR (27)
CHIKPET (28)
COTTONPET (29)
SKR MARKET (30)
BINNYPET (31)
KEMPAPURA AGRAHARA (32)
JAGAJIVANRAMNAGAR (44)
DHARMARAYASWAMI TEMPLE (47)
RICHMOND TOWN (76)
SAMPANGIRAMANAGAR (77)
VASANTANAGAR (78)
SHIVAJINAGAR (79)
BHARATHINAGAR (80)
ULSOOR (81)
BANASAWADI (88)
KACHARAKANAHALLI (89)
SAGAYAPURA (90)
PULIKESHINAGAR (91)
JAYAMAHAL (92)
DEVARAJIVANAHALLI (93)
KADUGONDANAHALLI (94)
KAVALBYRASANDRA (95)
HEBBAL (96)
JAYACHAMARAJENDRANAGAR (97)
GANGANAGAR (98)
ARAMANENAGAR (99)
SANJAYNAGAR (100)
LINGARAJAPURAM (87)
MARUTHISEVANAGAR (86)
BENNIGANAHALLI (84)
JOGPALYA (75)
YESHWANTPUR
H2
H4
H104
H103
H201
H202
H203
H204
H205
H206
H207
H301
H302
H303
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H306
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H308
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N
S
E
W
Legend
Drains
Catchment Boundary
Rail / Road
Arterial Road
Major Road
Minor Road
Rail
Hebbal Valley
Hebbal Main Valley
Hebbal Main Valley-1
Hebbal Minor Valley-1
Hebbal Minor Valley-2
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
16/12/2002
CLIENT
DRAWN
MNS
PROJECT
RE-MODELLING OF PRIMARY AND SECONDARY STORM WATER DRAINS IN BANGALORE CITY
PREPARED
CHECKED
TITLE
Storm Water Drain Details in Hebbal Valley
APPROVED
Fig. No. 2.6
REV
JOB No. 1495
SCALE
AS SPECIFIED
THIS DRAWING IS THE PROPERTY OF STUP CONSULTANTS LIMITED. IT SHOULD NOT BE USED, COPIED OR REPRODUCED WITHOUT THEIR WRITTEN PERMISSION.

Hebbal minor valley - II (H400) starts from the Chika Banaswadi and flows through O.M.B.R. layout, Erra reddy layout, Chowdeshwari layout, Kalyannagar, H.B.R. layout, Muniswamy layout, Nanjappa garden, Babusahibpalya, Chalkere & Hennur bunde

Hebbal minor valley - II primary drain comprises of One secondary storm drains, covering the entire Hebbal minor valley - II. The details of these drains are as mentioned in Table 2.2 and are shown in Figure 2.3.

TABLE 2.2 DETAILS OF HEBBAL VALLEY STORM DRAINS

SL. No.	Drain ID	Name	Type	Start	End	Length (Mts.)
Hebbal Main Valley (H1):						
1	H100	Hebbal Valley	Pri.	Matadahalli	Nagavara Tank	4,425
2	H101	Bhuvaneshwarinagar	Sec.	Rankanagar	Bhuvaneshwarinagar	575
3	H102	Rahamatnagar	Sec.	Rahamatnagar	Hanumanthappa Extn.	450
4	H103	Gangenahalli	Sec.	Gangenahalli Extn.	R.B.I. Colony	1,125
5	H104	Ganganagar	Sec.	H.M.T. Office	Chamundinagar	2,650
					Total Length of Primary Drain	**4,425**
					Total Length of Secondary Drains	**4,800**
Hebbal Main Valley-I (H2):						
1	H200	Yeshwanthapura	Pri.	Mysore Lamp Works	Hebbal tank	9,000
2	H201	Sachidanandanagar	Sec.	C.P.R.I. Campus	R.M.V.Extn.	2,825
3	H202	A.G.Colony	Sec.	Venkateshwara Layout	A.G.Colony	375
4	H203	H.M.T.Layout	Sec.	Devanarupalya	Mattikere Layout	1,450
5	H204	Subbedarpalya	Sec.	I.I.Sc. Campus	Gurumurthy Layout	800
6	H205	Tannairhalli	Sec.	H.M.T. Office	Muthyalanagar	2,600
7	H206	Bupasandra	Sec.	Sanjayanagar	Hebbal tank	1,125
8	H207	Tatanagar	Sec.	Devinagar main road	Hebbal tank inlet weir	1,150
					Total Length of Primary Drain	**9,000**
					Total Length of Secondary Drains	**10,675**

SL. No.	Drain ID	Name	Type	Start	End	Length (Mts.)
Hebbal Minor Valley-I (H3)						
1	H300	Kadugondanahalli	Pri.	Jaibharathnagar	Raja Canal S.T.P.	7,375
2	H301	Kacharakanahalli	Sec.	Keshavanagar	Gandhinagar	1,150
3	H302	Kammanahalli	Sec.	Ramaswamipalya	Hennur Main Road	975
4	H303	Kammanahalli - I	Sec.	Kammanahalli Mn. Rd.	Kammanahalli	250
5	H304	Venkateshpura	Sec.	Pillana Garden	Kariyannapalya	1,700
6	H305	Banaswadi	Sec.	Lingarajpura	Kanakadasa Layout	550
7	H306	Kavalabairasandra	Sec.	Munireddypalya	Arabic College	3,025
8	H307	Devarajivanahalli	Sec.	Chinnappagarden	Kavalabairasandra	685
9	H308	Ambedkarnagar	Sec.	Devarajeevanahalli	Doddanna nagar main road	1,000
Total Length of Primary Drain						**7,375**
Total Length of Secondary Drains						**9,335**
Hebbal Minor Valley-II (H4):						
1	H400	Hennur	Pri.	Chikka Banaswadi	Raja Canal STP	2,875
2	H401	Kalayananagar	Sec.	Kammanahalli Mn. Rd.	Sena Vihar	950
Total Length of Primary Drain						**2,875**
Total Length of Secondary Drains						**950**

The total length of primary and secondary drain mentioned in the TOR for all the four valleys was 179.3 kms. But during reconnaissance survey, it was observed that the length of primary and secondary drains in all the valleys were exceeding.

The additional drains considered for remodeling is shown in Figure 2.3.

2.4 RECONNAISSANCE SURVEY:

Reconnaissance survey was carried out in the entire Hebbal 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 HEBBAL 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) H100 = H1 represents Hebbal main valley first primary drain.

2) H101 = H1 represents Hebbal main valley first primary drain & 01 indicates first Secondary drain in Hebbal 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 HEBBAL VALLEY :

2.6.1 OBSERVATIONS DURING SITE INVESTIGATIONS OF HEBBAL MAIN VALLEY STORM DRAIN (H100):

Hebbal main valley nalla is divided into 4 segments, for ease of assessment.

The details of each segment is as mentioned below :

Segment - 1 (Chainage 0 m to 1,000.00 m.)

(From Venkateshwara swamy temple (R.K.theatre) near J.C. Nagar upto Kohinoor bus depot near Hanumanthappa layout)

•This reach of storm drain is almost covered with RCC/BS slabs near Adi kabir ashram and Meena masjid road.

•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 Adi kabir ashram, Meena masjid road and Mattadahalli.

•The width of drainage channel varies from 3.0 m to 4.0 m & depth varies from 1.2 to 1.8 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.

- Drain bed is in natural condition.

- The width of the drainage channel near Mattadahalli, Dhobi ghat is drastically reduced.

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

(From Kohinoor bus depot near Hanumanthappa layout upto Muninanjappa block)

- This reach of storm drain is an open drain.

- 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. near Dinnur main road, R.T. Nagar and Kausernagar.
- The width of drainage channel varies from 4.0 m to 5.0 m & depth varies from 1.4 to 1.8 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 Hanumanthappa layout and Muninanjappa block.

•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.

•Large number of manholes have been constructed inside the channel.

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

•Secondary storm drain (H 102) which starts from Rahmat nagar and joins the main drain near Mattadahalli, Dhobi ghat,

•Drain bed is in natural condition.

•Recently, BMP has constructed drain wall near Chamundi nagar.

Segment - 3 (Chainage 2,000.00 m to 3,000.00 m.)
(From Muninanjappa block upto Kanakanagar main road).

•This reach of drain is open drain.

•Drain width is reduced near Rathnamma layout and Venkateshwara layout.

•Recently, drain wall and residential building walls have been collapsed near Chamundi nagar.

•Due to non functionality of tertiary drains, localised flooding problems are observed at many places. i.e., near Rathnamma layout, Venkateshwara layout and Chamundinagar.

•Secondary storm drain (H104) which starts from H.M.T. office near Bellary road flows through Ganganagar joins the main drain near Chamundinagar and another sub drain (H101) which starts from Ranka nagar joins the main drain near Bhuvaneshwarinagar.

•The width of drainage channel varies from 7 m to 9 m & depth varies from 1.5 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.

•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 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.

•Existing drain is in natural condition near Kanakanagar main road.

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

(From Kanakanagar main road upto Nagavara tank).

•This reach of storm drain is an open drain.

•Due to non functionality of tertiary drains, localised flooding problems are observed at many places. i.e., near Sunrise colony and Inspectorate of Electronics layout.

•The width of drainage channel varies from 7.0 m to 12.0 m & depth varies from 1.3 m. to 2.2 m.

- S.S.M. Masonry walls have been constructed on left hand side and it is in natural condition on right hand side near Sunrise colony.

- The existing drain is in natural condition near Nagenahalli main road, Outer ring road and Yogeshnagar.

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

- The width of the drain is reduced near Yogeshnagar.

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

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

- Drain bed is in natural condition.

- The existing culvert constructed across Outer ring road and Yogeshnagar main road is having very inadequate vent size.

2.6.2 OBSERVATIONS DURING SITE INVESTIGATIONS OF HEBBAL MAIN VALLEY SECONDARY STORM DRAIN:

2.6.2.1 Bhuvaneshwari nagar Secondary storm drain (H101)

(Rankanagar upto Bhuvaneshwarinagar.)

- This reach of storm drain is in natural condition except near Bhuvaneshwari nagar main road. It is covered with RCC slab.

- Number of residential buildings are noticed on either side of the drain.

- The width of drainage channel varies from 1.6 m to 2.0 m & depth varies from 0.5 to 1.0 m.

- The drain width after Bhuvaneshwarinagar main road is drastically reduced.

•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.

2.6.2.2 Rahmatnagar Secondary storm drain (H102)

(Rahmatnagar upto Hanumanthappa Extn.)

•This reach of storm drain is an open drain.

•Number of residential buildings are noticed on either side of the drain.

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

•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 existing SSM wall is in good to moderate condition and bed is in natural condition.

•Large number of manholes noticed inside the drain.

•Intermittent support structures noticed at the culvert locations is obstructing free flow of water.

•Large number of utility lines noticed inside the drainage channel.

2.6.2.3 Gangenahalli Secondary storm drain (H103)

(Gangenahalli Extn. upto RBI colony)

•This reach of storm drain is an open drain.

•Number of residential buildings are noticed on either side of the drain.

•The width of drainage channel varies from 3.0 m to 6.0 m & depth varies from 1.4 to

1.8 m.

- 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 existing SSM wall is in good to moderate condition and bed is in natural condition.

- Large number of manholes noticed inside the drain.

- Intermittent support structures noticed at the culvert locations is obstructing free flow of water.

- Large number of utility lines noticed inside the drainage channel.

- Commercial buildings have been constructed over the storm drain near RT Nagar.

2.6.2.4 Ganganagar Secondary storm drain (H104)

(H.M.T. office upto Chamundinagar)

- This reach of storm drain is an open drain except near H.M.T. Bhavan.

- Number of residential buildings are noticed on either side of the drain.

- The width of drainage channel varies from 2.5 m to 8.0 m & depth varies from 1.2 to 2.0 m.
- 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 existing SSM wall is in good to moderate condition and bed is in natural condition.

- Large number of manholes noticed inside the drain.

- Intermittent support structures noticed at the culvert locations is obstructing free flow of water.

•Large number of utility lines noticed inside the drainage channel.

2.6.3 OBSERVATIONS DURING SITE INVESTIGATIONS OF HEBBAL MAIN VALLEY – I STORM DRAIN (H200):

Hebbal main valley nalla is divided into 9 segments, for ease of assessment.

The details of each segment is as mentioned below :

Segment - 1 (Chainage 0 m to 1,000.00 m.)

(From Old Tumkur road near Mysore lamp works upto Triveni road near Kamala nehru Extn.)

•This reach of storm drain is almost covered with RCC/BS slabs near C.V. Raman road.

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

•The drain size is drastically reduced near Nanjareddy colony telephone exchange.

•Due to non functionality of tertiary drains, localised flooding problems are observed at many places. i.e., near Subedarpalya, Diwanarapalya and Nanjareddy colony.

•The width of drainage channel varies from 2.0 m to 3.0 m & depth varies from 1.0 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.

•Drain bed is in natural condition.

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

(From Triveni road Kamalanagar Extn. Upto Mattikere bus stop near Mohan kumar road).

•This reach of storm drain is almost covered with RCC/BS slabs near B.K. Nagar, L.I.C. colony & H.M.T. layout except at few places at B.K. Nagar.

•The drain width is drastically reduced near Mohan kumar road.

•Due to non functionality of tertiary drains, localised flooding problems are observed at many places. i.e., near LIC colony, Chowdeshwari temple adjoining area & HMT layout.

•The width of drain varies from 2.0 m to 3.0 m & depth varies from 1.4 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.

•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 commercial establishment.

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

•Drain bed is in natural condition.

•Service roads exists on right hand side of the drain from L.I.C. colony upto Mohan kumar road.

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

(From Mattikere bus stop near Mohan kumar road upto Mattikere main road near KPTCL office).

•This reach of storm drain is open drain.

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

•The drain reach near Brindavanagar & S.B.M. colony is in natural condition.

•The drain width is drastically reduced due to construction of residential buildings near Brindavanagar, S.B.M. colony & Purnappa Garden.

•Due to non functionality of tertiary drains, localised flooding problems are observed at many places. i.e., near Brindavanagar, S.B.M. colony & Purnappa Garden.

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

•Secondary storm water drain H203 confluence with the main drain near Purnappa Garden.

•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.

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

•Drain bed is in natural condition.

•Large number of manholes are noticed inside the drainage channel.

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

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

(From Mattikere main road near KPTCL office upto Venkatachary nagar near New BEL road).

•This reach of storm drain is open drain.

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

•The drain reach near Sanjeevappa garden is in natural condition.

•Due to encroachment, alignment of drain is altered near Sanjeevappa garden and also the drain width is drastically reduced near Gowri apartments.

•Due to non functionality of tertiary drains, localised flooding problems are observed at many places. i.e., near Sanjeevappa garden.

•The width of drainage channel varies from 6.0 m to 8.0 m & depth varies from 1.6 to 2.0 m.

•S.S.M. Masonry walls have been constructed for a small stretch near Gowri apartments.

•Large number of tertiary drains are joining the main drain near Sanjeevappa Garden and also the bed level of the tertiary drains and the main drain is almost at the same level.

•Dumping of solid waste, garbage and silt deposition is noticed at many places inside the channel.

•Drain bed is in natural condition and it is almost flat.

•Large number of manholes are noticed inside the drainage channel.

•The existing RCC hume pipe culvert constructed across New B.E.L. road and also near R.M.V. Extn. II Stage is obstructing free flow of water.

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

(From Venkatachary nagar near New B.E.L. road upto Outer ring road).

•Service road exists on either side of the drain.

•Due to non functionality of tertiary drains, localised flooding problems are observed at many places. i.e., near R.M.V. Extn.

•The width of drainage channel varies from 8.0 m to 12.0 m & depth varies from 1.8 to 2.2 m.

•S.S.M. Masonry walls have been constructed for the entire length and it is in good condition.

•Dumping of solid waste, garbage and silt deposition is noticed at many places inside the channel.

•Summer flow drain is noticed inside the main drain in this reach.

•Drain bed is in natural condition and it is almost flat.

•Large number of manholes are noticed inside the drainage channel.

•Large quantity of silt, vegetation growth & sewage flow is noticed inside the drain.

•The existing RCC hume pipe culvert constructed near Sterling apartments is obstructing free flow of water.

•The drain reach near railway bridge is in natural condition.

•The secondary drain H201 is joining the main drain near Gandhi vidyalaya education association.

•Large number of manholes are noticed inside the drain.

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

(From Outer ring road upto Balaji layout 6^{th} cross road).

•This reach of storm drain is open drain.

•The drain width is drastically reduced near Outer ring road, Marutinagar & Bhadrappa layout.

•The drain reach near Marutinagar & Bhadrappa layout is in natural condition.

•Due to non functionality of tertiary drains, localised flooding problems are observed at many places. i.e., near Marutinagar & Bhadrappa layout.

•The width of drainage channel varies from 4.0 m to 8.0 m & depth varies from 1.8 to 2.2 m.

•S.S.M. Masonry walls have been constructed near Nageshetty halli main road and Balaji nagar and it is in 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.

•Drain bed is in natural condition and it is almost flat.

•Large quantity of silt, vegetation growth & sewage flow is noticed inside the 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 Marutinagar, Bhadrappa layout and Balaji nagar.

•Large number of sewer outlets from residential buildings are noticed near near Marutinagar, Bhadrappa layout and Balaji nagar.

•300 mm dia CI pipeline is noticed near Nagashetty halli main road culvert location.

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

(From Balaji layout 6th cross road upto location near Defence dairy farm near mashy land).

•This reach of storm drain is open drain.

•The drain width is reduced near Hebbal tank inlet weir.

•Stone revetment is provided on right hand side near Hebbal tank and it is in moderate condition.

•The width of drainage channel varies from 7.0 m to 9.0 m & depth varies from 1.0 to 1.6 m.

•Dense vegetation growth is noticed near Hebbal tank.

•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.

•Drain bed is in natural condition and it is almost flat.

•Large quantity of silt, vegetation growth & sewage flow is noticed inside the drain.

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

(Location near Defence dairy farm in mashy land upto Bellary road near Chiranjeevi nagar).

•This reach of storm drain is open drain.

•Stone revetment is provided on right hand side near Hebbal tank and it is in moderate condition.

•The width of drainage channel varies from 7.0 m to 10.0 m & depth varies from 1.2 to 1.6 m.

•Dense vegetation growth is noticed near Hebbal tank.

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

•Drain bed is in natural condition and it is almost flat.

•Large quantity of silt, vegetation growth & sewage flow is noticed inside the drain.

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

(From Chiranjeevi nagar upto Yogeshnagar).

•The alignment of drain is not properly defined and this reach of storm drain is in natural condition.

•Dense vegetation growth is noticed near Bellary road.

•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.

•Drain bed is in natural condition and it is almost flat.

•Large quantity of silt, vegetation growth & sewage flow is noticed inside the drain.

•Development of land by private developers is noticed near Yogeshnagar main road.

2.6.4 OBSERVATIONS DURING SITE INVESTIGATIONS OF HEBBAL MAIN VALLEY – I SECONDARY STORM DRAIN:

2.6.4.1 Sachidanandanagar Secondary storm drain (H201) (CPRI campus upto RMV Extn.)

- This reach of storm drain is covered with RCC slab from C.P.R.I upto A.E.C.S layout
- Number of residential buildings are noticed on either side of the drain.
- The width of drainage channel varies from 2.0 m to 5.0 m & depth varies from 1.4 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.
- The drain width near I.I.Sc. staff quarters is drastically reduced.
- 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.
- Large number of utility crossings and cables are observed at many places in this reach.
- SSM wall constructed near R.M.V. Extn. Park area is in moderate condition.

2.6.4.2 A.G. colony Secondary storm drain (H202) (Venkateshwara layout upto AG colony)

- This reach of storm drain is covered with BS slab near M.S. Ramaiah college
- Number of residential buildings are noticed on either side of the drain.
- The width of drainage channel varies from 0.5 m to 2.0 m & depth varies from 0.6 to 1.4 m.

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

- The drain width near A.G. colony park is drastically reduced.

- 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.

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

2.6.4.3 HMT Layout Secondary storm drain (H203) (Diwanarapalya upto Mattikere layout)

- This reach of storm drain is covered with BS slab from M.S. Ramaiah road upto Mohan kumar road. Further, near Brindavanagar 5th cross, RCC box drain is constructed.

- Number of residential & commercial buildings are noticed on either side of the drain.

- The width of drainage channel varies from 1.5 m to 2.5 m & depth varies from 1.0 to 1.4 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.

- Large number of utility crossings and cables are observed at many places in this reach.
- The secondary drain bed level and main drain bed level is almost the same.

- The drain reach near Brindavanagar is heavily silted.

- The tertiary drain bed level and secondary drain bed level near Chowdeshwari temple adjoining area and Brindavanagar is almost the same.

2.6.4.4 Subedarpalya Secondary storm drain (H204) (I.I.Sc. campus upto Gurumurthy layout)

- This reach of storm drain is covered with BS slab from M.S. Ramaiah road upto Mohan kumar road. Further, near Brindavanagar 5th cross, RCC box drain is constructed.
- Number of residential & commercial buildings are noticed on either side of the drain.

- The width of drainage channel varies from 2.0 m to 3.0 m & depth varies from 1.0 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.

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

- The secondary drain bed level and main drain bed level is almost the same.

- The drain reach near Brindavanagar is heavily silted.

- The tertiary drain bed level and secondary drain bed level near Chowdeshwari temple adjoining area and Brindavanagar is almost the same.

2.6.4.5 Tannirhalli Secondary storm drain (H205) (H.M.T. Office upto Muthyalanagar)

- S.S.M. Masonry walls have been constructed on either sides, the condition of the side walls is in good to moderate condition near H.M.T. quarters.
- Existing drain is in natural condition near Water Treatment Plant (WTP).
- Large quantity of waste water is being discharged into storm water drain from H.M.T. W.T.P
- The drain walls near Chlaret's School/A.S.C. Defence land is in good condition.
- Large quantity of silt and vegetation dump is noticed inside the drain near Chlaret's School/A.S.C. Defence land.
- The drain reach near Outer ring road/Railway track is in natural condition.
- Large quantity of garbage dump is noticed near Outer ring road/Railway track.
- The Existing drain is in natural condition near Tannirhalli.
- The SSM wall constructed near Bandapa garden(Muthyalanagar) is in moderate condition.
- The drain bed is in natural condition.
- The drain bed slope is almost flat.
- The tertiary drain bed level and main drain bed level are almost the same.
- The Existing drain is in natural condition near Mattikere tank.
- Large quantity of sewage flow is noticed inside the drain.
- Number of residential & commercial buildings are noticed on either side of the drain.
- The width of drainage channel varies from 2.5 m to 8.0 m & depth varies from 0.8 to 1.4 m.
- 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.

2.6.4.6 Bupasandra Secondary storm drain (H206) (Sanjaynagar upto Hebbal tank)

- Existing drain is in natural condition near Central excise layout.
- S.S.M. Masonry walls have been constructed on either sides, the condition of the side walls is in good to moderate condition near Central excise layout upto UAS College.
- The existing drain inside U.A.S. college campus is covered with BS slab.
- Existing drain width inside U.A.S. college campus is drastically reduced.
- Large quantity of silt accumulation and vegetation growth is noticed inside the drain near U.A.S. college.
- The existing culvert at Bupasandra main road is obstructing free flow of water.
- Large quantity of silt accumulation and vegetation growth is noticed inside the drain near Outer ring road (Hebbal tank).
- The drain bed slope is almost flat.
- Number of residential & commercial buildings are noticed on either side of the drain.
- The width of drainage channel varies from 3.0 m to 15.0 m & depth varies from 0.8 to 1.6 m.

2.6.5 OBSERVATIONS DURING SITE INVESTIGATIONS OF HEBBAL MINOR VALLEY – I STORM DRAIN (H300):

Hebbal main valley nalla is divided into 7 segments, for ease of assessment.

The details of each segment is as mentioned below :

Segment - 1 (Chainage 0 m to 1,000.00 m.)

(From Jaibharatnagar upto Kanakadasa layout near Lingarajapura.)

- This reach of storm drain is open drain.
- Number of residential buildings are noticed on either side of the drain.
- The drain reach near Lingarajapura railway track is in natural condition.
- Due to non functionality of tertiary drains, localised flooding problems are observed at many places. i.e., near Jaibharatnagar, Kanakadasa layout & K.H.B. quarters.
- The width of drainage channel varies from 2.0 m to 3.5 m & depth varies from 1.1 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.
- Large number of utility crossings and cables are observed at many places in this reach.
- Drain bed is in natural condition.

•Large number of sewer outlets from residential buildings have been connected to storm water drain.

•Secondary drain H305 confluence with the main drain near Kanakadasa layout.

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

(From Kanakadasa layout near Lingarajapura upto 60 ft. Road H.B.R. layout)

•This reach of storm drain is open drain.

•Number of residential buildings are noticed on either side of the drain.

•The existing stone slab culvert near Oil mill road, Kanakadasa layout is obstructing free flow of water.

•Due to non functionality of tertiary drains, localised flooding problems are observed at many places. i.e., near Sait palya.

•The width of drainage channel varies from 2.0 m to 3.5 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.

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

•Drain bed is in natural condition.

•The existing culverts near Jai matha devasthana road and Shamanna layout park is obstructing free flow of water.

•The drain width is drastically reduced near Shamanna layout park, Kariyannapalya.

•The drain reach near Kariyannapalya is covered with RCC slab.

•The existing stone slab culvert near Hennur main road petrol bunk is obstructing free flow of water.

•The drain width is drastically reduced near Hennur main road petrol bunk Kariyannapalya.

•Large quantity of debris and vegetation growth is noticed inside the drain between Hennur main road petrol bunk and 60 ft. Road H.B.R. layout.

•The secondary storm drain H304 confluence with the main drain near 60 Ft. Road, H.B.R. layout.

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

(From 60 ft. Road H.B.R. Layout upto Yaseennagar near H.B.R. Layout)

•This reach of storm drain is open drain.

•Service roads exists on right hand side of the drain.

•The existing RCC hume pipe culvert near Sri Rama temple on 60 Ft. Road is obstructing the free flow of water.

•The width of drainage channel varies from 9.0 m to 12.0 m & depth varies from 1.8 to 2.6 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.

•Drain bed is in natural condition.

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

(From Yaseennagar near H.B.R. Layout upto Rahat ali Layout)

•This reach of storm drain is open drain.

•Service roads exists on either sides of the drain.

•The existing RCC hume pipe culvert near 80 Ft. Road, H.B.R. layout is obstructing the free flow of water.

•The width of drainage channel varies from 10.0 m to 14.0 m & depth varies from 2.2 to 2.8 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.

•Drain bed is in natural condition.

•Large quantity of debris and vegetation growth is noticed inside the drain near 80 ft. Road H.B.R. layout.

•The secondary storm drain H301 & H306 confluence with the main drain near 60 Ft. Road, H.B.R. layout and Rahat ali layout.

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

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

(From Rahat ali layout upto Outer ring road)

•This reach of storm drain is open drain.

•The width of drainage channel varies from 12.5 m to 18.0 m & depth varies from 2.0 to 2.6 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.

•Drain bed is in natural condition.

•Large quantity of debris and vegetation growth is noticed inside the drain near Outer ring Road.

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

(From Outer ring road upto a location in marshy land near Geddalahalli main road)

•This reach of storm drain is open drain.

•The width of drainage channel varies from 14.0 m to 20.0 m & depth varies from 1.4 to 2.6 m.

•S.S.M. Masonry walls have been constructed on either sides upto Telecom employees Co-Op. Society layout and the condition of the side walls is in good to moderate condition. Further, the drain is in natural 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.

Segment - 7 (Chainage 6,000.00 m to 7,500.00 m.)

(From A location in marshy land near Geddalahalli main road upto Raja canal S.T.P.)

- This reach of storm drain is open drain.
- The width of drainage channel varies from 7.5 m to 12.0 m & depth varies from 1.4 to 2.2 m.
- The drain reach is in natural 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.
- The existing stone slab culvert across Geddalahalli main road is obstructing the free flow of water.
- The drain width is drastically reduced near Raja canal STP.

2.6.6 OBSERVATIONS DURING SITE INVESTIGATIONS OF HEBBAL MINOR VALLEY – I SECONDARY STORM DRAIN:

2.6.6.1 Kacharakanahalli secondary storm drain (H301)

(Keshavanagar to Gandhinagar)

•This reach of storm drain is open drain.

•Number of residential buildings 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 Kacharakanahalli.

•The width of drainage channel varies from 1.5 m to 3.2 m & depth varies from 1.0 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.

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

•The existing culvert near Teacher's colony is obstructing the free flow of water.

2.6.6.2 Kammanahalli secondary storm drain (H302)

(Ramaswamipalya to Hennur main road)

•This reach of storm drain is open drain except near Jyothi social work centre.

•Number of residential buildings 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 Kammanahalli.

•The width of drainage channel varies from 1.0 m to 3.0 m & depth varies from 0.6 to 1.4 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.

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

•The existing culvert near Nehru road and Jyothi social work centre is obstructing the free flow of water.

2.6.6.3 Kammanahalli - I secondary storm drain (H303)

(Kammanahalli main road upto Kammanahalli)

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

•Number of residential buildings are noticed on either side of the drain.

•The width of drainage channel varies from 1.2 m to 2.0 m & depth varies from 1.4 to 1.8 m.

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

2.6.6.4 Venkteshpura Secondary storm drain (H304)

(Pillanna garden upto Kariyannapalya)

- This reach of storm drain is an open drain.
- Number of residential buildings are noticed on either side of the drain.
- The width of drainage channel varies from 2.0m to 8.0 m & depth varies from 1.0 to 2.6 m.
- S.S.M. Masonry walls have been constructed on either sides, the condition of the side walls is in good to moderate condition.
- Large number of manholes are noticed inside the channel.
- Large quantity of silt and garbage dump are noticed inside the channel.
- Large number of sewer outlets from residential buildings are connected to storm water drains.
- The drain reach near Munirayappa Karamchand layout, Ramchandra layout is heavily silted.
- The drain reach behind the Institute of Speech and Hearing (Coconut plantation) is in natural condition.

2.6.6.5 Banaswadi Secondary storm drain (H305)

(Lingarajpura upto Kanakadasa layout)

- This reach of storm drain is an open drain.
- Number of residential buildings are noticed on either side of the drain.
- The width of drainage channel varies from 2.0 m to 4.0 m & depth varies from 1.0 to 1.5 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 number of manholes are noticed inside the channel.

•Large quantity of silt and garbage dump are noticed inside the channel.

•Large number of sewer outlets from residential buildings are connected to storm water drains.

•The drain reach near St. Thomas town is heavily silted.

•The intermittent support structures noticed at the culvert location is obstructing the free flow of water.

•The existing culvert near KHB quarters is obstructing free flow of water.

2.6.6.6 Kavalabairasandra Secondary storm drain (H306):

(Munireddypalya upto Arabic college)

•This reach of storm drain is open drain except at few stretch near Nagavara main road.

•The width of drainage channel varies from 2.0 m to 8.0 m & depth varies from 1.2 to 1.8 m.

•S.S.M. Masonry walls have been constructed on either sides near Modi garden, 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.
•Drain bed is in natural condition.

•The existing stone slab culvert near NP factory road is obstructing the free flow of water.

•The drain width is drastically reduced near Sayeedia Arabic college.

•The existing slab culvert near Sayeedia Arabic college is obstructing free flow of water.

•The drain reach from Shadabnagar is in natural condition upto Shampura main road.

•Densely built residential buildings are noticed on either sides of the drainage channel.

•Large number of sewer outlets are connected to storm water drain

•Large quantity of debris and vegetation growth is noticed inside the drain near near Ambedkar medical college.

•The drain reach at Gandhinagar near Kadugondanahalli is drastically reduced and also is in natural condition.

•The existing culvert near Gandhinagar is obstructing free flow of water.

•The bed slope is very flat and also in natural condition.

•The drain reach near Nagavara main road level crossing is in natural condition and also large quantity of sewage stagnation & vegetation growth is noticed.

•The drain reach near Nagavara main road is drastically reduced and also covered with BS slabs.

•The tertiary drain bed level and main drain bed level is almost the same near Nagavara main road.

•The drain width behind leather factory near Nagavara main road and Kamarajnagar is drastically reduced.

•The size stone masonry wall near Arabic college and Rahat ali layout is in moderate condition.

2.6.6.7 Devarajivanahalli Secondary storm drain (H307):

(Chinnappa garden upto Kavalabairasandra)

- This reach of storm drain is an open drain.
- Number of residential buildings are noticed on either side of the drain.
- The width of drainage channel varies from 1.8 m to 3.0 m & depth varies from 1.2 to 1.5 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 and garbage dump are noticed inside the channel.
- Large number of sewer outlets from residential buildings are connected to storm water drains.
- The drain width near Doddannanagar is drastically reduced
- The drain bed slope is almost flat and also in natural condition.

2.6.6.8 Ambedkarnagar Secondary storm drain (H308):

(Devarajivanahalli upto Doddannanagar)

- This reach of storm drain is an open drain.
- Number of residential buildings are noticed on either side of 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 and garbage dump are noticed inside the channel.
- Large number of sewer outlets from residential buildings are connected to storm

water drains.

•The drain width near Doddannanagar is drastically reduced

•The drain bed slope is almost flat and also in natural condition.

2.6.7 OBSERVATIONS DURING SITE INVESTIGATIONS OF HEBBAL MINOR VALLEY – II PRIMARY STORM DRAIN (H400):

Hebbal main valley nalla is divided into 5 segments, for ease of assessment.

The details of each segment is as mentioned below :

Segment - 1 (Chainage 0 m to 1,000.00 m.)

(From Chikka banaswadi railway track upto Banaswadi main road near Chowdeshwari layout.)

•This reach of storm drain is open drain.

•Number of residential buildings 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 O.M.B.R. Layout.

•The width of drainage channel varies from 3.0 m to 4.5 m & depth varies from 3.5 to 3.8 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.

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

•Drain bed is in natural condition.

•The existing RCC hume pipe culvert near Banaswadi main road (Fire station) is obstructing the free flow of water.

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

(From Banaswadi main road near Chowdeshwari layout upto H.B.R. layout, 1st block, 4th cross)

•This reach of storm drain is open drain.

•Number of residential buildings 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 H.B.R. layout & Kalyannagar.

•The width of drainage channel varies from 3.5 m to 4.5 m & depth varies from 3.4 to 3.6 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.

•The secondary drain H401 is confluencing with the main drain near H.B.R. layout,1st block.

•Drain bed is in natural condition.

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

(From H.B.R. layout, 1st block, 4th cross upto Muniswamy layout)

•This reach of storm drain is open drain.

•The width of drainage channel varies from 3.5 m to 5.0 m & depth varies from 3.4 to 4.0 m.

- The SSM wall has been constructed upto Nanjajappa Garden and it is in moderate condition. Further, the drain reach is in natural 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.

- Large number of manholes noticed inside the drainage channel.

- Large quantity of silt and vegetation growth is noticed inside the drainage channel.

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

(From Muniswamy layout upto Chalkere bus stop)

- This reach of storm drain is open drain.

- The drain reach is in natural 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.

- Large number of manholes noticed inside the drainage channel.
- Large quantity of silt and vegetation growth is noticed inside the drainage channel.

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

(From Chalkere bus stop upto Raja canal S.T.P.)

- This reach of storm drain is open drain.

- The drain reach is in natural 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.
- Large number of manholes noticed inside the drainage channel.

- Large quantity of silt and vegetation growth is noticed inside the drainage channel.

2.6.8 OBSERVATIONS DURING SITE INVESTIGATIONS OF HEBBAL MINOR VALLEY – II SECONDARY STORM DRAIN:

Kalyanagar Secondary storm drain (H401)

(From Kammanahalli main road upto Sena vihar)

•This reach of storm drain is open drain.

•Number of residential buildings are noticed on either side of the drain.

•The width of drainage channel varies from 1.0 m to 1.5 m & depth varies from 1.5 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.

•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.

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

•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 HEBBAL VALLEY:

During reconnaissance survey of Hebbal 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 Hebbal valley is as mentioned in Table 2.3 and same is depicted in Figure 2.5.

TABLE 2.3 List of Critical Low Lying Areas in Hebbal Valley

Sl.No.	Location	Valley	BMP Division
1.	Anandanagar	Hebbal Main Valley	West
2.	Brindavananagar	Hebbal Main Valley - I	West
3.	Tannirhalli	Hebbal Main Valley - I	West
4.	Sanjeevappa Garden	Hebbal Main Valley - I	West
5.	Kadugondanahalli (Shampura)	Hebbal Minor Valley – I	West
6.	Basavanagar near Ambedkar Medical College	Hebbal Minor Valley – I	West

2.8.1 Anandnagar

Anandnagar area is situated in Hebbal main valley. Hebbal main valley secondary storm drain (H104), which starts from H.M.T. Bhavan near Bellary road flows through Ganganagar, Visveswarayya nagar, Anand nagar & M.S.R. layout and cause localised flooding problem in these regions for the reasons mentioned below.

Reasons for flooding:

- Due to large scale encroachment, natural alignment of existing primary & secondary storm drain has been altered at many places.
- The existing RCC slab culvert near Anandnagar Ganesh temple is inadequate and also large number of utility lines noticed at that location is obstructing free flow of water.
- The drain width is drastically reduced near Anandnagar, Chamundinagar and Bhuvaneshwarinagar due to which water is heading up in the upstream reaches.
- Large number of manholes noticed inside the channel in this region is obstructing the free flow of water.
- Foundation / Floor level of residential buildings at few places in these layouts is much below the existing drain bed level.
- 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.
- Existing tertiary drain bed level and the secondary drain bed level is almost the same at many places.

2.8.2 Brindavanagar:

Brindavanagar is situated near Mattikere in Hebbal main valley-I. Hebbal main valley-I secondary storm water drain (H203) 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.

- The existing secondary drain bed level and the main drain bed level near 5th cross, Brindavanagar is almost the same and also the drain width of the main drain near H.M.T. main road is drastically reduced due to which the water is heading up in this region.

- Large number of residential buildings constructed inside the water way is obstructing the free flow of water near Brindavanagar.

- The main drain bed slope is almost flat in this region.

- RCC hume pipe culverts constructed near New B.E.L. Road, R.M.V. Extn. is obstructing free flow of water and causing the heading up of water in the upstream reaches.

- Drain width is drastically reduced near Devinagar, Marutinagar, which is causing the heading up of water in the upstream reaches.

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

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

- 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.

- Existing tertiary drain bed level and the secondary drain bed level is almost the same at many places.

2.8.3 Tannirhalli:

Tannirhalli is situated near Mattikere in Hebbal main valley-I. Hebbal main valley - I secondary storm water drain (H205) flows through this locality and due to reasons mentioned below, it is causing localised flooding problems in this region.

Reasons for flooding:

- Due to the reasons mentioned for Brindavananagar, this region is also experiencing flooding problems.
- The drain width is drastically reduced near Muthyalanagar.
- The drain is in natural condition near Mattikere tank.
- Large number of residential buildings constructed inside the water way is obstructing the free flow of water near Brindavananagar.
- RCC hume pipe culverts constructed near New B.E.L. road, R.M.V. Extn. is obstructing free flow of water and causing the heading up of water in the upstream reaches.
- Drain width is drastically reduced near Devinagar, Marutinagar, which is causing the heading up of water in the upstream reaches.
- Due to large scale encroachment, natural alignment of existing primary & secondary storm drain has been altered at many places.
- Foundation / Floor level of residential buildings at few places in these layouts is much below the existing drain bed level.
- 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.

•Existing tertiary drain bed level and the secondary drain bed level is almost the same at many places.

2.8.4 Sanjeevappa garden:

Sanjeevappa garden is situated near New B.E.L. road in Hebbal main valley-I. Hebbal main valley-I primary storm water drain (H200) flows through this locality and due to reasons mentioned below, it is causing localised flooding problems in this region.

Reasons for flooding:

•Due to the reasons mentioned for Brindavananagar, this region is also experiencing flooding problems.

•Due to large scale encroachment, natural alignment of existing primary & secondary storm drain has been altered at many places.

•This reach of storm drain is in natural condition.

•The bed slope of main drain is very flat and is in natural condition.

•Large number of tertiary drains from adjoining areas join the main drain at this location.

•The main drain bed slope is almost flat in this region.

•RCC hume pipe culverts constructed near New B.E.L. road, R.M.V. Extn. is obstructing free flow of water and causing the heading up of water in the upstream reaches.

•Drain width is drastically reduced near Devi nagar, Maruti nagar, which is causing the heading up of water in the upstream reaches.

•Due to large scale encroachment, natural alignment of existing primary & secondary storm drain has been altered at many places.

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

- 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.

- Existing tertiary drain bed level and the secondary drain bed level is almost the same at many places.

2.8.5 Kadugondanahalli (Shampura):

Shampura is situated near Nagavara main road in Hebbal minor valley-I. Hebbal minor valley-I secondary storm water drain (H306) 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 storm drain is in natural condition.

- The secondary drain is severely silted and large quantity of vegetation growth is noticed inside the drain near Nagavara main road level crossing.

- Due to large scale encroachment, natural alignment of existing secondary storm drain has been altered at many places.

- The drain width near Nagavara main road, Kamraj nagar and Rahat ali layout is drastically reduced.

- The bed slope of secondary drain is very flat and is in natural condition.

- Large number of tertiary drains from adjoining areas joins the secondary drain at this location.

- Due encroachment of land behind Leather factory at Nagavara main road is obstructing free flow of water and causing the heading up of water in the upstream reaches.

- Drain width is drastically reduced near Rahat ali layout, which is causing the heading up of water in the upstream reaches.

- Due to large scale encroachment, natural alignment of existing secondary storm drain has been altered at many places.

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

- 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.

2.8.6 Basavanagar (Near Ambedkar medical college):

Basavanagar is situated near Ambedkar medical college in Hebbal minor valley-I. Hebbal minor valley-I secondary storm water drain (H306) flows through this locality and due to reasons mentioned below, it is causing localised flooding problems in this region.

Reasons for flooding:

- Due to the reason mentioned for Shampura, this region is also experiencing flooding problems.

- This reach of storm drain is in natural condition.

- The secondary drain is severely silted and large quantity of vegetation growth is noticed inside the drain near Nagavara main road level crossing.

- Due to large scale encroachment, natural alignment of existing secondary storm drain has been altered at many places.

- The drain width near Nagavara main road, Kamraj nagar and Rahat ali layout is drastically reduced.

- The bed slope of secondary drain is very flat and is in natural condition.

- Large number of tertiary drains from adjoining areas joins the secondary drain at this location.

- Due encroachment of land behind Leather factory at Nagavara main road is obstructing the flow and causing the heading up of water in the upstream reaches.

- Drain width is drastically reduced near Rahat ali layout, which is causing the heading up of water in the upstream reaches.

- Due to large scale encroachment, natural alignment of existing secondary storm drain has been altered at many places.

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

- 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.

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.

CHAPTER - 3

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 and in some case, where large scale distraction of properties are observed, it was decided to consider two year return period for the analysis.

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 I.M.D. 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 (I.M.D.). 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.

$$X\,T = X + K\,Sx$$

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 Hebbal 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 Hebbal 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 Hebbal Main Valley, Hebbal Main Valley – I, Hebbal Minor Valley - I and Hebbal Minor Valley - II are provided in Table – 3.1 to Table – 3.8.

Table 3.1 HEBBAL MAIN VALLEY (H100) MICRO CATCHMENT CODE

Sl. No.	Micro Catchment Code	Area (Ha.)
1	A 5	52.65
2	A 8	135.13
3	A 9	44.61
4	A 9	40.70
5	A 10	38.25
6	A 11	150.33
7	A 12	86.15
8	A 13	129.14
9	A14	50.70
10	A15	61.53
11	A16	27.01
12	A29	19.58
	TOTAL	**835.78**

Table 3.2 HEBBAL MAIN VALLEY(H100) FLOW REGION CODE

Sl.No.	Flow Region Code	Area (ha.)
1.	A5(c)	27.65
2.	A5(d)	25.00
3.	A8(b)	109.89
4.	A8(c)	25.24
5.	A9(a)	16.97
6.	A9(b)	27.64
7.	A9(c)	40.70
8.	A10(a)	38.25
9.	A11(a)	28.22
10.	A11(b)	122.11
11.	A12(a)	50.98
12.	A12(b)	35.17
13.	A13(a)	38.27
14.	A13(b)	90.87
15.	A14	50.70
16.	A15	61.53
17.	A16(a)	12.20
18.	A16(b)	14.81
19.	A29	19.58
	TOTAL	**835.78**

Table 3.3 HEBBAL MAIN VALLEY- I (H200) MICRO CATCHMENT CODE

Sl. No.	Micro Catchment Code	Area (Ha.)
1	A1	487.39
2	A2	110.07
3	A3	259.67
4	A4	313.47
5	A5	448.44
6	A6	638.46
7	A7	275.74
8	A8	57.16
	TOTAL	**2590.4**

Table 3.4 HEBBAL MAIN VALLEY- I (H200) FLOW REGION CODE

Sl.No.	Flow Region Code	Area (ha.)
1.	A1(a)	42.33
2.	A1(b)	259.20
3.	A1(c)	185.86
4.	A2	110.07
5.	A3(a)	144.76
6.	A3(b)	32.00
7.	A3(c)	28.61
8.	A3(d)	54.30
9.	A4(a)	172.08
10.	A4(b)	129.74
11.	A4(c)	11.65
12.	A5(a)	81.24
13.	A5(b)	62.97
14.	A5(c)	61.46
15.	A5(d)	57.48
16.	A5(e)	113.77
17.	A5(f)	34.61
18.	A5(g)	36.91
19.	A6(a)	339.61
20.	A6(b)	119.60
21.	A6(c)	89.24
22.	A6(d)	28.04
23	A6(e)	37.42
24	A6(f)	24.55
25	A7(a)	109.82
26	A7(b)	165.92
27	A8(a)	39.67
28	A8(c)	17.49
	TOTAL	**2590.40**

Table 3.5 HEBBAL MINOR VALLEY- I (H300) MICRO CATCHMENT CODE

Sl. No.	Micro Catchment Code	Area (Ha.)
1	A17	82.39
2	A18	63.19
3	A19	68.59
4	A20	298.30
5	A21	178.22
6	A22	80.27
7	A23	33.69
8	A24	29.53
9	A25	24.33
10	A26	68.07
11	A27	181.30
12	A29	247.87
13	A30	143.51
14	A31	5.30
15	A34	24.04
	TOTAL	**1528.6**

Table 3.6 HEBBAL MINOR VALLEY- I (H300) FLOW REGION CODE

Sl.No.	Flow Region Code	Area (ha.)
1	A17(a)	40.92
2.	A17(b)	41.47
3.	A18(a)	23.79
4.	A18(b)	39.40
5.	A19(a)	43.66
6.	A19(b)	24.93
7.	A20(a)	159.82
8.	A20(b)	138.48
9.	A21(a)	80.88
10.	A21(b)	97.34
11.	A22(a)	22.54
12.	A22(b)	57.73
13.	A23(a)	15.22
14.	A23(b)	18.47
15.	A24	29.53
16.	A25	24.33
17.	A26(a)	5.38
18.	A26(b)	62.69
19.	A27(a)	105.56
20.	A27(b)	75.74
21.	A29	247.87
22.	A30	143.51
23	A31	5.30
24	A34	24.04
	TOTAL	**1528.60**

Table 3.7 HEBBAL MINOR VALLEY- II (H400) MICRO CATCHMENT CODE

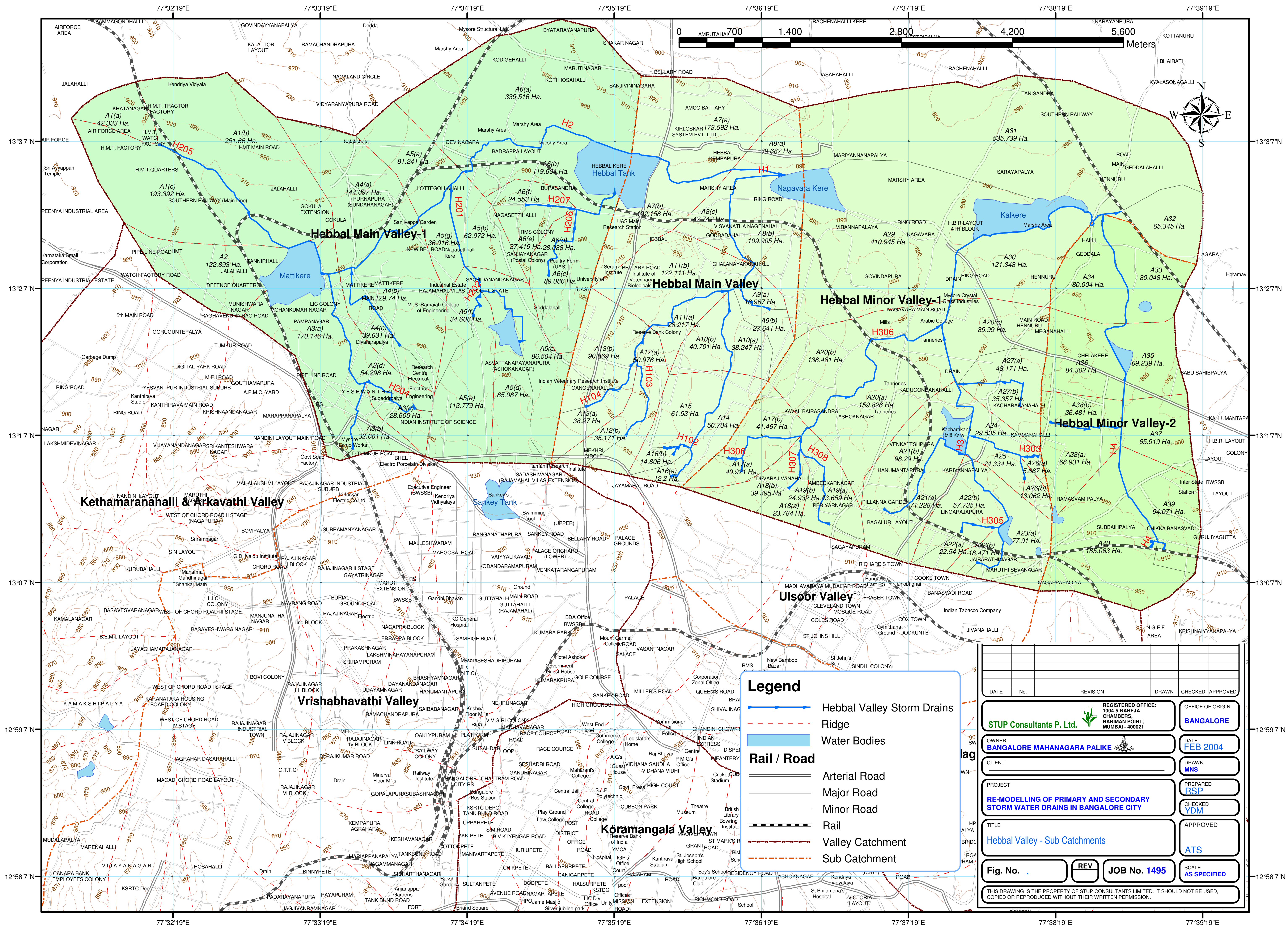
Sl. No.	Micro Catchment Code	Area (Ha.)
1	A27	70.74
2	A33	80.05
3	A34	106.17
4	A35	69.17
5	A36	34.17
6	A37	65.92
7	A38	48.27
8	A39	94.07
9	A40	185.06
	TOTAL	**753.62**

Table 3.8 HEBBAL MINOR VALLEY- II (H400) FLOW REGION CODE

Sl.No.	Flow Region Code	Area (ha.)
1.	A27(a)	70.74
2.	A33	80.05
3.	A34	106.17
4.	A35	69.17
5.	A36	34.17
6.	A37	65.92
7.	A38(a)	11.81
8.	A38(b)	36.46
9.	A39	94.07
10.	A40	185.06
	TOTAL	**753.62**

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



Hebbal Main Valley-1
Hebbal Main Valley
Hebbal Minor Valley-1
Hebbal Minor Valley-2
Kethamaranahalli & Arkavathi Valley
Vrishabhavathi Valley
Ulsoor Valley
Koramangala Valley
Hebbal Tank
Nagavara Kere
Kalkere
Mattikere
Sankey Tank
0 700 1,400 2,800 4,200 5,600 Meters
Legend
Hebbal Valley Storm Drains
Ridge
Water Bodies
Rail / Road
Arterial Road
Major Road
Minor Road
Rail
Valley Catchment
Sub Catchment
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 FEB 2004
CLIENT
DRAWN MNS
PROJECT RE-MODELLING OF PRIMARY AND SECONDARY STORM WATER DRAINS IN BANGALORE CITY
PREPARED RSP
CHECKED YDM
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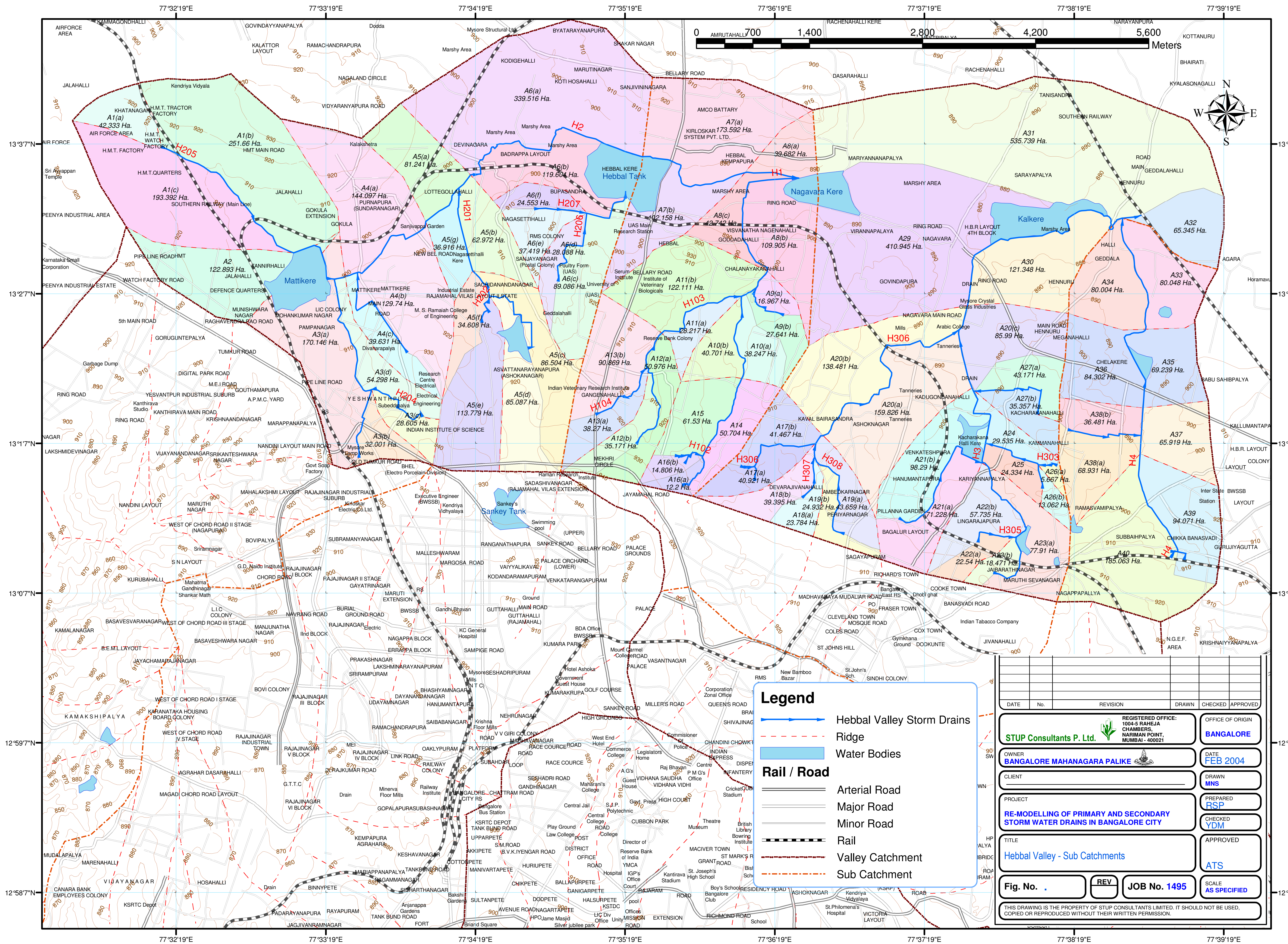

0 700 1,400 2,800 4,200 5,600 Meters
N
S
E
W
Hebbal Tank
Nagavara Kere
Kalkere
Mattikere
Sankey Tank
A1(a) 42.333 Ha.
A1(b) 251.66 Ha.
A1(c) 193.392 Ha.
A2 122.893 Ha.
A3(a) 170.146 Ha.
A3(b) 32.001 Ha.
A3(c) 28.605 Ha.
A3(d) 54.298 Ha.
A4(a) 144.097 Ha.
A4(b) 129.74 Ha.
A4(c) 39.631 Ha.
A5(a) 81.241 Ha.
A5(b) 62.972 Ha.
A5(c) 86.504 Ha.
A5(d) 85.087 Ha.
A5(e) 113.779 Ha.
A5(f) 34.608 Ha.
A5(g) 36.916 Ha.
A6(a) 339.516 Ha.
A6(b) 119.604 Ha.
A6(c) 89.086 Ha.
A6(d) 28.088 Ha.
A6(e) 37.419 Ha.
A6(f) 24.553 Ha.
A7(a) 173.592 Ha.
A7(b) 102.158 Ha.
A8(a) 39.682 Ha.
A8(b) 109.905 Ha.
A9(a) 16.967 Ha.
A9(b) 27.641 Ha.
A10(a) 38.247 Ha.
A10(b) 40.701 Ha.
A11(a) 28.217 Ha.
A11(b) 122.111 Ha.
A12(a) 50.976 Ha.
A12(b) 35.171 Ha.
A13(a) 38.27 Ha.
A13(b) 90.869 Ha.
A14 50.704 Ha.
A15 61.53 Ha.
A16(a) 12.2 Ha.
A16(b) 14.806 Ha.
A17(a) 40.921 Ha.
A17(b) 41.467 Ha.
A18(a) 23.784 Ha.
A18(b) 39.395 Ha.
A19(a) 43.659 Ha.
A19(b) 24.932 Ha.
A20(a) 159.826 Ha.
A20(b) 138.481 Ha.
A20(c) 85.99 Ha.
A21(a) 71.228 Ha.
A21(b) 98.29 Ha.
A22(a) 22.54 Ha.
A22(b) 57.735 Ha.
A23(a) 77.91 Ha.
A23(b) 18.471 Ha.
A24 29.535 Ha.
A25 24.334 Ha.
A26(a) 5.667 Ha.
A26(b) 13.062 Ha.
A27(a) 43.171 Ha.
A27(b) 35.357 Ha.
A29 410.945 Ha.
A30 121.348 Ha.
A31 535.739 Ha.
A32 65.345 Ha.
A33 80.048 Ha.
A34 80.004 Ha.
A35 69.239 Ha.
A36 84.302 Ha.
A37 65.919 Ha.
A38(a) 68.931 Ha.
A38(b) 36.481 Ha.
A39 94.071 Ha.
A40 185.063 Ha.
H1
H2
H3
H4
H14
H102
H103
H104
H201
H202
H204
H205
H206
H207
H303
H305
H306
H307
H308
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
13°3'7"N
13°2'7"N
13°1'7"N
13°0'7"N
12°59'7"N
12°58'7"N
Legend
Hebbal Valley Storm Drains
Ridge
Water Bodies
Rail / Road
Arterial Road
Major Road
Minor Road
Rail
Valley Catchment
Sub Catchment
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
FEB 2004
CLIENT
DRAWN
MNS
PROJECT
RE-MODELLING OF PRIMARY AND SECONDARY STORM WATER DRAINS IN BANGALORE CITY
PREPARED
RSP
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YDM
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Hebbal Valley - Sub Catchments
APPROVED
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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 - 3.9.& 3.12.

In order to compute the weighted average percent imperviousness for each flow region, intersection of flow region boundaries with settlement density boundaries is done. A composite plans for the entire Hebbal 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 3.9 HEBBAL MAIN VALLEY (H100) LAND COVER CHARACTERISTICS

Sl.No.	Land Cover Characteristics	Area (ha)	Assigned % Imperviousness
1.	Highly / Dense built up area with sparse vegetal cover	311.98	75 – 90
2.	Dense built up area with medium / thick vegetal cover	105.17	65 – 80
3.	Built up area with more open space as well as fairly dense vegetal cover	370.23	45 – 60
4.	Open space with no vegetal cover / Open space with scrubs and other vegetation	23.84	10 – 25
5	Parks	24.55	05 – 20
6	Water Bodies		--
	Total	**835.78**	

TABLE 3.10 HEBBAL MAIN VALLEY- I (H200) LAND COVER CHARACTERISTICS

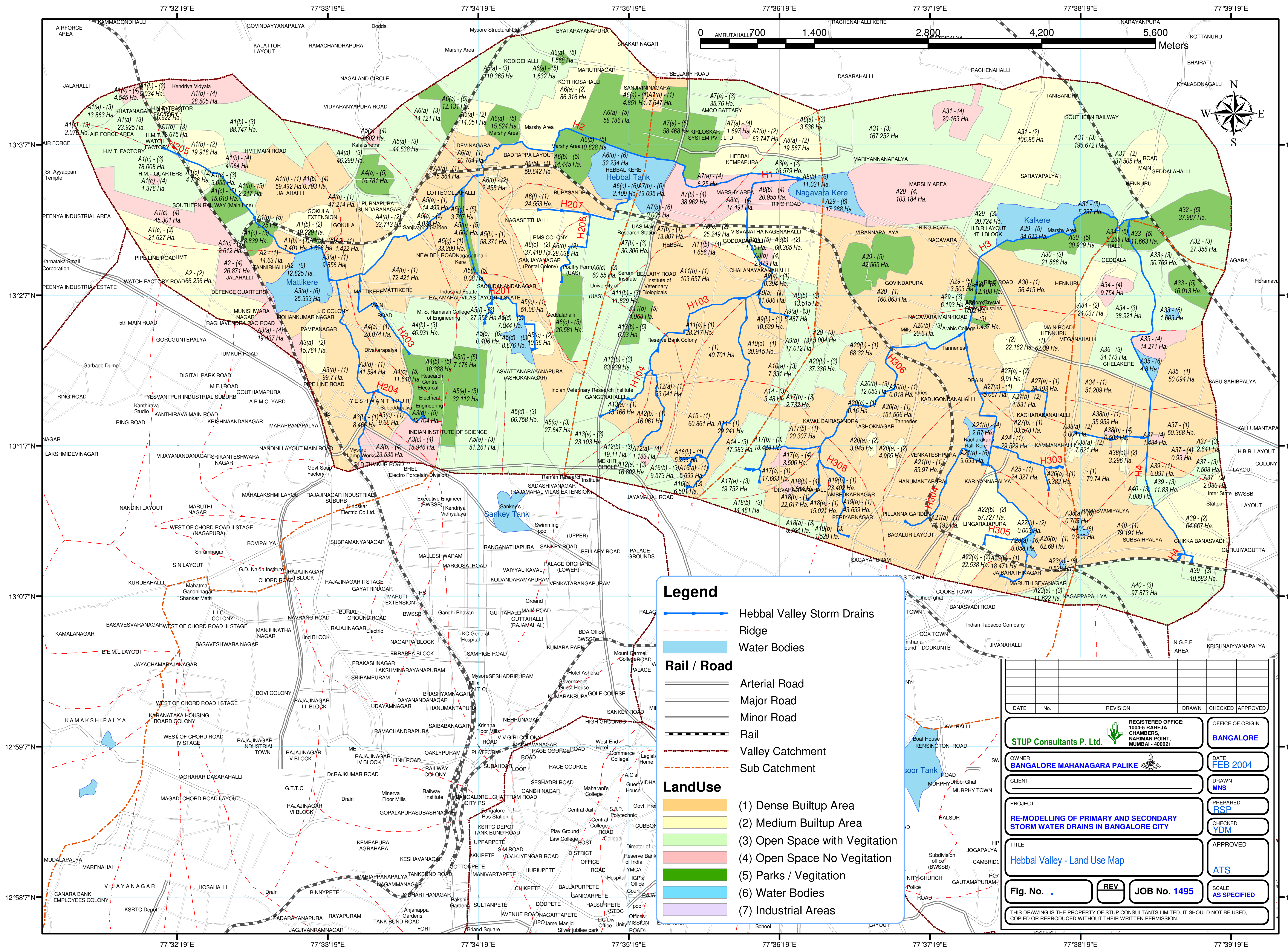
Sl.No.	Land Cover Characteristics	Area (ha)	Assigned % Imperviousness
1.	Highly / Dense built up area with sparse vegetal cover	761.20	75 – 90
2.	Dense built up area with medium / thick vegetal cover	430.53	65 – 80
3.	Built up area with more open space as well as fairly dense vegetal cover	794.34	45 – 60
4.	Open space with no vegetal cover / Open space with scrubs and other vegetation	207.25	10 – 25
5	Parks	306.68	05 – 20
6	Water Bodies	90.40	--
	Total	**2590.4**	

TABLE 3.11 HEBBAL MINOR VALLEY- I (H300) LAND COVER CHARACTERISTICS

Sl.No.	Land Cover Characteristics	Area (ha)	Assigned % Imperviousness
1.	Highly / Dense built up area with sparse vegetal cover	1007.16	75 – 90
2.	Dense built up area with medium / thick vegetal cover	146.30	65 – 80
3.	Built up area with more open space as well as fairly dense vegetal cover	233.21	45 – 60
4.	Open space with no vegetal cover / Open space with scrubs and other vegetation	2.67	10 – 25
5	Parks	129.03	05 – 20
6	Water Bodies	10.23	--
	Total	**1528.60**	

TABLE 3.12 HEBBAL MINOR VALLEY- II (H400) LAND COVER CHARACTERISTICS

Sl.No.	Land Cover Characteristics	Area (ha)	Assigned % Imperviousness
1.	Highly / Dense built up area with sparse vegetal cover	337.56	75 – 90
2.	Dense built up area with medium / thick vegetal cover	72.29	65 – 80
3.	Built up area with more open space as well as fairly dense vegetal cover	284.95	45 – 60
4.	Open space with no vegetal cover / Open space with scrubs and other vegetation	24.03	10 – 25
5	Parks	27.68	05 – 20
6	Water Bodies	7.11	--
	Total	**753.62**	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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
13°3'7"N
13°2'7"N
13°1'7"N
13°0'7"N
12°59'7"N
12°58'7"N
0
700
1,400
2,800
4,200
5,600
Meters
N
S
E
W
Hebbal Tank
Nagavara Kere
Kalkere
Mattikere
Sankey Tank
H1
H2
H3
H4
H14
H103
H104
H201
H203
H204
H205
H206
H207
H303
H304
H305
H306
H308
Legend
Hebbal Valley Storm Drains
Ridge
Water Bodies
Rail / Road
Arterial Road
Major Road
Minor Road
Rail
Valley Catchment
Sub Catchment
LandUse
(1) Dense Builtup Area
(2) Medium Builtup Area
(3) Open Space with Vegitation
(4) Open Space No Vegitation
(5) Parks / Vegitation
(6) Water Bodies
(7) Industrial Areas
DATE
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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 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.

$$\text{i)}\quad i = \frac{a}{t^n}$$

$$\text{ii) } i = \frac{a}{t + b}$$

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

$$I = (A_1I_1+A_2I_2+ \ldots\ldots..) / (A1+ A2+\ldots\ldots)$$

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 3.13. 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 – 3.13 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	0.86	.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 – 3.14 gives the analysis of the frequency of storms of stated intensities and duration during the past 25 years.

Table 3.14

Table 3.15 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 3.15, 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-3.15 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 :

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

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 3.16.

TABLE – 3.16

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 m^3/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 5.5 m/sec and 2.25 m/sec respectively. Keeping this velocities in view, a velocity of flow of 1.2 m/sec for terrain and maximum of 3.0 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 2 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 Hebbal Valley in Table 4.1 to Table 4.4 and is enclosed in the section 4.2 of Chapter - 4 in this report.

CHAPTER - 4

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 shall 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 Hebbal Valley is 5710 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 to Table 4.4

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.

Table 4.1 Showing Adequacy Analysis Results for Hebbal Main Valley (H1) - Existing Hydraulic Flow Conditions

Sl.No.	Description	Drain Reach		Chainage (m)		Catchment Area	Type	Average Velocity	Discharges (Q in m3/sec)					Existing Av.Drain	Area required for drain (A in m2)					Existing Av. Drain	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	H100	Shree Venkateshawara Mandira, Matadahalli Road	R.T. Nagar 1st Block Road	0	500	29	Pri.	4.28	2.175	2.9497	3.6905	4.2504	5.55888	2.19	0.508	0.689	0.862	0.993	1.2988	3.13	0.232	0.315	0.394	0.453	0.5931	AD	AD	AD	AD	AD
2	H100	R.T. Nagar 1st Block Road	Sriram Appartment Dinnur Main Road, R.T.Nagar	500	1500	156.04	Pri.	3.2	9.789	13.432	17.051	19.999	25.2761	1.76	3.059	4.198	5.328	6.25	7.8988	4.23	1.738	2.385	3.028	3.551	4.4879	AD	AD	AD	AD	IA
3	H100	Sriram Appartment Dinnur Main Road, R.T.Nagar	Bhuvaneswari nagar	1500	2675	262.62	Pri.	2.7	15.74	21.7	27.712	32.753	40.8073	1.5	5.829	8.037	10.26	12.13	15.114	5.83	3.886	5.358	6.842	8.087	10.076	AD	AD	IA	IA	IA
4	H100	Bhuvaneswari nagar	Kanakanagar main road	2675	2875	675.18	Pri.	2.1	23.95	33.157	42.549	50.59	62.3222	1.58	11.41	15.79	20.26	24.09	29.677	6.7	7.219	9.993	12.82	15.25	18.783	IA	IA	IA	IA	IA
5	H100	Kanakanagar main road	Rly track near Nagenahalli	2875	3750	760.82	Pri.	2.65	28.71	39.782	51.116	60.875	74.7633	2	10.83	15.01	19.29	22.97	28.213	10	5.417	7.506	9.644	11.49	14.106	AD	AD	AD	IA	IA
6	H100	Rly track near Nagenahalli	Nagavara Tank	3750	4425	835.77	Pri.	2.17	32.13	44.587	57.401	68.528	83.7779	1.57	14.81	20.55	26.45	31.58	38.607	11	9.43	13.09	16.85	20.11	24.591	AD	IA	IA	IA	IA
7	H101	Rankanagar	Bhuvaneshwarinagar	0	575	16.519	Sec.	1.75	1.271	1.744	2.2139	2.5967	3.28172	0.6	0.726	0.997	1.265	1.484	1.8753	1.8	1.21	1.661	2.108	2.473	3.1254	AD	AD	IA	IA	IA
8	H102	Rahamatnagar	Hanumanthappa Extn.	0	447	14.806	Sec.	3.6	0.935	1.2829	1.6277	1.9078	2.41414	1.41	0.26	0.356	0.452	0.53	0.6706	3.1	0.184	0.253	0.321	0.376	0.4756	AD	AD	AD	AD	AD
9	H103	Gangenahalli Extn.	R.B.I. Colony	0	1125	92.453	Sec.	3.19	5.699	7.8687	10.066	11.92	14.7947	1.69	1.786	2.467	3.155	3.737	4.6378	5	1.057	1.46	1.867	2.211	2.7443	AD	AD	AD	AD	AD
10	H104	Bellary Road near HMT Bhavan	CBI Road, Ganganagar	0	950	67.816	Sec.	3.48	4.172	5.737	7.3023	8.5936	10.7923	1.59	1.199	1.649	2.098	2.469	3.1012	4.17	0.754	1.037	1.32	1.553	1.9505	AD	AD	AD	AD	AD
11	H104	CBI Road, Ganganagar	Near MSH Layout	950	1800	251.14	Sec.	3.1	14.95	20.62	26.351	31.168	38.7737	2.14	4.821	6.652	8.5	10.05	12.508	5	2.253	3.108	3.972	4.698	5.8447	AD	AD	AD	AD	IA
12	H104	Near MSH Layout	Chamundinagar main road	1800	2650	401.47	Sec.	2.3	23.33	32.291	41.428	49.241	60.6962	1.53	10.14	14.04	18.01	21.41	26.39	8	6.63	9.176	11.77	13.99	17.248	AD	IA	IA	IA	IA

Table 4.2 Adequacy Analysis Results for Hebbal Main Valley - I (H2) - Existing Hydraulic Flow Conditions

Sl.No.	Description	Drain Reach		Chainage (m)		Catchment Area A	Type	Average Velocity V	Discharges (Q in m3/sec)					Existing Av.Drain	Area required for drain (A in m2)					Existing Av. Drain	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	H200	Old Tumkur Road near Mysore Lamp works	Triveni Road near Kamala Nehru Extn.	0	875	63.2	Pri.	2.63	3.906	5.3661	6.8217	8.0156	10.096	1.3	1.485	2.04	2.594	3.0478	3.8388	2.6	1.142	1.569	1.995	2.344	2.9529	AD	AD	AD	AD	IA
2	H200	Triveni Road near Kamala Nehru Extn.	H.M.T.Layout Mattikere, 5th Cross	875	1650	164.906	Pri.	2.4	9.697	13.373	17.083	20.195	25.148	1.7	4.04	5.572	7.118	8.4144	10.478	2.4	2.377	3.278	4.187	4.95	6.1638	AD	IA	IA	IA	IA
3	H200	H.M.T.Layout Mattikere, 5th Cross	Mattikere Tank Bund Road	1650	2450	230.366	Pri.	2.5	13.27	18.346	23.506	27.896	34.487	2.2	5.308	7.338	9.403	11.158	13.795	2.8	2.413	3.336	4.274	5.072	6.2704	AD	IA	IA	IA	IA
4	H200	Mattikere Tank Bund Road	Mathikere main road near KPTCL office	2450	2750	904.336	Pri.	2.35	30.82	42.686	54.812	65.224	80.227	2.1	13.12	18.16	23.32	27.755	34.139	5	6.246	8.65	11.11	13.22	16.257	IA	IA	IA	IA	IA
5	H200	Mathikere main road near KPTCL office	New BEL Road	2750	3500	1133.76	Pri.	2.45	37.25	51.711	66.603	79.564	97.157	1.8	15.2	21.11	27.18	32.475	39.656	7.6	8.446	11.73	15.1	18.04	22.031	IA	IA	IA	IA	IA
6	H200	New BEL Road	Near Sachidananda nagar	3500	4600	1262.3	Pri.	1.8	43.09	59.955	77.429	92.812	112.62	2.25	23.94	33.31	43.02	51.562	62.564	6.3	10.64	14.8	19.12	22.92	27.806	IA	IA	IA	IA	IA
7	H200	Near Sachidananda nagar	Outer Ring Road	4600	5000	1621.5	Pri.	2.7	48.81	67.913	87.706	105.13	127.56	2.1	18.08	25.15	32.48	38.937	47.246	11.5	8.609	11.98	15.47	18.54	22.498	AD	IA	IA	IA	IA
8	H200	Outer Ring Road	Balaji Layout 6th Cross	5000	6000	1743.68	Pri.	1.9	53.59	74.688	96.667	116.2	140.26	2	28.2	39.31	50.88	61.157	73.82	6	14.1	19.65	25.44	30.58	36.91	IA	IA	IA	IA	IA
9	H200	Balaji Layout 6th Cross	Near Defence Dairy Farm in marshy land	6000	7000	2085.9	Pri.	1.5	64.69	90.502	117.69	142.34	169.87	1.4	43.13	60.33	78.46	94.891	113.25	8.3	30.81	43.1	56.04	67.78	80.891	IA	IA	IA	IA	IA
10	H200	Near Defence Dairy Farm in marshy land	After Bellary Road adjacent to Chiranjeevi nagar	7000	7775	2393.06	Pri.	1.4	66.92	93.701	121.97	147.7	175.86	1.5	47.8	66.93	87.12	105.5	125.61	9.3	31.87	44.62	58.08	70.33	83.742	IA	IA	IA	IA	IA
11	H201	Near IISc Staff Qtrs., 8th cross, Adarsh Layout	RMV Extn.	1000	1450	118.94	Sec	1.95	7.026	9.6811	12.352	14.581	18.207	1.9	3.603	4.965	6.334	7.4774	9.3372	2	1.896	2.613	3.334	3.935	4.9143	AD	IA	IA	IA	IA

12	H201	RMV Extn.	RMV 1st Main Road	1450	2000	274.16	Sec	2.5	12.74	17.627	22.615	26.882	33.132	2	5.095	7.051	9.046	10.753	13.253	2.6	2.547	3.525	4.523	5.376	6.6265	AD	IA	IA	IA	IA
13	H201	C.P.R.I Campus	Gandhi Vidyalaya Assn. near RMV Extn. 2 nd stage	2000	2825	337.13	Sec	2.45	15.94	22.108	28.443	33.928	41.544	1.5	6.506	9.024	11.61	13.848	16.957	3.7	4.337	6.016	7.74	9.232	11.304	IA	IA	IA	IA	IA
14	H202	Venkateshwara Layout near MSR Medical college	A.G. Colony	0	375	37.74	Sec	2.2	2.098	2.8751	3.6436	4.2644	5.4112	1.2	0.954	1.307	1.656	1.9383	2.4596	1.5	0.795	1.089	1.38	1.615	2.0497	AD	AD	AD	IA	IA
15	H205	HMT Shopping Complex	Near St.Chlaret's School &Church, Military Area	0	1000	218.44	Sec	2.4	11.95	16.426	20.907	24.602	30.901	1.5	4.977	6.844	8.711	10.251	12.875	3.7	3.318	4.563	5.808	6.834	8.5836	AD	IA	IA	IA	IA
16	H205	Near St.Chlaret's School &Church, Military Area	Bandappa Garden, Mutyalamma Nagar	1000	2000	487.39	Sec	2.35	24.54	33.917	43.45	51.552	63.761	1.5	10.44	14.43	18.49	21.937	27.132	7	6.96	9.622	12.33	14.62	18.088	AD	IA	IA	IA	IA
17	H205	Bandappa Garden, Mutyalamma Nagar	Mathi Kere Lake	2000	2600	626.76	Sec	2.14	30.22	41.849	53.73	63.927	78.654	1.4	14.12	19.56	25.11	29.872	36.754	7	10.09	13.97	17.93	21.34	26.253	IA	IA	IA	IA	IA
18	H206	Sanjayanagar	Ring Road	0	1000	142.59	Sec	2	8.13	11.213	14.324	16.933	21.085	1.5	4.065	5.606	7.162	8.4664	10.543	6	2.71	3.738	4.775	5.644	7.0285	AD	AD	AD	AD	IA
19	H206	Ring Road	Hebbal Lake	1000	1125	228.64	Sec	1.6	11.01	15.212	19.479	23.097	28.599	1.5	6.88	9.508	12.17	14.436	17.874	15	4.587	6.338	8.116	9.624	11.916	AD	AD	AD	AD	AD

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 500 mm. for one and two year storms and 300 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. An abstract of the analysis for Hebbal Main Valley, Hebbal Main Valley - I, Hebbal Minor Valley - I & Hebbal Minor Valley - II is presented in Table 4.1 to Table 4.4

From the analysis and the assessment carried out, following outcomes are highlighted:

➔Hebbal Main Valley (H100) :

- Near Matadahalli, Rahamatnagar & Hanumanthappa layout the existing storm drain is having a larger catchment area with undulating topography, more paved, less time of concentration, sufficient drain depth and width, gentle slope is available, severely silted, max. obstructions, bed is in natural condition and also drain walls are in moderate condition. Drain capacity is adequate to cater for twenty year return period hydraulic requirements.

- Near R. T. Nagar area, the existing storm drain is having a larger catchment area, more paved, less time of concentration, drain depth and width is less, 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 to cater for ten year return period hydraulic requirements.

- Near Dinnur, Kausernagar, Munnarayanapalya, Sulthanpalya, Chamundinagar & Bhuvaneshwarinagar 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, moderate bed slope is available, silted, bed is in natural condition, max. obstructions and also drain walls are in very moderate condition. The drain capacity in this stretch is very inadequate

- Near Matadahalli layout, Venkatappa block, A.K. Colony, & H.M.T. layout the existing storm drain is having a larger catchment area with undulating topography, more paved, less time of concentration, sufficient drain depth and width, gentle slope is available, severely silted, max. obstructions, bed is in natural condition and also drain walls are in moderate condition. Drain capacity is adequate to cater for ten year return period hydraulic requirements.

- Near Ganganagar, Gunduppa block, Vishveshwariahnagar, RBI colony, Anandanagar, MSH layout & Amarjyothi layout the existing storm drain is having a larger catchment area with undulating topography, more paved, less time of concentration, inadequate drain depth and width, gentle slope is available, severely silted, max. obstructions, bed is in natural condition and also drain walls are in moderate condition. Drain capacity is adequate to cater for ten year return period hydraulic requirements.

- Near Cholanagar, Bhuvaneshwarinagar, Inspectorate of Electronics layout and Kanakanagar the existing storm drain is having a larger and sparsely built up catchment area, insufficient drain width and depth, less bed slope is available, silted, bed is in natural condition, max. obstructions and also drain walls is in natural condition. The drain capacity is very inadequate.

- Near Guddahalli, Cholanayakanahalli, Sunrise colony & V. Nagenahalli area the existing storm drain is having a wider catchment area, more time of concentration, less drain width and depth, very flat bed slope is available, severely silted, vegetation growth, bed is in natural condition, max. obstructions and also drain walls are in natural condition. The drain capacity is adequate to cater for only five year return period hydraulic characteristics.

- Near outer ring road & Yogeshnagar the existing storm drain is having a comparatively wider and sparsely builtup catchment area, less drain depth, drain width gets drastically reduced at few places, very flat bed slope is available, silted, bed is in natural condition and also drain walls are in moderate condition. The drain capacity is very inadequate.

➔Hebbal Main Valley – I (H200) :

- Near Mysore lamp works, Nanjappa reddy colony & Yeshwanthpura the existing storm drain is having a larger catchment area with sloping topography, more paved, less time of concentration, insufficient drain depth and width, moderate bed slope is available, severely silted, max. obstructions, completely covered, bed is in natural condition and also drain walls are in moderate condition. Drain capacity is adequate to cater for only five year return period hydraulic requirements.

- Near Yeshwanthpura, B.K. Nagar, L.I.C. Colony & Kamala Nehru Extension the existing storm drain is having a larger catchment area with undulating topography, more paved, completely covered, less time of concentration, insufficient drain depth and width, flat gradient, severely silted, max. obstructions, bed is in natural condition and also drain walls are in moderate condition. Drain capacity is adequate to cater for only one year return period.

- Near H.M.T. Layout & Chowdeshwarinagar the existing storm drain is having a larger catchment area with less undulating topography, more paved, completely covered, less time of concentration, insufficient drain depth and width, drain width is drastically reduced at few places, flat gradient, severely silted, max. obstructions, bed is in natural condition and also drain walls are in moderate condition. Drain capacity is adequate to cater for only one year return period hydraulic requirements.

- Near Shardhambanagar & Jalahalli Village the existing storm drain is having a larger catchment area with sloping topography, less time of concentration, insufficient drain depth and width, moderate gradient, severely silted, bed is in natural condition and also drain walls are in moderate condition. Drain capacity is adequate to cater for only one year return period hydraulic requirements.

- Near Tannirhalli & Muthyalanagar the existing storm drain is having a larger catchment area with sloping topography, more paved, less time of concentration, insufficient drain depth and width, drain width is drastically reduced at few places, flat gradient, severely silted, max. obstructions, bed is in natural condition and also drain walls are in natural condition. Drain capacity is adequate to cater for only one year return period.

- Near Mattikere tank bund road, Brindhavannagar, S.B.M. Colony, Gokul extension, Mattikere, Poornappa garden & Sanjeevappa Garden the existing storm drain is having a larger catchment area with sloping topography, more paved, less time of concentration, insufficient drain depth and width, drain width is drastically reduced at few places, very flat gradient, severely silted, max. obstructions, bed is in natural condition and also drain walls are in natural condition. Drain capacity is very inadequate.

- Near New B.E.L. Road, Venkatacharynagar, Sachidanandanagar & R.M.V. extension the existing storm drain is having a larger catchment area with sloping topography, more paved, less time of concentration, insufficient drain depth and width, drain width is drastically reduced at few places, very flat gradient, severely silted, max. obstructions, bed is in natural condition and also drain walls are in moderate condition. Drain capacity is very inadequate.

- Near C.P.R.I., Jaladarshini layout, I.T.I. layout, A.E.C.S. layout, R.M.V. Extension the existing storm drain is having a larger catchment area with sloping topography, more paved, less time of concentration, insufficient drain depth and width, drain width is drastically reduced at few places, moderate gradient, severely silted, max. obstructions, bed is in natural condition and also drain walls are in moderate condition. Drain capacity is very inadequate.

- Near Outer ring road, Maruthinagar, Badrappa layout & Balajinagar the existing storm drain is having a larger, dense built up catchment area with flatter topography, more paved, less time of concentration, insufficient drain depth and width, drain width is drastically reduced at few places, very flat gradient, severely silted, max. obstructions, bed is in natural condition and also drain walls are in natural condition. Drain capacity is very inadequate.

- Near Hebbal tank inlet weir, defence dairy farm land, Bellary road & Chiranjeevenagar the existing storm drain is having a larger catchment area, with more open land, flatter topography, more time of concentration, insufficient drain depth and width, very flat gradient, severely silted, vegetation growth, max. obstructions, bed is in natural condition and also drain walls are in natural condition. Drain capacity is very inadequate.

➔Hebbal Minor Valley – I (H300) :

- Near Jaibharathnagar & Lingarajpura, K.H.B. Quarters the existing storm drain is having a larger, dense built up catchment area with flatter topography, more paved, less time of concentration, moderate drain depth and width, very flat gradient, severely silted, max. obstructions, bed is in natural condition and also drain walls are in moderate condition. Drain capacity is adequate for twenty year return period hydraulic requirement.

- Near Kanakadasa layout, Oil mill road & Sait palya the existing storm drain is having a dense built up catchment area with sloping topography, more paved, less time of concentration, insufficient drain depth and width, drain width is drastically reduced at few places, moderate gradient, severely silted, max. obstructions, bed is in natural condition and also drain walls are in moderate condition. Drain capacity is very inadequate.

- Near Shammana layout & Kariyannapalya the existing storm drain is having a larger, dense built up catchment area with sloping topography, more paved, less time of concentration, insufficient drain depth and width, drain width is drastically reduced at few places, moderate gradient, severely silted, max. obstructions, bed is in natural condition and also drain walls are in moderate condition. Drain capacity is very inadequate.

- Near Pillana garden & Kariyannapalya the existing storm drain is having a larger, dense built up catchment area with flatter topography, less time of concentration, moderate drain depth and width, flat gradient, severely silted, max. obstructions, bed is in natural condition and also drain walls are in moderate condition. Drain capacity is adequate to cater for five year hydraulic requirements.

- Near H.B.R. Layout 60 ft. Road the existing storm drain is having a larger, sparse built up catchment area with sloping topography, more time of concentration, sufficient drain depth and width, flat gradient, severely silted, max. obstructions, bed is in natural condition and also drain walls are in moderate condition. Drain capacity is adequate to cater for twenty year hydraulic requirements.

- Near Ramaswamipalya, Kammanahalli & St. Thomas town the existing storm drain is having a larger, dense built up catchment area with sloping topography, less time of concentration, sufficient drain depth and width, moderate gradient, severely silted, max. obstructions, bed is in natural condition and also drain walls are in moderate condition. Drain capacity is adequate to cater for ten year hydraulic requirements.

- Near Kacharakanahalli the existing storm drain is having a larger, sparse built up catchment area with sloping topography, more time of concentration, sufficient drain depth and width, moderate gradient, severely silted, max. obstructions, bed is in natural condition and also drain walls are in moderate condition. Drain capacity is adequate to cater for ten year hydraulic requirements.
- Near Yaseennagar & H.B.R. Layout 2nd Block the existing storm drain is having a larger, sparse built up catchment area with flatter topography, more time of concentration, sufficient drain depth and width, flat gradient, severely silted,

max. obstructions, bed is in natural condition and also drain walls are in moderate condition. Drain capacity is adequate to cater for twenty year hydraulic requirements.

- Near Devarajeevanahalli, Ambedkarnagar, Periyarnagar & Doddannanagar the existing storm drain is having a larger, dense built up catchment area with sloping topography, less time of concentration, insufficient drain depth and width, flat gradient, severely silted, max. obstructions, bed is in natural condition and also drain walls are in moderate condition. Drain capacity is adequate to cater for five year hydraulic requirements.

- Near Modi garden, Sayeedayanagar, Munieshvaranagar, Kamarajnagar, Ambedkar Medical College & Shampura the existing storm drain is having a larger, very dense built up catchment area with flatter topography, less time of concentration, insufficient drain depth and width, very flat gradient, severely silted, max. obstructions, drain is in natural condition. Drain capacity is adequate to cater only for two year hydraulic requirements.

- Near Kadugondanahalli, Gandhinagar, Nagawara main road, Kuppaswamy layout, Arabic College & Rahat Ali layout the existing storm drain is having a larger, very dense built up catchment area with flatter topography, less time of concentration, insufficient drain depth and width, very flat gradient, severely silted, max. obstructions, drain bed is in natural condition, drain walls are in moderate condition. Drain capacity is inadequate.

- Near Rahat Ali layout, H.B.R. layout Outer Ring Road & Telecom Employees layout the existing storm drain is having a larger, sparse built up catchment area with flatter topography, more time of concentration, sufficient drain depth and width, flat gradient, severely silted, max. obstructions, bed is in natural condition and also drain walls are in moderate condition. Drain capacity is inadequate and caters for only two year hydraulic requirements.

- Near Hennur Road, Gedalahalli & Raja canal STP the existing storm drain is having a larger, vacant catchment area with flatter topography, more time of concentration, inadequate drain depth and width, flat gradient, severely silted, vegetation growth, max. obstructions, drain is in natural condition. Drain capacity is very inadequate.

➔**Hebbal Minor Valley – II (H400) :**

- Near Chika Banaswadi layout & OMBR layout the existing storm drain is having a smaller, sparse built up catchment area with flatter topography, more time of concentration, sufficient drain depth and width, flat gradient, silted, max. obstructions, bed is in natural condition and also drain walls are in moderate condition. Drain capacity is inadequate and caters for only five year hydraulic requirements.

- Near Banswadi main road, Chowdeshwarinagar & OMBR layout the existing storm drain is having a larger, dense built up catchment area with flatter topography, more time of concentration, sufficient drain depth and width, flat gradient, severely silted, max. obstructions, bed is in natural condition and also drain walls are in moderate condition. Drain capacity is inadequate and caters for only five year hydraulic requirements.

- Near Kammanahalli & Sena Vihar the existing storm drain is having a larger, dense built up catchment area with sloping topography, less time of concentration, sufficient drain depth and width, flat gradient, severely silted, bed is in natural condition and also drain walls are in moderate condition. Drain capacity is adequate and caters for only ten year hydraulic requirements.

- Near H.B.R. Layout, Kalayannagar & Outer Ring Road & the existing storm drain is having a larger, dense built up catchment area with sloping topography, less time of concentration, sufficient drain depth and width, moderate gradient, severely silted, max. obstructions, bed is in natural condition and also drain walls are in moderate condition. Drain capacity is inadequate and caters for only five year hydraulic requirements.

- Near Muniswamy layout, Chalkere & Hennur bande the existing storm drain is having a larger, sparse built up catchment area with flatter topography, insufficient drain depth and width, very flat gradient, severely silted, max. obstructions, drain is in natural condition. Drain capacity is very 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 4.5 shows the results of adequacy analysis of existing inadequate culverts/bridges 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 sizes 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 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.

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, indicate 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 Hebbal Main Valley, Hebbal Main Valley - I, Hebbal Minor Valley - I & Hebbal Minor Valley - II which are considered to be inadequate are listed in Table – 4.6

The inspection details of these existing culverts/bridges is enclosed in Volume 2 - Condition Survey.

Based on the assessment, 26 culverts which were structurally in moderate condition and also drastically obstructing the flow, has been shortlisted and considered for reconstruction. Out of 26 culverts 4 culverts i.e., near Shammana Layout Park (Kariyannapalya), 4th Cross Munithayappa Layout, TATA nagar – Kodigehalli main road Junction (Nagashettyhalli) and Near Hebbal are newely proposed, based on BMP requirements.

The detailed designs, estimates and relevant drawings of these culverts / bridges is enclosed in Volume III & Volume IV.

The list of culverts / bridges proposed for reconstruction is as listed below and the same is depicted in Figure 4.1.

TABLE 4.6 Existing Culvert / Bridges Considered for Remodeling

Sl. No.	Culvert No.	Chainage (m.)	Location	Remarks
Hebbal Main Valley Primary Storm Drain (H100) :				
1	HV2-C7	1,815	Munivenkatappa block	Ex. Culvert/Bridge considered for remodelling
2	HV2 -C13	4,100	Outer Ring Road	Ex. Culvert/Bridge considered for remodelling
3	HV2-C14	4,375	Yogeshnagar main road	Ex. Culvert/Bridge considered for remodelling
Ganganagar Secondary Storm Drain (H104) :				
1	HV2-S2C7	1,065	10 th cross, Vasanthaappa block, Ganganagar	Ex. Culvert/Bridge considered for remodelling
2	HV2-S2C11	1,615	Anandanagar main road	Ex. Culvert/Bridge considered for remodelling
Hebbal Main Valley-I Primary Storm Drain (H200) :				
1	H1V-C16	3,775	New B.E.L. Road	Ex. Culvert/Bridge considered for remodelling
2	H1V-C17	3,875	7th main, RMV Extension.	Ex. Culvert/Bridge considered for remodelling
3	H1V-C18	4,225	8th main road, Sterling Apartments	Ex. Culvert/Bridge considered for remodelling
4	N-3	5,600	TATA Nagar – Kodigehalli main road junction, Nagashettyhalli, Hebbal	Pro. RCC Slab bridge, single span, 12 m wide, 2.4 m ht.
5	N-4	6,400	Near Hebbal tank Inlet Weir	Pro. RCC Slab bridge, single span, 12 m wide, 2.4 m ht.
Bupasandra Secondary Storm Drain (H206) :				
1	H1S5 - C7	800	Bupasandra Main Road	Ex. Culvert/Bridge considered for remodelling
Hebbal Minor Valley-I Primary Storm Drain (H300) :				
1	H3V-C5	935	Kanakadasa Layout, Lingarajpura	Ex. Culvert/Bridge considered for remodelling
2	H3V-C10	1,285	Near Karimariamma temple	Ex. Culvert/Bridge considered for remodelling
3	H3V-C11	1,325	Jai Matha Devasthan road	Ex. Culvert/Bridge considered for remodelling
4	N-1	1,425	Near Shamanna layout park	Pro. RCC box culvert single span, 5 m wide 1.6 m ht.
5	H3V-C13	1,835	Hennur main road near Petrol bunk	Ex. Culvert/Bridge considered for remodelling
6	H3V-C14	1,965	1st stage, 1st block, 60 ft. road, HBR Layout.	Ex. Culvert/Bridge considered for remodelling
7	H3V-C27	6,815	Geddlahalli main road	Ex. Culvert/Bridge considered for remodelling
Kacharakanahalli Secondary Storm Drain (H301)				
1	H3S4-C5	1,140	Near Teacher's colony, H.B.R. Layout 2nd block	Ex. Culvert/Bridge considered for remodelling
Kammanahalli Secondary Storm Drain (H302)				
1	H3S3-C2	200	Nehru road, Kammanahalli	Ex. Culvert/Bridge considered for remodelling
2	H3S3-C4	625	Near Jyothi social work centre, Kammanahalli	Ex. Culvert/Bridge considered for remodelling

Sl. No.	Culvert No.	Chainage (m.)	Location	Remarks
Banaswadi Secondary Storm Drain (H305)				
1	N-2	380	4th cross road, Munithayappa layout	Pro. RCC box culvert single span, 3.5 m wide 1.6 m ht.

Sl. No.	Culvert No.	Chainage (m.)	Location	Remarks
2	H3S1-C5	565	Opp. K.H.B. Qtrs., Lingarajpura	Ex. Culvert/Bridge considered for remodelling
Kavalabairasandra Secondary Storm Drain (H306)				
1	H3S5-C1	300	N.P. Factory road	Ex. Culvert/Bridge considered for remodelling
2	H3S5-C2	515	Sayeediya Arabic college	Ex. Culvert/Bridge considered for remodelling
3	H3S5-C3	640	6th Cross, Shadabnagar	Ex. Culvert/Bridge considered for remodelling
4	H3S5-C6	1,832	2nd Cross, Gandhinagar, Kadugondanahalli	Ex. Culvert/Bridge considered for remodelling
Hebbal Minor Valley-II Primary Storm Drain (H400) :				
1	H3M5-C9	815	Banaswadi main road, near OMBR Layout Fire station.	Ex. Culvert/Bridge considered for remodelling

4.2 STRATEGIC ACTIONS AND RECOMMENDATIONS:

➢Hebbal Main Valley Primary Storm Drain (H100):

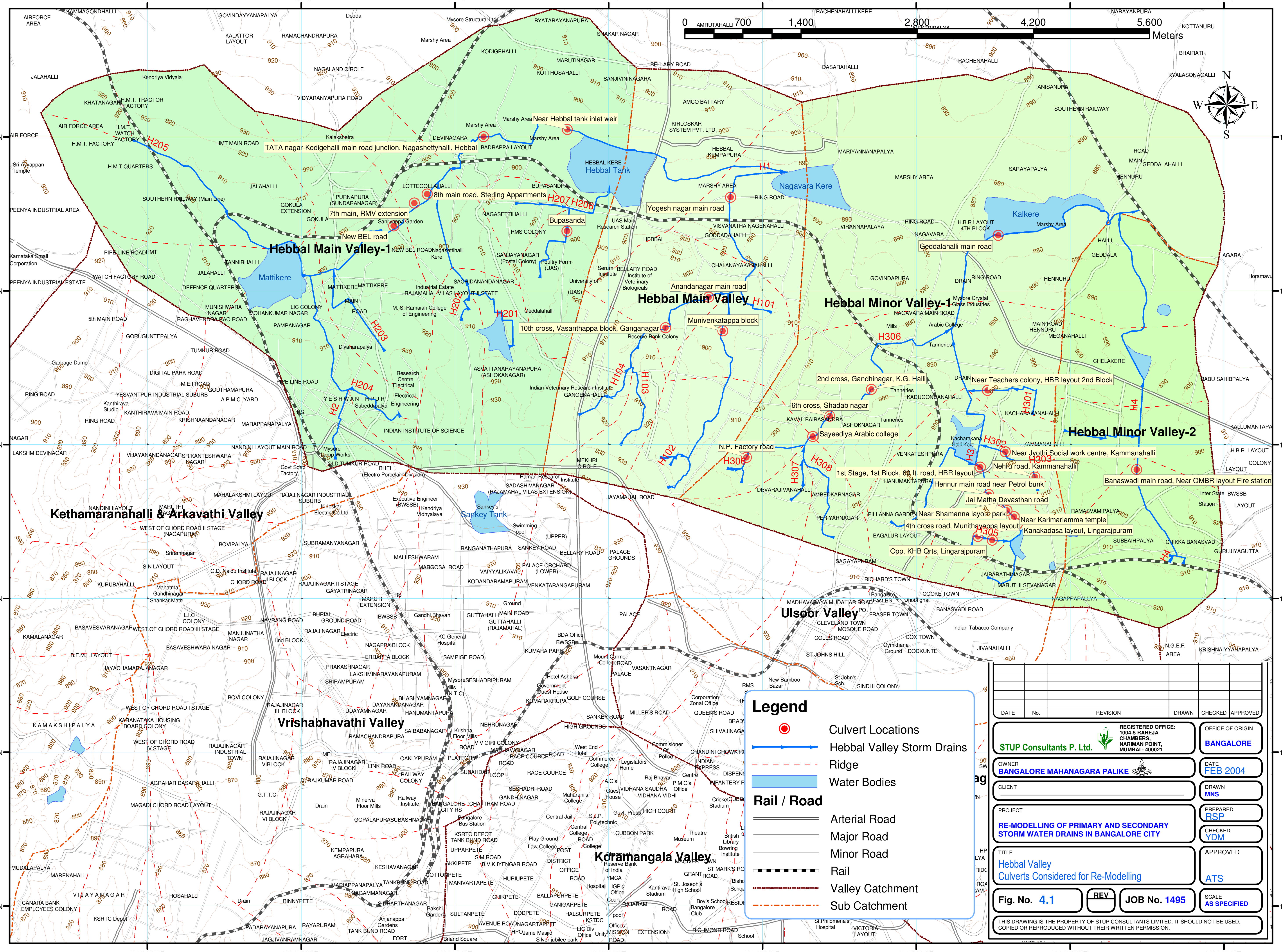
- The existing drain near J.C. Nagar & Matadahalli (i.e., near Adi Kabir Ashram) is almost covered, which needs to be opened at regular intervals, desilted and steel gratings has to be provided at regular intervals and also at all the road crossings.

- Since, the existing drain passes through dense built up and highly commercial area, large quantity of garbage that is noticed inside the drain needs to be cleaned very frequently.

- Drain walls near Matadahalli & Thimmiah garden is in moderate condition and it needs to be strengthened and bed protection to be provided

- Concerned authority should have strict vigil and levy penalty on the building owners who resort to takeup construction activity over the drain walls in this region.

- Existing main drain needs to be widened on right hand side near Chunchappa block dobhi ghat (i.e., secondary drain (H102) joining location).
- Drain width is drastically reduced near Kohinoor bus depot & Sri Ram properties apartments. Which needs to be widened and new walls to be constructed.



Hebbal Main Valley-1
Hebbal Main Valley
Hebbal Minor Valley-1
Hebbal Minor Valley-2
Kethamaranahalli & Arkavathi Valley
Vrishabhavathi Valley
Ulsoor Valley
Koramangala Valley
Hebbal Tank
Nagavara Kere
Kalkere
Mattikere
Sankey Tank
Near Hebbal tank inlet weir
TATA nagar-Kodigehalli main road junction, Nagashettyhalli, Hebbal
8th main road, Sterling Appartments
7th main, RMV extension
New BEL road
Bupasanda
Yogesh nagar main road
Anandanagar main road
Munivenkatappa block
10th cross, Vasanthappa block, Ganganagar
Geddalahalli main road
2nd cross, Gandhinagar, K.G. Halli
Near Teachers colony, HBR layout 2nd Block
6th cross, Shadab nagar
Sayeediya Arabic college
N.P. Factory road
Near Jyothi Social work centre, Kammanahalli
Nehru road, Kammanahalli
1st Stage, 1st Block, 60 ft. road, HBR layout
Hennur main road near Petrol bunk
Banaswadi main road, Near OMBR layout Fire station
Jai Matha Devasthan road
Near Shamanna layout park
Near Karimariamma temple
4th cross road, Munithayappa layout
Kanakadasa layout, Lingarajpuram
Opp. KHB Qrts, Lingarajpuram
0 700 1,400 2,800 4,200 5,600 Meters
Legend
Culvert Locations
Hebbal Valley Storm Drains
Ridge
Water Bodies
Rail / Road
Arterial Road
Major Road
Minor Road
Rail
Valley Catchment
Sub Catchment
STUP Consultants P. Ltd.
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OFFICE OF ORIGIN BANGALORE
OWNER BANGALORE MAHANAGARA PALIKE
DATE FEB 2004
CLIENT
DRAWN MNS
PROJECT RE-MODELLING OF PRIMARY AND SECONDARY STORM WATER DRAINS IN BANGALORE CITY
PREPARED RSP
CHECKED YDM
TITLE Hebbal Valley Culverts Considered for Re-Modelling
APPROVED ATS
Fig. No. 4.1
REV
JOB No. 1495
SCALE AS SPECIFIED
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•Drain reach near Dinnur & Kauser nagar is in natural condition, drain width needs to be increased and new walls to be constructed and bed protection to be provided.

•Large number of sewer outlets connected to storm drain needs to be plugged and sewerage system to be extended to the entire locality.

•Manholes noticed inside the drain near Kausernagar needs to be lowered/relocated.

•Existing stone slab culvert at Munivenkatappa block near Munnarayanapalya needs to be replaced with RCC box culvert.

•Drain width is drastically reduced near Munnarayanapalya & Chamundinagar. Which needs to be widened and new wall to be constructed on left hand side.

•Existing tertiary drain network in Munnarayanapalya, Chamundinagar & Bhuvaneshawarinagar area needs to be desilted and remodeled to match with the new drain bed level.

•Existing drain reach near Bhuvaneshawarinagar is in natural condition, which needs to be widened on both sides and new walls to be constructed on both sides.

•Existing drain reach near Sunrise colony & Inspectorate of Electronics Layout is in natural condition on right hand side, which needs to be widened and stone revetment to be provided & service road to be formed for routine maintenance.

•Existing tertiary drain network in Sunrise colony & Inspectorate of Electronics Layout area needs to be desilted and remodeled to match with the new drain bed level.

•Large quantity of silt accumulation and vegetation growth noticed near V. Naganehalli main road needs to be cleaned.

•Existing drain reach from V. Nagenahalli upto Outer Ring Road is in natural condition, which needs to be widened on both sides and stone revetment to be provided.

- Vent size of existing culvert, constructed across Outer Ring Road is very inadequate and it needs to be increased immediately.

- Existing drain reach from Outer Ring Road upto Nagavara tank is in natural condition, which needs to be widened on both sides and stone revetment to be provided and also service road to be formed for routine maintenance.

- Existing stone slab bridge near Yogeshnagar main road needs to be replaced with RCC bridge.

- Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management

- All openings made to the drain wall needs to be closed in this region to avoid back flow of water.

- Sewerage system and solid waste management system in this area needs to be improved.

- Encroachment / Development of land near the Nagavara tank bed needs to be prevented immediately.

- Provision for future drain requirement and also for service roads needs to be demarcated in this region.

➢ **Hebbal Main Valley Secondary Storm Drains:**

➢ **Bhuvaneshwarinagar Secondary Storm Drain - H101:**

- Existing drain in this reach is almost in natural condition, it needs to be widened on both sides from Bhuvaneshwarinagar main road upto main drain and new walls to be constructed.

•The existing closed drain near Bhuvaneshwarinagar main road needs to desilted, widened and replaced with RCC box drain.

➢**Rahamatnagar Secondary Storm Drain - H102:**

•Existing drain needs to be desilted, rehabilitation works & bed protection to be provided.

•Support structures noticed near the culvert locations at Chunchappa block needs to be removed.

•All openings made to the drain wall needs to be closed in this region to avoid back flow of water.

•Existing tertiary drain network in Rahamatnagar & Chunchappa block area needs to be desilted and remodeled to match the new drain bed level.

•Concerned authority should have strict vigil and levy penalty on the building owners who resort to takeup construction activity over the drain walls in this region.

•Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management

•Sewerage & solid waste management system in this area needs to be improved.

➢**Gangenahalli Secondary Storm Drain - H103:**

•The existing drain reach near Muthappa binny mill road & Matadahalli layout is almost covered, which needs to be opened at regular intervals, desilted and steel gratings has to be provided at regular intervals and also at all the road crossings.

- Since, the existing drain passes through dense built up and highly commercial area, large quantity of garbage that is noticed inside the drain needs to be cleaned very frequently.

- Existing tertiary drain network in Muthappa binny mill road & Matadahalli layout area needs to be desilted and remodeled to match with the new drain bed level.

- Drain walls near Matadahalli layout & Gangenahalli Extension is in moderate condition and it needs to be strengthened and bed protection to be provided

- Manholes noticed inside the drain near Matadahalli layout & Gangenahalli Extension needs to be lowered/relocated.

- Existing drain reach near Venkatappa block and A.K Colony needs to be desilted, rehabilitation works & bed protection to be provided.

- Drain width is drastically reduced near 5th main Ganganagar and also commercial shop constructed over the drain at this location needs to be relocated. And drain to be widened and new wall to be constructed.

- Existing covered drain near pillapa block (i.e., secondary drain H104 joining location) needs to be opened and desilted and also new RCC box drain to be constructed in addition to the existing at this location

- Existing tertiary drain network in Ganganagar & pillapa block area needs to be desilted and remodeled to match with the new drain bed level.

- Existing drain needs to be desilted, rehabilitation works & bed protection to be provided.

- Large number of sewer outlets connected to storm drain needs to be plugged and sewerage system to be extended to the entire locality.

•Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management

•Sewerage system and solid waste management system in this area needs to be improved.

•Concerned authority should have strict vigil and levy penalty on the building owners who resort to takeup construction activity over the drain walls in this region.

➢**Ganganagar Secondary Storm Drain - H104:**

•The existing drain reach near H.M.T. Bhavan is covered with RCC slab, which needs to be opened at regular intervals, desilted and steel gratings has to be provided at regular intervals.

•Existing drain in this reach is in natural condition near Dena Bank Colony , it needs to be widened on both sides and new walls to be constructed.

•Since, the existing drain passes through dense built up and highly commercial area, large quantity of garbage that is noticed inside the drain needs to be cleaned very frequently.

•Drain walls near Ganganagar & Papanna block is in moderate condition and it needs to be strengthened and bed protection to be provided.

•Existing tertiary drain network in Ganganagar & Papanna block area needs to be desilted and remodeled to match with the new drain bed level.

•Existing stone slab culvert at CBI Road (10^{th} Cross Vasanthappa block) near Vishveshwariahnagar needs to be replaced with RCC box culvert.

•Existing covered drain near 5^{th} Cross Vishveshwariahnagar needs to be opened and desilted and also new RCC box drain to be constructed in addition to the existing at this location.

•Manholes noticed inside the drain near Vishveshwariahnagar & Anandanagar needs to be lowered/relocated.

•Existing in adequate vest size RCC slab culvert near Anandanagar Ganesh temple needs to be replaced with increased vent size RCC box culvert .

•Drain width is drastically reduced from 5th Cross Vishveshwariahnagar upto Anandanagar Muslim Education Society. Which to be widened on right hand side and new wall to be constructed.

•Drain width is drastically reduced M.S.H. layout. Which to be widened on right hand side and new wall to be constructed.

•Manholes noticed inside the drain near M.S.H. layout & Amarjyothi layout needs to be lowered/relocated.

•Existing drain needs to be desilted, rehabilitation works & bed protection to be provided.

•Large number of sewer outlets connected to storm drain needs to be plugged and sewerage system to be extended to the entire locality near Chamundinagar.

•Existing tertiary drain network in Anandanagar, M.S.H. Layout, Amarjyothi layout & Chamundinagar area needs to be desilted and remodeled to match with the new drain bed level.

•Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management

•Sewerage system and solid waste management system in this area needs to be improved.

- Concerned authority should have strict vigil and levy penalty on the building owners who resort to takeup construction activity over the drain walls in this region.

➢ **Hebbal Main Valley – I Primary Storm Drain (H200):**

- The existing drain near Mysore lamp works, slum area near C.V. Raman road & Yeshwanthpur R.T.O. office is covered with BS slabs, which needs to be opened at regular intervals, desilted and steel gratings has to be provided at regular intervals and also at all the road crossings.

- Existing drain near Nanjappa reddy colony Telephone exchange is very narrow, a parallel RCC box drain needs to be constructed in Triveni road.

- The existing drain near Triveni road is covered with BS slabs, which needs to be opened at regular intervals, desilted and steel gratings has to be provided at regular intervals and also at all the road crossings.

- Since, the existing drain passes through dense built up and highly commercial area, large quantity of garbage that is noticed inside the drain needs to be cleaned very frequently.

- Drain reach near Gurumurthy layout, B.K. nagar & Kamala Nehru Extn. is covered with BS slabs, which needs to be opened at regular intervals, desilted and steel gratings has to be provided at regular intervals and also at all the road crossings.

- Debris dumped over the drain near Kamala Nehru Extn. needs to be cleared.

- Large number of sewer outlets connected to storm drain needs to be plugged and sewerage system to be extended to the entire locality near B.K. nagar & Kamala Nehru Extn.

- Drain reach near L.I.C. Colony & H.M.T. layout is covered with BS slabs, which needs to be opened at regular intervals, desilted and steel gratings has to be provided at regular intervals and also at all the road crossings.

- Existing tertiary drain network in L.I.C. Colony, H.M.T. Layout & Chowdeshwari temple adjoining area needs to be desilted and remodeled to match with the new drain bed level.

- Existing covered drain near Mohan Kumar Road needs to be opened and desilted and also new RCC box drain to be constructed in addition to the existing at this location.

- Existing drain reach from Mattikere tank bund road near S.B.M. colony upto Brindvananagar is in natural condition, which needs to be widened on both sides and new walls to be constructed on both sides, bed protection to be provided and also service road to be formed for routine maintenance.

- Manholes noticed inside the drain near S.B.M. colony & Brindvananagar needs to be lowered/relocated.

- The drain width is drastically reduced due to construction of residential building inside the drain at Brindavananagar. Which needs to be relocated immediately. Further, drain to be widened and new walls to be constructed and bed protection to be provided.

- Existing tertiary drain network in S.B.M. colony & Brindvananagar area needs to be desilted and remodeled to match with the new drain bed level.

- The drain width is drastically reduced from Poornappa Garden upto Mattikere main road due to construction of residential building either side of the drain. Hence existing drain needs to be desilted, rehabilitation works & bed protection to be provided.

Further, new RCC box drain to be constructed in private land in addition to the existing open drain at this location. (Refer sketch – 4. 1).

•Large number of utility lines noticed near Mattikere main road culvert location needs to be relocated.

•Alignment of existing drain needs to be slightly altered near Sanjeevappa Garden (Rly. Arch Culvert) and New B.E.L. Road.

•Existing drain reach near Sanjeevappa Garden and New B.E.L. Road is in natural condition, which needs to be widened on both sides and new walls to be constructed on both sides.

•Existing tertiary drain network in Sanjeevappa Garden area needs to be desilted and remodeled to match with the new drain bed level.

•Existing tertiary drain network behind Gowri Appartments, near New B.E.L. Road needs to be desilted and remodeled to match with the new drain bed level.

•Large number of sewer outlets connected to storm drain needs to be plugged and sewerage system to be extended to the entire locality.

•Existing RCC hume pipe bridge at New B.E.L. Road needs to be replaced with RCC bridge.

•Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management.

•Sewerage system and solid waste management system in this area needs to be improved.

•The drain width is drastically reduced between New B.E.L. Road bridge and R.M.V.

Extension 2nd Stage bridge. Which needs to be widened immediately on right hand side and new wall to be constructed and bed protection to be provided.

- Existing RCC hume pipe bridge at R.M.V. Extension 2nd Stage needs to be replaced with RCC bridge.

- The drain width is reduced between New B.E.L. Road bridge and R.M.V. Extension 2nd Stage Railway bridge. Which needs to be widened and new walls to be constructed and bed protection to be provided.

- Vent size of existing RCC hume pipe bridge at R.M.V. Extension 2nd Stage (near Sterling apartments) needs to be increased by adding additional RCC box culvert adjoining to the existing and also existing road alignment needs to be slightly altered near the park location.

- Large quantity of silt accumulation and vegetation growth noticed near railway bridge needs to be removed immediately.

- The existing culvert at Devinagar main road (near Outer ring road) needs to be dismantled and road alignment needs to slightly altered.

- The drain reach is in natural condition and also drain width is drastically reduced from Devinagar main road (near Outer ring road), Maruthinagar, Bhadarappa layout upto Hebbal tank inlet weir near Balajinagar. Which needs to be widened immediately and new wall/stone revetment to be constructed and bed protection to be provided.

  Further in addition to the existing open drain, new open drain has to be constructed near Tata nagar upto Hebbal tank inlet weir. Which intern acts as bypass drain. (Refer sketch – 4. 2).
  And also two new RCC bridges to be constructed across this new drain near Tata nagar – Kodigehalli Junction and Hebbal tank inlet weir.

- The drain reach is in natural condition and also drain width is drastically reduced due to vegetation growth near Defence dairy farm & Hebbal tank. Which needs to be widened immediately and stone revetment to be constructed and bed protection to be provided.

- The drain reach from Bellary road (NH-7) upto Nagavara tank (i.e. Near , Chiranjeevinagar) is in natural condition and also drain width is drastically reduced due to vegetation growth. Which needs to be widened immediately and stone revetment to be constructed and bed protection to be provided. (Refer sketch – 4.3)

➢ **Hebbal Main Valley – I Secondary Storm Drains:**

➢ **Sachidanandanagar Secondary Storm Drain - H201:**

- The existing drain from C.P.R.I., A.E.C.S. layout Upto I.I.Sc. Staff quarters is covered with RCC/BS slabs, which needs to be opened at regular intervals desilted and steel gratings has to be provided at regular intervals and also at all the road crossings.

- Existing drain near slum area (behind I.I.Sc. Staff quarters) is very narrow, it needs to be widened on right hand side and new wall to be constructed.

- Existing drain near I.I.Sc. Staff quarters upto A.E.C.S. Layout is very narrow, it needs to be widened on right hand side and new wall to be constructed.

- The existing drain reach near A.E.C.S. Layout is covered with RCC slabs, which needs to be widened and replaced with RCC box drain.

- Existing tertiary drain network in Jaladharshini layout area needs to be desilted and remodeled to match with the new drain bed level.
- Existing drain reach inside R.M.V. Extn. park area i.e., from A.E.C.S. Layout upto Gandhi Vidhyalaya Education Association needs to be desilted, rehabilitation

works & bed protection to be provided.

➢A.G.Colony Secondary Storm Drain - H202:

•The existing drain from M.S. Ramiah College campus Upto Jaladharshini layout is covered with RCC/BS slabs, except at few stretch. Which needs to be opened at regular intervals desilted and steel gratings has to be provided at regular intervals and also at all the road crossings.

•Existing tertiary drain network in Jaladharshini layout area needs to be desilted and remodeled to match with the new drain bed level.

➢H.M.T.Layout Secondary Storm Drain - H203:

•The existing drain reach near M.S. Ramiah main road near Institute of advanced studies Upto Brindavananagar 5th Cross Road is covered with BS/RCC slabs, except at few stretchs. Which needs to be opened at regular intervals desilted and steel gratings has to be provided at regular intervals and also at all the road crossings.

•Since, the existing drain passes through dense built up and highly commercial area, large quantity of garbage that is noticed inside the drain needs to be cleaned very frequently.

•New RCC box drain to be constructed near Mattikere main road and Mohan Kumar Road Junction. Further, the existing road side drain at Mattikere main road upto K.P.T.C.L office needs to be desilted.

•Existing tertiary drain network in Mattikere, Chowdeshwari temple adjoining area near Mohan Kumar Road & Brindavananagar needs to be desilted and remodeled to match with the new drain bed level.

➢Subbedarpalya Secondary Storm Drain - H204:

- The existing drain reach near M.S. Ramiah main road near I.I.Sc., Devanarapalya, Subbedarpalya, Gurumurthy layout Upto Triveni Road near Yeshwanthpura is covered with BS slabs, except at few stretchs. Which needs to be opened at regular intervals desilted and steel gratings has to be provided at regular intervals and also at all the road crossings.

- Drain walls near Devanarapalya, Subbedarpalya & Gurumurthy layout is in moderate condition, it needs to be strengthened and bed protection to be provided.

- Since, the existing drain passes through dense built up and highly commercial area, large quantity of garbage that is noticed inside the drain needs to be cleaned very frequently.

- The debris and garbage dumps noticed over the drain near Devanarapalya,& Subbedarpalya needs to be cleared immediately.

- Large number of sewer outlets connected to storm drain needs to be plugged and sewerage system to be extended to the entire locality near Devanarapalya,& Subbedarpalya.

- Existing tertiary drain network in Devanarapalya, Subbedarpalya & Gurumurthy layout needs to be desilted and remodeled to match with the new drain bed level.

➢ **Tannairhalli Secondary Storm Drain - H205:**

- Drain walls near H.M.T. quarters is in moderate condition, it needs to be strengthened and bed protection to be provided.

- The drain reach near H.M.T. factory water treatment plant is in natural condition. Which needs to be widened on both sides and stone revetment to be constructed and bed protection to be provided.
- The drain width is reduced near H.M.T. factory main road bridge location. Which

needs to be widened on left hand side and stone revetment to be constructed and bed protection to be provided.

•Large quantity of debris & vegetation growth noticed near St. Chalarets School & Defence area needs to be cleared immediately.

•The drain reach from Outer Ring Road Railway track, Tannirhalli upto Badappa Garden near Muthyalnagar is in natural condition. Which needs to be widened on both sides and stone revetment to be constructed and bed protection to be provided.

•Large number of sewer outlets connected to storm drain needs to be plugged and sewerage system to be extended to the entire locality near Tannirhalli & Muthyalanagar.

•The drain reach from Badappa Garden near Muthyalnagar upto Mattikere tank bund road is in natural condition. Which needs to be widened on both sides and stone revetment to be constructed and bed protection to be provided.

•The debris and garbage dumps noticed over the drain near Muthyalnagar needs to be cleared immediately.

•Existing tertiary drain network in Muthyalnagar & Tannirhalli needs to be desilted and remodeled to match with the new drain bed level.

➢**Bupasandra Secondary Storm Drain - H206:**

•The drain reach near Central Excise layout is in natural condition. Which needs to be widened on both sides and new walls to be constructed and bed protection to be provided.

•Drain walls near Central Excise layout is in moderate condition, it needs to be strengthened and bed protection to be provided.

- Large quantity of debris & vegetation growth noticed near Central Excise layout needs to be cleared immediately.

- The drain width inside U.A.S. college campus is drastically reduced. Which needs to be widened on both sides and stone revetment to be constructed and bed protection to be provided.

- The existing stone slab culvert constructed across Bupasandra main road needs to be replaced with RCC box culvert.

- The drain reach inside U.A.S. college campus upto Railway track is in natural condition. Wherein alignment of drain to be slightly altered and further, drain has to be widened on both sides and stone revetment and bed protection to be provided.

- Existing tertiary drain network in Central Excise layout needs to be desilted and remodeled to match with the new drain bed level.

➢ **Hebbal Minor Valley – I Primary Storm Drain (H300):**

- The drain reach near Jaibharathnagar, Maruthi seva nagar & Lingarajpura is heavily silted. Which needs to be desilted immediately.

- The drain reach near Lingarajpura railway track is in natural condition. Which needs to be widened and stone revetment to be provided.

- Since, the existing drain passes through dense built up area, large quantity of garbage that is noticed inside the drain needs to be cleaned very frequently.

- Large number of sewer outlets connected to storm drain needs to be plugged and sewerage system to be extended to the entire locality.

- Drain walls near Jaibharathnagar & Maruthisevanagar is in moderate condition & it has to be strengthened and bed protection to be provided.

- Sewerage system and solid waste management system in this area needs to be improved.

- Existing stone slab culvert near Kanakadasa layout (oil mill road) needs to be replaced with RCC box culvert.

- Drain width is reduced near K.H.B. Quarters, which needs to be widened and new walls to be constructed.

- Existing drain bed needs to be deepened before providing bed protection.

- Drain walls near Kanakadasa layout is in moderate condition and it needs to be strengthened and bed protection to be provided.

- Drain width is reduced near Saitpalya, which needs to be widened and new walls to be constructed on left hand side.

- Existing tertiary drain network in Kanakadasa layout & Kariyannapalya area needs to be desilted and remodeled to match with the new drain bed level.

- Existing stone slab culverts near Karimariamman temple, Jai Matha Devastana road & Shammana Layout park needs to be replaced with RCC box culvert.

- All openings made to the drain wall needs to be closed in this region to avoid back flow of water.

- Existing Drain width is reduced near Jai Matha Devastana road & Shammana Layout park (near Kariyannapalya) which needs to be widened and new walls to be constructed.

- Existing Drain width is reduced near Hennur main road Petrol bunk which needs to be widened and new walls to be constructed on left hand side.

•Existing stone slab culverts near Hennur main road Petrol bunk & H.B.R. layout 60 ft. road needs to be replaced with RCC box culvert.

•Drain walls near H.B.R. layout 60 ft.road is heavily silted, which needs to be desilted, walls needs to be strengthened and bed protection to be provided.

•Existing RCC hume pipe culverts near H.B.R. layout 60 ft.road Sri Rama Temple needs to be dismantled.

•Drain walls near H.B.R. layout 2nd Block is in moderate condition and it needs to be strengthened and bed protection to be provided.

•Existing RCC hume pipe culverts near H.B.R. layout 3rd block 80 ft. road needs to be dismantled and road alignment to be slightly altered.

•Drain walls near H.B.R. layout 3rd Block is heavily silted, which needs to be desilted, walls needs to be strengthened and bed protection to be provided.

•Large quantity of silt accumulation and vegetation growth noticed near Outer ring road needs to be cleaned.

•All openings made to the drain wall needs to be closed in this region to avoid back flow of water.

•Manhole noticed inside the drain needs to be relocated near Outer ring road.

•Existing drain reach from Telecom employees Cooperative Society Layout upto Raja Canal Sewerage treatment plant is in natural condition, which needs to be widened, stone revetment, bed protection to be provided and service road to be formed.

•Large quantity of silt accumulation and vegetation growth noticed near Raja Canal

Sewerage treatment plant needs to be cleaned.

•Existing stone slab culvert near Gedalahalli main road needs to be replaced with RCC bridge and also road alignment to be slightly altered.

•Encroachment / Development of land near the Nagavara tank bed & Kalkere tank bed needs to be prevented immediately.

•Provision for future drain requirement and also for service roads needs to be demarcated in this region.

➢**Hebbal Minor Valley – I Secondary Storm Drains:**

➢**Kacharakanahalli Secondary Storm Drain - H301:**

•Large quantity of silt accumulation and vegetation growth noticed inside the drain near Teachers colony & Kacharakanahalli needs to be cleaned.

•Large number of utility lines noticed inside the drain needs to be relocated.

•Existing drain needs to be desilted, rehabilitation works & bed protection to be provided.

•Existing stone slab culvert near Teachers Colony HBR layout 2nd block needs to be replaced with RCC box culvert.

➢**Kammanahalli Secondary Storm Drain - H302:**

•Large quantity of silt accumulation and vegetation growth noticed inside the drain near Kammanahalli & Ramaswamipalya needs to be cleaned.

•The existing drain reach near Kammanahalli (i.e., near Jyothi Social Work Centre) is covered with BS slabs, which needs to be opened at regular intervals, desilted and steel gratings has to be provided at regular intervals.

•Existing stone slab culvert near Nehru Road needs to be replaced with RCC box culvert.

•Drain width is drastically reduced near Jyothi Social Work Centre (Residential area). Which needs to be widened and new wall to be constructed.

•Existing stone slab culvert near Jyothi Social Work Centre (Residential area). needs to be replaced with RCC box culvert.

•All openings made to the drain wall needs to be closed in this region to avoid back flow of water.

•Concerned authority should have strict vigil and levy penalty on the building owners who resort to takeup construction activity over the drain walls in this region.

•Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management

•Sewerage system and solid waste management system in this area needs to be improved.

➢**Kammanahalli – I Secondary Storm Drain - H303:**

•The existing drain reach near Pillamma road (Kamanahalli police station road) is almost covered, which needs to be opened at regular intervals, desilted and steel gratings has to be provided at regular intervals and also at all the road crossings.

•Since, the existing drain passes through dense built up and highly commercial area, large quantity of garbage that is noticed inside the drain needs to be cleaned very frequently.

•Drain walls near St. Thomas Town is in moderate condition and it needs to be strengthened and bed protection to be provided

➢**Venkateshpura Secondary Storm Drain - H304:**

•The drain reach near Pillana Garden, Baglur layout & Muniramiah garden is heavily silted. Which needs to be desilted immediately.

•The drain reach near Lingarajpura railway track is heavily silted & vegetation growth noticed. Which needs to be cleaned immediately.

•Since, the existing drain passes through dense built up area, large quantity of garbage that is noticed inside the drain needs to be cleaned very frequently.

•Large number of sewer outlets connected to storm drain needs to be plugged and sewerage system to be extended to the entire locality.

•Drain walls near Pillana Garden, Baglur layout, Muniramiah garden, Karamchand layout & Ramachandrappa Layout is in moderate condition and it needs to be strengthened and bed protection to be provided.

•The drain reach near Karamchand layout & Ramachandrappa Layout is heavily silted. Which needs to be desilted immediately.

•Sewerage system and solid waste management system in this area needs to be improved.

•Existing drain bed needs to be deepened before providing bed protection.

•Existing tertiary drain network in Muniramiah garden, Karamchand layout & Ramachandrappa Layout needs to be desilted and remodeled to match with the new drain bed level.

•All openings made to the drain wall needs to be closed in this region to avoid back flow of water.

- Manhole noticed inside the drain needs to be relocated near Karamchand layout & Ramachandrappa Layout.

- The drain reach near Kariyannapalya (i.e., near Coconut plantation) is in natural condition, alignment of drain needs to be slightly altered, stone revetment & bed protection to be provided and also service road needs to be formed.

➢**Banaswadi Secondary Storm Drain - H305:**

- The drain reach near Banaswadi & Thomas town is heavily silted. Which needs to be desilted immediately.

- Since, the existing drain passes through dense built up area, large quantity of garbage that is noticed inside the drain needs to be cleaned very frequently.

- Large number of sewer outlets connected to storm drain needs to be plugged and sewerage system to be extended to the entire locality.

- Drain walls near Banaswadi & Thomas town is in moderate condition and it needs to be strengthened and bed protection to be provided.

- Sewerage system and solid waste management system in this area needs to be improved.

- Existing drain bed needs to be deepened before providing bed protection.

- Existing tertiary drain network in Banaswadi & Thomas town needs to be desilted and remodeled to match with the new drain bed level.

- All openings made to the drain wall needs to be closed in this region to avoid back flow of water.

•Manhole noticed inside the drain needs to be relocated near Banaswadi & Thomas town.

•Intermediate support structures noticed at culvert locations near Thomas town needs to be dismantled immediately.

•Large number of utility lines noticed inside the drain needs to be relocated.

•Existing stone slab culvert near Munithayappa layout & also Opp. K.H.B. quarters needs to be replaced with RCC box culvert.

➢**Kavalabairasandra Secondary Storm Drain - H306:**

•The drain reach near Modi garden is heavily silted. Which needs to be desilted immediately.

•Since, the existing drain passes through dense built up area, large quantity of garbage that is noticed inside the drain needs to be cleaned very frequently.

•Large number of sewer outlets connected to storm drain needs to be plugged and sewerage system to be extended to the entire locality.

•Drain walls near Modi garden is in moderate condition and it needs to be strengthened and bed protection to be provided.

•Sewerage system and solid waste management system in this area needs to be improved.

•Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management

•Sewerage system and solid waste management system in this area needs to be improved.

- Concerned authority should have strict vigil and levy penalty on the building owners who resort to takeup construction activity over the drain walls in this region.
- Existing drain bed needs to be deepened before providing bed protection.
- Existing tertiary drain network near Modi garden needs to be desilted and remodeled to match with the new drain bed level.
- All openings made to the drain wall needs to be closed in this region to avoid back flow of water.
- Existing stone slab culvert near Modi garden (N.P. Factory road) needs to be replaced with RCC box culvert.
- Drain width is drastically reduced near Sayeediya Arabic College. Which needs to be widened on left hand side and new wall to be constructed.
- Existing RCC slab culvert near Sayeediya Arabic College & Shadabnagar needs to be replaced with RCC box culvert.
- Large number of sewer outlets connected to storm drain needs to be plugged and sewerage system to be extended to the entire locality.
- Existing drain in this reach is in natural condition near Shadabnagar, it needs to be widened on both sides and new walls to be constructed immediately.
- Since, the existing drain passes through densely built residential area, large quantity of garbage that is noticed inside the drain needs to be cleaned very frequently.
- Existing drain in this reach is in natural condition near Kamarajnagar (opp. Srinivasa chitra mandira), wherein alignment of drain to be slightly altered, widened on both sides and new walls to be constructed immediately.

- Existing drain reach from Shampura main road, inside Ambedkar medical college upto Nagavara main road level crossing, drain is in natural condition wherein alignment of drain to be slightly altered, widened on both sides and stone revetment to be constructed immediately.

- Existing RCC slab culvert near 2nd Cross Gandhinagar Kadugondanahalli needs to be replaced with RCC bridge.

- The existing drain reach near Nagavara main road is covered with BS slabs, which needs to be opened at regular intervals, desilted and steel gratings has to be provided at regular intervals.

Further, new RCC box drain to be constructed from Nagavara main road level crossing upto Prithiv chitra mandira to provide link to the existing drain opp. Prithiv chitra mandira.

The existing drain to be desilted, widened, new wall to be constructed and bed protection to be provided.

In addition to the existing secondary drain the tertiary drains in this region to be desilted, rehabilitation works and bed protection to be provided. (Refer sketch - 4.4).

- The existing secondary drain is drastically reduced behind leather factory near Nagawara main road. Which needs to be widened.and new wall to be constructed.

- Since, the existing drain passes through dense built up and highly commercial area, large quantity of garbage that is noticed inside the drain needs to be cleaned very frequently.

- Drain width is drastically reduced near Kuppa swamy nagar. Wherein alignment of drain to be slightly altered and new drain to be constructed and stone revetment & bed protection to be provided for the new drain.

- Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management

- Sewerage system and solid waste management system in this area needs to be improved.

- Concerned authority should have strict vigil and levy penalty on the building owners who resort to takeup construction activity over the drain walls in this region.

- Since, the existing drain passes through densely built residential area, large quantity of garbage that is noticed inside the drain needs to be cleaned very frequently.

- The drain reach near Arabic college & Rahata Ali layout is heavily silted. Which needs to be desilted immediately.

- Drain width is drastically reduced near Arabic college & Rahata Ali layout which needs to be widened and new wall to be constructed. Further, drain bed needs to be deepened before providing bed protection.

- Large number of sewer outlets connected to storm drain needs to be plugged and sewerage system to be extended to the entire locality near near Arabic college & Rahata Ali layout

- Sewerage system and solid waste management system in this area needs to be improved.

➢**Devarajeevanahalli Secondary Storm Drain - H307:**

- The drain reach near Devarajeevanahalli is heavily silted. Which needs to be desilted immediately.

- Since, the existing drain passes through dense built up area, large quantity of garbage that is noticed inside the drain needs to be cleaned very frequently.

- Large number of sewer outlets connected to storm drain needs to be plugged and sewerage system to be extended to the entire locality.

- Drain walls near Devarajeevanahalli & Doddananagar is in moderate condition and it needs to be strengthened and bed protection to be provided.

- Sewerage system and solid waste management system in this area needs to be improved.

- Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management

- Concerned authority should have strict vigil and levy penalty on the building owners who resort to takeup construction activity over the drain walls in this region.

- Existing tertiary drain network near Devarajeevanahalli & Doddananagar needs to be desilted and remodeled to match with the new drain bed level.

- All openings made to the drain wall needs to be closed in this region to avoid back flow of water.

- Drain width is drastically reduced near Doddananagar. Which needs to be widened on right hand side and new wall to be constructed.

➢**Ambedkarnagar Secondary Storm Drain - H308:**

•The drain reach near Periyarnagar & Devarajeevanahalli (Ananda theatre) is heavily silted. Which needs to be desilted immediately.

•Since, the existing drain passes through dense built up area, large quantity of garbage that is noticed inside the drain needs to be cleaned very frequently.

•Large number of sewer outlets connected to storm drain needs to be plugged and sewerage system to be extended to the entire locality.

•Drain walls near Periyarnagar, Devarajeevanahalli & Doddananagar is in moderate condition and it needs to be strengthened and bed protection to be provided.

•Sewerage system and solid waste management system in this area needs to be improved.

•New RCC box drain to be constructed across Doddananagar temple street.(Refer sketch – 4.5)

•Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management

•Concerned authority should have strict vigil and levy penalty on the building owners who resort to takeup construction activity over the drain walls in this region.

•Existing tertiary drain network near Periyarnagar Devarajeevanahalli & Doddananagar needs to be desilted and remodelled to match with the new drain bed level.

•All openings made to the drain wall needs to be closed in this region to avoid back flow of water.

➢Hebbal Minor Valley – II Primary Storm Drain (H400):

- Since, the existing drain passes through dense built up and highly commercial area, large quantity of garbage that is noticed inside the drain needs to be cleaned very frequently.

- Drain walls near Chikka Banaswadi & OMBR layout is in moderate condition and it needs to be strengthened and bed protection to be provided.

- Existing RCC hume pipe culvert at Banaswadi Main Road, near OMBR layout Fire station needs to be replaced with RCC box culvert.

- Existing drain reach near Kalayannagar & HBR layout needs to be desilted, rehabilitation works & bed protection to be provided.

- Existing drain reach from Muniswamy extension near Outer Ring Road upto Hennur Bunde is in natural condition, alignment to be altered, widened on both sides, stone revetment to be provided and also service road to be formed for routine maintenance.

- Sewer Pipeline & Manholes noticed inside the drain near Muniswamy extension & Chalkere needs to be relocated.

- Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management

- Sewerage system and solid waste management system in this area needs to be improved.

- Concerned authority should have strict vigil and levy penalty on the building owners who resort to takeup construction activity over the drain walls in this region.

- **Hebbal Minor Valley – II Secondary Storm Drains:**

- **Kalayananagar Secondary Storm Drain - H401:**

- Since, the existing drain passes through dense built up area, large quantity of garbage that is noticed inside the drain needs to be cleaned very frequently.

- Drain walls near HRBR layout is in moderate condition and it needs to be strengthened and bed protection to be provided.

- Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management

4.3 MITIGATIVE MEASURES FOR LOW LYING AREAS:

4.3.1 Anandanagar:

Mitigative Measures

- Manholes noticed inside the drain near Vishveshwariahnagar & Anandanagar needs to be lowered/relocated.

- Existing in adequate vest size RCC slab culvert near Anandanagar Ganesh temple needs to be replaced with increased vent size RCC box culvert .

- Drain width is drastically reduced from 5th Cross Vishveshwariahnagar upto Anandanagar Muslim Education Society. Which to be widened on right hand side and new wall to be constructed.

- Drain width is drastically reduced M.S.H. layout. Which to be widened on right hand side and new wall to be constructed.

- Manholes noticed inside the drain near M.S.H. layout & Amarjyothi layout needs to be lowered/relocated.

- Existing drain needs to be desilted, rehabilitation works & bed protection to be provided.

- Large number of sewer outlets connected to storm drain needs to be plugged and sewerage system to be extended to the entire locality near Chamundinagar.

- Existing tertiary drain network in Anandanagar, M.S.H. Layout, Amarjyothi layout & Chamundinagar area needs to be desilted and remodeled to match with the new drain bed level.

- Caution boards and sign boards needs to be displayed to create awareness among people about storm drain and its management

•Sewerage system and solid waste management system in this area needs to be improved.

•Concerned authority should have strict vigil and levy penalty on the building owners who resort to takeup construction activity over the drain walls in this region.

•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.

•Caution boards/display boards has to be installed to educate and create public awareness regarding storm water and storm drain management.

4.3.2 Brindavananagar:

Mitigative Measures

•The existing covered reach of drain should be opened at regular intervals and desilted further steel gratings and inspection opening needs to be installed at regular interval for surface runoff water to enter into storm drain.

•New RCC box drain to be constructed near HMT main road upto KEB office.

•The residential buildings constructed inside the water way needs to be relocated immediately.

•Large quantity of garbage, silt and debris noticed inside the channel to be cleared immediately.

•The existing tertiary drain bed level needs to be regraded to the new drain bed level.

- Existing RCC hume pipe culverts noticed near New BEL road and RMV extension needs to be replaced with RCC single span bridges.

- The drain width near Marutinagar, Bhadrappa layout needs to be widened and bed protection to be provided.

- 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.

- Caution boards/display boards has to be installed to educate and create public awareness regarding storm water and storm drain management.

4.3.3 Tannirhalli:

Mitigative Measures

- Mitigative measures suggested for Brindavanagar holds good for Tannirhalli also.

- The existing drain width needs to be widened near Mattikere tank.

- Solid waste collection system needs to be improved in this region.

- Sewerage system to be extended to the entire locality.

- 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.

- Caution boards/display boards has to be installed to educate and create public awareness regarding storm water and storm drain management.

4.3.4 Sanjeevappa garden:

Mitigative Measures

•The existing drain width near New BEL road needs to be widened.

•Large quantity of garbage, silt and debris noticed inside the channel to be cleared immediately.

•The existing tertiary drain bed level needs to be regraded to the new drain bed level.

•Existing RCC hume pipe culverts noticed near New BEL road and RMV extension needs to be replaced with RCC single span bridges.

•The drain width near Marutinagar, Bhadrappa layout needs to be widened and bed protection to be provided.

•The large quantity of vegetation growth noticed near Outer ring road railway bridge needs to be cleared immediately.

•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.

•Caution boards/display boards has to be installed to educate and create public awareness regarding storm water and storm drain management.

4.3.5 Kadugondanahalli (Shampura):

Mitigative Measures

- The existing drain width near Nagavara main road needs to be widened.
- Large quantity of garbage, silt and debris noticed inside the channel to be cleared immediately.
- The existing tertiary drain bed level needs to be regraded to the new drain bed level.
- The existing drain width behind Leather factory near Nagavara main road needs to be widened.
- The drain width near Kamrajnagar needs to be widened and bed protection to be provided.
- The existing sub drains near Nagavara main road needs to be desilted immediately.
- By pass drain needs to be constructed opposite Prithivi Chitramandira to avoid heading up of water in upstream reaches.
- The drain width near Rahat ali layout needs to be widened.
- The vegetation growth near Nagavara main road level crossing needs to be cleaned immediately.
- Sewerage system and solid waste management system should be improved in the entire locality.
- 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.

•Caution boards/display boards has to be installed to educate and create public awareness regarding storm water and storm drain management.

4.3.6 Basavanagar (Near Ambedkar medical college):

Mitigative Measures

•Mitigative measures suggested for Shampura holds good for Basavanagar also.

•The existing drain width near Nagavara main road needs to be widened.

•Large quantity of garbage, silt and debris noticed inside the channel to be cleared immediately.

•The existing tertiary drain bed level needs to be regraded to the new drain bed level.

•The existing drain width behind Leather factory near Nagavara main road needs to be widened.

•The drain width near Kamrajnagar needs to be widened and bed protection to be provided.

•The existing sub drains near Nagavara main road needs to be desilted immediately.

•By pass drain needs to be constructed opposite Prithivi Chitramandira to avoid heading up of water in upstream reaches.

•The drain width near Rahat ali layout needs to be widened.

•The vegetation growth near Nagavara main road level crossing needs to be cleaned immediately.

•Sewerage system and solid waste management system should be improved in the entire locality.

- 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 BEST MANAGEMENT PRACTICES:

➢ Authorities should avoid taking up of restricted budgetary works.

➢ Authorities should not encourage for short term mitigative works.

➢ 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 :-

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.

5. Encourage rain water harvesting in institutions, public parks, open grounds, etc.,

Table 4.1 Showing Adequacy Analysis Results for Hebbal Main Valley (H1) - 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	H100	Shree Venkateshawara Mandira, Matadahalli Road	R.T. Nagar 1st Block Road	0	500	29	Pri.	4.28	2.17	2.95	3.69	4.25	5.56	2.19	0.51	0.69	0.86	0.99	1.3	3.13	0.23	0.31	0.39	0.45	0.59	AD	AD	AD	AD	AD
2	H100	R.T. Nagar 1st Block Road	Sriram Appartment Dinnur Main Road, R.T.Nagar	500	1500	156.04	Pri.	3.2	9.79	13.43	17.05	20	25.28	1.76	3.06	4.2	5.33	6.25	7.9	4.23	1.74	2.39	3.03	3.55	4.49	AD	AD	AD	AD	IA
3	H100	Sriram Appartment Dinnur Main Road, R.T.Nagar	Bhuvaneswari nagar	1500	2675	262.62	Pri.	2.7	15.74	21.7	27.71	32.75	40.81	1.5	5.83	8.04	10.26	12.13	15.11	5.83	3.89	5.36	6.84	8.09	10.08	AD	AD	IA	IA	IA
4	H100	Bhuvaneswari nagar	Kanakanagar main road	2675	2875	675.18	Pri.	2.1	23.97	33.18	42.57	50.62	62.36	1.58	11.41	15.8	20.27	24.1	29.7	6.7	7.22	10	12.83	15.26	18.79	IA	IA	IA	IA	IA
5	H100	Kanakanagar main road	Rly track near Nagenahalli	2875	3750	760.82	Pri.	2.65	28.72	39.8	51.14	60.9	74.8	2	10.84	15.02	19.3	22.98	28.23	10	5.42	7.51	9.65	11.49	14.11	AD	AD	AD	IA	IA
6	H100	Rly track near Nagenahalli	Nagavara Tank	3750	4425	835.77	Pri.	2.17	32.14	44.61	57.43	68.56	83.82	1.57	14.81	20.56	26.46	31.59	38.62	11	9.43	13.09	16.86	20.12	24.6	AD	IA	IA	IA	IA
7	H101	Rankanagar	Bhuvaneshwarinag ar	0	575	16.52	Sec.	1.75	1.27	1.74	2.21	2.6	3.28	0.6	0.73	1	1.27	1.48	1.88	1.8	1.21	1.66	2.11	2.47	3.13	AD	AD	IA	IA	IA
8	H102	Rahamatnagar	Hanumanthappa Extn.	0	447	14.81	Sec.	3.6	0.94	1.28	1.63	1.91	2.41	1.41	0.26	0.36	0.45	0.53	0.67	3.1	0.18	0.25	0.32	0.38	0.48	AD	AD	AD	AD	AD
9	H103	Gangenahalli Extn.	R.B.I. Colony	0	1125	92.45	Sec.	3.19	5.7	7.87	10.07	11.92	14.79	1.69	1.79	2.47	3.16	3.74	4.64	5	1.06	1.46	1.87	2.21	2.74	AD	AD	AD	AD	AD
10	H104	Bellary Road near HMT Bhavan	CBI Road, Ganganagar	0	950	67.82	Sec.	3.48	4.19	5.76	7.33	8.62	10.83	1.59	1.2	1.65	2.11	2.48	3.11	4.17	0.76	1.04	1.32	1.56	1.96	AD	AD	AD	AD	AD
11	H104	CBI Road, Ganganagar	Near MSH Layout	950	1800	251.14	Sec.	3.1	14.96	20.64	26.38	31.2	38.81	2.14	4.83	6.66	8.51	10.06	12.52	5	2.26	3.11	3.98	4.7	5.85	AD	AD	AD	AD	IA
12	H104	Near MSH Layout	Chamundinagar main road	1800	2650	401.47	Sec.	2.3	23.35	32.31	41.45	49.27	60.73	1.53	10.15	14.05	18.02	21.42	26.41	8	6.63	9.18	11.78	14	17.26	AD	IA	IA	IA	IA

Land Use Analysis for Hebbal Main Valley (H1) – 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 Coeffecent "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					Required Drain Width 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)
H100	0	500	A16(a)	12.2	12.2	0	75	10	0.02	1.5	4.28	1.95	3.33	15.28	0.456	66.12	89.43	111.50	127.85	168.59	1.02	1.38	1.72	1.98	2.6												
			A12(a)	16.8	13	3.8	62.56	11.81	0.01	1.2	4.28	1.95	4.17	17.92	0.416	59.39	80.75	101.34	117.16	152.13	1.15	1.57	1.97	2.27	2.95												
			Total	**29**							4.28										**2.17**	**2.95**	**3.69**	**4.25**	**5.56**	3.13	2.19	**0.5**	**0.7**	**0.9**	**1.0**	**1.3**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**
H102	0	447	A16(b)	14.81	11.85	2.96	64.02	11.6	0.01	1.2	3.6	2.07	9.72	23.39	0.458	49.65	68.10	86.41	101.28	128.16	0.94	1.28	1.63	1.91	2.41												
				14.81							3.6										**0.94**	**1.28**	**1.63**	**1.91**	**2.41**	3.1	1.41	**0.3**	**0.4**	**0.5**	**0.5**	**0.7**	**0.2**	**0.3**	**0.3**	**0.4**	**0.5**
H100	500	1500	A14	50.7	39.78	10.92	63.15	11.72	0.02	1.5	3.2	7.81	5.56	25.09	0.46	47.36	65.11	82.85	97.45	122.49	3.1	4.26	5.42	6.37	8.01												
			A15	61.53	48.69	12.84	63.52	11.67	0.01	1.2	3.2	7.81	8.33	27.82	0.47	44.18	60.95	77.89	92.11	114.62	3.58	4.94	6.32	7.47	9.3												
				112.23							3.2										**6.68**	**9.2**	**11.73**	**13.84**	**17.3**												
			Total	**156.04**							3.2										**9.79**	**13.43**	**17.05**	**20**	**25.28**	4.23	1.76	**3.1**	**4.2**	**5.3**	**6.2**	**7.9**	**1.7**	**2.4**	**3.0**	**3.6**	**4.5**
H100	1500	2675	A9(b)	27.64	22.11	5.53	63.99	11.6	0.01	1.2	2.7	13.43	7.64	32.67	0.497	39.65	55.00	70.74	84.35	103.34	1.51	2.1	2.7	3.22	3.94												
			A10(a)	38.25	32.51	5.74	66.75	11.2	0.01	1.2	2.7	13.43	10.42	35.04	0.520	37.82	52.58	67.82	81.17	98.77	2.09	2.91	3.75	4.49	5.46												
			A	40.7	40.7	0	75	10	0.01	1.2	2.7	13.43	12.5	35.93	0.558	37.19	51.75	66.82	80.07	97.20	2.35	3.26	4.21	5.05	6.13												
				106.59							2.7										**5.95**	**8.27**	**10.66**	**12.75**	**15.53**												
			Total	**262.62**							2.7										**15.74**	**21.7**	**27.71**	**32.75**	**40.81**	5.83	1.5	**5.8**	**8.0**	**10.3**	**12.1**	**15.1**	**3.9**	**5.4**	**6.8**	**8.1**	**10.1**
H103	0	1125	A13(a)	23.1	19.64	3.46	66.76	11.2	0.01	1.2	3.19	5.88	9.03	26.1	0.482	46.11	63.48	80.90	95.36	119.40	1.43	1.96	2.5	2.95	3.69												
			A12(a)	34.18	34.18	0	75	10	0.01	1.2	3.19	5.88	12.5	28.38	0.529	43.59	60.18	76.96	91.10	113.15	2.19	3.02	3.86	4.57	5.68												
			A12(b)	35.17	31.65	3.52	69.5	10.8	0.01	1.2	3.19	5.88	13.89	30.57	0.515	41.47	57.38	73.61	87.47	107.86	2.08	2.88	3.7	4.4	5.42												
			Total	**92.45**							3.19										**5.7**	**7.87**	**10.07**	**11.92**	**14.79**	5	1.69	**1.8**	**2.5**	**3.2**	**3.7**	**4.6**	**1.1**	**1.5**	**1.9**	**2.2**	**2.7**
H104	0	950	A13(a)	15.17	15.17	0	75	10	0.01	1.2	3.48	4.55	8.33	22.88	0.5	50.39	69.06	87.55	102.49	129.97	1.06	1.45	1.83	2.15	2.72												
			A5(c)	27.65	22.12	5.53	64	11.6	0.01	1.2	3.48	4.55	9.72	25.87	0.468	46.39	63.84	81.34	95.83	120.09	1.67	2.3	2.93	3.45	4.32												
			A5(d)	25	18.9	6.1	61.58	11.95	0.02	1.5	3.48	4.55	10	26.5	0.461	45.65	62.87	80.18	94.58	118.25	1.46	2.01	2.57	3.03	3.79												
				67.82							3.48										**4.19**	**5.76**	**7.33**	**8.62**	**10.83**	4.17	1.59	**1.2**	**1.7**	**2.1**	**2.5**	**3.1**	**0.8**	**1.0**	**1.3**	**1.6**	**2.0**

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					Required Drain Width 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)
H104	950	1800	A13 (b)	90.87	67.15	23.72	60.64	12.09	0.01	1.2	3.1	9.68	7.64	29.4	0.472	42.56	58.82	75.34	89.35	110.59	5.08	7.01	8.98	10.65	13.19												
				90.87							3.1										**5.08**	**7.01**	**8.98**	**10.65**	**13.19**												
			Total	**251.14**							3.1										**14.96**	**20.64**	**26.38**	**31.2**	**38.81**	5	2.14	**4.8**	**6.7**	**8.5**	**10.1**	**12.5**	**2.3**	**3.1**	**4.0**	**4.7**	**5.9**
H104	1800	2650	A11(a)	28.22	28.22	0	75.01	10	0.02	1.5	2.3	19.2	5	34.2	0.554	38.45	53.40	68.82	82.25	100.33	1.67	2.32	2.99	3.57	4.36												
			A11(b)	122.11	113.12	8.99	70.95	10.59	0.01	1.2	2.3	19.2	6.94	36.74	0.541	36.64	51.01	65.93	79.10	95.81	6.72	9.35	12.09	14.5	17.57												
				150.33							2.3										**8.39**	**11.67**	**15.08**	**18.07**	**21.92**												
			Total	**401.47**							2.3										**23.35**	**32.31**	**41.45**	**49.27**	**60.73**	8	1.53	**10.2**	**14.0**	**18.0**	**21.4**	**26.4**	**6.6**	**9.2**	**11.8**	**14.0**	**17.3**
H100	2675	2875	A9(a)	11.09	11.09	0	75	10	0.01	1.2	2.1	18.85	9.72	38.57	0.569	35.46	49.45	64.04	77.02	92.85	0.62	0.87	1.12	1.35	1.63												
				11.09							2.1										**0.62**	**0.87**	**1.12**	**1.35**	**1.63**												
			Total	**675.18**							2.1										**23.97**	**33.18**	**42.57**	**50.62**	**62.36**	6.7	1.58	**11.4**	**15.8**	**20.3**	**24.1**	**29.7**	**7.2**	**10.0**	**12.8**	**15.3**	**18.8**
H101	0	575	A8(b)	13.52	10.4	3.12	62.32	11.84	0.01	1.2	1.75	5.48	5.56	22.88	0.569	50.40	69.08	87.56	102.51	130.00	1.08	1.47	1.87	2.19	2.78												
			A29	3	2.2	0.8	60.28	12.14	0.01	1.2	1.75	5.48	11.11	28.73	0.541	43.23	59.71	76.39	90.49	112.26	0.19	0.27	0.34	0.41	0.51												
				16.52							1.75										**1.27**	**1.74**	**2.21**	**2.6**	**3.28**	1.8	0.6	**0.7**	**1.0**	**1.3**	**1.5**	**1.9**	**1.2**	**1.7**	**2.1**	**2.5**	**3.1**
			Total	**691.7**							1.75																										
H100	2875	3750	A9(a)	5.88	4.11	1.77	58.44	12.41	0.01	1.2	2.65	20.44	9.72	42.57	0.511	33.18	46.42	60.36	72.97	87.13	0.28	0.39	0.5	0.61	0.73												
			A8(b)	63.25	56.93	6.32	69.51	10.8	0.01	1.2	2.65	20.44	12.5	43.74	0.56	32.58	45.62	59.39	71.89	85.63	3.21	4.49	5.85	7.08	8.43												
				69.13							2.65										**3.49**	**4.88**	**6.35**	**7.69**	**9.16**												
			Total	**760.82**							2.65										**28.72**	**39.8**	**51.14**	**60.9**	**74.8**	10	2	**10.8**	**15.0**	**19.3**	**23.0**	**28.2**	**5.4**	**7.5**	**9.6**	**11.5**	**14.1**
H100	3750	4425	A29	16.58	13.26	3.32	63.99	11.6	0.02	1.5	2.17	30.15	5.56	47.3	0.548	30.91	43.39	56.67	68.88	81.41	0.78	1.1	1.43	1.74	2.06												
			A8(b)	33.13	21.71	11.42	56.04	12.76	0.01	1.2	2.17	30.15	5.56	48.46	0.522	30.41	42.73	55.86	67.97	80.16	1.46	2.05	2.68	3.26	3.85												
			A8(c)	25.24	21.45	3.79	66.74	11.2	0.01	1.2	2.17	30.15	9.72	51.07	0.573	29.35	41.32	54.13	66.05	77.49	1.18	1.66	2.17	2.65	3.11												
				74.95							2.17										**3.42**	**4.81**	**6.29**	**7.65**	**9.01**												
			Total	**835.77**							2.17										**32.14**	**44.61**	**57.43**	**68.56**	**83.82**	11	1.6	**14.8**	**20.6**	**26.5**	**31.6**	**38.6**	**9.4**	**13.1**	**16.9**	**20.1**	**24.6**

Table 4.1 Showing Adequacy Analysis Results for Hebbal Main Valley (H1) - For Improving 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	H100	Shree Venkateshawara Mandira, Matadahalli Road	R.T. Nagar 1st Block Road	0	500	29	Pri.	4.28	2.17	2.95	3.69	4.25	5.56	2.19	0.51	0.69	0.86	0.99	1.3	3.13	0.23	0.31	0.39	0.45	0.59	AD	AD	AD	AD	AD
2	H100	R.T. Nagar 1st Block Road	Sriram Appartment Dinnur Main Road, R.T.Nagar	500	1500	156.04	Pri.	4.4	9.79	13.43	17.05	20	25.28	2.1	2.22	3.05	3.88	4.55	5.74	5.5	1.06	1.45	1.85	2.16	2.74	AD	AD	AD	AD	AD
3	H100	Sriram Appartment Dinnur Main Road, R.T.Nagar	Bhuvaneswari nagar	1500	2675	262.62	Pri.	3.9	15.74	21.7	27.71	32.75	40.81	2.2	4.04	5.56	7.11	8.4	10.46	7.5	1.83	2.53	3.23	3.82	4.76	AD	AD	AD	AD	AD
4	H100	Bhuvaneswari nagar	Kanakanagar main road	2675	2875	675.18	Pri.	2.9	23.97	33.18	42.57	50.62	62.36	2.2	8.26	11.44	14.68	17.46	21.5	13	3.76	5.2	6.67	7.93	9.77	AD	AD	AD	AD	AD
5	H100	Kanakanagar main road	Rly track near Nagenahalli	2875	3750	760.82	Pri.	3.4	28.72	39.8	51.14	60.9	74.8	2.2	8.45	11.71	15.04	17.91	22	16	3.84	5.32	6.84	8.14	10	AD	AD	AD	AD	AD
6	H100	Rly track near Nagenahalli	Nagavara Tank	3750	4425	835.77	Pri.	2.9	32.14	44.61	57.43	68.56	83.82	2.2	11.08	15.38	19.8	23.64	28.9	22	5.04	6.99	9	10.75	13.14	AD	AD	AD	AD	AD
7	H101	Rankanagar	Bhuvaneshwarinagar	0	575	16.52	Sec.	2.4	1.27	1.74	2.21	2.6	3.28	0.9	0.53	0.73	0.92	1.08	1.37	1.8	0.59	0.81	1.02	1.2	1.52	AD	AD	AD	AD	AD
8	H102	Rahamatnagar	Hanumanthappa Extn.	0	447	14.81	Sec.	3.6	0.94	1.28	1.63	1.91	2.41	1.41	0.26	0.36	0.45	0.53	0.67	3.1	0.18	0.25	0.32	0.38	0.48	AD	AD	AD	AD	AD
9	H103	Gangenahalli Extn.	R.B.I. Colony	0	1125	92.45	Sec.	3.19	5.7	7.87	10.07	11.92	14.79	1.69	1.79	2.47	3.16	3.74	4.64	5	1.06	1.46	1.87	2.21	2.74	AD	AD	AD	AD	AD
10	H104	Bellary Road near HMT Bhavan	CBI Road, Ganganagar	0	950	67.82	Sec.	3.48	4.19	5.76	7.33	8.62	10.83	1.59	1.2	1.65	2.11	2.48	3.11	4.17	0.76	1.04	1.32	1.56	1.96	AD	AD	AD	AD	AD
11	H104	CBI Road, Ganganagar	Near MSH Layout	950	1800	251.14	Sec.	3.6	14.96	20.64	26.38	31.2	38.81	2.2	4.16	5.73	7.33	8.67	10.78	6	1.89	2.61	3.33	3.94	4.9	AD	AD	AD	AD	AD
12	H104	Near MSH Layout	Chamundinagar main road	1800	2650	401.47	Sec.	3	23.35	32.31	41.45	49.27	60.73	2.2	7.78	10.77	13.82	16.42	20.24	8	3.54	4.9	6.28	7.47	9.2	AD	AD	AD	AD	IA

 AD:ADEQUATE, IA: INADEQUATE

Land Use Analysis for Hebbal Main Valley (H1) – Proposed 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 m3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m2					Required Drain Width 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)
H100	0	500	A16(a)	12.2	12.2	0	75	10	0.02	1.5	4.28	1.95	3.33	15.28	0.456	66.12	89.43	111.50	127.85	168.59	1.02	1.38	1.72	1.98	2.6												
			A12(a)	16.8	13	3.8	62.56	11.81	0.01	1.2	4.28	1.95	4.17	17.92	0.416	59.39	80.75	101.34	117.16	152.13	1.15	1.57	1.97	2.27	2.95												
			Total	**29**							4.28										**2.17**	**2.95**	**3.69**	**4.25**	**5.56**	3.13	2.19	**0.5**	**0.7**	**0.9**	**1.0**	**1.3**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**
H102	0	447	A16(b)	14.81	11.85	2.96	64.02	11.6	0.01	1.2	3.6	2.07	9.72	23.39	0.458	49.65	68.10	86.41	101.28	128.16	0.94	1.28	1.63	1.91	2.41												
				14.81							3.6										**0.94**	**1.28**	**1.63**	**1.91**	**2.41**	3.1	1.41	**0.3**	**0.4**	**0.5**	**0.5**	**0.7**	**0.2**	**0.3**	**0.3**	**0.4**	**0.5**
H100	500	1500	A14	50.7	39.78	10.92	63.15	11.72	0.02	1.5	3.2	7.81	5.56	25.09	0.46	47.36	65.11	82.85	97.45	122.49	3.1	4.26	5.42	6.37	8.01												
			A15	61.53	48.69	12.84	63.52	11.67	0.01	1.2	3.2	7.81	8.33	27.82	0.47	44.18	60.95	77.89	92.11	114.62	3.58	4.94	6.32	7.47	9.3												
				112.23							3.2										**6.68**	**9.2**	**11.73**	**13.84**	**17.3**												
			Total	**156.04**							4.4										**9.79**	**13.43**	**17.05**	**20**	**25.28**	5.5	2.1	**2.2**	**3.1**	**3.9**	**4.5**	**5.7**	**1.1**	**1.5**	**1.8**	**2.2**	**2.7**
H100	1500	2675	A9(b)	27.64	22.11	5.53	63.99	11.6	0.01	1.2	2.7	13.43	7.64	32.67	0.497	39.65	55.00	70.74	84.35	103.34	1.51	2.1	2.7	3.22	3.94												
			A10(a)	38.25	32.51	5.74	66.75	11.2	0.01	1.2	2.7	13.43	10.42	35.04	0.520	37.82	52.58	67.82	81.17	98.77	2.09	2.91	3.75	4.49	5.46												
			A	40.7	40.7	0	75	10	0.01	1.2	2.7	13.43	12.5	35.93	0.558	37.19	51.75	66.82	80.07	97.20	2.35	3.26	4.21	5.05	6.13												
				106.59							2.7										**5.95**	**8.27**	**10.66**	**12.75**	**15.53**												
			Total	**262.62**							3.9										**15.74**	**21.7**	**27.71**	**32.75**	**40.81**	7.5	2.2	**4.0**	**5.6**	**7.1**	**8.4**	**10.5**	**1.8**	**2.5**	**3.2**	**3.8**	**4.8**
H103	0	1125	A13(a)	23.1	19.64	3.46	66.76	11.2	0.01	1.2	3.19	5.88	9.03	26.1	0.482	46.11	63.48	80.90	95.36	119.40	1.43	1.96	2.5	2.95	3.69												
			A12(a)	34.18	34.18	0	75	10	0.01	1.2	3.19	5.88	12.5	28.38	0.529	43.59	60.18	76.96	91.10	113.15	2.19	3.02	3.86	4.57	5.68												
			A12(b)	35.17	31.65	3.52	69.5	10.8	0.01	1.2	3.19	5.88	13.89	30.57	0.515	41.47	57.38	73.61	87.47	107.86	2.08	2.88	3.7	4.4	5.42												
			Total	**92.45**							3.19										**5.7**	**7.87**	**10.07**	**11.92**	**14.79**	5	1.69	**1.8**	**2.5**	**3.2**	**3.7**	**4.6**	**1.1**	**1.5**	**1.9**	**2.2**	**2.7**
H104	0	950	A13(a)	15.17	15.17	0	75	10	0.01	1.2	3.48	4.55	8.33	22.88	0.5	50.39	69.06	87.55	102.49	129.97	1.06	1.45	1.83	2.15	2.72												
			A5(c)	27.65	22.12	5.53	64	11.6	0.01	1.2	3.48	4.55	9.72	25.87	0.468	46.39	63.84	81.34	95.83	120.09	1.67	2.3	2.93	3.45	4.32												
			A5(d)	25	18.9	6.1	61.58	11.95	0.02	1.5	3.48	4.55	10	26.5	0.461	45.65	62.87	80.18	94.58	118.25	1.46	2.01	2.57	3.03	3.79												
				67.82							3.48										**4.19**	**5.76**	**7.33**	**8.62**	**10.83**	4.17	1.59	**1.2**	**1.7**	**2.1**	**2.5**	**3.1**	**0.8**	**1.0**	**1.3**	**1.6**	**2.0**

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 Coeffecent "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					Required Drain Width 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)
H104	950	1800	A13 (b)	90.87	67.15	23.72	60.64	12.09	0.01	1.2	3.1	9.68	7.64	29.4	0.472	42.56	58.82	75.34	89.35	110.59	5.08	7.01	8.98	10.65	13.19												
				90.87							3.1										**5.08**	**7.01**	**8.98**	**10.65**	**13.19**												
			Total	**251.14**							3.6										**14.96**	**20.64**	**26.38**	**31.2**	**38.81**	6	2.2	**4.2**	**5.7**	**7.3**	**8.7**	**10.8**	**1.9**	**2.6**	**3.3**	**3.9**	**4.9**
H104	1800	2650	A11(a)	28.22	28.22	0	75.01	10	0.02	1.5	2.3	19.2	5	34.2	0.554	38.45	53.40	68.82	82.25	100.33	1.67	2.32	2.99	3.57	4.36												
			A11(b)	122.11	113.12	8.99	70.95	10.59	0.01	1.2	2.3	19.2	6.94	36.74	0.541	36.64	51.01	65.93	79.10	95.81	6.72	9.35	12.09	14.5	17.57												
				150.33							2.3										**8.39**	**11.67**	**15.08**	**18.07**	**21.92**												
			Total	**401.47**							3										**23.35**	**32.31**	**41.45**	**49.27**	**60.73**	8	2.20	**7.8**	**10.8**	**13.8**	**16.4**	**20.2**	**3.5**	**4.9**	**6.3**	**7.5**	**9.2**
H100	2675	2875	A9(a)	11.09	11.09	0	75	10	0.01	1.2	2.1	18.85	9.72	38.57	0.569	35.46	49.45	64.04	77.02	92.85	0.62	0.87	1.12	1.35	1.63												
				11.09							2.1										**0.62**	**0.87**	**1.12**	**1.35**	**1.63**												
			Total	**675.18**							2.9										**23.97**	**33.18**	**42.57**	**50.62**	**62.36**	13	2.2	**8.3**	**11.4**	**14.7**	**17.5**	**21.5**	**3.8**	**5.2**	**6.7**	**7.9**	**9.8**
H101	0	575	A8(b)	13.52	10.4	3.12	62.32	11.84	0.01	1.2	1.75	5.48	5.56	22.88	0.569	50.40	69.08	87.56	102.51	130.00	1.08	1.47	1.87	2.19	2.78												
			A29	3	2.2	0.8	60.28	12.14	0.01	1.2	1.75	5.48	11.11	28.73	0.541	43.23	59.71	76.39	90.49	112.26	0.19	0.27	0.34	0.41	0.51												
				16.52							2.4										**1.27**	**1.74**	**2.21**	**2.6**	**3.28**	1.8	0.9	**0.5**	**0.7**	**0.9**	**1.1**	**1.4**	**0.6**	**0.8**	**1.0**	**1.2**	**1.5**
			Total	**691.7**																																	
H100	2875	3750	A9(a)	5.88	4.11	1.77	58.44	12.41	0.01	1.2	2.65	20.44	9.72	42.57	0.511	33.18	46.42	60.36	72.97	87.13	0.28	0.39	0.5	0.61	0.73												
			A8(b)	63.25	56.93	6.32	69.51	10.8	0.01	1.2	2.65	20.44	12.5	43.74	0.56	32.58	45.62	59.39	71.89	85.63	3.21	4.49	5.85	7.08	8.43												
				69.13							2.65										**3.49**	**4.88**	**6.35**	**7.69**	**9.16**												
			Total	**760.82**							3.4										**28.72**	**39.8**	**51.14**	**60.9**	**74.8**	16	2.2	**8.4**	**11.7**	**15.0**	**17.9**	**22.0**	**3.8**	**5.3**	**6.8**	**8.1**	**10.0**
H100	3750	4425	A29	16.58	13.26	3.32	63.99	11.6	0.02	1.5	2.17	30.15	5.56	47.3	0.548	30.91	43.39	56.67	68.88	81.41	0.78	1.1	1.43	1.74	2.06												
			A8(b)	33.13	21.71	11.42	56.04	12.76	0.01	1.2	2.17	30.15	5.56	48.46	0.522	30.41	42.73	55.86	67.97	80.16	1.46	2.05	2.68	3.26	3.85												
			A8(c)	25.24	21.45	3.79	66.74	11.2	0.01	1.2	2.17	30.15	9.72	51.07	0.573	29.35	41.32	54.13	66.05	77.49	1.18	1.66	2.17	2.65	3.11												
				74.95							2.17										**3.42**	**4.81**	**6.29**	**7.65**	**9.01**												
			Total	**835.77**							2.9										**32.14**	**44.61**	**57.43**	**68.56**	**83.82**	22	2.2	**11.1**	**15.4**	**19.8**	**23.6**	**28.9**	**5.0**	**7.0**	**9.0**	**10.7**	**13.1**

Table 4.2 Adequacy Analysis Results for Hebbal Main Valley - I (H2) - Existing Hydraulic Flow Conditions

Sl.No.	Description	Drain Reach		Chainage (m)		Catchment Area A (Ha.)	Type	Average Velocity V m/sec	Discharges (Q in m³/sec)					Existing Av.Drain Depth D in m.	Area required for drain (A in m²)					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	H200	Old Tumkur Road near Mysore Lamp works	Triveni Road near Kamala Nehru Extn.	0	875	63.2	Pri.	2.63	3.91	5.37	6.82	8.02	10.1	1.3	1.49	2.04	2.59	3.05	3.84	2.6	1.14	1.57	2	2.34	2.95	AD	AD	AD	AD	IA
2	H200	Triveni Road near Kamala Nehru Extn.	H.M.T.Layout Mattikere, 5th Cross	875	1650	164.91	Pri.	2.4	9.7	13.37	17.08	20.19	25.15	1.7	4.04	5.57	7.12	8.41	10.48	2.4	2.38	3.28	4.19	4.95	6.16	AD	IA	IA	IA	IA
3	H200	H.M.T.Layout Mattikere, 5th Cross	Mattikere Tank Bund Road	1650	2450	230.37	Pri.	2.5	13.27	18.35	23.51	27.9	34.49	2.2	5.31	7.34	9.4	11.16	13.79	2.8	2.41	3.34	4.27	5.07	6.27	AD	IA	IA	IA	IA
4	H200	Mattikere Tank Bund Road	Mathikere main road near KPTCL office	2450	2750	904.34	Pri.	2.35	30.82	42.69	54.81	65.22	80.23	2.1	13.12	18.16	23.32	27.75	34.14	5	6.25	8.65	11.11	13.22	16.26	IA	IA	IA	IA	IA
5	H200	Mathikere main road near KPTCL office	New BEL Road	2750	3500	1133.76	Pri.	2.45	37.25	51.71	66.6	79.56	97.16	1.8	15.2	21.11	27.18	32.47	39.66	7.6	8.45	11.73	15.1	18.04	22.03	IA	IA	IA	IA	IA
6	H200	New BEL Road	Near Sachidananda nagar	3500	4600	1262.3	Pri.	1.8	43.09	59.95	77.43	92.81	112.62	2.25	23.94	33.31	43.02	51.56	62.56	6.3	10.64	14.8	19.12	22.92	27.81	IA	IA	IA	IA	IA
7	H200	Near Sachidananda nagar	Outer Ring Road	4600	5000	1621.5	Pri.	2.7	48.81	67.91	87.71	105.13	127.56	2.1	18.08	25.15	32.48	38.94	47.25	11.5	8.61	11.98	15.47	18.54	22.5	AD	IA	IA	IA	IA
8	H200	Outer Ring Road	Balaji Layout 6th Cross	5000	6000	1743.68	Pri.	1.9	53.59	74.69	96.67	116.2	140.26	2	28.2	39.31	50.88	61.16	73.82	6	14.1	19.65	25.44	30.58	36.91	IA	IA	IA	IA	IA
9	H200	Balaji Layout 6th Cross	Near Defence Dairy Farm in marshy land	6000	7000	2085.9	Pri.	1.5	64.69	90.5	117.69	142.34	169.87	1.4	43.13	60.33	78.46	94.89	113.25	8.3	30.81	43.1	56.04	67.78	80.89	IA	IA	IA	IA	IA
10	H200	Near Defence Dairy Farm in marshy land	After Bellary Road adjacent to Chiranjeevi nagar	7000	7775	2393.06	Pri.	1.4	66.92	93.7	121.97	147.7	175.86	1.5	47.8	66.93	87.12	105.5	125.61	9.3	31.87	44.62	58.08	70.33	83.74	IA	IA	IA	IA	IA
11	H201	Near IISc Staff Qtrs., 8th cross, Adarsh Layout	RMV Extn.	1000	1450	118.94	Sec	1.95	7.03	9.68	12.35	14.58	18.21	1.9	3.6	4.96	6.33	7.48	9.34	2	1.9	2.61	3.33	3.94	4.91	AD	IA	IA	IA	IA
12	H201	RMV Extn.	RMV 1st Main Road	1450	2000	274.16	Sec	2.5	12.74	17.63	22.61	26.88	33.13	2	5.09	7.05	9.05	10.75	13.25	2.6	2.55	3.53	4.52	5.38	6.63	AD	IA	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)					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
13	H201	C.P.R.I Campus	Gandhi Vidyalaya Assn. near RMV Extn. 2 nd stage	2000	2825	337.13	Sec	2.45	15.94	22.11	28.44	33.93	41.54	1.5	6.51	9.02	11.61	13.85	16.96	3.7	4.34	6.02	7.74	9.23	11.3	IA	IA	IA	IA	IA
14	H202	Venkateshwara Layout near MSR Medical college	A.G. Colony	0	375	37.74	Sec	2.2	2.1	2.88	3.64	4.26	5.41	1.2	0.95	1.31	1.66	1.94	2.46	1.5	0.79	1.09	1.38	1.62	2.05	AD	AD	AD	IA	IA
15	H205	HMT Shopping Complex	Near St.Chlaret's School &Church, Military Area	0	1000	218.44	Sec	2.4	11.95	16.43	20.91	24.6	30.9	1.5	4.98	6.84	8.71	10.25	12.88	3.7	3.32	4.56	5.81	6.83	8.58	AD	IA	IA	IA	IA
16	H205	Near St.Chlaret's School &Church, Military Area	Bandappa Garden, Mutyalamma Nagar	1000	2000	487.39	Sec	2.35	24.54	33.92	43.45	51.55	63.76	1.5	10.44	14.43	18.49	21.94	27.13	7	6.96	9.62	12.33	14.62	18.09	AD	IA	IA	IA	IA
17	H205	Bandappa Garden, Mutyalamma Nagar	Mathi Kere Lake	2000	2600	626.76	Sec	2.14	30.22	41.85	53.73	63.93	78.65	1.4	14.12	19.56	25.11	29.87	36.75	7	10.09	13.97	17.93	21.34	26.25	IA	IA	IA	IA	IA
18	H206	Sanjayanagar	Ring Road	0	1000	142.59	Sec	2	8.13	11.21	14.32	16.93	21.09	1.5	4.06	5.61	7.16	8.47	10.54	6	2.71	3.74	4.77	5.64	7.03	AD	AD	AD	AD	IA
19	H206	Ring Road	Hebbal Lake	1000	1125	228.64	Sec	1.6	11.01	15.21	19.48	23.1	28.6	1.5	6.88	9.51	12.17	14.44	17.87	15	4.59	6.34	8.12	9.62	11.92	AD	AD	AD	AD	AD

LAND USE ANALYSIS FOR HEBBAL MAIN VALLEY 1 (H2) – 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 m3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m2					Required Drain Width 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)
H200	0	875	A3(c)	9.66	8.69	0.97	69.48	10.8	0.02	1.5	2.63	5.54	3.33	19.68	0.457	55.76	76.05	95.81	111.31	143.23	0.68	0.93	1.17	1.36	1.75												
			A3(b)	23.54	16.48	7.06	58.5	12.4	0.01	1.2	2.63	5.54	6.94	24.89	0.439	47.62	65.45	83.25	97.89	123.13	1.37	1.88	2.39	2.81	3.53												
			A3(a)	30	26.1	3.9	67.85	11.04	0.01	1.2	2.63	5.54	9.72	26.31	0.486	45.87	63.17	80.53	94.96	118.81	1.86	2.56	3.26	3.84	4.81												
			Total	**63.2**							2.63										**3.91**	**5.37**	**6.82**	**8.02**	**10.1**	2.6	1.3	**1.5**	**2.0**	**2.6**	**3.0**	**3.8**	**1.1**	**1.6**	**2.0**	**2.3**	**3.0**
H204	0	800	A3(d)	14.81	7.4	7.41	47.49	14	0.01	1.2	2.5	5.33	5.56	24.89	0.394	47.61	65.44	83.25	97.88	123.12	0.77	1.06	1.35	1.59	2												
			A3(c)	18.95	12.32	6.63	55.76	12.8	0.01	1.2	2.5	5.33	6.94	25.08	0.432	47.38	65.13	82.87	97.48	122.53	1.08	1.48	1.88	2.21	2.78												
			Total	**33.76**							2.5										**1.85**	**2.54**	**3.23**	**3.8**	**4.78**												
H200	875	1650	A3(b)	8.46	7.62	0.84	69.54	10.79	0.01	1.2	2.4	11.46	7.64	29.89	0.509	42.09	58.21	74.60	88.55	109.42	0.5	0.7	0.89	1.06	1.31												
			A3(d)	39.49	36.6	2.89	70.97	10.59	0.01	1.2	2.4	11.46	10.42	32.46	0.526	39.82	55.22	71.01	84.64	103.76	2.3	3.19	4.1	4.88	5.99												
			A3(a)	20	18	2	69.5	10.8	0.01	1.2	2.4	11.46	11.11	33.37	0.525	39.09	54.25	69.84	83.37	101.93	1.14	1.58	2.04	2.43	2.98												
			Total	**67.95**							2.4										**3.94**	**5.47**	**7.03**	**8.38**	**10.27**												
			Total	**164.91**							2.4										**9.7**	**13.37**	**17.08**	**20.19**	**25.15**	2.4	1.7	**4.0**	**5.6**	**7.1**	**8.4**	**10.5**	**2.4**	**3.3**	**4.2**	**4.9**	**6.2**
H200	1650	2450	A3(a)	65.46	57.6	7.86	68.4	10.96	0.01	1.2	2.5	16.33	9.03	36.32	0.532	36.92	51.39	66.38	79.59	96.52	3.57	4.97	6.42	7.7	9.34												
			Total	**230.37**							2.5										**13.27**	**18.35**	**23.51**	**27.9**	**34.49**	2.8	2.2	**5.3**	**7.3**	**9.4**	**11.2**	**13.8**	**2.4**	**3.3**	**4.3**	**5.1**	**6.3**
H205	0	1000	A1(c)	26.11	18.27	7.84	58.49	12.4	0.02	1.5	2.4	6.94	3.33	22.68	0.429	50.69	69.46	88.01	103.00	130.72	1.58	2.16	2.74	3.2	4.06												
			A1(a)	42.33	32.05	10.28	61.64	11.94	0.02	1.5	2.4	6.94	5	23.89	0.446	48.95	67.19	85.32	100.11	126.43	2.57	3.52	4.47	5.25	6.63												
			A1(b)	150	78.92	71.08	48.94	13.79	0.01	1.2	2.4	6.94	5.56	26.29	0.408	45.89	63.19	80.56	94.99	118.86	7.8	10.74	13.7	16.15	20.21												
			Total	**218.44**							2.4										**11.95**	**16.43**	**20.91**	**24.6**	**30.9**	3.7	1.5	**5.0**	**6.8**	**8.7**	**10.3**	**12.9**	**3.3**	**4.6**	**5.8**	**6.8**	**8.6**
H205	1000	2000	A1(b)	109.2	66.6	42.6	53.54	13.12	0.01	1.2	2.35	14.18	5.56	32.86	0.456	39.49	54.79	70.49	84.08	102.95	5.46	7.57	9.74	11.62	14.23												
			A1(c)	159.75	72.5	87.25	44.96	14.37	0.01	1.2	2.35	14.18	6.94	35.5	0.429	37.50	52.15	67.30	80.60	97.95	7.13	9.92	12.8	15.33	18.63												

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					Required Drain Width 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)
			Total	**268.95**							2.35										**12.59**	**17.49**	**22.54**	**26.95**	**32.86**												
			Total	**487.39**							2.35										**24.54**	**33.92**	**43.45**	**51.55**	**63.76**	7	1.5	**10.4**	**14.4**	**18.5**	**21.9**	**27.1**	**7.0**	**9.6**	**12.3**	**14.6**	**18.1**
H205	2000	2600	A3(a)	29.3	11.7	17.6	41.96	14.81	0.01	1.2	2.14	20.25	3.47	38.53	0.426	35.48	49.48	64.08	77.06	92.92	1.23	1.72	2.22	2.67	3.22												
			A2	110.07	36.6	73.47	38.29	15.34	0.02	1.5	2.14	20.25	3.89	39.48	0.417	34.91	48.72	63.15	76.04	91.47	4.45	6.21	8.06	9.7	11.67												
			Total	**139.37**							2.14										**5.68**	**7.93**	**10.28**	**12.37**	**14.89**												
			Total	**626.76**							2.14										**30.22**	**41.85**	**53.73**	**63.93**	**78.65**	7	1.4	**14.1**	**19.6**	**25.1**	**29.9**	**36.8**	**10.1**	**14.0**	**17.9**	**21.3**	**26.3**
H200	2450	2750	A4 (a)	47.21	42.48	4.73	69.49	10.8	0.01	1.2	2.35	19.5	11.81	42.11	0.557	33.42	46.75	60.76	73.40	87.75	2.44	3.42	4.44	5.36	6.41												
			Total	**904.34**							2.35										**30.82**	**42.69**	**54.81**	**65.22**	**80.23**	5	2.1	**13.1**	**18.2**	**23.3**	**27.8**	**34.1**	**6.2**	**8.6**	**11.1**	**13.2**	**16.3**
H203	0	1443	A4(a)	28.07	25.09	2.98	69.16	10.85	0.01	1.2	2	12.03	4.17	27.04	0.499	45.03	62.06	79.22	93.54	116.72	1.75	2.42	3.08	3.64	4.54												
			A4(b)	46.93	35.22	11.71	61.28	12	0.02	1.5	2	12.03	3.89	27.91	0.466	44.08	60.82	77.73	91.94	114.37	2.68	3.7	4.72	5.59	6.95												
			A4(c)	11.65	5.15	6.5	44.31	14.46	0.01	1.2	2	12.03	6.94	33.43	0.422	39.04	54.18	69.76	83.28	101.81	0.53	0.74	0.95	1.14	1.39												
			Total	**86.65**							2										**4.96**	**6.85**	**8.76**	**10.37**	**12.88**												
H200	2750	3500	A5(f)	7.26	3.86	3.4	49.24	13.75	0.01	1.2	2.45	23.81	9.03	46.58	0.486	31.23	43.82	57.19	69.46	82.22	0.31	0.43	0.56	0.68	0.81												
			A4(b)	72.42	61.24	11.18	66.51	11.24	0.01	1.2	2.45	23.81	12.5	47.54	0.561	30.80	43.25	56.50	68.68	81.15	3.47	4.88	6.37	7.75	9.15												
			A4(a)	63.09	35.17	27.92	50.66	13.54	0.02	1.5	2.45	23.81	11.11	48.46	0.496	30.41	42.73	55.86	67.97	80.15	2.64	3.72	4.86	5.91	6.97												
			Total	**142.77**							2.45										**6.43**	**9.02**	**11.79**	**14.34**	**16.93**												
			Total	**1133.76**							2.45										**37.25**	**51.71**	**66.6**	**79.56**	**97.16**	7.6	1.8	**15.2**	**21.1**	**27.2**	**32.5**	**39.7**	**8.4**	**11.7**	**15.1**	**18.0**	**22.0**
H200	3500	4600	A4(a)	33.71	28.56	5.15	66.6	11.22	0.01	1.2	1.8	34.49	6.94	52.66	0.575	28.76	40.52	53.15	64.95	75.98	1.55	2.18	2.86	3.5	4.09												
			A5(a)	61.63	51.85	9.78	66.27	11.27	0.01	1.2	1.8	34.49	8.33	54.09	0.579	28.24	39.82	52.30	64.00	74.67	2.8	3.95	5.19	6.35	7.41												
			A5(g)	33.2	28.59	4.61	67.36	11.11	0.02	1.5	1.8	34.49	10	55.6	0.586	27.72	39.13	51.44	63.04	73.36	1.5	2.11	2.78	3.41	3.96												

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					Required Drain Width 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)
			Total	**128.54**							1.8										**5.85**	**8.24**	**10.83**	**13.25**	**15.46**												
			Total	**1262.3**							1.8										**43.09**	**59.95**	**77.43**	**92.81**	**112.62**	6.3	2.3	**23.9**	**33.3**	**43.0**	**51.6**	**62.6**	**10.6**	**14.8**	**19.1**	**22.9**	**27.8**
H201	0	500	A5(c)	23.05	19.05	4	65.46	11.39	0.01	1.2	2.2	3.79	5.56	20.73	0.447	53.85	73.57	92.88	108.19	138.51	1.54	2.1	2.66	3.09	3.96												
			A5(d)	22.48	15.7	6.78	58.41	12.41	0.02	1.5	2.2	3.79	6.67	22.87	0.429	50.41	69.09	87.58	102.53	130.03	1.35	1.85	2.34	2.74	3.48												
			Total	**45.53**							2.2										**2.89**	**3.95**	**5.00**	**5.84**	**7.44**												
H201	500	1000	A5(d)	35	28.64	6.36	65.01	11.45	0.01	1.2	2.1	7.94	9.03	28.42	0.488	43.55	60.12	76.89	91.03	113.05	2.07	2.85	3.65	4.32	5.36												
			Total	**35**							2.1										**2.07**	**2.85**	**3.65**	**4.32**	**5.36**												
			Total	**80.53**							2.1										**4.95**	**6.8**	**8.65**	**10.16**	**12.8**												
H201	1000	1450	A5(c)	38.41	30.57	7.84	63.77	11.63	0.01	1.2	1.95	12.39	9.72	33.75	0.501	38.79	53.86	69.37	82.86	101.20	2.07	2.88	3.71	4.43	5.4												
			Total	**38.41**							1.95										**2.07**	**2.88**	**3.71**	**4.43**	**5.4**												
			Total	**118.94**							1.95										**7.03**	**9.68**	**12.35**	**14.58**	**18.21**	2	1.9	**3.6**	**5.0**	**6.3**	**7.5**	**9.3**	**1.9**	**2.6**	**3.3**	**3.9**	**4.9**
H202	0	375	A4(b)	10.39	4.16	6.23	42.02	14.8	0.01	1.2	2.2	2.84	4.17	21.8	0.359	52.05	71.23	90.11	105.24	134.08	0.54	0.74	0.93	1.09	1.39												
			A5(f)	27.35	16.15	11.2	52.48	13.28	0.01	1.2	2.2	2.84	6.94	23.06	0.409	50.12	68.72	87.14	102.06	129.33	1.56	2.14	2.71	3.17	4.02												
			Total	**37.74**							2.2										**2.1**	**2.88**	**3.64**	**4.26**	**5.41**	1.5	1.2	**1.0**	**1.3**	**1.7**	**1.9**	**2.5**	**0.8**	**1.1**	**1.4**	**1.6**	**2.0**
H201	1450	2000	A5(e)	113.77	70.75	43.02	54.2	13.03	0.01	1.2	2.5	13.33	9.72	36.08	0.474	37.09	51.61	66.65	79.88	96.93	5.55	7.73	9.98	11.96	14.51												
			A5(g)	3.71	1.48	2.23	41.94	14.81	0.02	1.5	2.5	13.33	9.44	37.59	0.423	36.08	50.27	65.04	78.11	94.41	0.16	0.22	0.28	0.34	0.41												
			Total	**117.48**							2.5										**5.71**	**7.95**	**10.26**	**12.3**	**14.92**												
			Total	**274.16**							2.5										**12.74**	**17.63**	**22.61**	**26.88**	**33.13**	2.6	2	**5.1**	**7.1**	**9.0**	**10.8**	**13.3**	**2.5**	**3.5**	**4.5**	**5.4**	**6.6**
H201	2000	2825	A5(b)	62.97	55.13	7.84	68.15	11	0.01	1.2	2.45	19.22	12.5	42.71	0.553	33.10	46.32	60.24	72.83	86.95	3.2	4.48	5.83	7.05	8.41												
			Total	**62.97**							2.45										**3.2**	**4.48**	**5.83**	**7.05**	**8.41**												
			Total	**337.13**							2.45										**15.94**	**22.11**	**28.44**	**33.93**	**41.54**	3.7	1.5	**6.5**	**9.0**	**11.6**	**13.8**	**17.0**	**4.3**	**6.0**	**7.7**	**9.2**	**11.3**

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					Required Drain Width 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)
H200	4600	5000	A5(a)	19.61	14	5.61	59.27	12.29	0.01	1.2	2.7	30.86	13.19	56.35	0.554	27.47	38.80	51.03	62.59	72.74	0.83	1.17	1.54	1.89	2.19												
			A6(b)	2.46	2.14	0.32	67.85	11.04	0.01	1.2	2.7	30.86	15.28	57.18	0.590	27.20	38.43	50.58	62.08	72.05	0.11	0.15	0.2	0.25	0.29												
			Total	**22.07**							2.7										**0.94**	**1.33**	**1.74**	**2.14**	**2.49**												
			Total	**1621.5**							2.7										**48.81**	**67.91**	**87.71**	**105.13**	**127.56**	11.5	2.1	**18.1**	**25.2**	**32.5**	**38.9**	**47.2**	**8.6**	**12.0**	**15.5**	**18.5**	**22.5**
H200	5000	6000	A6(a)	62.54	35.62	26.92	51.33	13.44	0.02	1.5	1.9	38.16	11.11	62.71	0.529	25.56	36.23	47.86	59.02	67.89	2.35	3.33	4.4	5.42	6.24												
			A6(b)	59.64	51.67	7.97	67.65	11.07	0.01	1.2	1.9	38.16	17.36	66.59	0.597	24.55	34.87	46.18	57.12	65.32	2.43	3.45	4.57	5.65	6.46												
			Total	**122.18**							1.9										**4.78**	**6.77**	**8.96**	**11.07**	**12.69**												
			Total	**1743.68**							1.9										**53.59**	**74.69**	**96.67**	**116.2**	**140.26**	6	2	**28.2**	**39.3**	**50.9**	**61.2**	**73.8**	**14.1**	**19.7**	**25.4**	**30.6**	**36.9**
H200	6000	7000	A6(a)	277.07	137.69	139.38	47.33	14.02	0.01	1.2	1.5	50.56	8.33	72.91	0.512	23.10	32.90	43.73	54.35	61.61	9.1	12.96	17.22	21.41	24.27												
			A6(b)	57.5	20.2	37.3	39.32	15.19	0.01	1.2	1.5	50.56	9.03	74.77	0.478	22.71	32.37	43.08	53.61	60.62	1.73	2.47	3.29	4.09	4.63												
			A7(a)	7.65	5.88	1.77	62.27	11.85	0.01	1.2	1.5	50.56	15.28	77.68	0.576	22.13	31.59	42.10	52.50	59.14	0.27	0.39	0.51	0.64	0.72												
			Total	**342.22**							1.5										**11.1**	**15.81**	**21.03**	**26.14**	**29.61**												
			Total	**2085.9**							1.5										**64.69**	**90.5**	**117.69**	**142.34**	**169.87**	8.3	1.4	**43.1**	**60.3**	**78.5**	**94.9**	**113.2**	**30.8**	**43.1**	**56.0**	**67.8**	**80.9**
H206	0	900	A6(c)	77.13	53.4	23.73	58.08	12.46	0.01	1.2	2	7.5	6.94	26.91	0.449	45.18	62.26	79.45	93.80	117.10	4.35	5.99	7.64	9.02	11.26												
			A6(e)	37.42	26.58	10.84	59.07	12.32	0.02	1.5	2	7.5	7.78	27.6	0.458	44.42	61.26	78.26	92.51	115.21	2.12	2.92	3.73	4.41	5.49												
			A6(d)	28.04	24.67	3.37	68.39	10.96	0.01	1.2	2	7.5	11.11	29.57	0.505	42.40	58.61	75.08	89.07	110.18	1.67	2.31	2.96	3.51	4.34												
			Total	**142.59**							2										**8.13**	**11.21**	**14.32**	**16.93**	**21.09**	6	1.5	**4.1**	**5.6**	**7.2**	**8.5**	**10.5**	**2.7**	**3.7**	**4.8**	**5.6**	**7.0**
H206	900	1125	A6(c)	12.11	10.29	1.82	66.73	11.2	0.01	1.2	1.6	11.72	9.03	31.95	0.506	40.25	55.78	71.68	85.38	104.83	0.68	0.95	1.22	1.45	1.78												
			A6(f)	24.55	22.1	2.45	69.51	10.8	0.01	1.2	1.6	11.72	10.42	32.93	0.522	39.44	54.71	70.39	83.97	102.80	1.4	1.95	2.51	2.99	3.66												
			A7(b)	49.39	20.69	28.7	43.04	14.65	0.02	1.5	1.6	11.72	8.89	35.26	0.424	37.67	52.37	67.58	80.90	98.38	2.19	3.05	3.94	4.71	5.73												
			Total	**86.05**							1.6										**2.88**	**4**	**5.16**	**6.16**	**7.51**												

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 m3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m2					Required Drain Width 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)
			Total	**228.64**							1.6										**11.01**	**15.21**	**19.48**	**23.1**	**28.6**	15	1.5	**6.9**	**9.5**	**12.2**	**14.4**	**17.9**	**4.6**	**6.3**	**8.1**	**9.6**	**11.9**
H200	7000	7775	A7(a)	64.71	25.88	38.83	42	14.8	0.01	1.2	1.4	63.39	6.94	85.14	0.486	20.81	29.79	39.86	49.93	55.75	1.82	2.6	3.48	4.36	4.87												
			A7(b)	13.81	7.9	5.91	51.46	13.42	0.01	1.2	1.4	63.39	10.42	87.23	0.529	20.47	29.33	39.28	49.27	54.89	0.42	0.59	0.8	1	1.11												
			Total	**78.52**							1.4										**2.23**	**3.2**	**4.28**	**5.36**	**5.99**												
			Total	**2393.06**							1.4										**66.92**	**93.7**	**121.97**	**147.7**	**175.86**	9.3	1.5	**47.8**	**66.9**	**87.1**	**105.5**	**125.6**	**31.9**	**44.6**	**58.1**	**70.3**	**83.7**
H200	7775	9000	A7(b)	102.72	72	30.72	58.55	12.39	0.01	1.2	1.5	72.78	8.33	93.5	0.559	19.54	28.06	37.68	47.43	52.49	3.11	4.47	6	7.56	8.36												
			A8(a)	39.67	31.73	7.94	63.99	11.6	0.01	1.2	1.5	72.78	11.11	95.49	0.580	19.26	27.68	37.21	46.89	51.78	1.23	1.77	2.38	3	3.31												
			A8(c)	17.49	13.47	4.02	62.36	11.84	0.02	1.5	1.5	72.78	12.22	96.84	0.576	19.08	27.44	36.90	46.53	51.32	0.53	0.77	1.03	1.3	1.43												
			A7(a)	37.46	22.46	15	52.98	13.2	0.01	1.2	1.5	72.78	12.5	98.48	0.533	18.87	27.14	36.53	46.10	50.76	1.05	1.51	2.03	2.56	2.82												
			Total	**197.34**							1.5										**4.88**	**7.01**	**9.41**	**11.86**	**13.11**												
			Total	**2590.4**							1.5										**71.8**	**100.71**	**131.39**	**159.56**	**188.97**												

Table 4.2 Showing Adequacy Analysis Results for Hebbal Main Valley- I (H2) - For Improving Hydraulic Flow Conditions

Sl.No.	Description	Drain Reach		Chainage (m)		Catchment Area A (Ha.)	Type	Average Velocity V m/sec	Discharges (Q in m³/sec)					Existing Av.Drain Depth D in m.	Area required for drain (A in m²)					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	H200	Old Tumkur Road near Mysore Lamp works	Triveni Road near Kamala Nehru Extn.	0	875	63.2	Pri.	3.5	3.91	5.37	6.82	8.02	10.1	1.5	1.12	1.53	1.95	2.29	2.88	2.6	0.74	1.02	1.3	1.53	1.92	AD	AD	AD	AD	AD
2	H200	Triveni Road near Kamala Nehru Extn.	H.M.T.Layout Mattikere, 5th Cross	875	1650	164.91	Pri.	3.2	9.7	13.37	17.08	20.19	25.15	2	3.03	4.18	5.34	6.31	7.86	2.4	1.52	2.09	2.67	3.16	3.93	AD	AD	IA	IA	IA
3	H200	H.M.T.Layout Mattikere, 5th Cross	Mattikere Tank Bund Road	1650	2450	230.37	Pri.	3.2	13.27	18.35	23.51	27.9	34.49	2.4	4.15	5.73	7.35	8.72	10.78	3.2	1.73	2.39	3.06	3.63	4.49	AD	AD	AD	IA	IA
4	H200	Mattikere Tank Bund Road	Mathikere main road near KPTCL office	2450	2750	904.34	Pri.	4.1	30.82	42.69	54.81	65.22	80.23	2.2	7.52	10.41	13.37	15.91	19.57	10	3.42	4.73	6.08	7.23	8.89	AD	AD	AD	AD	AD
5	H200	Mathikere main road near KPTCL office	New BEL Road	2750	3500	1133.76	Pri.	3.7	37.25	51.71	66.6	79.56	97.16	2.2	10.07	13.98	18	21.5	26.26	10	4.58	6.35	8.18	9.77	11.94	AD	AD	AD	AD	IA
6	H200	New BEL Road	Near Sachidananda nagar	3500	4600	1262.3	Pri.	3.7	43.09	59.95	77.43	92.81	112.62	2.4	11.65	16.2	20.93	25.08	30.44	13	4.85	6.75	8.72	10.45	12.68	AD	AD	AD	AD	AD
7	H200	Near Sachidananda nagar	Outer Ring Road	4600	5000	1621.5	Pri.	3.2	48.81	67.91	87.71	105.13	127.56	2.4	15.25	21.22	27.41	32.85	39.86	16.5	6.36	8.84	11.42	13.69	16.61	AD	AD	AD	AD	IA
8	H200	Outer Ring Road	Balaji Layout 6th Cross	5000	6000	1743.68	Pri.	2.8	26.79	37.34	48.33	58.1	70.13	2.5	9.57	13.34	17.26	20.75	25.05	11	3.83	5.33	6.9	8.3	10.02	AD	AD	AD	AD	AD
9	H200	Balaji Layout 6th Cross	Near Defence Dairy Farm in marshy land	6000	7000	2085.9	Pri.	3.1	64.69	90.5	117.69	142.34	169.87	2.4	20.87	29.19	37.97	45.92	54.8	20	8.69	12.16	15.82	19.13	22.83	AD	AD	AD	AD	IA
10	H200	Near Defence Dairy Farm in marshy land	After Bellary Road adjacent to Chiranjeevi nagar	7000	7775	2393.06	Pri.	3.1	66.92	93.7	121.97	147.7	175.86	2.4	21.59	30.23	39.35	47.65	56.73	22	9	12.59	16.39	19.85	23.64	AD	AD	AD	AD	IA
11	H201	Near IISc Staff Qtrs., 8th cross, Adarsh Layout	RMV Extn.	1000	1450	118.94	Sec	2.7	7.03	9.68	12.35	14.58	18.21	2	2.6	3.59	4.57	5.4	6.74	2.5	1.3	1.79	2.29	2.7	3.37	AD	AD	AD	IA	IA
12	H201	RMV Extn.	RMV 1st Main Road	1450	2000	274.16	Sec	3.5	12.74	17.63	22.61	26.88	33.13	2	3.64	5.04	6.46	7.68	9.47	5	1.82	2.52	3.23	3.84	4.73	AD	AD	AD	AD	AD

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
13	H201	C.P.R.I Campus	Gandhi Vidyalaya Assn. near RMV Extn. 2 nd stage	2000	2825	337.13	Sec	3.2	15.94	22.11	28.44	33.93	41.54	2	4.98	6.91	8.89	10.6	12.98	3.7	2.49	3.45	4.44	5.3	6.49	AD	AD	IA	IA	IA
14	H202	Venkateshwara Layout near MSR Medical college	A.G. Colony	0	375	37.74	Sec	2.5	2.1	2.88	3.64	4.26	5.41	1.4	0.84	1.15	1.46	1.71	2.16	1.8	0.6	0.82	1.04	1.22	1.55	AD	AD	AD	AD	AD
15	H205	HMT Shopping Complex	Near St.Chlaret's School &Church, Military Area	0	1000	218.44	Sec	4.2	11.95	16.43	20.91	24.6	30.9	2	2.84	3.91	4.98	5.86	7.36	5	1.42	1.96	2.49	2.93	3.68	AD	AD	AD	AD	AD
16	H205	Near St.Chlaret's School &Church, Military Area	Bandappa Garden, Mutyalamma Nagar	1000	2000	487.39	Sec	4	24.54	33.92	43.45	51.55	63.76	2	6.13	8.48	10.86	12.89	15.94	9	3.07	4.24	5.43	6.44	7.97	AD	AD	AD	AD	AD
17	H205	Bandappa Garden, Mutyalamma Nagar	Mathi Kere Lake	2000	2600	626.76	Sec	4	30.22	41.85	53.73	63.93	78.65	2.2	7.55	10.46	13.43	15.98	19.66	10	3.43	4.76	6.11	7.26	8.94	AD	AD	AD	AD	AD
18	H206	Sanjayanagar	Ring Road	0	1000	142.59	Sec	2	8.13	11.21	14.32	16.93	21.09	1.5	4.06	5.61	7.16	8.47	10.54	6	2.71	3.74	4.77	5.64	7.03	AD	AD	AD	AD	IA
19	H206	Ring Road	Hebbal Lake	1000	1125	228.64	Sec	1.6	11.01	15.21	19.48	23.1	28.6	1.5	6.88	9.51	12.17	14.44	17.87	15	4.59	6.34	8.12	9.62	11.92	AD	AD	AD	AD	AD
20	H207	Devinagar main road	Hebbal Tank inlet weir	0	1500	180	Sec	3.8	26.79	37.34	48.33	58.1	70.13	2.2	7.05	9.83	12.72	15.29	18.45	12	3.21	4.47	5.78	6.95	8.39	AD	AD	AD	AD	AD

LAND USE ANALYSIS FOR HEBBAL MAIN VALLEY 1 (H2) – PROPOSED 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 m3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m2					Required Drain Width 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)
H200	0	875	A3(c)	9.66	8.69	0.97	69.48	10.8	0.02	1.5	2.63	5.54	3.33	19.68	0.457	55.76	76.05	95.81	111.31	143.23	0.68	0.93	1.17	1.36	1.75												
			A3(b)	23.54	16.48	7.06	58.5	12.4	0.01	1.2	2.63	5.54	6.94	24.89	0.439	47.62	65.45	83.25	97.89	123.13	1.37	1.88	2.39	2.81	3.53												
			A3(a)	30	26.1	3.9	67.85	11.04	0.01	1.2	2.63	5.54	9.72	26.31	0.486	45.87	63.17	80.53	94.96	118.81	1.86	2.56	3.26	3.84	4.81												
			Total	**63.2**							3.5										**3.91**	**5.37**	**6.82**	**8.02**	**10.1**	2.6	1.5	**1.1**	**1.5**	**1.9**	**2.3**	**2.9**	**0.7**	**1.0**	**1.3**	**1.5**	**1.9**
H204	0	800	A3(d)	14.81	7.4	7.41	47.49	14	0.01	1.2	2.5	5.33	5.56	24.89	0.394	47.61	65.44	83.25	97.88	123.12	0.77	1.06	1.35	1.59	2												
			A3(c)	18.95	12.32	6.63	55.76	12.8	0.01	1.2	2.5	5.33	6.94	25.08	0.432	47.38	65.13	82.87	97.48	122.53	1.08	1.48	1.88	2.21	2.78												
			Total	**33.76**							2.5										**1.85**	**2.54**	**3.23**	**3.8**	**4.78**												
H200	875	1650	A3(b)	8.46	7.62	0.84	69.54	10.79	0.01	1.2	2.4	11.46	7.64	29.89	0.509	42.09	58.21	74.60	88.55	109.42	0.5	0.7	0.89	1.06	1.31												
			A3(d)	39.49	36.6	2.89	70.97	10.59	0.01	1.2	2.4	11.46	10.42	32.46	0.526	39.82	55.22	71.01	84.64	103.76	2.3	3.19	4.1	4.88	5.99												
			A3(a)	20	18	2	69.5	10.8	0.01	1.2	2.4	11.46	11.11	33.37	0.525	39.09	54.25	69.84	83.37	101.93	1.14	1.58	2.04	2.43	2.98												
			Total	**67.95**							2.4										**3.94**	**5.47**	**7.03**	**8.38**	**10.27**												
			Total	**164.91**							3.2										**9.7**	**13.37**	**17.08**	**20.19**	**25.15**	2.4	2	**3.0**	**4.2**	**5.3**	**6.3**	**7.9**	**1.5**	**2.1**	**2.7**	**3.2**	**3.9**
H200	1650	2450	A3(a)	65.46	57.6	7.86	68.4	10.96	0.01	1.2	2.5	16.33	9.03	36.32	0.532	36.92	51.39	66.38	79.59	96.52	3.57	4.97	6.42	7.7	9.34												
			Total	**230.37**							3.2										**13.27**	**18.35**	**23.51**	**27.9**	**34.49**	3.2	2.4	**4.1**	**5.7**	**7.3**	**8.7**	**10.8**	**1.7**	**2.4**	**3.1**	**3.6**	**4.5**
H205	0	1000	A1(c)	26.11	18.27	7.84	58.49	12.4	0.02	1.5	2.4	6.94	3.33	22.68	0.429	50.69	69.46	88.01	103.00	130.72	1.58	2.16	2.74	3.2	4.06												
			A1(a)	42.33	32.05	10.28	61.64	11.94	0.02	1.5	2.4	6.94	5	23.89	0.446	48.95	67.19	85.32	100.11	126.43	2.57	3.52	4.47	5.25	6.63												
			A1(b)	150	78.92	71.08	48.94	13.79	0.01	1.2	2.4	6.94	5.56	26.29	0.408	45.89	63.19	80.56	94.99	118.86	7.8	10.74	13.7	16.15	20.21												
			Total	**218.44**							2.4										**11.95**	**16.43**	**20.91**	**24.6**	**30.9**	3.7	1.5	**5.0**	**6.8**	**8.7**	**10.3**	**12.9**	**3.3**	**4.6**	**5.8**	**6.8**	**8.6**
H205	1000	2000	A1(b)	109.2	66.6	42.6	53.54	13.12	0.01	1.2	2.35	14.18	5.56	32.86	0.456	39.49	54.79	70.49	84.08	102.95	5.46	7.57	9.74	11.62	14.23												
			A1(c)	159.75	72.5	87.25	44.96	14.37	0.01	1.2	2.35	14.18	6.94	35.5	0.429	37.50	52.15	67.30	80.60	97.95	7.13	9.92	12.8	15.33	18.63												

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					Required Drain Width 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)
			Total	**268.95**							2.35										**12.59**	**17.49**	**22.54**	**26.95**	**32.86**												
			Total	**487.39**							2.35										**24.54**	**33.92**	**43.45**	**51.55**	**63.76**	7	1.5	**10.4**	**14.4**	**18.5**	**21.9**	**27.1**	**7.0**	**9.6**	**12.3**	**14.6**	**18.1**
H205	2000	2600	A3(a)	29.3	11.7	17.6	41.96	14.81	0.01	1.2	2.14	20.25	3.47	38.53	0.426	35.48	49.48	64.08	77.06	92.92	1.23	1.72	2.22	2.67	3.22												
			A2	110.07	36.6	73.47	38.29	15.34	0.02	1.5	2.14	20.25	3.89	39.48	0.417	34.91	48.72	63.15	76.04	91.47	4.45	6.21	8.06	9.7	11.67												
			Total	**139.37**							2.14										**5.68**	**7.93**	**10.28**	**12.37**	**14.89**												
			Total	**626.76**							2.14										**30.22**	**41.85**	**53.73**	**63.93**	**78.65**	7	1.4	**14.1**	**19.6**	**25.1**	**29.9**	**36.8**	**10.1**	**14.0**	**17.9**	**21.3**	**26.3**
H200	2450	2750	A4 (a)	47.21	42.48	4.73	69.49	10.8	0.01	1.2	2.35	19.5	11.81	42.11	0.557	33.42	46.75	60.76	73.40	87.75	2.44	3.42	4.44	5.36	6.41												
			Total	**904.34**							4.1										**30.82**	**42.69**	**54.81**	**65.22**	**80.23**	10	2.2	**7.5**	**10.4**	**13.4**	**15.9**	**19.6**	**3.4**	**4.7**	**6.1**	**7.2**	**8.9**
H203	0	1443	A4(a)	28.07	25.09	2.98	69.16	10.85	0.01	1.2	2	12.03	4.17	27.04	0.499	45.03	62.06	79.22	93.54	116.72	1.75	2.42	3.08	3.64	4.54												
			A4(b)	46.93	35.22	11.71	61.28	12	0.02	1.5	2	12.03	3.89	27.91	0.466	44.08	60.82	77.73	91.94	114.37	2.68	3.7	4.72	5.59	6.95												
			A4(c)	11.65	5.15	6.5	44.31	14.46	0.01	1.2	2	12.03	6.94	33.43	0.422	39.04	54.18	69.76	83.28	101.81	0.53	0.74	0.95	1.14	1.39												
			Total	**86.65**							2										**4.96**	**6.85**	**8.76**	**10.37**	**12.88**												
H200	2750	3500	A5(f)	7.26	3.86	3.4	49.24	13.75	0.01	1.2	2.45	23.81	9.03	46.58	0.486	31.23	43.82	57.19	69.46	82.22	0.31	0.43	0.56	0.68	0.81												
			A4(b)	72.42	61.24	11.18	66.51	11.24	0.01	1.2	2.45	23.81	12.5	47.54	0.561	30.80	43.25	56.50	68.68	81.15	3.47	4.88	6.37	7.75	9.15												
			A4(a)	63.09	35.17	27.92	50.66	13.54	0.02	1.5	2.45	23.81	11.11	48.46	0.496	30.41	42.73	55.86	67.97	80.15	2.64	3.72	4.86	5.91	6.97												
			Total	**142.77**							2.45										**6.43**	**9.02**	**11.79**	**14.34**	**16.93**												
			Total	**1133.76**							3.7										**37.25**	**51.71**	**66.6**	**79.56**	**97.16**	10	2.2	**10.1**	**14.0**	**18.0**	**21.5**	**26.3**	**4.6**	**6.4**	**8.2**	**9.8**	**11.9**
H200	3500	4600	A4(a)	33.71	28.56	5.15	66.6	11.22	0.01	1.2	1.8	34.49	6.94	52.66	0.575	28.76	40.52	53.15	64.95	75.98	1.55	2.18	2.86	3.5	4.09												
			A5(a)	61.63	51.85	9.78	66.27	11.27	0.01	1.2	1.8	34.49	8.33	54.09	0.579	28.24	39.82	52.30	64.00	74.67	2.8	3.95	5.19	6.35	7.41												
			A5(g)	33.2	28.59	4.61	67.36	11.11	0.02	1.5	1.8	34.49	10	55.6	0.586	27.72	39.13	51.44	63.04	73.36	1.5	2.11	2.78	3.41	3.96												

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					Required Drain Width 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)
			Total	**128.54**							1.8										**5.85**	**8.24**	**10.83**	**13.25**	**15.46**												
			Total	**1262.3**							3.7										**43.09**	**59.95**	**77.43**	**92.81**	**112.62**	13	2.4	**11.6**	**16.2**	**20.9**	**25.1**	**30.4**	**4.9**	**6.8**	**8.7**	**10.5**	**12.7**
H201	0	500	A5(c)	23.05	19.05	4	65.46	11.39	0.01	1.2	2.2	3.79	5.56	20.73	0.447	53.85	73.57	92.88	108.19	138.51	1.54	2.1	2.66	3.09	3.96												
			A5(d)	22.48	15.7	6.78	58.41	12.41	0.02	1.5	2.2	3.79	6.67	22.87	0.429	50.41	69.09	87.58	102.53	130.03	1.35	1.85	2.34	2.74	3.48												
			Total	**45.53**							2.8										**2.89**	**3.95**	**5.00**	**5.84**	**7.44**	2	1.4	**1.0**	**1.4**	**1.8**	**2.1**	**2.7**	**0.7**	**1.0**	**1.3**	**1.5**	**1.9**
H201	500	1000	A5(d)	35	28.64	6.36	65.01	11.45	0.01	1.2	2.1	7.94	9.03	28.42	0.488	43.55	60.12	76.89	91.03	113.05	2.07	2.85	3.65	4.32	5.36												
			Total	**35**							2.1										**2.07**	**2.85**	**3.65**	**4.32**	**5.36**												
			Total	**80.53**							3.2										**4.95**	**6.8**	**8.65**	**10.16**	**12.8**	2	1.8	**1.5**	**2.1**	**2.7**	**3.2**	**4.0**	**0.9**	**1.2**	**1.5**	**1.8**	**2.2**
H201	1000	1450	A5(c)	38.41	30.57	7.84	63.77	11.63	0.01	1.2	1.95	12.39	9.72	33.75	0.501	38.79	53.86	69.37	82.86	101.20	2.07	2.88	3.71	4.43	5.4												
			Total	**38.41**							1.95										**2.07**	**2.88**	**3.71**	**4.43**	**5.4**												
			Total	**118.94**							2.7										**7.03**	**9.68**	**12.35**	**14.58**	**18.21**	2.5	2	**2.6**	**3.6**	**4.6**	**5.4**	**6.7**	**1.3**	**1.8**	**2.3**	**2.7**	**3.4**
H202	0	375	A4(b)	10.39	4.16	6.23	42.02	14.8	0.01	1.2	2.2	2.84	4.17	21.8	0.359	52.05	71.23	90.11	105.24	134.08	0.54	0.74	0.93	1.09	1.39												
			A5(f)	27.35	16.15	11.2	52.48	13.28	0.01	1.2	2.2	2.84	6.94	23.06	0.409	50.12	68.72	87.14	102.06	129.33	1.56	2.14	2.71	3.17	4.02												
			Total	**37.74**							2.5										**2.1**	**2.88**	**3.64**	**4.26**	**5.41**	1.8	1.4	**0.8**	**1.2**	**1.5**	**1.7**	**2.2**	**0.6**	**0.8**	**1.0**	**1.2**	**1.5**
H201	1450	2000	A5(e)	113.77	70.75	43.02	54.2	13.03	0.01	1.2	2.5	13.33	9.72	36.08	0.474	37.09	51.61	66.65	79.88	96.93	5.55	7.73	9.98	11.96	14.51												
			A5(g)	3.71	1.48	2.23	41.94	14.81	0.02	1.5	2.5	13.33	9.44	37.59	0.423	36.08	50.27	65.04	78.11	94.41	0.16	0.22	0.28	0.34	0.41												
			Total	**117.48**							2.5										**5.71**	**7.95**	**10.26**	**12.3**	**14.92**												
			Total	**274.16**							3.5										**12.74**	**17.63**	**22.61**	**26.88**	**33.13**	5	2	**3.6**	**5.0**	**6.5**	**7.7**	**9.5**	**1.8**	**2.5**	**3.2**	**3.8**	**4.7**
H201	2000	2825	A5(b)	62.97	55.13	7.84	68.15	11	0.01	1.2	2.45	19.22	12.5	42.71	0.553	33.10	46.32	60.24	72.83	86.95	3.2	4.48	5.83	7.05	8.41												
			Total	**62.97**							2.45										**3.2**	**4.48**	**5.83**	**7.05**	**8.41**												
			Total	**337.13**							3.2										**15.94**	**22.11**	**28.44**	**33.93**	**41.54**	3.7	2	**5.0**	**6.9**	**8.9**	**10.6**	**13.0**	**2.5**	**3.5**	**4.4**	**5.3**	**6.5**

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 Coeffecent "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					Required Drain Width 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)
H200	4600	5000	A5(a)	19.61	14	5.61	59.27	12.29	0.01	1.2	2.7	30.86	13.19	56.35	0.554	27.47	38.80	51.03	62.59	72.74	0.83	1.17	1.54	1.89	2.19												
			A6(b)	2.46	2.14	0.32	67.85	11.04	0.01	1.2	2.7	30.86	15.28	57.18	0.590	27.20	38.43	50.58	62.08	72.05	0.11	0.15	0.2	0.25	0.29												
			Total	**22.07**							2.7										**0.94**	**1.33**	**1.74**	**2.14**	**2.49**												
			Total	**1621.5**							3.2										**48.81**	**67.91**	**87.71**	**105.13**	**127.56**	16.5	2.4	**15.3**	**21.2**	**27.4**	**32.9**	**39.9**	**6.4**	**8.8**	**11.4**	**13.7**	**16.6**
H200	5000	6000	A6(a)	62.54	35.62	26.92	51.33	13.44	0.02	1.5	1.9	38.16	11.11	62.71	0.529	25.56	36.23	47.86	59.02	67.89	2.35	3.33	4.4	5.42	6.24												
			A6(b)	59.64	51.67	7.97	67.65	11.07	0.01	1.2	1.9	38.16	17.36	66.59	0.597	24.55	34.87	46.18	57.12	65.32	2.43	3.45	4.57	5.65	6.46												
			Total	**122.18**							1.9										**4.78**	**6.77**	**8.96**	**11.07**	**12.69**												
			Total	**1743.68**							2.8										**53.59**	**74.69**	**96.67**	**116.2**	**140.26**	11	2.5	**19.1**	**26.7**	**34.5**	**41.5**	**50.1**	**7.7**	**10.7**	**13.8**	**16.6**	**20.0**
H200	6000	7000	A6(a)	277.07	137.69	139.38	47.33	14.02	0.01	1.2	1.5	50.56	8.33	72.91	0.512	23.10	32.90	43.73	54.35	61.61	9.1	12.96	17.22	21.41	24.27												
			A6(b)	57.5	20.2	37.3	39.32	15.19	0.01	1.2	1.5	50.56	9.03	74.77	0.478	22.71	32.37	43.08	53.61	60.62	1.73	2.47	3.29	4.09	4.63												
			A7(a)	7.65	5.88	1.77	62.27	11.85	0.01	1.2	1.5	50.56	15.28	77.68	0.576	22.13	31.59	42.10	52.50	59.14	0.27	0.39	0.51	0.64	0.72												
			Total	**342.22**							1.5										**11.1**	**15.81**	**21.03**	**26.14**	**29.61**												
			Total	**2085.9**							3.1										**64.69**	**90.5**	**117.69**	**142.34**	**169.87**	20	2.4	**20.9**	**29.2**	**38.0**	**45.9**	**54.8**	**8.7**	**12.2**	**15.8**	**19.1**	**22.8**
H206	0	900	A6(c)	77.13	53.4	23.73	58.08	12.46	0.01	1.2	2	7.5	6.94	26.91	0.449	45.18	62.26	79.45	93.80	117.10	4.35	5.99	7.64	9.02	11.26												
			A6(e)	37.42	26.58	10.84	59.07	12.32	0.02	1.5	2	7.5	7.78	27.6	0.458	44.42	61.26	78.26	92.51	115.21	2.12	2.92	3.73	4.41	5.49												
			A6(d)	28.04	24.67	3.37	68.39	10.96	0.01	1.2	2	7.5	11.11	29.57	0.505	42.40	58.61	75.08	89.07	110.18	1.67	2.31	2.96	3.51	4.34												
			Total	**142.59**							2										**8.13**	**11.21**	**14.32**	**16.93**	**21.09**	6	1.5	**4.1**	**5.6**	**7.2**	**8.5**	**10.5**	**2.7**	**3.7**	**4.8**	**5.6**	**7.0**
H206	900	1125	A6(c)	12.11	10.29	1.82	66.73	11.2	0.01	1.2	1.6	11.72	9.03	31.95	0.506	40.25	55.78	71.68	85.38	104.83	0.68	0.95	1.22	1.45	1.78												
			A6(f)	24.55	22.1	2.45	69.51	10.8	0.01	1.2	1.6	11.72	10.42	32.93	0.522	39.44	54.71	70.39	83.97	102.80	1.4	1.95	2.51	2.99	3.66												
			A7(b)	49.39	20.69	28.7	43.04	14.65	0.02	1.5	1.6	11.72	8.89	35.26	0.424	37.67	52.37	67.58	80.90	98.38	2.19	3.05	3.94	4.71	5.73												
			Total	**86.05**							1.6										**2.88**	**4**	**5.16**	**6.16**	**7.51**												

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 m3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m2					Required Drain Width 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)
			Total	**228.64**							1.6										**11.01**	**15.21**	**19.48**	**23.1**	**28.6**	15	1.5	**6.9**	**9.5**	**12.2**	**14.4**	**17.9**	**4.6**	**6.3**	**8.1**	**9.6**	**11.9**
H200	7000	7775	A7(a)	64.71	25.88	38.83	42	14.8	0.01	1.2	1.4	63.39	6.94	85.14	0.486	20.81	29.79	39.86	49.93	55.75	1.82	2.6	3.48	4.36	4.87												
			A7(b)	13.81	7.9	5.91	51.46	13.42	0.01	1.2	1.4	63.39	10.42	87.23	0.529	20.47	29.33	39.28	49.27	54.89	0.42	0.59	0.8	1	1.11												
			Total	**78.52**							1.4										**2.23**	**3.2**	**4.28**	**5.36**	**5.99**												
			Total	**2393.06**							3.1										**66.92**	**93.7**	**121.97**	**147.7**	**175.86**	22	2.4	**21.6**	**30.2**	**39.3**	**47.6**	**56.7**	**9.0**	**12.6**	**16.4**	**19.9**	**23.6**
H200	7775	9000	A7(b)	102.72	72	30.72	58.55	12.39	0.01	1.2	1.5	72.78	8.33	93.5	0.559	19.54	28.06	37.68	47.43	52.49	3.11	4.47	6	7.56	8.36												
			A8(a)	39.67	31.73	7.94	63.99	11.6	0.01	1.2	1.5	72.78	11.11	95.49	0.580	19.26	27.68	37.21	46.89	51.78	1.23	1.77	2.38	3	3.31												
			A8(c)	17.49	13.47	4.02	62.36	11.84	0.02	1.5	1.5	72.78	12.22	96.84	0.576	19.08	27.44	36.90	46.53	51.32	0.53	0.77	1.03	1.3	1.43												
			A7(a)	37.46	22.46	15	52.98	13.2	0.01	1.2	1.5	72.78	12.5	98.48	0.533	18.87	27.14	36.53	46.10	50.76	1.05	1.51	2.03	2.56	2.82												
			Total	**197.34**							1.5										**4.88**	**7.01**	**9.41**	**11.86**	**13.11**												
			Total	**2590.4**							3.2										**71.8**	**100.71**	**131.39**	**159.56**	**188.97**	24	2.4	**22.4**	**31.5**	**41.1**	**49.9**	**59.1**	**9.3**	**13.1**	**17.1**	**20.8**	**24.6**

Table 4.3 Showing Adequacy Analysis Results for Hebbal Minor Valley – I (H3) - Existing Hydraulic Flow Conditions

Sl.No.	Description	Drain Reach		Chainage (m)		Catchment Area A (Ha.)	Type	Average Velocity V m/sec	Discharges (Q in m³/sec)					Existing Av.Drain Depth D in m.	Area required for drain (A in m²)					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	H300	Jaibharathnagar	Kanakadas Layout	0	750	33.69	Pri.	2	2.05	2.82	3.59	4.23	5.3	1.4	1.02	1.41	1.79	2.11	2.65	2.8	0.73	1.01	1.28	1.51	1.89	AD	AD	AD	AD	AD
2	H300	Kanakadas Layout	Jai Maatadi Devasthan Road	750	1350	176.65	Pri.	2.5	10.88	14.99	19.12	22.57	28.18	1.5	4.35	5.99	7.65	9.03	11.27	3	2.9	4	5.1	6.02	7.52	AD	IA	IA	IA	IA
3	H300	Jai Maatadi Devasthan Road	60 ft Road HBR Layout	1350	1975	182.03	Pri.	2.4	11.19	15.43	19.68	23.24	29.01	1.5	4.66	6.43	8.2	9.68	12.09	3.2	3.11	4.28	5.47	6.46	8.06	AD	IA	IA	IA	IA
4	H300	60 ft Road HBR Layout	Kammanahalli	1975	2200	348.89	Pri.	3.56	21.38	29.46	37.61	44.42	55.41	2.02	6	8.28	10.57	12.48	15.57	10.6	2.97	4.1	5.23	6.18	7.71	AD	AD	AD	AD	AD
5	H300	Kammanahalli	1 st Stage, 2 nd Block, HBR Layout	2200	2600	402.74	Pri.	3.32	24.75	34.12	43.54	51.41	64.16	2.4	7.46	10.28	13.11	15.49	19.32	10.27	3.11	4.28	5.46	6.45	8.05	AD	AD	AD	AD	AD
6	H300	1 st Stage, 2 nd Block, HBR Layout	5 th cross road, HBR Layout, Yaseen nagar	2600	3050	419.18	Pri.	3.43	25.48	35.13	44.85	52.99	66.07	2.51	7.43	10.24	13.08	15.45	19.26	11.56	2.96	4.08	5.21	6.16	7.67	AD	AD	AD	AD	AD
7	H300	5 th cross road, HBR Layout, Yaseen nagar	Near Telephone exchange, Yaseen nagar	3050	3600	533.02	Pri.	2.7	32.33	44.58	56.91	67.25	83.83	2.63	11.98	16.51	21.08	24.91	31.05	12.09	4.55	6.28	8.02	9.47	11.81	AD	AD	AD	AD	AD
8	H300	Near Telephone exchange, Yaseen nagar	Near Rahat Ali Layout	3600	4200	1142.91	Pri.	2.6	51.45	71.14	91.18	108.25	133.74	2.79	19.79	27.36	35.07	41.63	51.44	14	7.09	9.81	12.57	14.92	18.44	AD	AD	AD	IA	IA
9	H300	Near Rahat Ali Layout	5 th block, HBR Layout near Outer Ring Road	4200	4800	1241.89	Pri.	2.24	55.72	77.16	99.08	117.92	145.02	2.4	24.87	34.45	44.23	52.64	64.74	14.47	10.36	14.35	18.43	21.93	26.97	AD	AD	IA	IA	IA
10	H300	5 th block, HBR Layout near Outer Ring Road	Telecom employer co-operating society layout	4800	5400	1365.77	Pri.	2.7	60.97	84.58	108.86	129.94	158.94	2.11	22.58	31.33	40.32	48.12	58.87	16	10.7	14.85	19.11	22.81	27.9	AD	AD	IA	IA	IA
11	H300	Telecom employer co-operating society layout	Near Gedalahalli main road	5400	6000	1440.12	Pri.	1.8	63.98	88.86	114.51	136.92	166.94	1.6	35.54	49.36	63.62	76.07	92.74	16.51	22.21	30.85	39.76	47.54	57.96	IA	IA	IA	IA	IA
12	H300	Near Gedalahalli main road	Near Hennur Main Road	6000	6600	1505.68	Pri.	2.1	66.04	91.78	118.4	141.74	172.42	1.9	31.45	43.71	56.38	67.5	67.5	12.5	16.55	23	29.67	35.52	35.52	IA	IA	IA	IA	IA
13	H300	Near Hennur Main Road	Raja Canal STP	6600	7375	1528.6	Sec.	2	66.71	92.74	119.68	143.33	174.21	2.2	33.35	46.37	59.84	71.67	87.11	8.68	15.16	21.08	27.2	32.58	39.59	IA	IA	IA	IA	IA

Sl.No.	Description	Drain Reach		Chainage (m)		Catchment Area A (Ha.)	Type	Average Velocity V m/sec	Discharges (Q in m³/sec)					Existing Av.Drain Depth D in m.	Area required for drain (A in m²)					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
14	H301	Keshavanagar, near Kacharakanahlli	Near Hennur Main Road	0	500	33.58	Sec.	2.6	2.47	3.36	4.22	4.88	6.33	1.23	0.95	1.29	1.62	1.88	2.44	1.6	0.77	1.05	1.32	1.53	1.98	AD	AD	AD	AD	IA
7	H301	Near Hennur Main Road	Gandhinagar	500	1150	61.77	Pri.	2.3	4.32	5.9	7.44	8.66	11.11	1.62	1.88	2.57	3.24	3.77	4.83	2.81	1.16	1.58	2	2.32	2.98	AD	AD	AD	AD	IA
8	H302	Ramaswamipalya	60 ft Road HBR Layout	0	975	36.14	Pri.	2.2	2.37	3.25	4.13	4.84	6.12	1.2	1.08	1.48	1.88	2.2	2.78	2.31	0.9	1.23	1.56	1.83	2.32	AD	AD	AD	AD	IA
9	H303	Kammanahalli Mn. Road	Nehru road, Kammanahalli	0	225	11.81	Pri.	2.5	0.85	1.16	1.45	1.69	2.18	1.55	0.34	0.46	0.58	0.68	0.87	1.5	0.22	0.3	0.38	0.44	0.56	AD	AD	AD	AD	AD
10	H304	Pillana Garden near Lingarajapura	1 st Cross, Ramachandrapa Layout	0	900	71.19	Pri.	2.9	4.63	6.35	8.07	9.48	11.95	1.2	1.6	2.19	2.78	3.27	4.12	2.5	1.33	1.83	2.32	2.72	3.43	AD	AD	AD	IA	IA
11	H304	1 st Cross, Ramachandrapa Layout	1 st block, 60 ft road, HBR Layout	900	1700	166.85	Pri.	2.7	10.18	14.04	17.93	21.18	26.4	2.59	3.77	5.2	6.64	7.85	9.78	7.4	1.46	2.01	2.56	3.03	3.78	AD	AD	AD	AD	AD
12	H305	Banaswadi	Kanakadasa Layout	0	550	40.27	Pri.	1.7	2.57	3.52	4.48	5.25	6.63	1.5	1.51	2.07	2.63	3.09	3.09	3.2	1.01	1.38	1.76	2.06	2.06	AD	AD	AD	AD	AD
13	H306	Modi Garden near Kavala bairasandra	Sayeedaya nagar	0	450	59.35	Pri.	1.8	3.58	4.91	6.22	7.29	9.24	1.4	1.99	2.73	3.46	4.05	5.13	2.6	1.42	1.95	2.47	2.89	3.67	AD	AD	AD	IA	IA
14	H306	Sayeedaya nagar	Near Shampura main road	450	1000	234.29	Pri.	2.1	13.98	19.25	24.56	28.97	36.21	1.6	6.66	9.17	11.69	13.79	17.24	6.32	4.16	5.73	7.31	8.62	10.78	AD	AD	IA	IA	IA
15	H306	Near Shampura main road	Gandhinagar 4 th cross road, K.G.Halli	1000	2000	381.46	Pri.	2.8	22.37	30.89	39.51	46.79	58.08	2.1	7.99	11.03	14.11	16.71	20.74	7.1	3.8	5.25	6.72	7.96	9.88	AD	AD	AD	IA	IA
16	H307	Modi road near Devara jeevanahalli	Kavala Bairasandra	0	682	88.12	Pri.	2.1	5.23	7.2	9.17	10.81	13.54	1.3	2.49	3.43	4.37	5.15	6.45	2.8	1.91	2.64	3.36	3.96	4.96	AD	AD	IA	IA	IA

Landuse Analysis for Hebbal Minor Valley -1(H3) – 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					Required Drain Width 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)
H300	0	750	A23(a)	15.22	10.65	4.57	58.49	12.4	0.01	1.2	2	6.25	6.94	25.6	0.444	46.73	64.28	81.86	96.40	120.92	0.88	1.21	1.54	1.81	2.27												
			A23(b)	18.47	16.62	1.85	69.49	10.8	0.01	1.2	2	6.25	9.03	26.08	0.494	46.14	63.52	80.95	95.42	119.48	1.17	1.61	2.05	2.42	3.03												
			Total	**33.69**							2										**2.05**	**2.82**	**3.59**	**4.23**	**5.3**	2.8	1.4	**1.0**	**1.4**	**1.8**	**2.1**	**2.6**	**0.7**	**1.0**	**1.3**	**1.5**	**1.9**
H305	0	550	A22(a)	22.54	18.5	4.04	65.14	11.43	0.01	1.2	1.7	5.39	6.94	23.77	0.462	49.11	67.40	85.57	100.38	126.83	1.42	1.95	2.48	2.9	3.67												
			A22(b)	17.73	15.95	1.78	69.48	10.8	0.01	1.2	1.7	5.39	8.33	24.53	0.483	48.09	66.06	83.98	98.67	124.29	1.14	1.57	2	2.35	2.96												
				40.27							1.7										**2.57**	**3.52**	**4.48**	**5.25**	**6.63**	3.2	1.5	**1.5**	**2.1**	**2.6**	**3.1**	**3.9**	**1.0**	**1.4**	**1.8**	**2.1**	**2.6**
			Total	**73.96**																	**4.61**	**6.34**	**8.06**	**9.48**	**11.93**												
H300	750	1350	A26(b)	62.69	56.42	6.27	69.5	10.8	0.02	1.5	2.5	9	7.78	27.58	0.499	44.44	61.29	78.29	92.54	115.25	3.86	5.33	6.8	8.04	10.02												
			A22(b)	40	36	4	69.5	10.8	0.01	1.2	2.5	9	9.72	29.52	0.509	42.45	58.67	75.16	89.15	110.30	2.4	3.32	4.25	5.05	6.24												
			Total	102.69							2.5										**6.26**	**8.65**	**11.06**	**13.09**	**16.26**												
			Total	**176.65**							2.5										**10.88**	**14.99**	**19.12**	**22.57**	**28.18**	3	1.5	**4.4**	**6.0**	**7.6**	**9.0**	**11.3**	**2.9**	**4.0**	**5.1**	**6.0**	**7.5**
H300	1350	1975	A26(a)	5.38	4.84	0.54	69.46	10.81	0.01	1.2	2.4	13.72	6.25	30.77	0.515	41.28	57.14	73.32	87.15	107.40	0.32	0.44	0.56	0.67	0.83												
			Total	**182.03**							2.4										**11.19**	**15.43**	**19.68**	**23.24**	**29.01**	3.2	1.5	**4.7**	**6.4**	**8.2**	**9.7**	**12.1**	**3.1**	**4.3**	**5.5**	**6.5**	**8.1**
H304	0	900	A21(a)	71.19	64.07	7.12	69.5	10.8	0.01	1.2	2.9	5.17	8.33	24.31	0.483	48.38	66.45	84.44	99.17	125.02	4.63	6.35	8.07	9.48	11.95												
			Total	**71.19**							2.9										**4.63**	**6.35**	**8.07**	**9.48**	**11.95**	2.5	1.2	**1.6**	**2.2**	**2.8**	**3.3**	**4.1**	**1.3**	**1.8**	**2.3**	**2.7**	**3.4**
H304	900	1700	A21(a)	9.69	2.94	6.75	36.68	15.57	0.02	1.5	2.7	10.49	2.22	28.29	0.369	43.68	60.30	77.10	91.26	113.38	0.43	0.6	0.77	0.91	1.13												
			A21(b)	85.97	77.27	8.7	69.43	10.81	0.01	1.2	2.7	10.49	9.03	30.33	0.515	41.68	57.67	73.95	87.84	108.40	5.12	7.09	9.09	10.8	13.32												

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					Required Drain Width 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)
				95.66							2.7										**5.56**	**7.69**	**9.85**	**11.7**	**14.45**												
			Total	**166.85**							2.7										**10.18**	**14.04**	**17.93**	**21.18**	**26.4**	7.4	2.59	**3.8**	**5.2**	**6.6**	**7.8**	**9.8**	**1.5**	**2.0**	**2.6**	**3.0**	**3.8**
H300	1975	2200		**348.89**							3.56										**21.38**	**29.46**	**37.61**	**44.42**	**55.41**	10.6	2.02	**6.0**	**8.3**	**10.6**	**12.5**	**15.6**	**3.0**	**4.1**	**5.2**	**6.2**	**7.7**
H303	0	225	A24	11.81	10.63	1.18	69.5	10.8	0.01	1.2	2.5	1.5	6.94	19.24	0.457	56.62	77.16	97.11	112.69	145.32	0.85	1.16	1.45	1.69	2.18	1.5	1.55	**0.3**	**0.5**	**0.6**	**0.7**	**0.9**	**0.2**	**0.3**	**0.4**	**0.4**	**0.6**
H302	0	975	A25	24.33	21.89	2.44	69.49	10.8	0.01	1.2	2.2	7.39	8.33	26.52	0.494	45.62	62.84	80.14	94.54	118.19	1.52	2.1	2.67	3.16	3.94												
			Total	**36.14**							2.2										**2.37**	**3.25**	**4.13**	**4.84**	**6.12**	2.31	1.2	**1.1**	**1.5**	**1.9**	**2.2**	**2.8**	**0.9**	**1.2**	**1.6**	**1.8**	**2.3**
H300	2200	2600	A24	17.72	15.95	1.77	69.51	10.8	0.01	1.2	3.32	13.05	9.72	33.57	0.525	38.93	54.04	69.59	83.09	101.53	1.01	1.4	1.8	2.15	2.63												
			Total	**402.74**							3.32										**24.75**	**34.12**	**43.54**	**51.41**	**64.16**	10.27	2.4	**7.5**	**10.3**	**13.1**	**15.5**	**19.3**	**3.1**	**4.3**	**5.5**	**6.5**	**8.1**
H300	2600	3050	A21(b)	11.37	3.12	8.25	35.09	15.8	0.01	1.2	3.43	14.82	6.25	36.87	0.395	36.55	50.89	65.79	78.94	95.58	0.46	0.63	0.82	0.98	1.19												
			A27(a)	5.07	4.56	0.51	69.5	10.8	0.01	1.2	3.43	14.82	12.5	38.12	0.544	35.74	49.82	64.49	77.51	93.56	0.27	0.38	0.49	0.59	0.72												
			Total	**16.44**							3.43										**0.73**	**1.02**	**1.31**	**1.58**	**1.91**												
			Total	**419.18**							3.43										**25.48**	**35.13**	**44.85**	**52.99**	**66.07**	11.56	2.51	**7.4**	**10.2**	**13.1**	**15.4**	**19.3**	**3.0**	**4.1**	**5.2**	**6.2**	**7.7**
H301	0	500	A27(b)	33.58	30.22	3.36	69.5	10.8	0.01	1.2	2.6	3.21	4.17	18.17	0.450	58.84	80.04	100.51	116.28	150.78	2.47	3.36	4.22	4.88	6.33	1.6	1.23	**1.0**	**1.3**	**1.6**	**1.9**	**2.4**	**0.8**	**1.1**	**1.3**	**1.5**	**2.0**
H301	500	1150	A27(a)	28.19	25.37	2.82	69.49	10.8	0.02	1.5	2.3	8.33	4.44	23.58	0.478	49.38	67.75	85.99	100.83	127.49	1.85	2.54	3.22	3.78	4.78												
			Total	**61.77**							2.3										**4.32**	**5.9**	**7.44**	**8.66**	**11.11**	2.81	1.62	**1.9**	**2.6**	**3.2**	**3.8**	**4.8**	**1.2**	**1.6**	**2.0**	**2.3**	**3.0**
			Total	**480.95**							2.3										**29.8**	**41.03**	**52.3**	**61.65**	**77.18**												

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 Terrain (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					Required Drain Width 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)
H300	3050	3775	A27(a)	9.91	7.93	1.98	64.01	11.6	0.01	1.2	2.7	23.3	8.33	43.23	0.539	32.84	45.97	59.81	72.35	86.27	0.49	0.68	0.89	1.07	1.28												
			A27(b)	42.16	33.78	8.38	64.07	11.59	0.01	1.2	2.7	23.3	9.72	44.61	0.543	32.15	45.05	58.69	71.12	84.54	2.04	2.86	3.73	4.52	5.37												
			Total	**52.07**							2.7										**2.53**	**3.55**	**4.62**	**5.59**	**6.65**												
			Total	**533.02**							2.7										**32.33**	**44.58**	**56.91**	**67.25**	**83.83**	12.09	2.63	**12.0**	**16.5**	**21.1**	**24.9**	**31.0**	**4.6**	**6.3**	**8.0**	**9.5**	**11.8**
H306	0	450	A17(a)	40.92	28.75	12.17	58.64	12.38	0.01	1.2	1.8	4.17	5.56	22.1	0.429	51.58	70.62	89.39	104.46	132.92	2.51	3.44	4.35	5.09	6.48												
			A17(b)	18.43	12.9	5.53	58.5	12.4	0.01	1.2	1.8	4.17	8.33	24.9	0.439	47.60	65.43	83.23	97.86	123.09	1.07	1.47	1.87	2.2	2.76												
			Total	**59.35**							1.8										**3.58**	**4.91**	**6.22**	**7.29**	**9.24**	2.6	1.4	**2.0**	**2.7**	**3.5**	**4.0**	**5.1**	**1.4**	**1.9**	**2.5**	**2.9**	**3.7**
H307	0	682	A18(a)	23.79	15.58	8.21	56.02	12.76	0.02	1.5	2.1	5.41	5.56	23.73	0.426	49.17	67.48	85.66	100.48	126.97	1.38	1.9	2.41	2.83	3.57												
			A18(b)	39.4	30.49	8.91	62.56	11.81	0.01	1.2	2.1	5.41	9.72	26.94	0.465	45.14	62.21	79.39	93.73	116.99	2.3	3.17	4.04	4.77	5.96												
			A19(b)	24.93	22.44	2.49	69.51	10.8	0.01	1.2	2.1	5.41	11.11	27.32	0.499	44.72	61.65	78.72	93.01	115.94	1.55	2.13	2.72	3.21	4.01												
			Total	**88.12**							2.1										**5.23**	**7.2**	**9.17**	**10.81**	**13.54**	2.8	1.3	**2.5**	**3.4**	**4.4**	**5.1**	**6.4**	**1.9**	**2.6**	**3.4**	**4.0**	**5.0**
H306	450	1000	A19(a)	43.66	39.29	4.37	69.49	10.8	0.01	1.2	2.1	7.94	9.72	28.46	0.504	43.51	60.07	76.83	90.96	112.94	2.66	3.67	4.7	5.56	6.91												
			A20(a)	20.12	17.11	3.01	66.77	11.2	0.01	1.2	2.1	7.94	11.81	30.94	0.502	41.13	56.94	73.08	86.90	107.02	1.15	1.6	2.05	2.44	3												
			A17(b)	23.04	20.74	2.3	69.51	10.8	0.01	1.2	2.1	7.94	12.5	31.24	0.518	40.87	56.59	72.66	86.44	106.37	1.36	1.88	2.41	2.87	3.53												
			Total	**86.82**							2.1										**5.17**	**7.15**	**9.16**	**10.87**	**13.44**												
			Total	**234.29**							2.1										**13.98**	**19.25**	**24.56**	**28.97**	**36.21**	6.32	1.6	**6.7**	**9.2**	**11.7**	**13.8**	**17.2**	**4.2**	**5.7**	**7.3**	**8.6**	**10.8**
H306	1000	2000	A20(a)	97.79	88.01	9.78	69.5	10.8	0.01	1.2	2.8	11.9	9.03	31.73	0.518	40.43	56.02	71.98	85.70	105.29	5.69	7.89	10.13	12.06	14.82												
			A20(b)	49.38	39.51	9.87	64.01	11.6	0.02	1.5	2.8	11.9	10	33.5	0.505	38.98	54.11	69.67	83.19	101.67	2.7	3.75	4.82	5.76	7.04												

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					Required Drain Width 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)
			Total	**147.17**							2.8										**8.39**	**11.63**	**14.96**	**17.82**	**21.86**												
			Total	**381.46**							2.8										**22.37**	**30.89**	**39.51**	**46.79**	**58.08**	7.1	2.1	**8.0**	**11.0**	**14.1**	**16.7**	**20.7**	**3.8**	**5.3**	**6.7**	**8.0**	**9.9**
H306	2000	3025	A20(a)	41.91	37.72	4.19	69.5	10.8	0.01	1.2	2	21.46	5.56	37.81	0.540	35.93	50.08	64.80	77.86	94.05	2.26	3.15	4.07	4.89	5.91												
			A20(b)	89.1	73.84	15.26	65.58	11.37	0.01	1.2	2	21.46	8.33	41.16	0.537	33.94	47.43	61.59	74.32	89.04	4.51	6.31	8.19	9.88	11.84												
			Total	**131.01**							2										**6.77**	**9.45**	**12.26**	**14.78**	**17.75**												
			Total	**512.47**							2										**29.14**	**40.34**	**51.78**	**61.57**	**75.83**												
H300	3775	4200	A29	35.03	30.53	4.5	67.93	11.03	0.01	1.2	2.6	26.92	11.11	49.06	0.572	30.16	42.39	55.44	67.51	79.52	1.68	2.36	3.08	3.75	4.42												
			A27(a)	62.39	51.3	11.09	65.22	11.42	0.02	1.5	2.6	26.92	13.33	51.68	0.568	29.12	41.01	53.75	65.62	76.90	2.87	4.04	5.29	6.46	7.58												
			Total	**97.42**							2.6										4.55	6.4	8.38	10.22	12												
			Total	**1142.91**							2.6										**51.45**	**71.14**	**91.18**	**108.25**	**133.74**	14	2.79	**19.8**	**27.4**	**35.1**	**41.6**	**51.4**	**7.1**	**9.8**	**12.6**	**14.9**	**18.4**
H300	4200	4800	A30	26.42	7.93	18.49	36.51	15.6	0.02	1.5	2.24	30.13	7.78	53.51	0.450	28.45	40.10	52.64	64.38	75.20	0.94	1.32	1.74	2.12	2.48												
			A34	24.04	20.4	3.64	66.67	11.21	0.01	1.2	2.24	30.13	12.5	53.85	0.577	28.33	39.94	52.44	64.16	74.90	1.09	1.54	2.02	2.47	2.89												
			A29	48.52	43.67	4.85	69.5	10.8	0.01	1.2	2.24	30.13	13.89	54.82	0.592	27.99	39.49	51.88	63.53	74.03	2.23	3.15	4.14	5.07	5.91												
			Total	**98.98**							2.24										**4.26**	**6.01**	**7.9**	**9.67**	**11.27**												
			Total	**1241.89**							2.24										**55.72**	**77.16**	**99.08**	**117.92**	**145.02**	14.47	2.4	**24.9**	**34.4**	**44.2**	**52.6**	**64.7**	**10.4**	**14.4**	**18.4**	**21.9**	**27.0**
H300	4800	5400	A30	68.52	49.98	18.55	60.11	12.17	0.01	1.2	2.7	33.33	12.5	58	0.560	26.95	38.09	50.16	61.60	71.39	2.87	4.06	5.35	6.57	7.62												
			A29	55.36	44.29	11.07	64	11.6	0.01	1.2	2.7	33.33	13.89	58.82	0.580	26.69	37.75	49.74	61.13	70.75	2.38	3.36	4.43	5.45	6.31												
			Total	**123.88**							2.7										**5.25**	**7.43**	**9.78**	**12.02**	**13.92**												
			Total	**1365.77**							2.7										**60.97**	**84.58**	**108.86**	**129.94**	**158.94**	16	2.11	**22.6**	**31.3**	**40.3**	**48.1**	**58.9**	**10.7**	**14.8**	**19.1**	**22.8**	**27.9**

Description about drain	Chainage		Sub Catchment	Total Area (Ha.)	Area of builitup 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					Required Drain Width 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)
H300	5400	6000	A29	74.34	60.28	14.06	64.6	11.51	0.01	1.2	1.8	43.06	10.42	64.99	0.584	24.96	35.41	46.85	57.88	66.35	3.01	4.27	5.65	6.98	8												
			Total	**1440.12**							1.8										**63.98**	**88.86**	**114.51**	**136.92**	**166.94**	16.51	1.6	**35.5**	**49.4**	**63.6**	**76.1**	**92.7**	**22.2**	**30.9**	**39.8**	**47.5**	**58.0**
H300	6000	6600	A30	30.94	10.21	20.73	38.15	15.36	0.01	1.2	2.1	46.43	8.33	70.12	0.474	23.71	33.73	44.77	55.52	63.18	0.97	1.37	1.82	2.26	2.57												
			A29	34.62	13.84	20.78	41.99	14.8	0.01	1.2	2.1	46.43	10.42	71.65	0.486	23.37	33.27	44.19	54.87	62.31	1.09	1.56	2.07	2.57	2.91												
			Total	**65.56**							2.1										**2.06**	**2.93**	**3.89**	**4.83**	**5.48**												
			Total	**1505.68**							2.1										**66.04**	**91.78**	**118.4**	**141.74**	**172.42**	12.5	1.9	**31.4**	**43.7**	**56.4**	**67.5**	**82.1**	**16.6**	**23.0**	**29.7**	**35.5**	**43.2**
H300	6600	7375	A31	5.3	1.34	3.96	33.91	15.98	0.01	1.2	2	55.21	6.94	78.13	0.452	22.05	31.48	41.96	52.33	58.93	0.15	0.21	0.28	0.35	0.39												
			A30	17.63	7.12	10.51	42.21	14.77	0.01	1.2	2	55.21	9.72	79.7	0.491	21.76	31.08	41.46	51.77	58.18	0.52	0.75	1	1.24	1.4												
			Total	**22.93**							2										**0.67**	**0.96**	**1.28**	**1.59**	**1.79**												
			Total	1528.6							2										**66.71**	**92.74**	**119.68**	**143.33**	**174.21**	8.68	2.2	**33.4**	**46.4**	**59.8**	**71.7**	**87.1**	**15.2**	**21.1**	**27.2**	**32.6**	**39.6**

Table 4.3 Showing Adequacy Analysis Results for Hebbal Minor Valley - I(H3) - For Improving Hydraulic Flow Conditions

Sl.No.	Description	Drain Reach		Chainage (m)		Catchment Area A (Ha.)	Type	Average Velocity V m/sec	Discharges (Q in m³/sec)					Av.Drain Depth D in m.	Area required for drain (A in m²)					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	H300	Jaibharathnagar	Kanakadas Layout	0	750	33.69	Pri.	2	2.05	2.82	3.59	4.23	5.3	1.4	1.02	1.41	1.79	2.11	2.65	2.8	0.73	1.01	1.28	1.51	1.89	AD	AD	AD	AD	AD
2	H300	Kanakadas Layout	Jai Maatadi Devasthan Road	750	1350	176.65	Pri.	4	10.88	14.99	19.12	22.57	28.18	1.8	2.72	3.75	4.78	5.64	7.05	4	1.51	2.08	2.66	3.13	3.91	AD	AD	AD	AD	AD
3	H300	Jai Maatadi Devasthan Road	60 ft Road HBR Layout	1350	1975	182.03	Pri.	3.7	11.19	15.43	19.68	23.24	29.01	1.8	3.03	4.17	5.32	6.28	7.84	6	1.68	2.32	2.96	3.49	4.36	AD	AD	AD	AD	AD
4	H300	60 ft Road HBR Layout	Kammanahalli	1975	2200	348.89	Pri.	3.56	21.38	29.46	37.61	44.42	55.41	2.2	6	8.28	10.57	12.48	15.57	10.6	2.73	3.76	4.8	5.67	7.08	AD	AD	AD	AD	AD
5	H300	Kammanahalli	1 st Stage, 2 nd Block, HBR Layout	2200	2600	402.74	Pri.	3.32	24.75	34.12	43.54	51.41	64.16	2.4	7.46	10.28	13.11	15.49	19.32	10.27	3.11	4.28	5.46	6.45	8.05	AD	AD	AD	AD	AD
6	H300	1 st Stage, 2 nd Block, HBR Layout	5 th cross road, HBR Layout, Yaseen nagar	2600	3050	419.18	Pri.	3.43	25.48	35.13	44.85	52.99	66.07	2.51	7.43	10.24	13.08	15.45	19.26	11.56	2.96	4.08	5.21	6.16	7.67	AD	AD	AD	AD	AD
7	H300	5 th cross road, HBR Layout, Yaseen nagar	Near Telephone exchange, Yaseen nagar	3050	3600	533.02	Pri.	3.1	32.33	44.58	56.91	67.25	83.83	2.63	10.43	14.38	18.36	21.69	27.04	12.09	3.97	5.47	6.98	8.25	10.28	AD	AD	AD	AD	AD
8	H300	Near Telephone exchange, Yaseen nagar	Near Rahat Ali Layout	3600	4200	1142.91	Pri.	3	51.45	71.14	91.18	108.25	133.74	2.9	17.15	23.71	30.39	36.08	44.58	14	5.91	8.18	10.48	12.44	15.37	AD	AD	AD	AD	IA
9	H300	Near Rahat Ali Layout	5 th block, HBR Layout near Outer Ring Road	4200	4800	1241.89	Pri.	2.7	55.72	77.16	99.08	117.92	145.02	2.6	20.64	28.58	36.7	43.67	53.71	14.47	7.94	10.99	14.11	16.8	20.66	AD	AD	AD	IA	IA
10	H300	5 th block, HBR Layout near Outer Ring Road	Telecom employer co-operating society layout	4800	5400	1365.77	Pri.	3.2	60.97	84.58	108.86	129.94	158.94	2.6	19.05	26.43	34.02	40.61	49.67	16	7.33	10.17	13.08	15.62	19.1	AD	AD	AD	AD	IA
11	H300	Telecom employer co-operating society layout	Near Gedalahalli main road	5400	6000	1440.12	Pri.	3.4	63.98	88.86	114.51	136.92	166.94	2.6	18.82	26.13	33.68	40.27	49.1	22	7.24	10.05	12.95	15.49	18.88	AD	AD	AD	AD	AD
12	H300	Near Gedalahalli main road	Near Hennur Main Road	6000	6600	1505.68	Pri.	3.2	66.04	91.78	118.4	141.74	172.42	2.6	20.64	28.68	37	44.29	44.29	24	7.94	11.03	14.23	17.04	17.04	AD	AD	AD	AD	AD
13	H300	Near Hennur Main Road	Raja Canal STP	6600	7375	1528.6	Sec.	2.9	66.71	92.74	119.68	143.33	174.21	2.6	23	31.98	41.27	49.43	60.07	24	8.85	12.3	15.87	19.01	23.11	AD	AD	AD	AD	AD
14	H301	Keshavanagar, near Kacharakanahlli	Near Hennur Main Road	0	500	33.58	Sec.	2.6	2.47	3.36	4.22	4.88	6.33	1.5	0.95	1.29	1.62	1.88	2.44	1.6	0.63	0.86	1.08	1.25	1.62	AD	AD	AD	AD	IA

Sl.No.	Description	Drain Reach		Chainage (m)		Catchment Area A (Ha.)	Type	Average Velocity V m/sec	Discharges (Q in m³/sec)					Av.Drain Depth D in m.	Area required for drain (A in m²)					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
7	H301	Near Hennur Main Road	Gandhinagar	500	1150	61.77	Pri.	2.5	4.32	5.9	7.44	8.66	11.11	1.8	1.73	2.36	2.98	3.46	4.44	2.81	0.96	1.31	1.65	1.92	2.47	AD	AD	AD	AD	AD
8	H302	Ramaswamipalya	60 ft Road HBR Layout	0	975	36.14	Pri.	2.4	2.37	3.25	4.13	4.84	6.12	1.4	0.99	1.36	1.72	2.02	2.55	2.31	0.71	0.97	1.23	1.44	1.82	AD	AD	AD	AD	AD
9	H303	Kammanahalli Mn. Road	Nehru road, Kammanahalli	0	225	11.81	Pri.	2.5	0.85	1.16	1.45	1.69	2.18	1.55	0.34	0.46	0.58	0.68	0.87	1.5	0.22	0.3	0.38	0.44	0.56	AD	AD	AD	AD	AD
10	H304	Pillana Garden near Lingarajapuram	1 st Cross, Ramachandrapa Layout	0	900	71.19	Pri.	3.3	4.63	6.35	8.07	9.48	11.95	1.5	1.4	1.93	2.45	2.87	3.62	2.5	0.93	1.28	1.63	1.92	2.41	AD	AD	AD	AD	AD
11	H304	1 st Cross, Ramachandrapa Layout	1 st block, 60 ft road, HBR Layout	900	1700	166.85	Pri.	2.7	10.18	14.04	17.93	21.18	26.4	2.59	3.77	5.2	6.64	7.85	9.78	9	1.46	2.01	2.56	3.03	3.78	AD	AD	AD	AD	AD
12	H305	Banaswadi	Kanakadasa Layout	0	550	40.27	Pri.	2	2.57	3.52	4.48	5.25	6.63	1.5	1.28	1.76	2.24	2.63	2.63	3.2	0.86	1.17	1.49	1.75	1.75	AD	AD	AD	AD	AD
13	H306	Modi Garden near Kavala bairasandra	Sayeedayanagar	0	450	59.35	Pri.	2.4	3.58	4.91	6.22	7.29	9.24	1.6	1.49	2.05	2.59	3.04	3.85	2.6	0.93	1.28	1.62	1.9	2.41	AD	AD	AD	AD	AD
14	H306	Sayeedayanagar	Near Shampura main road	450	1000	234.29	Pri.	3	13.98	19.25	24.56	28.97	36.21	2.4	4.66	6.42	8.19	9.66	12.07	7.5	1.94	2.67	3.41	4.02	5.03	AD	AD	AD	AD	AD
15	H306	Near Shampura main road	Gandhinagar 4 th cross road, K.G.Halli	1000	2000	381.46	Pri.	3.4	22.37	30.89	39.51	46.79	58.08	2.4	6.58	9.08	11.62	13.76	17.08	10	2.74	3.79	4.84	5.73	7.12	AD	AD	AD	AD	AD
16	H306	Gandhinagar 4 th cross road, K.G.Halli	Kammanahalli	2000	3025	512.47	Pri.	3.4	29.14	40.34	51.78	61.57	75.83	2.4	8.57	11.87	15.23	18.11	22.3	8	3.57	4.94	6.34	7.55	9.29	AD	AD	AD	AD	IA
17	H307	Modi road near Devara jeevanahalli	Kavala Bairasandra	0	682	88.12	Pri.	2.7	5.23	7.2	9.17	10.81	13.54	2	1.94	2.67	3.4	4	5.01	4.5	0.97	1.33	1.7	2	2.51	AD	AD	AD	AD	AD

Landuse Analysis for Hebbal Minor Valley -1(H3) – Proposed 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 m3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m2					Required Drain Width 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)
H300	0	750	A23(a)	15.22	10.65	4.57	58.49	12.4	0.01	1.2	2	6.25	6.94	25.6	0.444	46.73	64.28	81.86	96.40	120.92	0.88	1.21	1.54	1.81	2.27												
			A23(b)	18.47	16.62	1.85	69.49	10.8	0.01	1.2	2	6.25	9.03	26.08	0.494	46.14	63.52	80.95	95.42	119.48	1.17	1.61	2.05	2.42	3.03												
			Total	**33.69**							2										**2.05**	**2.82**	**3.59**	**4.23**	**5.3**	2.8	1.4	**1.0**	**1.4**	**1.8**	**2.1**	**2.6**	**0.7**	**1.0**	**1.3**	**1.5**	**1.9**
H305	0	550	A22(a)	22.54	18.5	4.04	65.14	11.43	0.01	1.2	1.7	5.39	6.94	23.77	0.462	49.11	67.40	85.57	100.38	126.83	1.42	1.95	2.48	2.9	3.67												
			A22(b)	17.73	15.95	1.78	69.48	10.8	0.01	1.2	1.7	5.39	8.33	24.53	0.483	48.09	66.06	83.98	98.67	124.29	1.14	1.57	2	2.35	2.96												
				40.27							2										**2.57**	**3.52**	**4.48**	**5.25**	**6.63**	3.2	1.5	**1.3**	**1.8**	**2.2**	**2.6**	**3.3**	**0.9**	**1.2**	**1.5**	**1.8**	**2.2**
			Total	**73.96**																	**4.61**	**6.34**	**8.06**	**9.48**	**11.93**												
H300	750	1350	A26(b)	62.69	56.42	6.27	69.5	10.8	0.02	1.5	2.5	9	7.78	27.58	0.499	44.44	61.29	78.29	92.54	115.25	3.86	5.33	6.8	8.04	10.02												
			A22(b)	40	36	4	69.5	10.8	0.01	1.2	2.5	9	9.72	29.52	0.509	42.45	58.67	75.16	89.15	110.30	2.4	3.32	4.25	5.05	6.24												
			Total	102.69							2.5										**6.26**	**8.65**	**11.06**	**13.09**	**16.26**												
			Total	**176.65**							4										**10.88**	**14.99**	**19.12**	**22.57**	**28.18**	4	1.8	**2.7**	**3.7**	**4.8**	**5.6**	**7.0**	**1.5**	**2.1**	**2.7**	**3.1**	**3.9**
H300	1350	1975	A26(a)	5.38	4.84	0.54	69.46	10.81	0.01	1.2	2.4	13.72	6.25	30.77	0.515	41.28	57.14	73.32	87.15	107.40	0.32	0.44	0.56	0.67	0.83												
			Total	**182.03**							3.7										**11.19**	**15.43**	**19.68**	**23.24**	**29.01**	6	1.8	**3.0**	**4.2**	**5.3**	**6.3**	**7.8**	**1.7**	**2.3**	**3.0**	**3.5**	**4.4**
H304	0	900	A21(a)	71.19	64.07	7.12	69.5	10.8	0.01	1.2	2.9	5.17	8.33	24.31	0.483	48.38	66.45	84.44	99.17	125.02	4.63	6.35	8.07	9.48	11.95												
			Total	**71.19**							3.3										**4.63**	**6.35**	**8.07**	**9.48**	**11.95**	2.5	1.5	**1.4**	**1.9**	**2.4**	**2.9**	**3.6**	**0.9**	**1.3**	**1.6**	**1.9**	**2.4**
H304	900	1700	A21(a)	9.69	2.94	6.75	36.68	15.57	0.02	1.5	2.7	10.49	2.22	28.29	0.369	43.68	60.30	77.10	91.26	113.38	0.43	0.6	0.77	0.91	1.13												
			A21(b)	85.97	77.27	8.7	69.43	10.81	0.01	1.2	2.7	10.49	9.03	30.33	0.515	41.68	57.67	73.95	87.84	108.40	5.12	7.09	9.09	10.8	13.32												

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					Required Drain Width 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)
				95.66							2.7										**5.56**	**7.69**	**9.85**	**11.7**	**14.45**												
			Total	**166.85**							2.7										**10.18**	**14.04**	**17.93**	**21.18**	**26.4**	9	2.59	**3.8**	**5.2**	**6.6**	**7.8**	**9.8**	**1.5**	**2.0**	**2.6**	**3.0**	**3.8**
H300	1975	2200		**348.89**							3.56										**21.38**	**29.46**	**37.61**	**44.42**	**55.41**	10.6	2.2	**6.0**	**8.3**	**10.6**	**12.5**	**15.6**	**2.7**	**3.8**	**4.8**	**5.7**	**7.1**
H303	0	225	A24	11.81	10.63	1.18	69.5	10.8	0.01	1.2	2.5	1.5	6.94	19.24	0.457	56.62	77.16	97.11	112.69	145.32	0.85	1.16	1.45	1.69	2.18	1.5	1.55	**0.3**	**0.5**	**0.6**	**0.7**	**0.9**	**0.2**	**0.3**	**0.4**	**0.4**	**0.6**
H302	0	975	A25	24.33	21.89	2.44	69.49	10.8	0.01	1.2	2.2	7.39	8.33	26.52	0.494	45.62	62.84	80.14	94.54	118.19	1.52	2.1	2.67	3.16	3.94												
			Total	**36.14**							2.4										**2.37**	**3.25**	**4.13**	**4.84**	**6.12**	2.31	1.4	**1.0**	**1.4**	**1.7**	**2.0**	**2.6**	**0.7**	**1.0**	**1.2**	**1.4**	**1.8**
H300	2200	2600	A24	17.72	15.95	1.77	69.51	10.8	0.01	1.2	3.32	13.05	9.72	33.57	0.525	38.93	54.04	69.59	83.09	101.53	1.01	1.4	1.8	2.15	2.63												
			Total	**402.74**							3.32										**24.75**	**34.12**	**43.54**	**51.41**	**64.16**	10.27	2.4	**7.5**	**10.3**	**13.1**	**15.5**	**19.3**	**3.1**	**4.3**	**5.5**	**6.5**	**8.1**
H300	2600	3050	A21(b)	11.37	3.12	8.25	35.09	15.8	0.01	1.2	3.43	14.82	6.25	36.87	0.395	36.55	50.89	65.79	78.94	95.58	0.46	0.63	0.82	0.98	1.19												
			A27(a)	5.07	4.56	0.51	69.5	10.8	0.01	1.2	3.43	14.82	12.5	38.12	0.544	35.74	49.82	64.49	77.51	93.56	0.27	0.38	0.49	0.59	0.72												
			Total	**16.44**							3.43										**0.73**	**1.02**	**1.31**	**1.58**	**1.91**												
			Total	**419.18**							3.43										**25.48**	**35.13**	**44.85**	**52.99**	**66.07**	11.56	2.51	**7.4**	**10.2**	**13.1**	**15.4**	**19.3**	**3.0**	**4.1**	**5.2**	**6.2**	**7.7**
H301	0	500	A27(b)	33.58	30.22	3.36	69.5	10.8	0.01	1.2	2.6	3.21	4.17	18.17	0.450	58.84	80.04	100.51	116.28	150.78	2.47	3.36	4.22	4.88	6.33	1.6	1.5	**1.0**	**1.3**	**1.6**	**1.9**	**2.4**	**0.6**	**0.9**	**1.1**	**1.3**	**1.6**
H301	500	1150	A27(a)	28.19	25.37	2.82	69.49	10.8	0.02	1.5	2.3	8.33	4.44	23.58	0.478	49.38	67.75	85.99	100.83	127.49	1.85	2.54	3.22	3.78	4.78												
			Total	**61.77**							2.5										**4.32**	**5.9**	**7.44**	**8.66**	**11.11**	2.81	1.8	**1.7**	**2.4**	**3.0**	**3.5**	**4.4**	**1.0**	**1.3**	**1.7**	**1.9**	**2.5**
			Total	**480.95**							2.3										**29.8**	**41.03**	**52.3**	**61.65**	**77.18**												

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 Coeffecent "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					Required Drain Width 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)
H300	3050	3775	A27(a)	9.91	7.93	1.98	64.01	11.6	0.01	1.2	2.7	23.3	8.33	43.23	0.539	32.84	45.97	59.81	72.35	86.27	0.49	0.68	0.89	1.07	1.28												
			A27(b)	42.16	33.78	8.38	64.07	11.59	0.01	1.2	2.7	23.3	9.72	44.61	0.543	32.15	45.05	58.69	71.12	84.54	2.04	2.86	3.73	4.52	5.37												
			Total	**52.07**							2.7										**2.53**	**3.55**	**4.62**	**5.59**	**6.65**												
			Total	**533.02**							3.1										**32.33**	**44.58**	**56.91**	**67.25**	**83.83**	12.09	2.63	**10.4**	**14.4**	**18.4**	**21.7**	**27.0**	**4.0**	**5.5**	**7.0**	**8.2**	**10.3**
H306	0	450	A17(a)	40.92	28.75	12.17	58.64	12.38	0.01	1.2	1.8	4.17	5.56	22.1	0.429	51.58	70.62	89.39	104.46	132.92	2.51	3.44	4.35	5.09	6.48												
			A17(b)	18.43	12.9	5.53	58.5	12.4	0.01	1.2	1.8	4.17	8.33	24.9	0.439	47.60	65.43	83.23	97.86	123.09	1.07	1.47	1.87	2.2	2.76												
			Total	**59.35**							2.4										**3.58**	**4.91**	**6.22**	**7.29**	**9.24**	2.6	1.6	**1.5**	**2.0**	**2.6**	**3.0**	**3.9**	**0.9**	**1.3**	**1.6**	**1.9**	**2.4**
H307	0	682	A18(a)	23.79	15.58	8.21	56.02	12.76	0.02	1.5	2.1	5.41	5.56	23.73	0.426	49.17	67.48	85.66	100.48	126.97	1.38	1.9	2.41	2.83	3.57												
			A18(b)	39.4	30.49	8.91	62.56	11.81	0.01	1.2	2.1	5.41	9.72	26.94	0.465	45.14	62.21	79.39	93.73	116.99	2.3	3.17	4.04	4.77	5.96												
			A19(b)	24.93	22.44	2.49	69.51	10.8	0.01	1.2	2.1	5.41	11.11	27.32	0.499	44.72	61.65	78.72	93.01	115.94	1.55	2.13	2.72	3.21	4.01												
			Total	**88.12**							2.7										**5.23**	**7.2**	**9.17**	**10.81**	**13.54**	4.5	2	**1.9**	**2.7**	**3.4**	**4.0**	**5.0**	**1.0**	**1.3**	**1.7**	**2.0**	**2.5**
H306	450	1000	A19(a)	43.66	39.29	4.37	69.49	10.8	0.01	1.2	2.1	7.94	9.72	28.46	0.504	43.51	60.07	76.83	90.96	112.94	2.66	3.67	4.7	5.56	6.91												
			A20(a)	20.12	17.11	3.01	66.77	11.2	0.01	1.2	2.1	7.94	11.81	30.94	0.502	41.13	56.94	73.08	86.90	107.02	1.15	1.6	2.05	2.44	3												
			A17(b)	23.04	20.74	2.3	69.51	10.8	0.01	1.2	2.1	7.94	12.5	31.24	0.518	40.87	56.59	72.66	86.44	106.37	1.36	1.88	2.41	2.87	3.53												
			Total	**86.82**							2.1										**5.17**	**7.15**	**9.16**	**10.87**	**13.44**												
			Total	**234.29**							3										**13.98**	**19.25**	**24.56**	**28.97**	**36.21**	7.5	2.4	**4.7**	**6.4**	**8.2**	**9.7**	**12.1**	**1.9**	**2.7**	**3.4**	**4.0**	**5.0**
H306	1000	2000	A20(a)	97.79	88.01	9.78	69.5	10.8	0.01	1.2	2.8	11.9	9.03	31.73	0.518	40.43	56.02	71.98	85.70	105.29	5.69	7.89	10.13	12.06	14.82												
			A20(b)	49.38	39.51	9.87	64.01	11.6	0.02	1.5	2.8	11.9	10	33.5	0.505	38.98	54.11	69.67	83.19	101.67	2.7	3.75	4.82	5.76	7.04												

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					Required Drain Width 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)
			Total	**147.17**							2.8										**8.39**	**11.63**	**14.96**	**17.82**	**21.86**												
			Total	**381.46**							3.4										**22.37**	**30.89**	**39.51**	**46.79**	**58.08**	10	2.4	**6.6**	**9.1**	**11.6**	**13.8**	**17.1**	**2.7**	**3.8**	**4.8**	**5.7**	**7.1**
H306	2000	3025	A20(a)	41.91	37.72	4.19	69.5	10.8	0.01	1.2	2	21.46	5.56	37.81	0.540	35.93	50.08	64.80	77.86	94.05	2.26	3.15	4.07	4.89	5.91												
			A20(b)	89.1	73.84	15.26	65.58	11.37	0.01	1.2	2	21.46	8.33	41.16	0.537	33.94	47.43	61.59	74.32	89.04	4.51	6.31	8.19	9.88	11.84												
			Total	**131.01**							2										**6.77**	**9.45**	**12.26**	**14.78**	**17.75**												
			Total	**512.47**							3.4										**29.14**	**40.34**	**51.78**	**61.57**	**75.83**	8	2.4	**8.6**	**11.9**	**15.2**	**18.1**	**22.3**	**3.6**	**4.9**	**6.3**	**7.5**	**9.3**
H300	3775	4200	A29	35.03	30.53	4.5	67.93	11.03	0.01	1.2	2.6	26.92	11.11	49.06	0.572	30.16	42.39	55.44	67.51	79.52	1.68	2.36	3.08	3.75	4.42												
			A27(a)	62.39	51.3	11.09	65.22	11.42	0.02	1.5	2.6	26.92	13.33	51.68	0.568	29.12	41.01	53.75	65.62	76.90	2.87	4.04	5.29	6.46	7.58												
			Total	**97.42**							2.6										4.55	6.4	8.38	10.22	12												
			Total	**1142.91**							3										**51.45**	**71.14**	**91.18**	**108.25**	**133.74**	14	2.9	**17.2**	**23.7**	**30.4**	**36.1**	**44.6**	**5.9**	**8.2**	**10.5**	**12.4**	**15.4**
H300	4200	4800	A30	26.42	7.93	18.49	36.51	15.6	0.02	1.5	2.24	30.13	7.78	53.51	0.450	28.45	40.10	52.64	64.38	75.20	0.94	1.32	1.74	2.12	2.48												
			A34	24.04	20.4	3.64	66.67	11.21	0.01	1.2	2.24	30.13	12.5	53.85	0.577	28.33	39.94	52.44	64.16	74.90	1.09	1.54	2.02	2.47	2.89												
			A29	48.52	43.67	4.85	69.5	10.8	0.01	1.2	2.24	30.13	13.89	54.82	0.592	27.99	39.49	51.88	63.53	74.03	2.23	3.15	4.14	5.07	5.91												
			Total	**98.98**							2.24										**4.26**	**6.01**	**7.9**	**9.67**	**11.27**												
			Total	**1241.89**							2.7										**55.72**	**77.16**	**99.08**	**117.92**	**145.02**	14.47	2.6	**20.6**	**28.6**	**36.7**	**43.7**	**53.7**	**7.9**	**11.0**	**14.1**	**16.8**	**20.7**
H300	4800	5400	A30	68.52	49.98	18.55	60.11	12.17	0.01	1.2	2.7	33.33	12.5	58	0.560	26.95	38.09	50.16	61.60	71.39	2.87	4.06	5.35	6.57	7.62												
			A29	55.36	44.29	11.07	64	11.6	0.01	1.2	2.7	33.33	13.89	58.82	0.580	26.69	37.75	49.74	61.13	70.75	2.38	3.36	4.43	5.45	6.31												
			Total	**123.88**							2.7										**5.25**	**7.43**	**9.78**	**12.02**	**13.92**												
			Total	**1365.77**							3.2										**60.97**	**84.58**	**108.86**	**129.94**	**158.94**	16	2.6	**19.1**	**26.4**	**34.0**	**40.6**	**49.7**	**7.3**	**10.2**	**13.1**	**15.6**	**19.1**

Description about drain	Chainage from	Chainage to	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. For terain	Average Velocity in m/sec. For Drain	Flow in drain (min.)	Flow in Terain (min.)	Total time of concentration (min.)	Runoff Coeffiecent "C"	Rainfall Intensity "i" in mm/hour (For 1 Year)	Rainfall Intensity "i" in mm/hour (For 2 Year)	Rainfall Intensity "i" in mm/hour (For 5 Year)	Rainfall Intensity "i" in mm/hour (For 10 Year)	Rainfall Intensity "i" in mm/hour (For 20 Year)	Quantity (Q)= 10 C.i A m3/sec. (For 1 Year)	Quantity (Q)= 10 C.i A m3/sec. (For 2 Year)	Quantity (Q)= 10 C.i A m3/sec. (For 5 Year)	Quantity (Q)= 10 C.i A m3/sec. (For 10 Year)	Quantity (Q)= 10 C.i A m3/sec. (For 20 Year)	Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m2 (For 1 Year)	Area required for Drain in m2 (For 2 Year)	Area required for Drain in m2 (For 5 Year)	Area required for Drain in m2 (For 10 Year)	Area required for Drain in m2 (For 20 Year)	Required Drain Width in m (For 1 Year)	Required Drain Width in m (For 2 Year)	Required Drain Width in m (For 5 Year)	Required Drain Width in m (For 10 Year)	Required Drain Width in m (For 20 Year)
H300	5400	6000	A29	74.34	60.28	14.06	64.6	11.51	0.01	1.2	1.8	43.06	10.42	64.99	0.584	24.96	35.41	46.85	57.88	66.35	3.01	4.27	5.65	6.98	8												
			Total	**1440.12**							3.4										**63.98**	**88.86**	**114.51**	**136.92**	**166.94**	22	2.6	**18.8**	**26.1**	**33.7**	**40.3**	**49.1**	**7.2**	**10.1**	**13.0**	**15.5**	**18.9**
H300	6000	6600	A30	30.94	10.21	20.73	38.15	15.36	0.01	1.2	2.1	46.43	8.33	70.12	0.474	23.71	33.73	44.77	55.52	63.18	0.97	1.37	1.82	2.26	2.57												
			A29	34.62	13.84	20.78	41.99	14.8	0.01	1.2	2.1	46.43	10.42	71.65	0.486	23.37	33.27	44.19	54.87	62.31	1.09	1.56	2.07	2.57	2.91												
			Total	**65.56**							2.1										**2.06**	**2.93**	**3.89**	**4.83**	**5.48**												
			Total	**1505.68**							3.2										**66.04**	**91.78**	**118.4**	**141.74**	**172.42**	24	2.6	**20.6**	**28.7**	**37.0**	**44.3**	**53.9**	**7.9**	**11.0**	**14.2**	**17.0**	**20.7**
H300	6600	7375	A31	5.3	1.34	3.96	33.91	15.98	0.01	1.2	2	55.21	6.94	78.13	0.452	22.05	31.48	41.96	52.33	58.93	0.15	0.21	0.28	0.35	0.39												
			A30	17.63	7.12	10.51	42.21	14.77	0.01	1.2	2	55.21	9.72	79.7	0.491	21.76	31.08	41.46	51.77	58.18	0.52	0.75	1	1.24	1.4												
			Total	**22.93**							2										**0.67**	**0.96**	**1.28**	**1.59**	**1.79**												
			Total	**1528.6**							2.9										**66.71**	**92.74**	**119.68**	**143.33**	**174.21**	24	2.6	**23.0**	**32.0**	**41.3**	**49.4**	**60.1**	**8.8**	**12.3**	**15.9**	**19.0**	**23.1**

Table4.4 Showing Adequacy Analysis Results for Hebbal Minor Valley – II (H4) - Existing Hydraulic Flow Conditions

Sl.No.	Description	Drain Reach		Chainage (m)		Catchment Area A (Ha.)	Type	Average Velocity V m/sec	Discharges (Q in m³/sec)					Existing Av.Drain Depth D in m.	Area required for drain (A in m²)					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	H400	Chikka Banaswadi near Railway Track	Near OMBR Layout	0	500	90.58	Pri.	2.55	6.24	8.52	10.73	12.47	16.04	1.8	2.45	3.34	4.21	4.89	6.29	2.6	1.36	1.86	2.34	2.72	3.49	AD	AD	AD	IA	IA
2	H400	Near OMBR Layout	Banaswadi main road near Chowdeshwari layout	500	1000	213.12	Pri.	3.3	13.49	18.48	23.41	27.38	34.78	2.7	4.09	5.6	7.09	8.3	10.54	2.8	1.51	2.07	2.63	3.07	3.9	AD	AD	AD	IA	IA
3	H400	Banaswadi main road near Chowdeshwari layout	3 rd 'A' Cross Road, HBR Layout 1st Block	1000	1675	289.62	Pri.	2.65	17.96	24.66	31.33	36.77	46.4	3.7	6.78	9.31	11.82	13.88	17.51	3.6	1.83	2.52	3.19	3.75	4.73	AD	AD	AD	IA	IA
4	H400	3 rd 'A' Cross Road, HBR Layout 1st Block	4 th 'A' Cross Road, Kalyan nagar	1675	2000	496.06	Pri.	2.8	30.51	41.9	53.25	62.55	78.84	3.7	10.9	14.97	19.02	22.34	28.16	4.16	2.95	4.04	5.14	6.04	7.61	AD	AD	IA	IA	IA
5	H400	4 th 'A' Cross Road, Kalyan nagar	Muniswamy layout near Chalkere bus stop	2000	2500	618.61	Pri.	2.2	36.94	50.86	64.83	76.44	95.66	3.5	16.79	23.12	29.47	34.74	43.48	4.18	4.8	6.61	8.42	9.93	12.42	IA	IA	IA	IA	IA
6	H401	Kammanahalli Main Road	Sena vihar	0	500	61.91	Sec.	3.3	3.59	4.89	6.16	7.15	9.21	1.8	1.09	1.48	1.87	2.17	2.79	1.3	0.6	0.82	1.04	1.2	1.55	AD	AD	AD	AD	IA

Landuse Analysis for Hebbal Minor Valley -2 (H4) – 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 m3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m2					Required Drain Width 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)
H400	0	500	A39	40.58	31.44	9.14	62.61	11.8	0.01	1.2	2.55	3.27	4.17	19.24	0.428	56.63	77.18	97.14	112.71	145.35	2.73	3.73	4.69	5.44	7.02												
			A40	50	45	5	69.5	10.8	0.01	1.2	2.55	3.27	6.25	20.32	0.463	54.58	74.52	94.01	109.39	140.32	3.51	4.79	6.04	7.03	9.02												
			Total	**90.58**							2.55										**6.24**	**8.52**	**10.73**	**12.47**	**16.04**	2.6	1.8	**2.4**	**3.3**	**4.2**	**4.9**	**6.3**	**1.4**	**1.9**	**2.3**	**2.7**	**3.5**
H400	500	1000	A39	34.67	28.74	5.93	65.59	11.37	0.01	1.2	3.3	5.05	6.94	23.36	0.462	49.69	68.15	86.46	101.34	128.25	2.21	3.03	3.85	4.51	5.71												
			A40	87.87	61.51	26.36	58.5	12.4	0.01	1.2	3.3	5.05	8.33	25.78	0.444	46.50	63.98	81.51	96.01	120.36	5.04	6.93	8.83	10.4	13.04												
			Total	**122.54**							3.3										**7.25**	**9.96**	**12.68**	**14.91**	**18.75**												
			Total	**213.12**							3.3										**13.49**	**18.48**	**23.41**	**27.38**	**34.78**	2.8	2.7	**4.1**	**5.6**	**7.1**	**8.3**	**10.5**	**1.5**	**2.1**	**2.6**	**3.1**	**3.9**
H400	1000	1675	A37	10.49	8.19	2.3	62.94	11.75	0.01	1.2	2.65	10.53	5.56	27.84	0.470	44.15	60.91	77.84	92.06	114.54	0.61	0.83	1.07	1.26	1.57												
			A39	18.82	14.5	4.32	62.38	11.84	0.02	1.5	2.65	10.53	6.11	28.48	0.476	43.48	60.04	76.79	90.92	112.88	1.08	1.49	1.91	2.26	2.81												
			A40	47.19	40.47	6.72	67.17	11.14	0.01	1.2	2.65	10.53	8.33	30.01	0.506	41.98	58.07	74.43	88.36	109.15	2.79	3.85	4.94	5.87	7.25												
			Total	**76.5**							2.65										**4.47**	**6.18**	**7.92**	**9.39**	**11.62**												
			Total	**289.62**							2.65										**17.96**	**24.66**	**31.33**	**36.77**	**46.4**	3.6	3.7	**6.8**	**9.3**	**11.8**	**13.9**	**17.5**	**1.8**	**2.5**	**3.2**	**3.8**	**4.7**
H401	0	500	A38(a)	11.81	9.45	2.36	64.01	11.6	0.01	1.2	3.3	2.53	2.78	16.9	0.418	61.78	83.84	104.96	120.98	157.99	0.85	1.15	1.44	1.66	2.17												
			A38(b)	20.1	18.09	2.01	69.5	10.8	0.01	1.2	3.3	2.53	4.86	18.19	0.450	58.81	80.00	100.46	116.23	150.71	1.48	2.01	2.53	2.92	3.79												
			A27(a)	30	27	3	69.5	10.8	0.01	1.2	3.3	2.53	6.94	20.27	0.463	54.67	74.63	94.14	109.53	140.54	2.11	2.88	3.63	4.22	5.42												
			Total	**61.91**							3.3										**3.59**	**4.89**	**6.16**	**7.15**	**9.21**	1.3	1.8	**1.1**	**1.5**	**1.9**	**2.2**	**2.8**	**0.6**	**0.8**	**1.0**	**1.2**	**1.6**

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 m3/sec.					Existing Ave.width in m	Ave. Depth of drain m	Area required for Drain in m2					Required Drain Width 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)
H401	500	950	A38(b)	16.36	14.72	1.64	69.49	10.8	0.01	1.2	2.5	6.33	4.17	21.3	0.468	52.87	72.30	91.38	106.59	136.11	1.12	1.54	1.94	2.27	2.89												
			A27(a)	40.74	36.66	4.08	69.49	10.8	0.01	1.2	2.5	6.33	5.56	22.69	0.473	50.67	69.44	87.99	102.97	130.69	2.71	3.72	4.71	5.51	7												
			Total	**57.1**							2.5										**3.84**	**5.26**	**6.65**	**7.78**	**9.89**												
			Total	**119.01**							2.5										**7.42**	**10.14**	**12.81**	**14.93**	**19.1**												
H400	1675	2000	A37	55.43	49.89	5.54	69.5	10.8	0.01	1.2	2.8	11.9	8.33	31.04	0.518	41.04	56.82	72.94	86.74	106.80	3.27	4.53	5.82	6.92	8.52												
			A35	32	28.8	3.2	69.5	10.8	0.01	1.2	2.8	11.9	9.72	32.43	0.522	39.85	55.25	71.05	84.69	103.83	1.85	2.56	3.3	3.93	4.82												
			Total	**87.43**							2.8										**5.12**	**7.1**	**9.12**	**10.85**	**13.34**												
			Total	**496.06**							2.8										**30.51**	**41.9**	**53.25**	**62.55**	**78.84**	4.16	3.7	**10.9**	**15.0**	**19.0**	**22.3**	**28.2**	**2.9**	**4.0**	**5.1**	**6.0**	**7.6**
H400	2000	2500	A36	34.17	23.92	10.25	58.5	12.4	0.01	1.2	2.2	18.94	4.17	35.51	0.487	37.49	52.14	67.29	80.59	97.94	1.73	2.41	3.11	3.72	4.53												
			A35	37.17	28.62	8.55	62.35	11.84	0.01	1.2	2.2	18.94	5.56	36.34	0.507	36.91	51.37	66.37	79.57	96.49	1.93	2.69	3.48	4.17	5.05												
			A34	51.21	46.09	5.12	69.5	10.8	0.01	1.2	2.2	18.94	8.33	38.07	0.544	35.77	49.86	64.54	77.57	93.63	2.77	3.86	4.99	6	7.24												
			Total	**122.55**							2.2										**6.43**	**8.96**	**11.58**	**13.89**	**16.82**												
			Total	**618.61**							2.2										**36.94**	**50.86**	**64.83**	**76.44**	**95.66**	4.18	3.5	**16.8**	**23.1**	**29.5**	**34.7**	**43.5**	**4.8**	**6.6**	**8.4**	**9.9**	**12.4**
H400	2500	2825	A34	54.96	29.52	25.44	49.54	13.7	0.01	1.2	2	23.54	2.78	40.02	0.467	34.59	48.29	62.64	75.47	90.67	2.46	3.44	4.46	5.38	6.46												
			A33	80.05	44.04	36.01	50.26	13.6	0.01	1.2	2	23.54	4.17	41.31	0.474	33.86	47.33	61.46	74.18	88.84	3.57	4.99	6.48	7.82	9.37												
			Total	**135.01**							2										**6.03**	**8.43**	**10.94**	**13.2**	**15.83**												
			Total	**753.62**							2										**42.98**	**59.29**	**75.77**	**89.64**	**111.49**												

Table 4.4 Showing Adequacy Analysis Results for Hebbal Minor Valley - II - For Improving Hydraulic Flow Conditions

Sl.No.	Description	Drain Reach		Chainage (m)		Catchment Area A (Ha.)	Type	Average Velocity V m/sec	Discharges (Q in m³/sec)					Existing Av.Drain Depth D in m.	Area required for drain (A in m²)					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	H400	Chikka Banaswadi near Railway Track	Near OMBR Layout	0	500	90.58	Pri.	3.2	6.24	8.52	10.73	12.47	16.04	2	1.95	2.66	3.35	3.9	5.01	2.6	0.98	1.33	1.68	1.95	2.51	AD	AD	AD	AD	AD
2	H400	Near OMBR Layout	Banaswadi main road near Chowdeshwari layout	500	1000	213.12	Pri.	3.8	13.49	18.48	23.41	27.38	34.78	3	3.55	4.86	6.16	7.21	9.15	2.8	1.18	1.62	2.05	2.4	3.05	AD	AD	AD	AD	IA
3	H400	Banaswadi main road near Chowdeshwari layout	3 rd 'A' Cross Road, HBR Layout 1st Block	1000	1675	289.62	Pri.	3.6	17.96	24.66	31.33	36.77	46.4	4	4.99	6.85	8.7	10.21	12.89	3.6	1.25	1.71	2.18	2.55	3.22	AD	AD	AD	AD	AD
4	H400	3 rd 'A' Cross Road, HBR Layout 1st Block	4 th 'A' Cross Road, Kalyan nagar	1675	2000	496.06	Pri.	3.6	30.51	41.9	53.25	62.55	78.84	4	8.48	11.64	14.79	17.37	21.9	4.16	2.12	2.91	3.7	4.34	5.48	AD	AD	AD	IA	IA
5	H400	4 th 'A' Cross Road, Kalyan nagar	Muniswamy layout near Chalkere bus stop	2000	2500	618.61	Pri.	4.3	36.94	50.86	64.83	76.44	95.66	3.9	8.59	11.83	15.08	17.78	22.25	5	2.2	3.03	3.87	4.56	5.7	AD	AD	AD	AD	IA
6	H400	Muniswamy layout near Chalkere bus stop	Raja Canal STP	2500	2825	753.62	Pri.	4.5	42.98	59.29	75.77	89.64	111.49	2.4	9.55	13.18	16.84	19.92	24.78	8	3.98	5.49	7.02	8.3	10.32	AD	AD	AD	IA	IA
7	H401	Kammanahalli Main Road	Sena vihar	0	950	119.01	Sec.	3	7.42	10.14	12.81	14.93	19.1	2.4	2.47	3.38	4.27	4.98	6.37	2.2	1.03	1.41	1.78	2.07	2.65	AD	AD	AD	AD	IA

Landuse Analysis for Hebbal Minor Valley -2 (H4) – Improving 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 Coeffecent "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					Required Drain Width 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)
H400	0	500	A39	40.58	31.44	9.14	62.61	11.8	0.01	1.2	2.55	3.27	4.17	19.24	0.428	56.63	77.18	97.14	112.71	145.35	2.73	3.73	4.69	5.44	7.02												
			A40	50	45	5	69.5	10.8	0.01	1.2	2.55	3.27	6.25	20.32	0.463	54.58	74.52	94.01	109.39	140.32	3.51	4.79	6.04	7.03	9.02												
			Total	**90.58**							3.2										**6.24**	**8.52**	**10.73**	**12.47**	**16.04**	2.6	2	**2.0**	**2.7**	**3.4**	**3.9**	**5.0**	**1.0**	**1.3**	**1.7**	**1.9**	**2.5**
H400	500	1000	A39	34.67	28.74	5.93	65.59	11.37	0.01	1.2	3.3	5.05	6.94	23.36	0.462	49.69	68.15	86.46	101.34	128.25	2.21	3.03	3.85	4.51	5.71												
			A40	87.87	61.51	26.36	58.5	12.4	0.01	1.2	3.3	5.05	8.33	25.78	0.444	46.50	63.98	81.51	96.01	120.36	5.04	6.93	8.83	10.4	13.04												
			Total	**122.54**							3.3										**7.25**	**9.96**	**12.68**	**14.91**	**18.75**												
			Total	**213.12**							3.8										**13.49**	**18.48**	**23.41**	**27.38**	**34.78**	2.8	3	**3.6**	**4.9**	**6.2**	**7.2**	**9.2**	**1.2**	**1.6**	**2.1**	**2.4**	**3.1**
H400	1000	1675	A37	10.49	8.19	2.3	62.94	11.75	0.01	1.2	2.65	10.53	5.56	27.84	0.470	44.15	60.91	77.84	92.06	114.54	0.61	0.83	1.07	1.26	1.57												
			A39	18.82	14.5	4.32	62.38	11.84	0.02	1.5	2.65	10.53	6.11	28.48	0.476	43.48	60.04	76.79	90.92	112.88	1.08	1.49	1.91	2.26	2.81												
			A40	47.19	40.47	6.72	67.17	11.14	0.01	1.2	2.65	10.53	8.33	30.01	0.506	41.98	58.07	74.43	88.36	109.15	2.79	3.85	4.94	5.87	7.25												
			Total	**76.5**							2.65										**4.47**	**6.18**	**7.92**	**9.39**	**11.62**												
			Total	**289.62**							3.6										**17.96**	**24.66**	**31.33**	**36.77**	**46.4**	3.6	4	**5.0**	**6.9**	**8.7**	**10.2**	**12.9**	**1.2**	**1.7**	**2.2**	**2.6**	**3.2**
H401	0	500	A38(a)	11.81	9.45	2.36	64.01	11.6	0.01	1.2	3.3	2.53	2.78	16.9	0.418	61.78	83.84	104.96	120.98	157.99	0.85	1.15	1.44	1.66	2.17												
			A38(b)	20.1	18.09	2.01	69.5	10.8	0.01	1.2	3.3	2.53	4.86	18.19	0.450	58.81	80.00	100.46	116.23	150.71	1.48	2.01	2.53	2.92	3.79												
			A27(a)	30	27	3	69.5	10.8	0.01	1.2	3.3	2.53	6.94	20.27	0.463	54.67	74.63	94.14	109.53	140.54	2.11	2.88	3.63	4.22	5.42												
			Total	**61.91**							3.7										**3.59**	**4.89**	**6.16**	**7.15**	**9.21**	1.3	2	**1.0**	**1.3**	**1.7**	**1.9**	**2.5**	**0.5**	**0.7**	**0.8**	**1.0**	**1.2**

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					Required Drain Width 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)
H401	500	950	A38(b)	16.36	14.72	1.64	69.49	10.8	0.01	1.2	2.5	6.33	4.17	21.3	0.468	52.87	72.30	91.38	106.59	136.11	1.12	1.54	1.94	2.27	2.89												
			A27(a)	40.74	36.66	4.08	69.49	10.8	0.01	1.2	2.5	6.33	5.56	22.69	0.473	50.67	69.44	87.99	102.97	130.69	2.71	3.72	4.71	5.51	7												
			Total	**57.1**							2.5										**3.84**	**5.26**	**6.65**	**7.78**	**9.89**												
			Total	**119.01**							3										**7.42**	**10.14**	**12.81**	**14.93**	**19.1**	2.2	2.4	**2.5**	**3.4**	**4.3**	**5.0**	**6.4**	**1.0**	**1.4**	**1.8**	**2.1**	**2.7**
H400	1675	2000	A37	55.43	49.89	5.54	69.5	10.8	0.01	1.2	2.8	11.9	8.33	31.04	0.518	41.04	56.82	72.94	86.74	106.80	3.27	4.53	5.82	6.92	8.52												
			A35	32	28.8	3.2	69.5	10.8	0.01	1.2	2.8	11.9	9.72	32.43	0.522	39.85	55.25	71.05	84.69	103.83	1.85	2.56	3.3	3.93	4.82												
			Total	**87.43**							2.8										**5.12**	**7.1**	**9.12**	**10.85**	**13.34**												
			Total	**496.06**							3.6										**30.51**	**41.9**	**53.25**	**62.55**	**78.84**	4.16	4	**8.5**	**11.6**	**14.8**	**17.4**	**21.9**	**2.1**	**2.9**	**3.7**	**4.3**	**5.5**
H400	2000	2500	A36	34.17	23.92	10.25	58.5	12.4	0.01	1.2	2.2	18.94	4.17	35.51	0.487	37.49	52.14	67.29	80.59	97.94	1.73	2.41	3.11	3.72	4.53												
			A35	37.17	28.62	8.55	62.35	11.84	0.01	1.2	2.2	18.94	5.56	36.34	0.507	36.91	51.37	66.37	79.57	96.49	1.93	2.69	3.48	4.17	5.05												
			A34	51.21	46.09	5.12	69.5	10.8	0.01	1.2	2.2	18.94	8.33	38.07	0.544	35.77	49.86	64.54	77.57	93.63	2.77	3.86	4.99	6	7.24												
			Total	**122.55**							2.2										**6.43**	**8.96**	**11.58**	**13.89**	**16.82**												
			Total	**618.61**							4.3										**36.94**	**50.86**	**64.83**	**76.44**	**95.66**	5	3.9	**8.6**	**11.8**	**15.1**	**17.8**	**22.2**	**2.2**	**3.0**	**3.9**	**4.6**	**5.7**
H400	2500	2825	A34	54.96	29.52	25.44	49.54	13.7	0.01	1.2	2	23.54	2.78	40.02	0.467	34.59	48.29	62.64	75.47	90.67	2.46	3.44	4.46	5.38	6.46												
			A33	80.05	44.04	36.01	50.26	13.6	0.01	1.2	2	23.54	4.17	41.31	0.474	33.86	47.33	61.46	74.18	88.84	3.57	4.99	6.48	7.82	9.37												
			Total	**135.01**							2										**6.03**	**8.43**	**10.94**	**13.2**	**15.83**												
			Total	**753.62**							4.5										**42.98**	**59.29**	**75.77**	**89.64**	**111.49**	8	2.4	**9.6**	**13.2**	**16.8**	**19.9**	**24.8**	**4.0**	**5.5**	**7.0**	**8.3**	**10.3**

Table 4.5 Showing Check for Adequacy of Existing Culverts with measured Site Slopes - Hebbal Valley

(Clean Condition) (with freeboard 100mm)

Sl.No.	Culvert No.	Chainage	Vent / No. of Spans	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
	H100	(m)	No.	(B) m	(D) m	(S)	(D- 0.1) m	(m²)	(m²)	%	(m)	(m)		(m/s)	(Cumec	(Cumec)	(Cumec)	(Cumec)	(Cumec)	(Cumec)	(Cumec)										
1	HV2-C7	Munivenkat appa Block @1815	1	2.210	1.390	0.0070	1.290	2.851			4.790	0.595	0.020	2.960	8.439																
			2	2.230	1.390	0.0070	1.290	2.877			4.810	0.598	0.020	2.970	8.542																
				4.440			1.290	5.728	7.250	20.999				2.970		16.981	11.435	15.719	20.000	23.527	29.572	AD	AD	IA	IA	IA	2.99	4.1	5.22	6.14	7.72
2	HV2-C14	Yogesh nagar main road @4375	1	1.150	0.900	0.0028	0.800	0.920			2.750	0.335	0.020	1.275	1.173																
			2	1.250	0.900	0.0028	0.800	1.000			2.850	0.351	0.020	1.316	1.316																
			3	1.230	1.110	0.0028	1.010	1.242			3.250	0.382	0.020	1.394	1.731																
			4	1.200	1.110	0.0028	1.010	1.212			3.220	0.376	0.020	1.379	1.672																
				4.830			1.010	4.374	5.350	18.237				1.316		5.892	32.143	44.607	57.426	68.558	83.816	IA	IA	IA	IA	IA	24.18	33.56	43.2	51.57	63.05
	H104																														
1	HV2-S2C7	10th cross, Vasanthapp a block, Ganganaga r @1065	1	3.180	2.000	0.0090	1.900	6.042			6.980	0.866	0.020	4.308	26.031																
				3.180			1.900	6.042	6.830	11.537				4.308		26.031	5.741	7.904	10.076	11.880	14.867	AD	AD	AD	AD	AD	0.7	0.97	1.23	1.45	1.82
2	HV2-S2C11	Anandanag ar main road @1615	1	3.500	0.910	0.0055	0.810	2.835			5.120	0.554	0.020	2.500	7.089																
				3.500			0.810	2.835	9.770	70.983				2.500		7.089	12.513	17.259	22.050	26.070	32.455	IA	IA	IA	IA	IA	6.18	8.52	10.89	12.87	16.02

Sl.No.	Culvert No.	Chainage	Vent / No. of Spans	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
	H200																														
1	H1V-C16	New BEL Road @3775	1	1.200	-	0.0024	-	1.131			3.771	0.300	0.011	1.996	2.258												Diameter of the Pipe				
			10	12				11.314	13.000	12.967				1.996		22.582	38.416	53.359	68.768	82.213	100.249	IA	IA	IA	IA	IA	1.57	1.85	2.1	2.29	2.53
2	H1V-C17	7 th main, RMV Extn. @ 3875	1	1.200	-	0.0030	-	1.131			3.771	0.300	0.011	2.231	2.525												Diameter of the Pipe				
			4	4.8				4.526	11.980	11.980				2.231		10.099	39.196	54.459	70.212	83.980	102.310	IA	IA	IA	IA	IA	2.37	2.79	3.17	3.46	3.82
3	H1V-C18	8 th main road, Sterling Apartments @4225	1	1.200	-	0.0030	-	1.131			3.771	0.300	0.011	2.231	2.525												Diameter of the Pipe				
			5	6				5.657	12.590	55.066				2.231		12.623	40.755	56.657	73.099	87.513	106.432	IA	IA	IA	IA	IA	2.16	2.54	2.89	3.16	3.49
	H300																														
1	H3V-C5	Kanakadas Layout, Lingarajpuram @935	1	1.730	1.900	0.0020	1.800	3.114			5.330	0.584	0.020	1.563	4.866																
			2	1.730	1.900	0.0020	1.800	3.114			5.330	0.584	0.020	1.563	4.866																
				3.460			1.800	6.228	3.510	-77.436				1.563		9.733	4.622	6.365	8.118	9.576	11.972	AD	AD	AD	AD	IA	1.64	2.26	2.89	3.4	4.26
2	H3V-C10	Near Karimariamma Temple @1285	1	2.000	1.500	0.0080	1.400	2.800			4.800	0.583	0.020	3.122	8.742																
				2.000			1.400	2.800	3.290	14.894				3.122		8.742	9.773	13.465	17.179	20.276	25.324	IA	IA	IA	IA	IA	2.24	3.08	3.93	4.64	5.79
3	H3V-C11	Jai Matha Devasthan road @1325	1	0.850	1.900	0.0064	1.800	1.530			4.450	0.344	0.020	1.963	3.004																
			2	0.850	1.900	0.0064	1.800	1.530			4.450	0.344	0.020	1.963	3.004																
				1.700			1.800	3.060	3.420	10.526				1.963		6.007	10.509	14.479	18.473	21.805	27.231	IA	IA	IA	IA	IA	2.97	4.1	5.23	6.17	7.71

Sl.No.	Culvert No.	Chainage	Vent / No. of Spans	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
4	H3V-C13	Hennur main road near petrol bunk @1835	1	2.100	1.000	0.0120	0.900	1.890			3.900	0.485	0.020	3.379	6.387																
			2	1.800	1.000	0.0120	0.900	1.620			3.600	0.450	0.020	3.216	5.211																
				3.900			0.900	3.510	5.360	34.515				3.216		11.597	11.118	15.320	19.549	23.079	28.813	AD	IA	IA	IA	IA	3.84	5.29	6.75	7.97	9.95
5	H3V-C14	1st block, 60ft road, HBR Layout @1965	1	1.300	1.200	0.0050	1.100	1.430			3.500	0.409	0.020	1.947	2.784																
			2	1.200	1.200	0.0050	1.100	1.320			3.400	0.388	0.020	1.882	2.484																
				2.500			1.100	2.750	5.360	48.694				1.882		5.267	11.169	15.391	19.639	23.186	28.945	IA	IA	IA	IA	IA	5.4	7.44	9.49	11.2	13.98
6	H3V-C27	Geddalahalli main road @6815	1	1.850	3.000	0.0050	2.900	5.365			7.650	0.701	0.020	2.791	14.973																
			2	1.850	3.000	0.0050	2.900	5.365			7.650	0.701	0.020	2.791	14.973																
			3	1.850	3.000	0.0050	2.900	5.365			7.650	0.701	0.020	2.791	14.973																
			4	1.850	3.000	0.0050	2.900	5.365			7.650	0.701	0.020	2.791	14.973																
			5	1.850	3.000	0.0050	2.900	5.365			7.650	0.701	0.020	2.791	14.973																
				9.250			2.900	26.825	15.020	-78.595				2.791		74.863	66.295	92.154	118.894	142.359	173.116	AD	IA	IA	IA	IA	8.19	11.39	14.69	17.59	21.39
	H301																														
1	H3S4-C5	Teachers colony, HBR Layout 2nd block	1	1.170	1.500	0.0100	1.400	1.638			3.970	0.413	0.020	2.771	4.539																
			2	1.170	1.500	0.0100	1.400	1.638			3.970	0.413	0.020	2.771	4.539																
				2.340			1.400	3.276	5.090	35.639				2.771		9.078	4.321	5.900	7.443	8.661	11.110	AD	AD	AD	AD	IA	1.11	1.52	1.92	2.23	2.86

Sl.No.	Culvert No.	Chainage	Vent / No. of Spans	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
	H302																														
1	H3S3-C2	Nehru road, Kammanahalli @200	1	1.400	0.900	0.0120	0.800	1.120			3.000	0.373	0.020	2.840	3.181																
				1.400			0.800	1.120	3.590	68.802				2.840		3.181	0.78	1.07	1.37	1.61	2.01	AD	AD	AD	AD	AD	0.34	0.47	0.6	0.71	0.89
2	H3S3-C4	Jyothi social work centre, Kammanahalli @625	1	0.700	1.500	0.0112	1.400	0.980			3.500	0.280	0.020	2.265	2.219																
			2	0.700	1.500	0.0112	1.400	0.980			3.500	0.280	0.020	2.265	2.219																
				1.400			1.400	1.960	3.590	45.404				2.265		4.439	1.210	1.667	2.126	2.508	3.135	AD	AD	AD	AD	AD	0.38	0.53	0.67	0.79	0.99
	H305																														
1	H3S1-C5	Opp. KHB Qtrs. Lingarajpuram @565	1	3.400	1.150	0.0040	1.050	3.570			5.500	0.649	0.020	2.371	8.463																
				3.400			1.050	3.570	4.730	24.524				2.371		8.463	2.57	3.52	4.48	5.25	6.63	AD	AD	AD	AD	AD	1.03	1.42	1.8	2.11	2.66
	H306																														
1	H3S5-C1	Modi Garden, N.P. Factory road @300	1	1.500	0.600	0.0050	0.500	0.750			2.500	0.300	0.020	1.584	1.188																
			2	1.500	0.600	0.0050	0.500	0.750			2.500	0.300	0.020	1.584	1.188																
				3.000			0.500	1.500	0.630	-138.095				1.584		2.377	1.433	1.964	2.490	2.915	3.696	AD	AD	IA	IA	IA	1.81	2.48	3.14	3.68	4.67
2	H3S5-C2	Sayeediya Arabic College @515	1	4.200	1.800	0.0020	1.700	7.140			7.600	0.939	0.020	2.145	15.315																
				4.200			1.700	7.140	8.160	12.500				2.145		15.315	4.53	6.21	7.89	9.26	11.69	AD	AD	AD	AD	AD	1.24	1.7	2.16	2.54	3.21

Sl.No.	Culvert No.	Chainage	Vent / No. of Spans	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
3	H3S5-C3	6th cross, Shadab nagar @640	1	5.450	1.650	0.0025	1.550	8.448			8.550	0.988	0.020	2.480	20.950																
				5.450			1.550	8.448	10.050	15.945				2.480		20.950	6.89	9.47	12.06	14.19	17.82	AD	AD	AD	AD	AD	1.79	2.46	3.14	3.69	4.64
4	H3S5-C6	2nd cross, Gandhinagar, K.G.Halli @1832	1	4.400	1.900	0.0025	1.800	7.920			8.000	0.990	0.020	2.483	19.668																
				4.400			1.800	7.920	17.560	54.897				2.483		19.668	19.01	26.23	33.53	39.66	49.33	AD	IA	IA	IA	IA	4.25	5.87	7.5	8.87	11.04
	H400																														
1	H3MS -C9	Banaswadi main road, near OMBR Layout @815	1	4.800	1.200	0.0120	1.100	5.280			7.000	0.754	0.020	4.539	23.964																
				4.800			1.100	5.280	27.690	80.932				4.539		23.964	10.592	14.495	18.339	21.419	27.285	AD	AD	AD	AD	IA	2.12	2.9	3.67	4.29	5.47

Check for Adequacy of Remodelled Culverts with measured Site Slopes - Hebbal Valley

(Clean Condition) (with freeboard 100mm)

Sl.No.	Culvert No.	Chainage	Vent / No. of Spans	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
	H100	(m)	No.	(B) m	(D) m	(S)	(D- 0.1) m	(m²)	(m²)	%	(m)	(m)		(m/s)	(Cumec)	(Cumec)	(Cumec)	(Cumec)	(Cumec)	(Cumec)	(Cumec)										
1	HV2-C7	Munivenkata Block @1815	1	8.00	1.60	0.01	1.50	12.00			11.00	1.09	0.02	4.43	53.20																
				8.00			1.50	12.00	6.83	-75.70				4.43		53.20	11.43	15.72	20.00	23.53	29.57	AD	AD	AD	AD	AD	1.72	2.36	3.01	3.54	4.45
2	HV2-C14	Yogesh nagar main road @4375	1	12.00	2.40	0.00	2.30	27.60			16.60	1.66	0.02	3.71	102.48																
			2	12.00	2.40	0.00	2.30	27.60			16.60	1.66	0.02	3.71	102.48																
				24.00			2.30	55.20	10.00	-452.00				3.71		204.97	32.14	44.61	57.43	68.56	83.82	AD	AD	AD	AD	AD	3.76	5.22	6.72	8.03	9.81
	H104																														
1	HV2-S2C7	10th cross, Vasanthappa block, Ganganagar @1065	1	5.00	2.20	0.01	2.10	10.50			9.20	1.14	0.02	5.18	54.39																
				5.00			2.10	10.50	8.00	-31.25				5.18		54.39	5.74	7.90	10.08	11.88	14.87	AD	AD	AD	AD	AD	0.53	0.73	0.93	1.09	1.37
2	HV2-S2C11	Anandanagar main road @1615	1	5.00	2.00	0.01	1.90	9.50			8.80	1.08	0.02	3.90	37.07																
				5.00			1.90	9.50	9.77	2.76				3.90		37.07	12.51	17.26	22.05	26.07	32.46	AD	AD	AD	AD	AD	1.69	2.33	2.97	3.52	4.38
	H200																														
1	H1V-C16	New BEL Road @3775	1	15.00	3.50	0.00	3.40	51.00			21.80	2.34	0.02	4.32	220.15																
				15.00			3.40	51.00	20.00	-155.00				4.32		220.15	38.42	53.36	68.77	82.21	100.25	AD	AD	AD	AD	AD	2.62	3.64	4.69	5.60	6.83

Sl.No.	Culvert No.	Chainage	Vent / No. of Spans	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 $_{Reqd.}$) 1year	2year	5year	10year	20year	Remarks 1year	2year	5year	10year	20year	Required Width (B) 1year	2year	5year	10year	20year
2	H1V-C17	7 th main, RMV Extn. @ 3875	1	14.00	2.40	0.00	2.30	32.20			18.60	1.73	0.02	3.95	127.14																
				14.00			2.30	32.20	22.00	-46.36				3.95		127.14	39.20	54.46	70.21	83.98	102.31	AD	AD	AD	AD	AD	4.32	6.00	7.73	9.25	11.27
3	H1V-C18	8 th main road, Sriram Apartments @4225	1	1.20	-	0.00	-	1.13			3.77	0.30	0.01	2.58	2.92																
			5	6.00				5.66	12.00	52.86				2.58		14.58															
			1	3.00	1.50	0.00	1.40	4.20			5.80	0.72	0.02	2.55	10.71																
				3.00			1.40	4.20	4.50	6.67				2.55		25.29	40.75	56.66	73.10	87.51	106.43	IA	IA	IA	IA	IA	11.42	15.87	20.48	24.51	29.81
4	N-3	TATA Nagar-Kodigehalli main road junction, Nagashettyhalli, Hebbal @5600	1	12.00	2.40	0.00	2.30	27.60			16.60	1.66	0.02	3.14	86.62																
				12.00			2.30	27.60	28.00	1.43				3.14		86.62	31.09	43.30	56.00	67.25	81.32	AD	AD	AD	AD	AD	4.31	6.00	7.76	9.32	11.27
5	N-4	Near Hebbal Tank inlet weir @6400	1	12.00	2.40	0.00	2.30	27.60			16.60	1.66	0.02	3.44	94.88																
				12.00			2.30	27.60	28.00	1.43				3.44		94.88	31.09	43.30	56.00	67.25	81.32	AD	AD	AD	AD	AD	3.93	5.48	7.08	8.50	10.28
	H300																														
1	H3V-C5	Kanakadas Layout, Lingarajpuram @935	1	6.00	1.80	0.00	1.70	10.20			9.40	1.09	0.02	2.36	24.08																
				6.00			1.70	10.20	6.00	-70.00				2.36		24.08	4.62	6.37	8.12	9.58	11.97	AD	AD	AD	AD	AD	1.15	1.59	2.02	2.39	2.98

Sl.No.	Culvert No.	Chainage	Vent / No. of Spans	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
2	H3V-C10	Near Karimariamma Temple @1285	1	5.00	1.60	0.01	1.50	7.50			8.00	0.94	0.02	4.28	32.13																
				5.00			1.50	7.50	8.00	6.25				4.28		32.13	9.77	13.46	17.18	20.28	25.32	AD	AD	AD	AD	AD	1.52	2.10	2.67	3.16	3.94
3	H3V-C11	Jai Matha Devasthan road @1325	1	5.00	1.75	0.01	1.65	8.25			8.30	0.99	0.02	3.98	32.87																
				5.00			1.65	8.25	8.00	-3.13				3.98		32.87	10.51	14.48	18.47	21.80	27.23	AD	AD	AD	AD	AD	1.60	2.20	2.81	3.32	4.14
4	N-1	Near Shamanna layout park @1425	1	5.00	1.60	0.01	1.50	7.50			8.00	0.94	0.02	3.95	29.62																
				5.00			1.50	7.50	8.00	6.25				3.95		29.62	10.91	15.04	19.19	22.65	28.28	AD	AD	AD	AD	AD	1.84	2.54	3.24	3.82	4.77
5	H3V-C13	Hennur main road near petrol bunk @1835	1	6.00	1.80	0.01	1.70	10.20			9.40	1.09	0.02	5.78	58.99																
				6.00			1.70	10.20	10.00	-2.00				5.78		58.99	11.12	15.32	19.55	23.08	28.81	AD	AD	AD	AD	AD	1.13	1.56	1.99	2.35	2.93
6	H3V-C14	1st block, 60ft road, HBR Layout @1965	1	7.00	1.80	0.01	1.70	11.90			10.40	1.14	0.02	3.87	46.03																
				7.00			1.70	11.90	10.00	-19.00				3.87		46.03	11.17	15.39	19.64	23.19	28.94	AD	AD	AD	AD	AD	1.70	2.34	2.99	3.53	4.40
7	H3V-C27	Geddalahalli main road @6815	1	12.00	2.40	0.01	2.30	27.60			16.60	1.66	0.02	5.44	150.02																
			2	12.00	2.40	0.01	2.30	27.60			16.60	1.66	0.02	5.44	150.02																
				24.00			2.30	55.20	24.00	-130.00				5.44		300.04	66.30	92.15	118.89	142.36	173.12	AD	AD	AD	AD	AD	5.30	7.37	9.51	11.39	13.85

Sl.No.	Culvert No.	Chainage	Vent / No. of Spans	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
	H301																														
1	H3S4-C5	Teachers colony, HBR Layout 2nd block	1	3.00	1.60	0.01	1.50	4.50			6.00	0.75	0.02	4.13	18.57																
				3.00			1.50	4.50	8.00	43.75				4.13		18.57	4.32	5.90	7.44	8.66	11.11	AD	AD	AD	AD	AD	0.70	0.95	1.20	1.40	1.79
	H302																														
1	H3S3-C2	Nehru road, Kammanahalli @200	1	3.00	1.75	0.01	1.65	4.95			6.30	0.79	0.02	4.66	23.09																
				3.00			1.65	4.95	4.00	-23.75				4.66		23.09	0.78	1.07	1.37	1.61	2.01	AD	AD	AD	AD	AD	0.10	0.14	0.18	0.21	0.26
2	H3S3-C4	Jyothi social work centre, Kammanahalli @625	1	3.00	1.80	0.01	1.70	5.10			6.40	0.80	0.02	4.55	23.20																
				3.00			1.70	5.10	5.00	-2.00				4.55		23.20	1.21	1.67	2.13	2.51	3.13	AD	AD	AD	AD	AD	0.16	0.22	0.27	0.32	0.41
	H305																														
1	N-2	4 th cross, Munithayappa layout @380	1	3.50	1.60	0.00	1.50	5.25			6.50	0.81	0.02	2.38	12.47																
				3.50			1.50	5.25	5.00	-5.00				2.38		12.47	2.15	2.95	3.74	4.39	5.54	AD	AD	AD	AD	AD	0.60	0.83	1.05	1.23	1.56
2	H3S1-C5	Opp. KHB Qtrs. Lingarajpuram @565	1	3.50	1.60	0.00	1.50	5.25			6.50	0.81	0.02	2.74	14.40																
				3.50			1.50	5.25	5.50	4.55				2.74		14.40	2.57	3.52	4.48	5.25	6.63	AD	AD	AD	AD	AD	0.62	0.86	1.09	1.28	1.61

Sl.No.	Culvert No.	Chainage	Vent / No. of Spans	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
	H306																														
1	H3S5-C1	N.P. Factory road @300	1	3.00	1.40	0.01	1.30	3.90			5.60	0.70	0.02	2.78	10.83																
				3.00			1.30	3.90	2.50	-56.00				2.78		10.83	1.43	1.96	2.49	2.92	3.70	AD	AD	AD	AD	AD	0.40	0.54	0.69	0.81	1.02
2	H3S5-C2	Sayeediya Arabic College @515	1	7.00	1.80	0.00	1.70	11.90			10.40	1.14	0.02	2.45	29.11																
				7.00			1.70	11.90	8.16	-45.83				2.45		29.11	4.53	6.21	7.89	9.26	11.69	AD	AD	AD	AD	AD	1.09	1.49	1.90	2.23	2.81
3	H3S5-C3	6th cross, Shadab nagar @640	1	7.00	2.00	0.00	1.90	13.30			10.80	1.23	0.02	2.87	38.20																
				7.00			1.90	13.30	10.05	-32.34				2.87		38.20	6.89	9.47	12.06	14.19	17.82	AD	AD	AD	AD	AD	1.26	1.74	2.21	2.60	3.27
4	H3S5-C6	2nd cross, Gandhinagar , K.G.Halli @1832	1	10.00	2.20	0.00	2.10	21.00			14.20	1.48	0.02	3.25	68.15																
				10.00			2.10	21.00	20.00	-5.00				3.25		68.15	19.01	26.23	33.53	39.66	49.33	AD	AD	AD	AD	AD	2.79	3.85	4.92	5.82	7.24
	H400																														
1	H3MS -C9	Banaswadi main road, near DMBR Layout @815	1	5.00	3.30	0.01	3.20	16.00			11.40	1.40	0.02	6.87	109.86																
				5.00			3.20	16.00	27.69	42.22				6.87		109.86	10.59	14.49	18.34	21.42	27.28	AD	AD	AD	AD	AD	0.48	0.66	0.83	0.97	1.24

CHAPTER - 5

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 for the development of primary and secondary storm water drainage system in the city by the stake holders beyond the 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 BMP, BDA & BMRDA area have been filled up and converted into residential layouts and recreational areas. These lake areas otherwise would have acted as buffer zones for flood protection. The tank beds, and its adjoining areas being the lowest point in the valley are always prone for flooding, to prevent flooding in such areas. It requires, construction of new drains or expensive mechanical means of pumping arrangement. Therefore inorder to avert such expensive recurring problems & expenditures. 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.

As mentioned earlier in the Chapter 2 of this report, storm drains in Hebbal valley flows through dense residential and commercial areas of the city. Due to encroachments and also due to inappropriate planning by the landuse planners, the natural coarse of the drain is altered at many places in the initial reaches.

Further, the carrying capacity of drains is 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 intern causing siltation problems, inconvenience to the surrounding localities and threatening the health aspects of the communities residing in the close proximity of the waterway.

Although in many drainage basins of Hebbal valley, under ground sewerage system has been provided, But, still large quantity of raw sewage is seen flowing in the drains and waterways. This is caused by a various reasons like, 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 etc.

Even though the sewer lines exists, the sewer out lets from the toilets blocks of residential buildings in some of the localities are not connected to the sewerage system and they are discharging raw sewage directly into storm drains and intern distracting the visual aesthetic amenity of waterway, causing odour problem, making place favorable for mosquito breading, causing substantial inconvenience to the surrounding locality resident, pedestrians and vehicular movement and also the tanneries and slaughter houses located near the drains in the valley 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 in the valley, 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.

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.

Further, another significant cause of frequent flooding of low-lying areas is due to development of new layouts near the receiving water bodies, large accumulation of sediments and vegetal growth that reduce the carrying capacity of the 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.

The end result is environmentally most polluting, flooding and nuisance value being high. Hebbal valley is one such valley around the city, which suffers from all the above problems.

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 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 Mattadahalli, Hanumanthappa Layout, Kausernagar, Munnarayanapalya, Bhuvaneshwarinagar, Yogeshnagar, Chamundinagar, Viveshwariahnagar, Gundappa block, Venkatappa block and Ganganagar in Hebbal Main Valley.

Yeshwanthpura, Subbedarpalya, Devanarapalya, Gurumurthy layout, B.K. Nagar, H.M.T. layout, Shardambanagar, Tannirhalli, Brindavananagar, Muthyalanagar, Mattikere, Gokula Extn., Sanjeevappa garden, Maruthinagar, Badarappa layout, Sanjayanagar, Bupasandra and Balajinagar in Hebbal Main Valley– I.

Lingarajapura, Kanakadasa layout, Kariyannapalya, H.B.R. layout, Kammanahalli, Kacharakanahalli, St. Thomas Town, Pillana garden, Ambedkarnagar, Devarajeevanahalli, Doddananagar, Munisvaranagar, Modi garden, Kavalabairasandra, Kadugondanahalli, Shampura, Gandhinagar, Nagavara Mn. Road, Arabic College and Rahat Ali Layout in Hebbal Minor Valley – I.

Chikka Banswadi, O.M.B.R. layout, Subbaiyapalya, H.R.B.R. layout and Hennur in Hebbal Minor Valley – II 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 Hebbal 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 Mattadahalli, Bhuvaneshwarinagar, Yogeshnagar, Chamundinagar, Viveshwariahnagar and Ganganagar in Hebbal Main Valley.

  Yeshwanthpura, Subbedarpalya, H.M.T. layout, Tannirhalli, Brindavananagar, Muthyalanagar, Mattikere, Gokula Extn., Sanjeevappa garden, Jaladarshini layout, Maruthinagar, Badarappa layout & Balajinagar in Hebbal Main Valley– I.

  Lingarajapura, Kanakadasa layout, Kariyannapalya, Ambedkarnagar, Devarajeevanahalli, Doddananagar, Munisvaranagar, Kavalabairasandra, Kadugondanahalli, Shampura, Gandhinagar, Nagavara Mn. Road, Arabic College and Rahat Ali Layout in Hebbal Minor Valley – I.

  Chikka Banswadi, Subbaiyapalya, H.R.B.R. layout and Hennur in Hebbal Minor Valley – II

- 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 stake holders and 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, small scale industries, , tanneries, leather industries, slums and densely populated areas.

- There should be stringent penalty on commercial establishments, tanneries, leather tanning industries, textile 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, tanneries 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 sewer outlet connection 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

In Hebbal Main Valley (H100):

1. University of Agriculture Science College Campus.
2. University of Agriculture College staff quarters.
3. Rajiv Gandhi Dental College.
4. Open land near Inspectorate of Electronics layout.
5. Defence land near Munnireddypalya.

In Hebbal Main Valley – I (H200):

1.Indian Institute of Science Campus.
2.Central Power Research Institute Campus.
3.National Remote Sensing Agency Campus.
4.M.S. Ramaiah Educational Institutions.
5.Open land adjacent to railway track near Gokul Extension.
6.H.M.T. Factory campus near Jalahalli.
7.B.E.L. Factory campus near Lottegollahalli.
8.Eucalyptus plantation area near Lottegollahalli.
9.Airforce campus near Jalahalli.
10.Open land near Tannirhalli.
11.B.H.E.L. campus near Yeshwanthpura.
12.U.A.S. Horticultural farm near Boopasandra Extension.

In Hebbal Minor Valley – I (H300):

1.P & T Staff quarters campus near Kavalabairasandra.
2.Dr. Ambedkar medical college campus near Kadugondanahalli.
3.Arabic college near H.B.R. Layout.
4.Open land near Modi garden
5.Open land near Sayeedia nagar (N.P. Factory)
6.Open land near H.R.B.R. layout outer ring road
7.Telecom Employees Co-Operative society layout
8.Open land near H.B.R. layout 60 ft. road
9.Stone quarries near Devarajeevanahalli

In Hebbal Minor Valley – II (H400):

1.Open land near Babu Sahibpalya (Outer ring road)
2.Sena Vihar Campus
3.Open land near Ramaswamipalya

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 spuch 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 resultsf to improve the existing situation.

CHAPTER - 6

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 cost 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:

Cost estimates has been worked out for the techno-economical proposals suggested in this feasibility report, considering the current schedule of rates and the lead statements furnished by BMP.

Further, for ease of assessment and better working connivence, the works envisaged in the entire Hebbal Valley has been sliced into four packages, which are as follows,

Package (HVD-I) : Hebbal Main Valley (H100)

Package (HVD-II) : Hebbal Main Valley – I (H200)

Package (HVD-III): Hebbal Minor Valley – I (H300)

Package (HVD-IV): Hebbal Minor Valley – II (H400)

The works envisaged in Hebbal valley primary and secondary storm drains and also which are grouped under each package is as listed below in Table 6.1 to Table 6.8.

TABLE 6.1 Details of Primary and Secondary Storm Drains of Hebbal Main Valley (H100) considered for Remodeling in Package (HVD-I) :

SL. No.	Drain ID	Name	Type	Start	End	Length (Mts.)
Hebbal Main Valley (H1):						
1	H100	Hebbal Valley	Pri.	Matadahalli	Nagavara Tank	4,425
2	H101	Bhuvaneshwarinagar	Sec.	Rankanagar	Bhuvaneshwarinagar	575
3	H102	Rahamatnagar	Sec.	Rahamatnagar	Hanumanthappa Extn.	450
4	H103	Gangenahalli	Sec.	Gangenahalli Extn.	R.B.I. Colony	1,125
5	H104	Ganganagar	Sec.	H.M.T. Office	Chamundinagar	2,650
				Total Length of Primary Drain		**4,425**
				Total Length of Secondary Drains		**4,800**

TABLE – 6.2 Details of Culverts / Bridges Constructed across Primary and Secondary Storm Water Drains in Hebbal Main Valley (H100) Considered for Remodeling in Package HVD – I

Sl. No.	Culvert No.	Chainage (m.)	Location	Remarks
Hebbal Main Valley Primary Storm Drain (H100) :				
1	HV2-C7	1,815	Munivenkatappa block	Ex. Culvert/Bridge considered for remodelling
2	HV2-C13	4100	Outer Ring Road	Ex. Culvert/Bridge considered for remodelling
3	HV2-C14	4,375	Yogeshnagar main road	Ex. Culvert/Bridge considered for remodelling
Ganganagar Secondary Storm Drain (H104) :				
1	HV2-S2C7	1,065	10 th Cross, Vasanthaappa block, Ganganagar	Ex. Culvert/Bridge considered for remodelling
2	HV2-S2C11	1,615	Anandanagar main road	Ex. Culvert/Bridge considered for remodelling

TABLE – 6.3 Details of Primary and Secondary Storm Drains of Hebbal Main Valley-I (H200) Considered for Remodeling in Package HVD – II

SL. No.	Drain ID	Name	Type	Start	End	Length (Mts.)
Hebbal Main Valley-I (H2):						
1	H200	Yeshwanthapura	Pri.	Mysore Lamp Works	Hebbal tank	9,000
2	H201	Sachidanandanagar	Sec.	C.P.R.I. Campus	R.M.V.Extn.	2,825
3	H202	A.G.Colony	Sec.	Venkateshwara Layout	A.G.Colony	375
4	H203	H.M.T.Layout	Sec.	Devanarupalya	Mattikere Layout	1,450
5	H204	Subbedarpalya	Sec.	I.I.Sc. Campus	Gurumurthy Layout	800
6	H205	Tannairhalli	Sec.	H.M.T. Office	Muthyalanagar	2,600
7	H206	Bupasandra	Sec.	Sanjayanagar	Hebbal tank	1,125
8	H207	Tatanagar	Sec.	Devinagar main road	Hebbal tank inlet weir	1,150
				Total Length of Primary Drain		**9,000**
				Total Length of Secondary Drains		**10,675**

TABLE – 6.4 Details of Culverts / Bridges Constructed across Primary and Secondary Storm Water Drains in Hebbal Main Valley- I (H200) Considered for Remodeling in - Package HVD - II

Sl. No.	Culvert No.	Chainage (m.)	Location	Remarks
Hebbal Main Valley - I Primary Storm Drain (H200) :				
1	H1V-C16	3,775	New B.E.L. Road	Ex. Culvert/Bridge considered for remodelling
2	H1V-C17	3,875	7th main, R.M.V. Extension.	Ex. Culvert/Bridge considered for remodelling
3	H1V-C18	4,225	8th main road, Near Sterling Apartments	Ex. Culvert/Bridge considered for remodelling
4	N-3	5,600	TATA Nagar – Kodigehalli main road junction, Nagashettyhalli, Hebbal	Pro. RCC Slab bridge
5	N-4	6,400	Near Hebbal tank Inlet Weir	Pro. RCC Slab bridge
Bupasandra Secondary Storm Drain (H206) :				
1	H1S5 - C7	800	Bupasandra Main Road	Ex. Culvert/Bridge considered for remodelling

TABLE – 6.5 Details of Primary and Secondary Storm Drains of Hebbal Minor Valley-I (H300) Considered for Remodeling in Package HVD – III

SL. No.	Drain ID	Name	Type	Start	End	Length (Mts.)
Hebbal Minor Valley-I (H3)						
1	H300	Kadugondanahalli	Pri.	Jaibharathnagar	Raja Canal STP	7,375
2	H301	Kacharakanahalli	Sec.	Keshavanagar	Gandhinagar	1,150
3	H302	Kammanahalli	Sec.	Ramaswamipalya	Hennur Main Road	975
4	H303	Kammanahalli - I	Sec.	Kammanahalli Mn. Rd.	Kammanahalli	250
5	H304	Venkateshpura	Sec.	Pilana Garden	Kariyannapalya	1,700
6	H305	Banaswadi	Sec.	Lingarajpura	Kanakadasa Layout	550
7	H306	Kavalabairasandra	Sec.	Munireddypalya	Arabic College	3,025
8	H307	Devarajivanahalli	Sec.	Chinnappagarden	Kavalabairasandra	685
9	H308	Ambedkarnagar	Sec.	Devarajeevanahalli	Doddanna nagar main road	1,000
				Total Length of Primary Drain		**7,375**
				Total Length of Secondary Drains		**9,335**

TABLE – 6.6 Details of Culverts / Bridges Constructed across Primary and Secondary Storm Water Drains in Hebbal Minor Valley-I (H300) Considered for Remodeling in Package HVD – III

Sl. No.	Culvert No.	Chainage (m.)	Location	Remarks
Hebbal Minor Valley-I Primary Storm Drain (H300) :				
1	H3V-C5	935	Kanakadasa Layout, Lingarajpura	Ex. Culvert/Bridge considered for remodelling
2	H3V-C10	1,285	Near Karimariamma temple	Ex. Culvert/Bridge considered for remodelling
3	H3V-C11	1,325	Jai Matha Devasthan road	Ex. Culvert/Bridge considered for remodelling
4	N-1	1,425	Near Shamanna layout park	Pro. RCC box culvert
5	H3V-C13	1,835	Hennur main road, near Petrol bunk	Ex. Culvert/Bridge considered for remodelling
6	H3V-C14	1,965	1st stage, 1st block, 60 ft. road, H.B.R. Layout.	Ex. Culvert/Bridge considered for remodelling
7	H3V-C27	6,815	Geddlahalli main road	Ex. Culvert/Bridge considered for remodelling
Kacharakanahalli Secondary Storm Drain (H301)				
1	H3S4-C5	1,140	Near Teacher's colony, HBR Layout 2nd block	Ex. Culvert/Bridge considered for remodelling
Kammanahalli Secondary Storm Drain (H302)				
1	H3S3-C2	200	Nehru road, Kammanahalli	Ex. Culvert/Bridge considered for remodelling
2	H3S3-C4	625	Near Jyothi social work centre, Kammanahalli	Ex. Culvert/Bridge considered for remodelling
Banaswadi Secondary Storm Drain (H305)				
1	N-2	380	4th cross road, Munithayappa layout	Pro. RCC box culvert
2	H3S1-C5	565	Opp. K.H.B. Qtrs., Lingarajpura	Ex. Culvert/Bridge considered for remodelling
Kavalabairasandra Secondary Storm Drain (H306)				
1	H3S5-C1	300	N.P. Factory road	Ex. Culvert/Bridge considered for remodelling
2	H3S5-C2	515	Sayeediya Arabic college	Ex. Culvert/Bridge considered for remodelling
3	H3S5-C3	640	6th Cross, Shadabnagar	Ex. Culvert/Bridge considered for remodelling
4	H3S5-C6	1,832	2nd Cross, Gandhinagar, Kadugondanahalli	Ex. Culvert/Bridge considered for remodelling

TABLE – 6.7 Details of Primary and Secondary Storm Drains of Hebbal Minor Valley-II (H400) Considered for Remodeling in Package HVD – IV

Sl. No.	Drain ID	Name	Type	Start	End	Length (Mts.)
Hebbal Minor Valley-II (H4):						
1	H400	Hennur	Pri.	Chikka Banaswadi	Raja Canal STP	5,000
2	H401	Kalayananagar	Sec.	Kammanahalli Mn. Rd.	Sena Vihar	950
				Total Length of Primary Drain		**5,000**
				Total Length of Secondary Drains		**950**

TABLE – 6.8 Details of Culverts / Bridges Constructed across Primary and Secondary Storm Water Drains in Hebbal Minor Valley-II (H400) Considered for Remodeling in Package HVD - IV

Sl. No.	Culvert No.	Chainage (m.)	Location	Remarks
Hebbal Minor Valley-II Primary Storm Drain (H400) :				
1	H3M5-C9	815	Banaswadi main road, near O.M.B.R. Layout Fire station.	Ex. Culvert/Bridge considered for remodelling

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 few tertiary drains and other allied works to minimizing the flooding problems in low lying areas.

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 worked out and given in Volume IV of this report.

Further for better understanding work summary statements and strip plans for every kilometer length, 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 of KPWD, NH, MI, Market rates/Consultants data bank 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 and Secondary storm drain in Hebbal Main Valley (H100).

Table 6.11 & 6.12 indicates carrying capacity improvement works & rehabilitation works for Primary and Secondary storm drains in Hebbal Main Valley - I (H200).

Table 6.13 & 6.14 indicates carrying capacity improvement works & rehabilitation works for Primary and Secondary storm drain in Hebbal Minor Valley – I (H300).

Table 6.15 & 6.16 indicates carrying capacity improvement works & rehabilitation works for Primary and Secondary storm drains in Hebbal Minor Valley – II (H400).

Table 6.17 Indicates abstract of cost for remodelling of existing culverts / bridges and also construction of new bridges in the entire Hebbal Valley.

6.4 Work Programme for Hebbal Valley:

The works proposed for remodeling of storm drains in Hebbal Valley, shall be taken up in a phased manner simultaneously in all the packages. Since, some of the critical issues which requires 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 perspective 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 the entire Hebbal Valley:**

- Before commencement of any work, detailed work plan has to be prepared for all the packages and get approved by BMP.

- 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.

6.5 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.Public awareness campaigns
6.Maintenance of desilting equipment's
7.Manpower requirement for maintenance of the system.

Table 6.18 Indicates abstract of cost for annual operation and maintenance of the

Abstract of Cost

for Remodeling of Primary and Secondary

Storm Water Drains, Culverts/Bridges & its appurtenant works in Hebbal 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.,	15,938.24
2	Cost for Remodeling of Bridges / Culverts constructed across Primary & Secondary Storm Water Drains.	1,311.96
3	Cost for shifting utility lines, footpath improvement works, barricading, traffic diversion, strengthening of diversion routes etc.	862.51
4	Construction of Detention Ponds / Retarding Basins	174.00
5	Construction of Wells with pumping arrangement in low lying areas	400.00
6	Procurement of desilting machine	45.00
7	Miscellaneous and rounding off	0.02
8	Advisory, Project Management & Establishment charges. (1.5 % of Item 1 to 7)	280.98
	1.TOTAL	**19,012.71**
9	Annual Operation & Maintenance Cost (1.0 % of Item 1 to 7)	187.32

Table 6.18 Abstract of Cost for Operation and Maintenance of Primary and Secondary Storm Water Drains in Hebbal Valley

Sl. No.	*Description*	*Amount (Rs. In lakhs)*	*Remarks*
1	**Operation & Maintenance**		(Cost considered is for per annum).
1.1	Establishment Charges	18.73	
1.2	Purchase & maintenance of equipments.	18.73	
1.3	Construction of new components	56.20	
1.4	Drain Desilting works	37.46	Av. Silt depth of Min. 0.3 to 0.5 m. per year
1.5	Rehabilitation works	46.83	
1.6	Staff training, community awareness etc.	9.37	
	Total	**187.32**	

drainage system in the entire Hebbal Valley.

Table 6.9 - Schedule For Improving the Carrying Capacity of Existing Primary Storm Drains in Hebbal Main Valley (H100)

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Carrying Capacity Improvements Works (H100)							
					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
H100 – Hebbal Main Valley Primary Storm Drain:												
1	0	1000	Sri Venkateshwara Swamy temple near R.K. Theatre	Kohinoor bus depot near Hanumanthappa layout	475-550	Near RT Nagar, 1st block road (Dhobi Ghat) Right side: Ex-drain is in natural condition, needs to be widened on right hand side and new RCC wall to be const. for a height of 2.2 m. Ex. Av. Width: 4.0 m, Pro. Av. Width : 6.0 m.	a) 0-200	From J.C. Nagar main road near Sri Venkatateshwara Swamy temple upto Meena Masjid road. Ex-covered drain needs to be opened at regular interval and desilt by about 0.3 m and further, pre-fabricated steel grating needs to be provided near Meena Masjid Road.			200-1000	After desilting, bed protection needs to be provided for full length and width. Ex. Av. width: 3.5 m
					950-1000	Near old cinema talkies Left side: Ex- drain needs to be widened on left side & new RCC wall to be const for a ht. of 2.2 m. Ex.Av width: 3.5 m, Pro. Av.width: 6.0 m	b) 200-1000	From Meena Masjid road upto Kohinoor bus depot near Hanumanthappa layout. Ex-drain needs to be desilt by about 0.5 m.				
2	1000	2000	Kohinoor bus depot near Hanumanthappa layout	Muninanjappa block	1000-1200	Near Kohinoor bus depot. Left side: Ex.drain needs to be widened on left side and new RCC wall to be const. for a ht. of 2.2 m, Ex.Av width: 3.5 m, Pro. Av.width: 6.0 m.	1000-2000	Kohinoor bus depot upto Muninanjappa block. Ex-drain needs to be desilted by about 0.5 m.			1000-2000	After desilting, bed protection needs to be provided for full length and width. Ex. Av. width: 8.0 m
					1200-1400	Adjacent to Sriram Properties. Right side: Ex-drain needs to be widened on right side and new RCC wall to be const. for a ht. Of 2.2 m. Ex.Av. Width 4.5 m, Pro. Av. Width 6.0 m.						
					1525-1700	Dinnur main road upto Muninanjappa block. Right side: Ex-drain needs to be widened on right side and new RCC wall to be const. for a ht. Of 2.2 m. Ex.Av. Width 4.5 m, Pro. Av. Width 7.0 m.						
					1700-2000	Near Srinivasa hollow block industries. Right side: Ex-drain needs to be widened on right side and new RCC wall to be const. for a ht. Of 2.2 m. Ex.Av. Width 5.5 m, Pro. Av. Width 8.0 m.						
3	2000	3000	Muninanjappa block	Kanakanagar main road	a)2000-2125	Near John Engg. Works. Right side: Ex-drain needs to be widened on right side and new RCC wall to be const. for a ht. Of 2.2 m. Ex.Av. Width 6.0 m, Pro. Av. Width 8.0 m.	2000-3000	Muninanjappa block upto Kanakanagar main road. Ex-drain needs to be desilted by about 0.5 m.			2000-3000	After desilting, bed protection needs to be provided for full length and width.
					b)2175-2275	Near Rathnamma layout. Both side: Ex-drain is in natural condition, needs to be widened on left side and new walls to be const. on both side for a ht. Of 2.2 m. Ex.Av. Width 6.0 m, Pro. Av. Width 8.0 m.						
					c)2275-2675	Near Chamundinagar. Both side: Ex-drain is in natural condition, needs to be widened on left side and new walls to be const. on both side for a ht. Of 2.2 m. Ex.Av. Width 6.0 m, Pro. Av. Width 8.0 m.						
					d)2675-2875	Right side: Ex-drain needs to be widened on right side and new RCC wall to be const. for a ht. Of 2.2 m. Ex.Av. Width 6.0 m, Pro. Av. Width 13.0 m.						
					e)2875-3000	Both side: Ex-drain is in natural, needs to be widened on left side and new walls to be const. on both side for a ht. Of 2.2 m. Ex.Av. Width 6.0 m, Pro. Av. Width 14.0 m.						

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Carrying Capacity Improvements Works (H100)							
					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
4	3000	4500	Kanakanagar main road	Nagavana tank	a)3000-3325	Kanakanagar main road upto Sunrise colony. Both side: Ex-drain is in natural condition, needs to be widened on right side and embankment needs to be formed with imported earth and stone revetment needs to be formed. Further, 4.5 m wide service road needs to be formed on right hand side and guard stones at regular interval. Ex.Av. Width 8.0 m, Pro. Av. Width 16.0 m., Ht: 2.2 m.	3000-4500	Kanakanagar main road upto Nagavara tank. Ex-drain needs to be desilted by about 0.5 m.			3000-4500	After drain desilting, bed protection needs to be provided for full length and width.
					b)3325-3600	Sunrise colony upto V. Nagenahalli. Right side: Ex-drain needs to be widened on right side and also SSM wall exists on left side only and no wall on right side. Hence, after widening, embankment needs to be formed with imported earth and stone revetment needs to be provided on right side for a ht. of 2.2 m. Further, 4.5 m wide service road needs to be formed on right hand side and guard stones to be laid at regular interval. Ex.Av. Width 8.0 m, Pro. Av. Width 16.0 m.						
					c)3600-3800	V. Nagenahalli main road upro Railway bridge. Both side: Ex-drain is in natural condition, needs to be widened on both side and embankment needs to be formed with imported earth and stone revetment needs to be formed on both sides for a ht. of about 2.2 m. Further, 4.5 m wide service road needs to be formed on right hand side and guard stones to be laid at regular interval. Ex.Av. Width 11.0 m, Pro. Av. Width 18.0 m.						
					d)3800-4100	Railway track upto Outer ring road. Both side: Ex-drain is in natural condition, needs to be widened on both side and embankment needs to be formed with imported earth on both sides and stone revetment needs to be provided on both sides for a ht. of about 2.2 m. Further, 4.5 m wide service road needs to be formed on right hand side and guard stones to be provided at regular interval. Ex.Av. Width 12.0 m, Pro. Av. Width 20.0 m.						
					e)4125-4500	Outer ring road upto Nagavara tank. Both side: Ex-drain is in natural, needs to be widened on both side and embankment needs to be formed with imported earth on both sides and stone revetment needs to be provided on both sides for a ht. of about 2.2 m. Further, 4.5 m wide service road needs to be formed on right hand side and guard stones to be provided at regular interval. Ex.Av. Width 6.5 m, Pro. Av. Width 22.0 m.						

Table 6.10 - Schedule For Providing Rehabilatation to the Existing Primary Storm Drains in Hebbal Main Valley (H100)

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Rehabilitation Works (H100)					
					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
H100 – Hebbal Main Valley Primary Storm Drain:										
1	0	1000	Sri Venkateshwara Swamy temple near R.K. Theatre	Kohinoor bus depot near Hanumanthappa layout	0-500	Sri Venkateshwara swamy temple road upto RT nagar 1st block road. Left side: 100 m. length SSM wall to be reconstd. at different reaches for a ht. of about 2.0 m. Right side: 50 m. length SSM wall to be reconstd. at different reaches for a ht. about 2.0 m.	200-1000	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be done on both sides to the Ex-drain wall for a ht of 2.0 m.	0-500	a) 2 Nos. of 75 mm dia cables exits. b) 8 Nos. of 1.2 m dia manholes exits.
					500-1000	RT nagar 1st block road upto Kohinoor bus depot near Hanumanthappa layout. Left side: 25 m. length SSM. wall to be reconstd. at different reaches for a ht. of about 2.0 m. Right side: 10 m. length SSM wall to be reconstd. at different reaches for a ht. about 2.0 m.				a) 12 Nos. of 1.2 m dia manholes exists.
2	1,000	2000	Kohinoor bus depot near Hanumanthappa layout	Muninanjappa block			1000-1200	Right side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be done on right side to the Ex-drain wall for a ht of 2.0 m.	a)1000-1500	a) 16 Nos. of 1.2 m dia manholes exists.
							1200-1400	Left side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be done on left side to the Ex-drain wall for a ht of 2.0 m.	b)1500-2000	b) 23 Nos. of 1.2 m dia manholes exists.
							1400-1500	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be done on both side to the Ex-drain wall for a ht of 2.0 m.		
							1525-1700	Left side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be done on left side to the Ex-drain wall for a ht of 2.0 m.		
							1700-2000	Left side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be done on left side to the Ex-drain wall for a ht of 2.0 m.		

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Rehabilitation Works (H100)					
					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
3	2,000	3000	Muninanjappa block	Kanakanagar main road			a)2000-2125	Left side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be done on left side to the Ex-drain wall for a ht of 2.0 m.	a)2000-2500	a) 15 Nos. of 1.2 m dia manholes exists. b) 8 Nos. of 1.2 m dia manholes exists.
							b)2675-2875	Left side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be done on left side to the Ex-drain wall for a ht of 2.0 m.	b)2500-3000	
4	3,000	4500	Kanakanagar main road	Nagavara tank			a)3325-3600	Left side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be done on left side to the Ex-drain wall for a ht of 2.0 m.	a)3000-3500	a) 6 Nos. of 1.6 m dia manholes exists.
									b)3500-4000	b) 7 Nos. of 1.6 m dia manholes exists.

Table 6.9 - Schedule For Improving the Carrying Capacity of Existing Secondary Storm Drains in Hebbal Main Valley (H100)

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Carrying Capacity Improvements Works (H100)							
					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
H101 – Bhuvaneshwari nagar Secondary Storm Drain:												
1	0	575	Ranka nagar	Bhuvaneshwari nagar	0-375	Munnarayana palya main road upto Bhuvaneshwarinagar 1st main road. Both side: Ex. Drain is in natural condition, new walls to be constd. On both sides. Pro. Av. Width: 3.0 m, ht: 1.8 m.	0-575	Ex.drain needs to be desilted by about 0.5 m.			0-375	After drain desilting, bed protection needs to be provided for full length and width. Ex. Av. width: 3.0 m
					375-400	Bhuvaneshwarinagar 1st main road. Ex. SSM wall to be dismantled and new RCC box drain of size 3 x 2 for a length of 20 m. needs to be constd.					400-575	After drain desilting, bed protection needs to be provided for full length and width. Pro. Av. width: 4.0 m
					400-575	Near Bhuvaneshwarinagar 1st main road. Both sides: Ex. Drain is in natural condition, new walls to be constd. On both sides. Pro. Av. Width: 4.0 m.						
H102 – Rahmat nagar Secondary Storm Drain:												
1	0	450	5th cross road, Rahmt nagar	Chunchappa block near Hanumanthappa layout			0-450	Near 5th cross road, Rahmat nagar upto Chunchappa block. Ex.drain needs to be desilted by about 0.5 m.			0-450	After drain desilting, bed protection needs to be provided for full length and width. Ex. Av. width: 3.0 m
							275-450	Further, after desilting drain bed needs to be deepened by 0.3 m. Ex. Av. Width: 3.0 m.				
H103 – Gangenahalli Secondary Storm Drain:												
1	0	1125	Binny mill road near Gangenahalli	RBI colony	1000-1025	Near Ganganagar 5th cross road. Left side: Ex commercial building constd. Over the drain to be dismantled, widened on left side and new wall to be constd. Ex. Av. Width: 5 m, Ht: 2.0 m. Pro. Av. Width: 7.0 m, ht: 2.2 m.	0-225	Ex.drain needs to be desilted by about 0.3 m. Ex. Av. Width: 3.0 m.			0-225	After drain desilting, bed protection needs to be provided for full length and width. Ex. Av. width: 3.0 m
					1100-1125	Near Pillappa block main road. New RCC box drain of size 3 x 2 m. needs to be constd. for a length of about 25 m.	225-1125	Ex.drain needs to be desilted by about 0.5 m. Ex. Av. Width: 6.0 m.			225-1125	After drain desilting, bed protection needs to be provided for full length and width. Ex. Av. width: 6.0 m
							0-1125	After desilting, drain bed needs to be deepened by about 0.3 m.				
H104 – Ganganagar Secondary Storm Drain:												
1	0	1000	Bellary road near HMT Bhavan	CBI road, Ganganagar	200-250	Behind HMT office. Both side: Ex. drain is in natural condition, widened & new SSM wall to be constd. Ex. Av. Width: 2.5 m, Pro. Av. Width: 4.0 m, ht: 1.6 m.	0-1000	Ex.drain needs to be desilted by about 0.3 m. Further, after desilting drain bed needs to be deepened by about 0.3 m. Ex. Av. Width: 3.5 m.			0-1000	After drain desilting, bed protection needs to be provided for full length and width. Ex. Av. width: 3.5 m

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Carrying Capacity Improvements Works (H100)							
					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
2	1,000	2650	CBI road, Ganganagar	Chamundinagar main road	1075-1250	Near 10th cross Vasanthappa block, Ganganagar. Right side: Ex. SSM wall to be dismantled, widened & new wall to be constd. On right side. Ex. Av. Width: 3.5 m, Pro. Av. Width: 5.0 m, ht: 2.0 m.	1000-1500	Ex.drain needs to be desilted by about 0.5 m. Ex. Av. Width: 5.0 m.			1000-1250	After drain desilting, bed protection needs to be provided for full length and width. Pro. Av. width: 5.0 m
					1250-1300	Near Vishveshwaraiah nagar. New RCC box drain of size 2 x 2 m. needs to be constd. for a length of 50 m.	1500-1800	Ex.drain needs to be desilted by about 0.3 m. Ex. Av. Width: 5.5 m.			1300-1500	After drain desilting, bed protection needs to be provided for full length and width. Pro. Av. width: 5.5 m
					1500-1700	Near Anandnagar Ganesh temple. Right side: Ex. SSM wall to be dismantled, widened & new wall to be constd. On right side. Ex. Av. Width: 4.0 m, Pro. Av. Width: 6.5 m, ht: 2.2 m.	1800-2650	Ex.drain needs to be desilted by about 0.5 m. Ex. Av. Width: 6.5 m.			1500-2650	After drain desilting, bed protection needs to be provided for full length and width. Pro. Av. width: 6.5 m
					1700-1800	Near Muslim Edan society. Left side: Ex. SSM wall to be dismantled, widened & new wall to be constd. On left side. Ex. Av. Width: 4.0 m, Pro. Av. Width: 6.5 m, ht: 2.2 m.						
					1940-1975	Near MSH layout. Right side: Ex. SSM wall to be dismantled, widened & new wall to be constd. On right side. Ex. Av. Width: 3.0 m, Pro. Av. Width: 7.0 m, ht: 2.2 m.						
					2400-2550	Near Amarjyothi layout. Both side: Ex. Drain is in natural condition, new walls to be constd. On both sides for a ht of 2.2 m.						

Table 6.10 - Schedule For Providing Rehabilatation to the Existing Secondary Storm Drains in Hebbal Main Valley (H100)

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Rehabilitation Works (H100)					
					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
H101 – Bhuvaneshwari nagar Secondary Storm Drain:										
1	0	575	Ranka nagar	Bhuvaneshwari nagar					0-575	a) 2 Nos. of water sewage pipelines of 75 mm dia exists.
H102 – Rahmat nagar Secondary Storm Drain:										
1	0	450	5th cross road, Rahmt nagar	Chunchappa block near Hanumanthappa layout	150-175	Near Rahmat nagar 1st cross road. Left side: 25 m. length SSM wall to be reconstd. For a ht. Of about 1.6 m.	0-450	Both sides: After desilting, cavities to be filled eroded, stones to be restored, pointing & plastering to be done on both sides to the Ex.drain wall for a ht. Of about 1.6 m.	0-450	a) 11 Nos. of 1.2 m dia manholes exits.
H103 – Gangenahalli Extn. Secondary Storm Drain:										
1	0	1125	Binny mill road near Gangenahalli	RBI colony	300-350 450-500 575-600 800-850 800-825	Right side: Ex. Drain wall to be reconstd. For a length of 25 m. on right side, ht: 2.0 m. Near Burial ground. Right side: Ex. Drain wall to be reconstd. For a length of 50 m. on right side, ht: 2.0 m. Near Venkatappa block. Both side: Ex. Drain wall to be reconstd. For a length of 15 m. on right side, ht: 2.2 m. Near A.K. Colony. Left side: Ex. Drain wall to be reconstd. For a length of 50 m. on left side, ht: 2.2 m. Near A.K. Colony. Left side: Ex. Drain wall to be reconstd. For a length of 10 m. on left side, ht: 2.2 m.	0-1125	After desilting, cavities to be filled eroded, stones to be restored, painting & plastering to be provided for a ht. Of about 2.2 m.	0-500 500-1125	a) 2 Nos. of 60 mm & 40 mm dia water sewage pipelines exists. b) 11 Nos. of 1.2 m dia manholes exits. a) 2 Nos. of 60 mm & 40 mm dia cables exists. b) 24 Nos. of 1.2 m dia manholes exits.
H104 – Ganganagar Secondary Storm Drain:										
1	0	1000	Bellary road near HMT Bhavan	CBI road, Ganganagar	a)75-100 b)375-400 c)600-625 d)750-800 e)975-1000	Right side: Ex. Drain wall to be reconstd. For a length of 10 m. on right side, ht: 1.6 m. Right side: Ex. Drain wall to be reconstd. For a length of 10 m. on right side, ht: 1.6 m. Right side: Ex. Drain wall to be reconstd. For a length of 15 m. on right side, ht: 2.0 m. Both side: Ex. Drain wall to be reconstd. For a length of 50 m. on both side, ht: 2.0 m. Right side: Ex. Drain wall to be reconstd. For a length of 25 m. on right side, ht: 2.0 m.	0-500 500-1000	Both side: After desilting, eroded stones to be restored, pointing & plastering to be provided for a ht. Of about 1.6 m. Both side: After desilting, eroded stones to be restored, pointing & plastering to be provided for a ht. Of about 2.0 m.	a)0-500 b)500-1000	a) 3 Nos. of telephone cables of 110 mm & 175 mm dia exists. b) 21 Nos. of 1.2 m dia manholes exits.

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Rehabilitation Works (H100)					
					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
2	1,000	2650	CBI road, Ganganagar	Chamundinagar main road	1100-1125	Left side: Ex. Drain wall to be reconstd. For a length of 10 m. on left side, ht: 2.0 m.	1000-1075	Both side: After desilting, cavities to be filled, eroded stones to be restored, pointing & plastering to be provided on both sides for a ht. Of about 2.0 m.	a)1000-1500	a) 3 Nos. of telephone cables exists. b) 9 Nos. of 110 mm dia & 175 mm dia water sewage pipelines exists. c) 10 Nos. of 1.2 m dia manholes exits.
					1375-1400	Left side: Ex. Drain wall to be reconstd. For a length of 10 m. on left side, ht: 2.0 m.	1075-1250	Left side: After desilting, cavities to be filled, eroded stones to be restored, pointing & plastering to be provided on left side for a ht. Of about 2.0 m.	b) 1500-2000	a) 4 Nos. of 110 mm dia & 175 mm dia water sewage pipelines exists. b) 3 Nos. of 1.2 m dia manholes exits.
					1300-1325	Right side: Ex. Drain wall to be reconstd. For a length of 10 m. on right side, ht: 2.0 m.	1250-1300	Both side: After desilting, cavities to be filled, eroded stones to be restored, pointing & plastering to be provided on both sides for a ht. Of about 2.0 m.	c) 2000-2650	a) 13 Nos. of 1.2 m dia manholes exists.
							1300-1500	Both side: After desilting, cavities to be filled, eroded stones to be restored, pointing & plastering to be provided on both sides for a ht. Of about 2.2 m.		
							1500-1700	Left side: After desilting, cavities to be filled, eroded stones to be restored, pointing & plastering to be provided on left side for a ht. Of about 2.2 m.		
							1700-1800	Right side: After desilting, cavities to be filled, eroded stones to be restored, pointing & plastering to be provided on right side for a ht. Of about 2.2 m.		
							1800-1900	Both side: After desilting, cavities to be filled, eroded stones to be restored, pointing & plastering to be provided on both sides for a ht. Of about 2.2 m.		
							1900-2000	Left side: After desilting, cavities to be filled, eroded stones to be restored, pointing & plastering to be provided on left side for a ht. Of about 2.2 m.		
							2000-2400	Both side: After desilting, cavities to be filled, eroded stones to be restored, pointing & plastering to be provided on both sides for a ht. Of about 2.2 m.		
							2550-2650	Both side: After desilting, cavities to be filled, eroded stones to be restored, pointing & plastering to be provided on both sides for a ht. Of about 2.2 m.		

Table 6.11 - Schedule For Improving the Carrying Capacity of Existing Primary Storm Drains in Hebbal Main Valley - I (H200)

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Carrying Capacity Improvements Works (H200)							
					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
	H200 – Hebbal Main Valley Primary Storm Drain:											
1	0	1000	Old Tumkur Road near Mysore lamp works.	Triveni Road near Kamala Nehru Extn.	425-550	Near Karnataka Bank. New RCC box drain of size 3 x 1.5 m needs to be constd. for a length of 125 m.	0-1000	Ex- BS slabs covered drain needs to be opened at regular interval and desilt by about 0.5 m. Ex. Avg. Width: 2.5 m.			900-1000	After drain desilting, bed protection needs to be provided for full length and width. Ex. Av. width: 3.0 m
					525-550	Near Triveni Road. Right side: Ex.drain needs to be widened on right side and new wall to be const. Ex.Av width: 2.2 m, Pro. Av.width: 3.0 m., Ht: 2.0 m						
2	1000	2000	Triveni Road near Kamala Nehru Extn.	Mathikere bus stop near Mohan kumar road	1700-1900	Near Mohan kumar road. Right side: Ex.drain needs to be widened on right side and new wall to be const. for a ht. of 2.0 m, Ex.Av width: 3.0 m, Pro. Av.width: 4.5 m.	1000-2000	Ex- BS slabs covered drain needs to be opened at regular interval and desilt by about 0.5 m.			1300-1500	Near B.K. Nagar. After drain desilting, bed protection needs to be provided for full length and width. Ex. Av. width: 3.0 m
					1900-2000	New RCC box chain of size 4 x 2 m. needs to be constd. for a length of 100 m.	1700-2000	Further, after desilting, drain bed to be deepened by about 0.5 m. Ex. Avg. Width: 3.0 m.				
3	2000	3000	Mathikere bus stop near Mohan kumar road	Mathikere main road near KPTCL office	2475-2800	Near SBM Colony. Both side: Ex-drain needs to be widened on right side and new walls to be const. on both sides. Further, 4.5 m wide WBM road needs to be formed and guard stones to be provided at regular interval. Ex.Av. Width 5.0 m, Pro. Av. Width 10.0 m., Ht: 2.2 m.	2000-3000	Ex-drain needs to be desilted by about 0.5 m.			2450-2950	After drain desilting, bed protection needs to be provided for full length and width. Pro. Av. width: 10.0 m
					2800-2925	New RCC box chain of size 3 x 2 m. needs to be constd. for a length of 125 m.						
					2925-2950	Ex-drain needs to be widened on right side and new RCC box drain of size 3 x 2 m. needs to be const. for a length of 25 m.						
4	3000	4000	Mathikere main road near KPTCL office	Venkatachary nagar near New BEL Road		Note: Ch:2950-3625 m. **Drain improvement works has been taken up under separate contract.**	3000-4000	Ex-drain needs to be desilted by about 0.3 m. Ex.Avg. Width: 5.5 m.			3625-4000	Near RMV Extn. II Stage. After desilting, bed protection needs to be provided for full length and width. Pro. Av. width: 14.0 m
					3625-3775	Near New BEL road. Both side: Ex-drain is in natural condition alignment to be slightly altered, new wall to be constd. on both side. Pro. Av. Width: 14 m., Ht: 2.2 m.						
					3800-3950	Near RMV extn. II Stage. Right side: Ex-SSM wall to be dismantled, widened and new wall to be constd. on right side. Ex. Avg. Width: 5.5 m.., Pro. Avg. Width: 14 m., Ht: 2.4 m.						
					3950-4000	Near Venkatachary nagar. Left side: Ex-SSM wall to be dismantled widened and new wall to be constd. on left side. Ex.Av. Width 6.0 m, Pro. Av. Width 14.0 m., Ht: 2.4 m						

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Carrying Capacity Improvements Works (H200)							
					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
5	4000	5000	Venkatachary nagar near New BEL Road	Outer Ring Road	4000-4225	Near Sterling Properties Apartments. Left side: Ex-SSM wall to be dismantled widened and new wall to be constd. on left side. Ex.Av. Width 6.0 m, Pro. Av. Width 15.0 m., Ht: 2.4 m	4000-4600	Ex-drain needs to be desilted by about 1.0 m. Ex.Avg. Width: 6.0 m.			4000-4550	Near Sriram Properties Apartments upto Gandhi Vidhayalaya Assn.. After drain desilting, bed protection needs to be provided for full length and width. Pro. Av. width: 15.0 m
					4250-4450	Near Sterling Properties Apartments. Left side: Ex-SSM wall to be dismantled widened and new wall to be constd. on left side. Ex.Av. Width 6.5 m, Pro. Av. Width 15.0 m.	4600-5000	Ex-drain needs to be desilted by about 1.0 m. Ex.Avg. Width: 11.5 m.			4550-4925	Near railway track. After drain desilting, bed protection needs to be provided for full length and width. Pro. Av. Width: 16.5 m.
					4450-4550	Near Gandhi Vidyalaya Assn.. Right side: Ex-SSM wall to be dismantled widened and new wall to be constd. on right side. Ex.Av. Width 6.5 m, Pro. Av. Width 15.0 m.						
					4550-4825	Near Railway track. Both side: Ex SSM wall to be dismantled widened and new wall to be constd. on both side. Ex.Av. Width 11.5 m, Pro. Av. Width 16.5 m., Ht: 2.4 m						
					4825-4950	Near Railway track. Both side: Ex drain is in natural condition, embankment to be formed with imported earth and stone revetment to be provided on both side. Pro. Av. Width 16.5 m., Ht: 2.4 m						
6	5000	6000	Outer Ring Road	Balaji layout 6th cross road	5025-5075	Near Devinagar main road. Both side: Ex-SSM wall to be dismantled, widened and new RCC wall to be constd. on both sides. Ex.Av. Width 11.5 m, Pro. Av. Width 18.0 m., Ht: 3.2 m.	5000-6000	Ex-drain needs to be desilted by about 0.5 m. Ex. Av. Width: 5.5 m.			5025-5175	Near Marutinagar. After drain desilting, bed protection needs to be provided for full length and width. Pro. Av. Width: 18.0 m.
					5075-5175	Near Marutinagar. Both side: Ex-drain is in natural condition, to be widened on right side and new walls to be constd. on both sides. Ex.Av. Width 5.5 m, Pro. Av. Width 18.0 m., Ht: 2.4 m.					5175-5600	Near Mottappa layout. After drain desilting, bed protection needs to be provided for full length and width. Pro. Av. Width: 10.0 m.
					5175-5600	Near Motappa layout. Both side: Ex-drain is in natural condition, to be widened on right side and embankment to be formed with imported earth on both sides. Further, 4.5 m. wide WBM road to be formed on left side and guard stones to be provided at regular interval. Ex.Av. Width 5.5 m, Pro. Av. Width 10.0 m., Ht: 2.4 m.					5600-5750	Adjacent to Nagashetty halli main road. After drain desilting, bed protection needs to be provided for full length and width. Pro. Av. Width: 10.0 m.
					5600-5750	Adjacent to Nagashetty halli main road.. Right side: Ex-SSM wall to be dismantled, widened and new embankment to be formed with imported earth on right side. Ex.Av. Width 5.0 m, Ht: 2.0 m. and Pro. Av. Width 10.0 m., Ht: 2.4 m.					5750-6000	Near Balajinagar 6th cross. After drain desilting, bed protection needs to be provided for full length and width. Ex. Av. Width: 6.0 m.
7	6000	7000	Balaji layout 6th cross road	A location near Defence Dairy farm in marshy land.	6000-6075	Near Balaji layout 7th cross road.. Right side: Ex-SSM wall to be dismantled, widened and new wall to be constd. on right side. Ex.Av. Width 4.0 m, Pro. Av. Width 10.0 m., Ht: 2.4 m.	6000-6075	Ex-drain needs to be desilted by about 0.5 m.			6000-6075	Near Balaji layout 7th cross road. After draindesilting, bed protection needs to be provided for full length and width. Pro. Av. Width: 10.0 m.

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Carrying Capacity Improvements Works (H200)							
					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
					6075-6350	Near Hebbal tank inlet weir. Both side: Ex-drain is in natural condition, to be widened on left side and new embankment to be formed with imported earth and stone revetment to be provided on both sides. Further, 4.5 m wide WBM Service road to be formed on left side and guard stones to be provided at regular interval. Ex.Av. Width 6.5 m, Pro. Av. Width 12.0 m., Ht: 2.4 m.	6075-6350	Ex-drain needs to be desilted by about 1.0 m.			6075-6350	Near Hebbal tank inlet weir. After drain desilting, bed protection needs to be provided for full length and width. Pro. Av. Width: 12.0 m.
					6350-7000	Near AMCO colony. Both side: Ex-drain is in natural condition, to be widened on left side and the existing embankment on right side to be rehabilited with imported earth for a ht. of 1 m. and stone revetment to be provided on both sides. Ex.Av. Width 10.0 m, Pro. Av. Width 22.0 m., Ht: 2.4 m.	6350-7000	Ex-drain needs to be desilted by about 1.2 m.			6350-7000	Near AMCO colony. After drain desilting, bed protection needs to be provided for full length and width. Pro. Av. Width: 22.0 m.
8	7000	8000	A location near Defence Dairy farm in marshy land.	A location after bellary road (NH-7) adjacent to Chiranjeevi nagar.	7000-7750	A location near Defence dairy farm in marshy land. Both side: Ex-drain is in natural condition, to be widened on left side and the existing embankment on right side to be rehabilited with imported earth for a ht. of 1 m. and stone revetment to be provided on both sides. Ex.Av. Width 10.0 m, Pro. Av. Width 22.0 m., Ht: 2.4 m.					7000-7750	A location near Defence dairy farm in marshy land.. After drain desilting, bed protection needs to be provided for full length and width. Pro. Av. Width: 22.0 m.
					7800-8000	Near Bellary road. Ex-drain is in natural condition, embankment to be formed on right side with imported earth and stone revetment to be provided on both sides. Further, 4.5 m wide WBM Service road to be formed on left side and guard stones to be provided at regular interval. Pro. Av. Width 24.0 m., Ht: 2.4 m.					7800-8000	Near Bellary road. After drain desilting, bed protection needs to be provided for full length and width. Pro. Av. Width: 24.0 m.
9	8000	9000	A location after bellary road (NH-7) adjacent to Chiranjeevi nagar.	Yogesh nagar	8000-9000	Near Chiranjeevi nagar. Ex-drain is in natural condition, embankment to be formed on with imported earth on both sides and stone revetment to be provided on both sides. Further, 4.5 m wide WBM Service road to be formed on left side and guard stones to be provided at regular interval. Pro. Av. Width 24.0 m., Ht: 2.4 m.	8000-9000	Ex-drain needs to be desilted by about 0.5 m.			8000-9000	After drain desilting, bed protection needs to be provided for full length and width. Pro. Av. Width: 24.0 m.

Table 6.12 - Schedule For Providing Rehabilatation to the Existing Primary Storm Drains in Hebbal Main Valley - I (H200)

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Rehabilitation Works (H200)					
					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
H200 – Hebbal Main Valley - I Primary Storm Drain:										
1	0	1000	Old Tumkur Road near Mysore lamp works.	Triveni Road near Kamala Nehru Extn.			0-1000	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of 1.4 m.		
2	1,000	2000	Triveni Road near Kamala Nehru Extn.	Mathikere bus stop near Mohan kumar road	1150-1175 1250-1300 1375-1425	Near Kamala Mohan Extn. Both side: Ex. SSM wall to be reconstd. On both sides For a ht: 2.2 m. Near B.K. Nagar. Both side: Ex. SSM wall to be reconstd. On both sides For a ht: 2.2 m. Both side: Ex. SSM wall to be reconstd. On both sides For a ht: 2.2 m.	1000-1700 1700-1900 1900-2000	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of 2.0 m. Left side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on left side for a ht of 2.0 m. Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of 2.0 m.	a)1000-1500 b)1500-2000	a) 3 Nos. of cables exists between Ch.1325-1350 m.. b) 5 Nos. of cables exists between Ch.1400-1425 m. a) 3 Nos. of cables exists between Ch. 1525-1550 m.
3	2,000	3000	Mathikere bus stop near Mohan kumar road	Mathikere main road near KPTCL office			2000-2475 2800-2925	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of 2.2 m. Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of 2.2 m.	a)2000-2500 a)2500-3000	 a) 6 Nos. of 1.2 m dia manholes exists.
4	3,000	4000	Mathikere main road near KPTCL office	Venkatachary nagar near New BEL Road			3800-3925 3925-4000	Left side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on left side for a ht of 2.4 m. Right side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on right side for a ht of 2.4 m.	a)3000-3500 a)3500-4000	a) 2 Nos. of 1.2 m dia manholes exists.
5	4,000	5000	Venkatachary nagar near New BEL Road	Outer Ring Road	4325-4350 4375-4425 4475-4500	Near RMV Extn. 7th cross road. Right side: Ex. SSM wall to be reconstd. On right side For a length of about 10 m. & ht: 2.4 m. Near Sterling properties apartments Extn. Right side: Ex. SSM wall to be reconstd. On right side For a length of about 30 m. & ht: 2.4 m. Near Gandhi vidyalaya Assn. Left side: Ex. SSM wall to be reconstd. On left side For a length of about 25 m. & ht: 2.4 m.	4000-4225 4250-4475	Right side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on right side for a ht of 2.4 m. Right side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on right side for a ht of 2.4 m.	a)4000-4500 a)4500-5000	a) 1 No. of 250 mm dia water supply pipeline exists between Ch.4250-4275 m. a) 5 Nos. of 1.2 m. dia manholes exists.
6	5,000	6000	Outer Ring road	Balaji layout 6th cross road	5800-5825	Near Balaji layout 1st cross road. Right side: Ex. SSM wall to be reconstd. On right side For a length of about 25 m. & ht: 2.4 m.	5400-6000	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on both side for a ht of 2.4 m.	a)5000-5500 b)5500-6000	 a) 1 No. of 450 mm dia water supply pipeline exists. b) 2 Nos. of 110 mm dia cable lines exists.
7	6,000	7000	Balaji layout 6th cross road	A location near Defence Dairy farm in marshy land.						
8	7,000	8000	A location near Defence Dairy farm in marshy land.	A location after bellary road (NH-7) adjacent to Chiranjeevi nagar.						

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Rehabilitation Works (H200)					
					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
9	8,000	9000	A location after bellary road (NH-7) adjacent to Chiranjeevi nagar.	Yogesh nagar						

Table 6.11 - Schedule For Improving the Carrying Capacity of Existing Secondary Storm Drains in Hebbal Main Valley - I (H200)

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Carrying Capacity Improvements Works (H200)							
					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
H201 – Sachidananda nagar Secondary Storm Drain:												
1	0	1000	CPRI campus	Near IISC staff qtrs, 8th cross road, Adarsh layout	900-950	Near IISC staff qtrs. Slum area. Right side: Ex-SSM wall to be dismantled, widened and new wall to be constd. On right side. Ex. Av. Width: 2.0 m., Pro. Av. Width: 3.5 m., Ht: 2.0 m.	0-1000	Ex- drain is almost covered, it needs to be opened at regular intervals and desilted by about 0.5 m. Further, after desilting pre-fabricated steel grating needs to be provided at regular intervals. Ex. Avg. Width: 2.0 m.				
2	1000	2850	Near IISC staff qtrs, 8th cross road, Adarsh layout	Gandhi vidyalaya Assn. Near RMV extn. II Stage	a)1450-1575	Adj. To IISC staff quarters. Left side: Ex.drain needs to be widened on left side and new wall to be const. for a ht. of 2.0 m, Ex.Av width: 2.0 m, Pro. Av.width: 5.0 m.	1000-2000	Ex-drain needs to be desilted by about 0.3 m. Ex. Av. Width: 2.5 m.			1450-1575	After drain desilting, bed protection needs to be provided for full length and width. Pro. Av. width: 5.0 m
					b)1600-1725	Adjacent to ISRO. Left side: Ex.drain needs to be widened on left side and new wall to be const. for a ht. of 2.0 m, Ex.Av width: 2.0 m, Pro. Av.width: 5.0 m.	2000-2825	Ex-drain needs to be desilted by about 0.3 m. Ex. Av. Width: 3.5 m.			1600-1725	After drain desilting, bed protection needs to be provided for full length and width. Pro. Av. width: 5.0 m
					c) 1725-1800	From 5th main road upto 3rd main road, RMV extn. II Stage. Ex.SSM drain needs to be dismantled and new RCC box drain of size 5 x 2 m. needs to be constd.					1800-2000	After drain desilting, bed protection needs to be provided for full length and width. Pro. Av. width: 5.0 m
					d)1800-2000	Near RMV Extn. II Stage park. Right side: Ex.SSM wall needs to be dismantled, widened and new wall to be constd. On right side. Ex. Av. Width: 2.5 m., Pro. Av. Width: 5.0 m., Ht: 2.2 m.					2000-2825	After drain desilting, bed protection needs to be provided for full length and width. Pro. Av. width: 3.5 m
H202 – A.G. Colony Secondary Storm Drain:												
1	0	375	Venkateshwara layout near MSR Medical college	A.G. Colony	325-375	Near A.G. Colony main road. Left side: Ex-SSM wall to be dismantled, widened and new wall to be constd. Ex. Av. Width: 1.2 m., Pro. Av. Width: 2.5 m., Ht: 1.4 m.	0-375	Ex- drain is almost covered, it needs to be opened at regular intervals and desilted by about 0.3 m. Ex. Avg. Width: 1.2 m.			325-375	After drain desilting, bed protection needs to be provided for full length and width. Pro. Av. width: 2.5 m
H203 – HMT Layout Secondary Storm Drain:												
1	0	1445	Devanarapalya	Mattikere layout		a) Near Mohan kumar road New RCC box drain of size 2 x 1.6 m. for a length of 70 m. needs to be constd. Further, pre-fabricated steel grating needs to be provided at regular interval.	a) 0-1000	a) Ex- drain is almost covered, it needs to be opened at regular intervals and desilted by about 0.3 m. Ex. Avg. Width: 2.0 m.			325-375	After drain desilting, bed protection needs to be provided for full length and width. Pro. Av. width: 2.5 m
						b) Vacant land. Opp. To KPTCL office, Mattikere. New open drain of size 2 x 1.6 m. needs to be constd. For a length of 80 m.	b)1000-1445	b) Ex- drain is almost covered, it needs to be opened at regular intervals and desilted by about 0.3 m. Ex. Avg. Width: 3.0 m.				
								c) Ex. Tertiary drains in Mattikere main road, i.e. after Mohan kumar road needs to be desilted. Appro. Length: 200 m.				

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Carrying Capacity Improvements Works (H200)							
					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
H204 – Subbedarpalya Secondary Storm Drain:												
1	0	800	IISC near MSR road Subbedarpalya	Triveni road near Gurumurthy layout			0-800	Ex- drain is almost covered with BS slabs, to be opened at regular intervals and desilted by about 0.5 m. Further, after desilting pre fabricated steel grating needs to be provided at regular interval.				
H205 – Tannirhalli Secondary Storm Drain:												
1	0	1000	Near HMT shopping complex near HMT main road	Near St. Chlaret's school play ground, Sharadamba nagar	475-700	Near HMT factory water treatment plant. Both side: Ex. Drain is in natural condition, embankment to be formed with imported earth and stone revetment to be provided on both sides. Pro. Av. Width: 6.0 m, Ht: 2.0 m.	0-1000	Ex.drain needs to be desilted by about 0.3 m. Ex. Av. Width: 2.5 m.			0-500	After drain desilting, bed protection needs to be provided for full length and width. Ex. Av. width: 2.0 m
					700-1000	Near HMT quarters. Right side: Ex. SSM wall to be dismantled, widened and embankment to be formed with imported earth and stone revetment to be provided on right side. Ex. Av. Width: 2.5 m, Ht: 1.6 m., Pro. Av. Width: 6.0 m, Ht: 2.0 m.					500-1000	After drain desilting, bed protection needs to be provided for full length and width. Pro. Av. width: 6.0 m
2	1000	2600	Near St. Chlaret's school play ground, Sharadamba nagar	Mattikere tank bund road	1000-1300	Near St. Chlaret's school play. Right side: Ex. SSM wall to be dismantled, widened and stone revetment to be provided on right side. Further, SSM parapet wall to be constd. For a ht. of 0.6 m. Ex. Av. Width: 3.0 m, Ht: 1.8 m., Pro. Av. Width: 8.0 m, Ht: 2.0 m.	1000-1400	Ex.drain needs to be desilted by about 0.3 m. Ex. Av. Width: 3.0 m.			1000-1400	After drain desilting, bed protection needs to be provided for full length and width. Pro. Av. width: 8.0 m
					1300-1400	Near Sharadamba nagar. Right side: Ex. SSM wall to be dismantled, widened and new RCC wall to be constd. Ex. Av. Width: 3.0 m, Ht: 1.8 m., Pro. Av. Width: 8.0 m, Ht: 2.0 m.	1400-2600	Ex.drain needs to be desilted by about 0.3 m. Ex. Av. Width: 7.5 m.			1475-2075	After drain desilting, bed protection needs to be provided for full length and width. Pro. Av. width: 10.0 m
					1475-1700	Near Outer Ring road railway track. Both side: Ex. drain is in natural condition, embankment to be formed with imported earth and stone revetment to be provided on both sides. Pro. Av. Width: 10.0 m, Ht: 2.0 m.					2075-2150	After drain desilting, bed protection needs to be provided for full length and width. Pro. Av. width: 5.5 m
											2150-2600	After drain desilting, bed protection needs to be provided for full length and width. Pro. Av. width: 10.0 m

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Carrying Capacity Improvements Works (H200)							
					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
					1700-1800	Near Badappa garden. Both side: Ex. Drain is in natural condition, new RCC wall to be constd. on both sides. Pro. Av. Width: 10.0 m, Ht: 2.2 m.						
					1800-1925	Near Badappa garden Hi tension wire. Left side: Ex. SSM wall to be dismantled, widened and new RCC wall to be constd. Ex. Av. Width: 6.5 m, Ht: 2.0 m., Pro. Av. Width: 10.0 m, Ht: 2.2 m.						
					1925-2075	Near Muthyalamma nagar. Right side: Ex. SSM wall to be dismantled, widened and embankment to be formed with imported earth and stone revetment to be provided on right side. Ex. Av. Width: 7.0 m, Ht: 2.0 m., Pro. Av. Width: 10.0 m, Ht: 2.2 m.						
					2150-2600	Near Mattikere park (Tank area). Ex. Drain is in natural condition, embankment to be formed with imported earth and stone revetment to be provided on both side. Pro. Av. Width: 10.0 m, Ht: 2.2 m.						
H206 – Boopasandra Secondary Storm Drain:												
1	0	1125	Sanjayanagar	Hebbal tank	0-225	Near RMV Extn. 1st main road. Both side: Ex. Drain is in natural condition, new walls to be constd. On both sides. Pro. Av. Width: 3.5 m., Ht: 2.0 m.	0-975	Ex. Drain needs to be desilted by about 1.0 m. Ex. Av. Width: 3.5 m.			0-475	After drain desilting, bed protection needs to be provided for full length and width. Ex. Av. Width: 3.5 m.
					475-550	Near 1st Cross Central Excise layout. Both side: Ex. Drain is in natural condition, new walls to be constd. On both sides. Pro. Av. Width: 4.5 m., Ht: 2.2 m.	975-1125	Ex. Drain needs to be desilted by about 1.0 m. Ex. Av. Width: 16.0 m.			475-550	After drain desilting, bed protection needs to be provided for full length and width. Pro. Av. Width: 4.5 m.
					550-800	Inside UAS property. Both side: Ex. BS slab cover to be removed, SSM wall to be dismantled, widened and new wall to be constd on both sides. Ex. Av. Width: 3.0 m., Ht: 1.8 m., Pro. Av. Width: 6.0 m, Ht: 2.0 m.	550-975	After desilting drain bed to be lowered by 0.3 m.			550-800	After drain desilting, bed protection needs to be provided for full length and width. Pro. Av. Width: 6.0 m.
					800-975	Near Boopasandra main road. Both side: Ex. Drain is in natural condition, embankment needs to be formed with imported earth on both sides and stone revetment to be provided on both sides. Pro. Av. Width: 7.5 m., Ht: 2.2 m.					800-975	After drain desilting, bed protection needs to be provided for full length and width. Pro. Av. Width: 7.5 m.
											1025-1125	After drain desilting, bed protection needs to be provided for full length and width. Ex. Av. Width: 16.0 m.

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Carrying Capacity Improvements Works (H200)							
					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
H207 – TATA Nagar Secondary Storm Drain:												
1	0	1500	Devinagar main road	Hebbal tank inlet weir	0-500	Adjacent to Devinagar main road. Both side: Embankment needs to be formed with imported earth and stone revetment to be provided on both sides. Further, 4.5 m. wide WBM Service road to be formed over the embankment on left side. Guard stone to be provided at regular interval. Pro. Av. Width: 12 m., Ht: 2.2 m.					0-1500	After formation of embankment and stone pitching, drain bed protection needs to be provided for full length and width.
					500-800	Adjacent to TATA nagar main road. Both side: New Embankment needs to be formed on right side and stone revetment to be provided on both sides. Further, guard stone to be provided at regular interval. Pro. Av. Width: 12 m., Ht: 2.2 m.						
					800-1500	Adjacent to Balajinagar extension. Both side: New Embankment needs to be formed on left side and stone revetment to be provided on both sides. Further, guard stone to be provided at regular interval. Pro. Av. Width: 12 m., Ht: 2.2 m.						

Table 6.12- Schedule For Providing Rehabilatation to the Existing Secondary Storm Drains in Hebbal Main Valley - I (H200)

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Rehabilitation Works (H200)					
					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
H201 – Sachidananda nagar Secondary Storm Drain:										
1	0	1000	CPRI campus	Near IISC staff qtrs, 8th cross road, Adarsh layout			300-1000	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of 1.6 m.		
2	1,000	2850	Near IISC staff qtrs, 8th cross road, Adarsh layout	Gandhi vidyalaya Assn. Near RMV extn. II Stage			1000-1450	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of 2.0 m.	a)1000-1500	a) 1 No. of cable line exists. b) 1 No. of water supply pipeline exists between Ch.1250-1275 m. c) 1 No. of 1.2 m dia manhole exists.
							1450-1575	Right side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on right side for a ht of 2.2 m.	b) 1500-2000	
							1600-1725	Right side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on right side for a ht of 2.2 m.	c) 2000-2850	a) 1 No. of 1.2 m dia manhole exists.
							1800-2000	Left side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on left side for a ht of 2.2 m.		
							2000-2850	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of 2.4 m.		
H202 – A.G. Colony Secondary Storm Drain:										
1	0	375	Venkateshwara layout near MSR Medical college	A.G. Colony	225-250	Near New BEL road. Left side: Ex. SSM wall to be reconstd. For a length of about 20 m, ht: 1.4 m on left side.	0-325	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of 1.2 m.	a)0-375	a) 7 Nos. of water supply pipeline exists between Ch.175-225 m. b) 2 Nos. of 1.2 m dia manholes exists.
							325-375	Right side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on right side for a ht of 1.4 m.		
H203 – HMT layout Secondary Storm Drain:										
1	0	1445	Devanarapalya	Mattikere layout			0-1445	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of 1.6 m.		
H204 – Subbedarpalya Secondary Storm Drain:										
1	0	800	IISC near MSR road Subbedarpalya	Triveni road near Gurumurthy layout			0-800	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of 2.0 m.		

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Rehabilitation Works (H200)					
					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
H205 – Tannirhalli Secondary Storm Drain:										
1	0	1000	Near HMT shopping complex	Near St. Chlaret's school play ground, Sharadamba nagar	50-75	Both side: Ex. Drain wall to be reconstd. For a length of about 10 m, ht: 1.8 m on both sides.	0-475	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of 1.8 m.	a) 0-500	a) 1 No. of cable lines exists between Ch.0-25 m.. b) 1 No. of water supply pipeline of 110 mm dia exists between Ch.25-50 m. c) 1 No. of cable lines exists between Ch.175-200 m. d) 3 Nos. of water supply pipelines exists between Ch.475-500 m.
					125-175	Both side: Ex. Drain wall to be reconstd. For a length of about 25 m, ht: 2.0 m on both sides.	700-1000	Left side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of 2.2 m.	b) 500-1000	a) 3 Nos. of water supply pipelines of 300, 180 & 110 mm dia exists between 700-725 m. b) 1 No. of 1.2 m dia manhole exits.
2	1,000	2600	Near St. Chlaret's school play ground, Sharadamba nagar	Mattikere tank bund road			1000-1400	Left side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of 1.8 m.	1000-1500	a) 2 Nos. of water supply pipelines of 300 & 180 mm dia exists between Ch. 425 - 1450 m.
							1800-1925	Right side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of 2.0 m.	1500-2000	a) 2 Nos. of water supply pipelines exists between Ch.1825-1850 m.
							1925-2075	Left side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be done to the Ex-drain wall for a ht of 2.0 m.	2000-2600	a) 3 Nos. of water supply pipelines exists between Ch. 2150-2175 m.
							2075-2150	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be done to the Ex-drain wall for a ht of 2.0 m.		

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Rehabilitation Works (H200)					
					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
H206 – Bhoopasandra Secondary Storm Drain:										
1	0	1125	Sanjayanagar	Hebbal tank	350-375	Both side: Ex. SSM wall to be reconstd. On both sides for a length of about 10 m, ht: 2.0 m.	225-475	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of 2.0 m.	0-500	a) 7 Nos. of cable exists between Ch.225-250 m.. b) 1 No. of water supply pipeline of 300 mm dia exists between Ch.325-350 m. c) 4 Nos. of water supply pipeline exists between Ch.400-425 m. d) 3 Nos. of 1.2 m dia manhole exists.
					400-425	Both side: Ex. SSM wall to be reconstd. On both sides for a length of about 25 m, ht: 2.0 m.	1025-1125	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be provided on both sides for a ht of 2.6 m.	500-1125	a) 1 No. of water supply pipeline exists between Ch.1025-1050 m. b) 6 Nos. of 1.2 m dia manhole exists.
H207 – TATA nagar Secondary Storm Drain:										
1	0	1500	Devinagar main road	Hebbal tank inlet weir						

Table 6.13 - Schedule For Improving the Carrying Capacity of Existing Primary Storm Drain in Hebbal Minor Valley - I (H300)

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Carrying Capacity Improvements Works (H300)							
					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
H300 – Hebbal Minor Valley - I Primary Storm Drain:												
1	0	1000	Jaibharathi nagar 3rd cross near Lingarajpura railway track	Muniswamy street, Kanakadasa layout, Lingarajpura	850-900	Near KHB Qtrs. Both sides: Alignment of drain needs to be slightly altered, widened and new RCC walls to be constd. on both sides. Ex. Av. Width: 3.0 m, Pro. Av. Width : 5.0 m., Ht: 2.0 m	0-1000	Ex-drain needs to be desilted by about 0.5 m.			0-1000	After drain desilting, bed protection needs to be provided for full length and width.
2	1000	2000	Muniswamy street, Kanakadasa layout, Lingarajpura	1st Stage, 1st Block, 60 Ft. Road, HBR Layout	1250-1400 1430-1550 1750-1800 1850-1950	Near Jai Matha Devasthana Road, Kanakadan layout. Left side: Ex- drain needs to be widened & new wall to be const on left hand side. Ex.Av width: 2.2 m, Pro. Av.width: 5.0 m, Ht: 2.0 m. Near Shammanna layout park. Left side: Ex-drain needs to be widened on leftt side and stone revetment to be provided. Ex.Av. Width 2.2 m, Pro. Av. Width 5.0 m, Ht: 2.0 m. Near Hennur main road petrol bunk. Left side: SSM wall to be dismantled and drain to be widened. Further, new wall to be const. on left side. Ex.Av. Width 3.0 m, Pro. Av. Width 6.0 m., Ht: 2.0 m. Near 1st Stage, 1st Block, HBR layout. Right side: Ex-drain needs to be widened on right side and new wall to be const. for a ht. Of 2.0 m. Ex.Av. Width 4.0 m, Pro. Av. Width 7.0 m.	a)1000-2000 b)1550-1800	Ex-drain needs to be desilted by about 0.5 m. Near Kariyannapalya, After desilting, drain bed needs to be deepened by about 0.5 m.			1000-2000	After drain desilting, bed protection needs to be provided for full length and width. Ex. Av. width: 8.0 m
3	2000	3000	1st Stage, 1st Block, 60 Ft. Road, HBR layout	1st Stage, 3rd block, 5th cross road, HBR layout, Yaseen nagar			2000-3000	Ex-drain needs to be desilted by about 0.75 m. Ex. Avg. Width: 10.0 m.			2000-3000	After drain desilting, bed protection needs to be provided for full length and width. Ex. Avg. Width: 10.0 m.
4	3000	4000	1st Stage, 3rd block, 5th cross road, HBR layout, Yaseen nagar	Near Rahat Ali layout			3000-4000	Ex-drain needs to be desilted by about 0.75 m. Ex. Avg. Width: 13.0 m.			3000-4000	After drain desilting, bed protection needs to be provided for full length and width. Ex. Avg. Width: 13.0 m.
5	4000	5000	Near Rahat Ali layout	17th main road, 5th block, HBR layout near ORR.			4000-5000	Ex-drain needs to be desilted by about 0.75 m. Ex. Avg. Width: 14.50 m.			4000-5000	After drain desilting, bed protection needs to be provided for full length and width. Ex. Avg. Width: 14.50 m.

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Carrying Capacity Improvements Works (H300)							
					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
6	5000	6000	17th main road, 5th block, HBR layout near ORR.	Location in marshy land near Gedalahalli main road	5200-6000	Near Prakruthi layout & Telecom Employees Co-operative society layout. Both side: Alignment of Ex-drain in marshy area needs to be slightly altered, widened on both sides. Embankment to be formed with imported earth and stone revetment to be provided on both sides for a ht. of 2.6 m. Further, 7.5 m wide WBM service road to be formed on both sides and guard stone to be provided at regular interval. Pro. Avg. Width: 22 m.	5000-6000	Ex-drain needs to be desilted by about 0.75 m. Ex. Avg. Width: 17.50 m.			5000-6000	After drain desilting, bed protection needs to be provided for full length and width.
7	6000	7500	Location in marshy land near Gedalahalli main road	Raja canal STP	6000-7500	Near Prakruthi layout & Telecom Employees Co-operative society layout. Both side: Alignment of Ex-drain in marshy area needs to be slightly altered, widened on both sides. Embankment to be formed with imported earth and stone revetment to be provided on both sides for a ht. of 2.6 m. Further, 7.5 m wide WBM service road to be formed on both sides and guard stone to be provided at regular interval. Pro. Avg. Width: 24 m.	6000-7500	Ex-drain needs to be desilted by about 0.75 m. Ex. Avg. Width: 10.0 m.			6000-7500	After drain desilting, bed protection needs to be provided for full length and width.

Table 6.14 - Schedule For Providing Rehabilatation to the Existing Primary Storm Drain in Hebbal Minor Valley - I (H300)

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Rehabilitation Works (H300)					
					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
H300 – Hebbal Minor Valley Primary Storm Drain:										
1	0	1000	Jaibharath nagar 3rd cross near Lingarajpura railway track	Muniswamy street, Kanakadasa layout, Lingarajapura	350-450	Near Lingarajapura railway track. Both side: Embankment needs to be formed with imported, earth on both sides and stone pitching to be provided for a ht. of about 2.0 m.	a) 0-350	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be done on both sides to the Ex-drain wall for a ht of 1.6 m.		
							b) 450-900	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be done on both sides to the Ex-drain wall for a ht of 1.6 m.		
2	1,000	2000	Muniswamy street, Kanakadasa layout, Lingarajapura	1st Stage, 1st Block, 60 Ft. Road, HBR layout.	1700-1710	Near Kariyanapalya. Right side: Ex-drain wall to be reconstd. On right hand side for a length of about 10 m & ht. 2.0 m.	a)1000-1250	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be done on both sides to the Ex-drain wall for a ht of 1.6 m.	a)1000-1500	a) 1 No. of water supply pipeline of 300 mm dia at Ch.1175 m to 1200 m.
							b)1250-1400	Right side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be done on right side to the Ex-drain wall for a ht of 1.6 m.		b) 1 No. of water supply pipeline of 300 mm dia at Ch.1400 m to 1425 m.
							c)1430-1550	Right side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be done on right side to the Ex-drain wall for a ht of 1.6 m.		c) 2 Nos. of cables of 110 mm dia exists.
							d)1550-1800	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be done on both the sides to the Ex-drain wall for a ht of 2.0 m.		d) 16 Nos. of 1.2 m dia manhole exists.
							e)1800-1950	Left side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be done on left side to the Ex-drain wall for a ht of 2.0 m.	b)1500-2000	
3	2,000	3000	1st Stage, 1st Block, 60 Ft. Road, HBR layout.	1st Stage, 3rd Block, 5th cross road, HBR layout, Yaseen nagar.	a)2050-2075	Both side: Ex-drain wall needs to be reconstd. On both the sides for a length of about 25 m & ht. 3.0 m.	2000-3000	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be done on both sides to the Ex drain wall for a ht of 3.0 m.		
					b)2200-2250	Right side: Ex-drain wall needs to be reconstd. On right side for a length of about 50 m & ht. 3.0 m.				

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Rehabilitation Works (H300)					
					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
4	3,000	4000	1st Stage, 3rd Block, 5th cross road, HBR layout, Yaseen nagar.	Near Rahat ali layout	3025-3050 3425-3550 3675-3750 3725-3750	Left side: Ex-drain wall needs to be reconstd. On left side for a length of about 20 m & ht. 3.0 m. Left side: Ex-drain wall needs to be reconstd. On left side for a length of about 20 m & ht. 3.0 m. Left side: Ex-drain wall needs to be reconstd. On left side for a length of about 75 m & ht. 3.0 m. Right side: Ex-drain wall needs to be reconstd. On right side for a length of about 25 m & ht. 3.0 m.	3000-4000	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be done on both sides to the Ex-drain wall for a ht of 3.0 m.		
5	4,000	5000	Near Rahat ali layout	17th Main road, 5th Block, HBR layout near DRR	4025-4050 4275-4300 4400-4425 4550-4575 4750-4725 4975-5000	Left side: Ex-drain wall needs to be reconstd. On left side for a length of about 10 m & ht. 3.0 m. Left side: Ex-drain wall needs to be reconstd. On left side for a length of about 10 m & ht. 3.0 m. Right side: Ex-drain wall needs to be reconstd. On right side for a length of about 25 m & ht. 3.0 m. Left side: Ex-drain wall needs to be reconstd. On left side for a length of about 10 m & ht. 3.0 m. Left side: Ex-drain wall needs to be reconstd. On left side for a length of about 10 m & ht. 3.0 m. Right side: Ex-drain wall needs to be reconstd. On right side for a length of about 20 m & ht. 3.0 m.	4000-5000	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be done on both sides to the Ex-drain wall for a ht of 3.0 m.	a)4500-5000	a) 2 Nos. of 2.6 m dia manhole exists.
6	5,000	6000	17th Main road, 5th Block, HBR layout near DRR	Location in marshy land near Gedalahalli main road			5000-5200	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be done on both sides to the Ex-drain wall for a ht of 3.0 m.		
7	6,000	7500	Location in marshy land near Gedalahalli main road	Raju canal STP						

Table 6.13 - Schedule For Improving the Carrying Capacity of Existing Secondary Storm Drain in Hebbal Minor Valley - I (H300)

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Carrying Capacity Improvements Works (H300)							
					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
H301 – Kacharakanahalli Secondary Storm Drain:												
1	0	1150	Keshavanagar, near Kacharakanahalli (St. Thomas town)	Gandhinagar 1st Stage, 2nd Block, HBR layout			0-1150	Ex-drain needs to be desilted by about 0.4 m. After desilting, the drain bed to be deepened by about 0.3 m. Ex. Avg. Width: 2.5 m.			0-1150	After drain desilting, bed protection needs to be provided for full length and width.
H302 – Kammanahalli Secondary Storm Drain:												
1	0	975	Ramaswamy palya	1st Stage, 2nd Block, 60 Ft. Road, HBR layout	600-750	Arvind nagar near Hennur main road Right side: Ex-drain needs to be widened on right side. Ex. Avg. Width: 1.5 m, Pro. Avg. Width: 3.5 m., Ht: 1.6 m	0-975	Ex-drain needs to be desilted by about 0.4 m. Ex. Avg. Width: 2.0 m.			0-975	After drain desilting, bed protection needs to be provided for full length and width.
H303 – Kammanahalli - I Secondary Storm Drain:												
1	0	250	Kammanahalli main road	Nehru road, Kammanahalli			0-250	Ex-drain needs to be desilted by about 0.3 m. Ex. Avg. Width: 1.6 m.			0-250	After drain desilting, bed protection needs to be provided for full length and width.
H304 – Venkateshpura Secondary Storm Drain:												
1	0	1700	Pillana garden near Lingarajpura	1st Stage, 1st Block, 60 Ft. Road, HBR layout	1) 350-400	Near Lingarajapura railway track. Right side: Ex-drain needs to be widened on right hand side. Ex.Avg. width: 1.8 m, Ht: 3.0 m., Ht: 1.6 m	a) 0-900 b) 900-1700	a) Ex-drain needs to be desilted by about 0.5 m. Ex. Avg. Width: 4.0 m. b) Ex-drain needs to be desilted by about 0.5 m. Ex. Avg. Width: 7.0 m.			0-1700	After drain desilting, bed protection needs to be provided for full length and width.
					2)1200-1700	Near Ramachandrappa layout coconut plantation. Both side: Ex-drain is in natural condition. Alignment of drain needs to be slightly altered and existing embankment needs to be reformed with imported earth and stone revetment to be provideed on both sides for a ht. of about 2.4 m. Further, 4.5 m wide WBM service road to be formed on right hand side. Ex. Avg. Width: 7.0 m, Pro. Avg. Width: 10.0 m, Ht.: 2.4 m.						
H305 – Banaswadi Secondary Storm Drain:												
1	0	550	Banaswadi	Kanakadasa layout	525-550	Near Munityappa layout Left side: Ex-drain needs to be widened and new wall to be const. on left hand side. Ex.Avg. width: 3.0 m, Pro. Avg. Width: 5.0 m, Ht: 2.2 m.	0-550	Ex-drain needs to be desilted by about 0.5 m. Ex. Avg. Width: 3.0 m.			a) 0-525 b) 525-550	After drain desilting, bed protection needs to be provided for full length and width. Ex. Avg. Width: 3.0 m. After drain desilting, bed protection needs to be provided for full length and width. Ex. Avg. Width: 5.0 m.

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Carrying Capacity Improvements Works (H300)							
					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
H306 – Kavala Bairasandra Secondary Storm Drain:												
1	0	1000	Modi garden near Kavala bairasandra	Srinivasa chitra mandira near Shampura main road	a) 400-525	Near Sayeedin Arabic College. Right side: Ex-drain needs to be widened and new RCC wall to be const. on right hand side. Ex.Avg. width: 4.0 m, Pro. Avg. Width: 7.0 m, Ht: 2.0 m.	0-400	Ex-drain needs to be desilted by about 0.5 m. Ex. Avg. Width: 2.6 m.			0-400	After drain desilting, bed protection needs to be provided for full length and width. Ex. Avg. Width: 2.6 m.
					525-675	Near Sayeedin nagar 6th cross road. Left side: Ex-drain is in natural condition needs to be widened and new RCC wall to be const. on left hand side. Ex.Avg. width: 4.5 m, Pro. Avg. Width: 7.5 m, Ht: 2.4 m.	400-1000	Ex-drain needs to be desilted by about 0.5 m. Ex. Avg. Width: 7.0 m.			400-825	After drain desilting, bed protection needs to be provided for full length and width. Ex. Avg. Width: 7.5 m.
					675-825	Near Kamaraj nagar. Both side: Ex-drain is in natural condition and new RCC wall to be const. on both side. Ex.Avg. width: 7.5 m, Ht: 2.4 m.						
					825-1000	National Oil factory Near Kamaraj nagar. Both side: Ex-drain is in natural condition, it needs to be widened on right side and also alignment to be slightly altered in front of Srinivasa Chitra mandira. Further, new RCC wall to be const. on both sides. Ex.Avg. width: 4.5 m. Pro. Avg. Width:8.0 m, Ht: 2.4 m.						
2	1000	2000	Srinivasa chitra mandira near Shampura main road	Gandhinagar 4th cross road, K.G. Halli	1000-1075	Near Srinivasa Chitra mandira. Both side: Ex-drain is in natural condition, it needs to be widened on right side and new RCC wall to be const. on right side and stone revetment on left hand side. Ex.Avg. width: 5.5 m. Pro. Avg. Width:8.5 m, Ht: 2.4 m.	1000-2000	Ex-drain needs to be desilted by about 0.4 m. Further, after desilting drain bed needs to be deepened by about 0.3 m.Ex. Avg. Width: 7.0 m.			1000-1075	After drain desilting, bed protection needs to be provided for full length and width. Ex. Avg. Width: 8.5 m.
					1100-1650	Near Ambedkar Medical College. Both sides: Ex-drain needs to be widened on both side and stone revetment to be provided on both sides. Ex.Avg. width: 7.5 m. Pro. Avg. Width:10.0 m, Ht: 2.4 m.					1075-2000	After drain desilting, bed protection needs to be provided for full length and width. Ex. Avg. Width: 10.0 m.
					1650-1800	Near Gandhinagar 2nd cross road, K.G. Halli. Both sides: Ex-drain needs to be widened on left side and new wall to be constd. On both sides. Ex.Avg. width: 7.5 m. Pro. Avg. Width:10.0 m, Ht: 2.4 m.						
					1800-2000	Near Gandhinagar 4th cross road, K.G. Halli. Left side: Ex-drain needs to be widened on left side and new wall to be constd. On left side. Ex.Avg. width: 6.0 m. Pro. Avg. Width:10.0 m, Ht: 2.4 m.						

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Carrying Capacity Improvements Works (H300)							
					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
3	2000	3025	Gandhinagar 4th cross road, K.G. Halli	Rahati ali layout near primary drain	a) 2000-2340	Near Nagavara main road level crossing. Both side: Ex-drain is in natural condition, needs to be slightly altered, embankment needs to be formed with imported earth and stone revetment to be provided on both sides. Ex.Avg. width: 8.0 m. Pro. Avg. Width:10.0 m.	a)2000-2340	a) Near Nagavara main road level crossing. Ex- drain needs to be desilted by about 1.0 m. Ex. Avg. Width: 8.0 m.			a)2000-2340	Near Nagavara main road level crossing. After desilting, drain bed needs to be provided for full length and width. Pro. Avg. Width: 10.0 m.
					b) 2340-2400	Near Nagavara main road. New RCC box drain of size 6 x 2 m. needs to be constd. for a length of 60 m.	b)2340-2400	Near Nagavara main road level crossing. Ex- drain needs to be desilted by about 0.5 m. Ex. Avg. Width: 2.5 m.			b)2340-2400	Near Nagavara main road level crossing. After desilting, drain bed needs to be provided for full length and width. Ex. Avg. Width: 2.5 m.
					c) 2450-2550	Opp. Prithiv chitra mandira near Nagavara main. 1.8 m. wide, 100 m. length ex-teritiary drain needs to be widened to 6 m.	c)2475-2600	Opp. Royal function hall. Ex- drain needs to be desilted by about 0.5 m. Ex. Avg. Width: 2.0 m.			c)2450-2550	Opp. To Prithiv Chitra mandira. After desilting, drain bed needs to be provided for full length and width. Pro. Avg. Width: 6.0 m.
					d) 2350-2550	Adjacent to Kamarajnagar leather factory. Ex. 2.5 m. wide drain needs to be widened to 4 m.	d) 2450-2550	Opp. Prithiv Chitra Mandira Ex- drain needs to be desilted by about 0.5 m. Ex. Avg. Width: 1.8 m.			d)2350-2550	Adjacent to Kamrajnagar leather factory. After desilting, drain bed needs to be provided for full length and width. Pro. Avg. Width: 4.0 m.
					e) 2550-2700	Near Matkar lane kuppa swamy nagar. Alignment of drains needs to be slightly altered and embankment to be formed with imported with imported earth and stone revetment to be provided on both sides. Further, 4.5 m wide WBM Service road to be provided on right hand side.Pro. Avg. Width:10.0 m., Ht: 2.2 m.	e) 2550-2700	Near Matkar lane kuppa swamy nagar. Ex- drain needs to be desilted by about 0.5 m. Ex. Avg. Width: 2.5 m.			e)2475-2600	Opp. Royal function hall. After desilting, drain bed needs to be provided for full length and width. Ex. Avg. Width: 2.0 m.
					f) 2700-3025	Near Rahat ali layout. Right side: Ex-drain needs to be widened on right hand side and stone revetment to be provided on right hand side. Further, 4.5 m. wide WBM Service road to be formed on right hand side and guard stones to be provided at regular interval. Ex.Avg. width: 4.0 m. Pro. Avg. Width:10.0 m., Ht: 2.4 m.	f) 2350-2550	Adjacent to Kamarajnagar leather factory. Ex- drain needs to be desilted by about 0.5 m. Ex. Avg. Width: 2.5 m.			f)2575-2675	Near Kamrajnagar public toilet block. After desilting, drain bed needs to be provided for full length and width. Ex. Avg. Width: 4.0 m.
							g) 2700-3025	Near Rahat ali layout. Ex- drain needs to be desilted by about 0.5 m. Further, after desilting, the drain bed needs to be deepened by about 0.3 m. Ex. Avg. Width: 4.0 m.			g)2550-2700	Near Matkar lane, Kuppa swamy nagar. After desilting, drain bed needs to be provided for full length and width. Pro. Avg. Width: 10.0 m.
											g)2700-3025	Near Rahat ali layout. After desilting, drain bed needs to be provided for full length and width. Pro. Avg. Width: 10.0 m.

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Carrying Capacity Improvements Works (H300)							
					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
H307 – Devara Jeevanahalli Secondary Storm Drain:												
1	0	680	Modi road near Devanajeevanahalli	Sayeedin nagar near Kavala Bairasandra	375-680	From Doddannanagar main road upto Sayeedin nagar. Right side: Ex drain needs to be widened and new wall to be const. on right hand side. Ex.Avg. width: 3.0 m, Pro. Avg. Width: 6.0 m, Ht: 2.2 m.	0-680	Ex-drain needs to be desilted by about 0.5 m.			0-375 375-680	After desilting, bed protection needs to be provided for full length and width. Ex. Avg. Width: 2.5 m. After desilting, bed protection needs to be provided for full length and width. Pro. Avg. Width: 6.0 m.
H308 – Ambedkarnagar Secondary Storm Drain:												
1	0	1000	Ananda theatre near Devana Jeevanahalli	Doddanna nagar main road	0-1000 940-1000	Ananda theatre upto Doddannanagar main road upto Sayeedin nagar. Both side: Ex-drain is in natural condition, it needs to be widened and new wall to be const. on both sides. Ex.Avg. width: 1.4 m, Pro. Avg. Width: 2.0 m, Ht: 1.4 m. Near Doddannanagar main road pack. New RCC box drain of size 2 x 1.5 m needs to be const. for a length of 60 m.	0-1000	Ex-drain needs to be desilted by about 0.3 m. Ex. Avg. Width: 1.4 m.			0-1000	After desilting, bed protection needs to be provided for full length and width. Ex. Avg. Width: 1.4 m.

Table 6.14 - Schedule For Providing Rehabilitation to the Existing Secondary Storm Drain in Hebbal Minor Valley - I (H300)

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Rehabilitation Works (H300)					
					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
H301 – Kacharakanahalli Secondary Storm Drain:										
1	0	1150	Keshavanagar	Gandhinagar	125-175	Both side: Ex-drain wall needs to be reconstd. On both sides for a length of about 20 m. ht. 1.6 m.	0-1150	Both side: After desilting, cavities to be filled, eroded stones to be restored, pointing and plastering to be provided to the Ex-drain wall for a ht. Of about 1.6 m.	0-500	1 No. of 75 mm dia water supply pipeline exists between Ch. 0-25.
H302 – Kammanahalli Secondary Storm Drain:										
1	0	975	Ramaswamy palya	1st Stage, 2nd Block, 60 Ft. Road, HBR layout	a) 75-100 b) 825-850	Left side: Ex-drain wall needs to be reconstd. On left side for a length of about 25 m. ht. 1.4 m. Right side: Ex-drain wall needs to be reconstd. On right side for a length of about 10 m. ht. 1.6 m.	0-975	Both side: After desilting, cavities to be filled, eroded stones to be restored, pointing and plastering to be provided to the Ex-drain wall for a ht. Of about 1.6 m.	a) 0-500	a) 2 Nos. of water supply cable lines of 300 mm & 180 mm exists between Ch. 75-100. b) 3 Nos. of 75 mm dia water supply pipeline exists.
H303 – Kammanahalli - I Secondary Storm Drain:										
1	0	250	Kammanahalli main road	Nehru road, Kammanahalli			0-225	Both side: After desilting, cavities to be filled, eroded stones to be restored, pointing and plastering to be provided to the Ex-drain wall for a ht. Of about 1.6 m.		
H304 – Venkateshpura Secondary Storm Drain:										
1	0	1700	Pillana garden near Lingarajpura	1st Stage, 1st Block, 60 Ft. Road, HBR layout	a) 50-75	Left side: Ex-drain wall needs to be reconstd. On left side for a length of about 15 m. ht. 2.0 m.	0-1200	Both sides: After desilting, cavities to be filled, eroded stones to be restored, pointing and plastering to be provided to the Ex-drain wall for a ht. Of about 2.0 m.	a) 0-500	a) 4 Nos. of 1.2m dia manholes exists.
					b) 125-175 c) 275-300 d) 25-75	Left side: Ex-drain wall needs to be reconstd. On left side for a length of about 50 m. ht. 2.4 m. Both side: Ex-drain wall needs to be reconstd. On both the sides for a length of about 25 m. ht. 2.4 m. Right side: Ex-drain wall needs to be reconstd. On right side for a length of about 40 m. ht. 2.0 m.			b) 500-1700	b) 3 Nos. of 175 mm dia cable pipelines exists between Ch. 175-200. c) 2 Nos. of 75 mm dia pipelines exists between Ch. 225-250. a) 5 Nos. of 1.2 m dia manhole exists. b) 2 Nos. of 175 mm dia cable pipelines exists between Ch. 525-550. c) 1 No. of 110 mm dia water supply pipeline exists between Ch. 650-675.
H305 – Banaswadi Secondary Storm Drain:										
1	0	550	Banaswadi	Kanakadasa layout			0-550	Both sides: After desilting, cavities to be filled, eroded stones to be restored, pointing and plastering to be provided to the Ex-drain wall for a ht. Of about 1.6 m.	a) 0-550	a) 3 Nos. of 1.2 m dia manhole exists. b) 3 Nos. of water supply & cables of 300, 110 & 25 mm dia exists between Ch. 275-400.
H306 – Kavala Bairasandra Secondary Storm Drain:										
1	0	1000	Modi garden near Kavala bairasandra	Srinivasa chitra mandira near Shampura main road	a) 0-25 b) 300-325	a) Both side: Ex-drain wall needs to be reconstd. On both the sides for a length of about 25 m. ht. 1.4 m. b) Both side: Ex-drain wall needs to be reconstd. On both the sides for a length of about 10 m. ht. 2.0 m.	a) 25-400	Near N.P. Factory. Both sides: After desilting, cavities to be filled, eroded stones to be restored, pointing and plastering to be provided to the Ex-drain wall for a ht. Of about 1.6 m.	a) 0 -500 b) 500-1000	a) 2 Nos. of 110 mm dia cables exists between Ch. 215-300. b) 2 Nos. of 75 mm dia cables exists between Ch. 425-450.

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Rehabilitation Works (H300)					
					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
2	1000	2000	Srinivasa chitra mandira near Shampura main road	Gandhinagar 4th cross road, K.G. Halli						
3	2000	3025	Gandhinagar 4th cross road, K.G. Halli	Rahati ali layout near primary drain	a) 2975-3025	Left side: Ex-drain wall needs to be reconstd. On left side for a length of about 50 m. ht. 2.2 m.	a)2340-2400 b)2475-2600 c) 2450-2550 d) 2350-2550 e) 2550-2700 f) 2700-2975	Near Nagavara main road. Both sides: After desilting, cavities to be filled, eroded stones to be restored, pointing and plastering to be provided to the Ex-drain wall for a ht. Of about 1.6 m. Opp. Royal function hall. Both sides: After desilting, cavities to be filled, eroded stones to be restored, pointing and plastering to be provided to the Ex-drain wall for a ht. Of about 2.0 m. Opp. Prithiv Chitra Mandira. Left side: After desilting, cavities to be filled, eroded stones to be restored, pointing and plastering to be provided to the Ex-drain wall for a ht. Of about 2.0 m. Adjacent to Kamarajnagar leather factory. Left side: After desilting, cavities to be filled, eroded stones to be restored, pointing and plastering to be provided to the Ex-drain wall for a ht. Of about 2.0 m. Near Matkara lane, Kuppaswamy nagar. Both sides: After desilting, cavities to be filled, eroded stones to be restored, pointing and plastering to be provided to the Ex-drain wall for a ht. Of about 2.0 m. Near Rahat ali layout. Left side: After desilting, cavities to be filled, eroded stones to be restored, pointing and plastering to be provided to the Ex-drain wall for a ht. Of about 2.0 m.	a) 2500-3025	a) 2 Nos. of 300 mm dia water supply pipeline exists between Ch. 2750-2800.
H307 – Devara Jeevanahalli Secondary Storm Drain:										
1	0	680	Modi road near Devanajeevanahalli	Sayeedin nagar near Kavala Bairasandra	525-600	Left side: Ex.drain wall needs to be reconstd. For a length of 30 m. ht. 2.0 m.	0-375	Both side: After desilting, cavities to be filled, eroded stones to be restored, pointing and plastering to be provided for a ht. Of about 1.4 m.	0-680	7 Nos. of water supply pipelines and cables exists between Ch. 50-100.
H308 – Ambedkarnagar Secondary Storm Drain:										
1	0	1000	Ananda theatre near Devana Jeevanahalli	Doddanna nagar main road						

Table 6.15 - Schedule For Improving the Carrying Capacity of Existing Primary Storm Drain in Hebbal Minor Valley - II (H400)

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Carrying Capacity Improvements Works (H400)							
					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
	H400 – Hebbal Minor Valley - II Primary Storm Drain:											
1	0	1000	Chikka Banaswadi near railway track, Bhuvanagiri	Banaswadi main road near Chowdeshwari layout			0-1000	Existing drain needs to be desilted by about 0.3 m.. Further, after desilting, drain bed needs to be deepened by about 0.3 m.			0-1000	After drain desilting, bed protection needs to be provided for full length and width. Ex. Av. width: 2.5 m
2	1000	2000	Banaswadi main road near Chowdeshwari layout	HBR layout 1st block, 4th A cross road			1000-2000	Existing drain needs to be desilted by about 0.5 m.			1000-2000	After drain desilting, bed protection needs to be provided for full length and width. Ex. Av. width: 4.0 m
3	2000	3000	HBR layout 1st block, 4th A cross road	Muniswamy layout near Chalkere bus stop	2300-2800 2800-3000	Outer ring road upto Muniswamy layout. Right side: Ex-SSM wall to be dismantled and drain to be widened. Further, embankment needs to be formed with imported earth and stone revetment to be provided for a ht. of 2.4 m. Ex.Av. Width 4.0 m, Pro. Av. Width 8.0 m. Near Muniswamy layout upto Chalkere bus stop. Both side: Ex. drain is in natural condition, embankment needs to be formed with imported earth on both sides and stone revetment to be provided for a ht. of about 2.4 m. Further, 4.5 m. wide WBM Service road needs to be formed on left side over the embankment. Guard stones to be provided at regular interval on right side of the road. Pro. Av. Width 8.0 m.	2000-3000	Ex-drain needs to be desilted by about 0.5 m.			2000-3000	After desilting, bed protection needs to be provided for full length and width.
4	3000	5000	Muniswamy layout near Chalkere bus stop	Railway track	3000-5000	Near Hennur bande. Both side: Ex. drain is in natural condition, embankment needs to be formed with imported earth on both sides and stone revetment to be provided for a ht. of about 2.4 m. Further, 4.5 m. wide WBM Service road needs to be formed on left side over the embankment. Guard stones to be provided at regular interval on right side of the road. Pro. Av. Width 10.0 m.	3000-5000	Ex-drain needs to be desilted by about 0.3 m.			3000-5000	After desilting, bed protection needs to be provided for full length and width.

Table 6.16 - Schedule For Providing Rehabilatation to the Existing Primary Storm Drain in Hebbal Minor Valley - II (H400)

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Rehabilitation Works (H400)					
					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
H400 – Hebbal Minor Valley - II Primary Storm Drain:										
1	0	1000	Chikka Banaswadi near railway track, Bhuvanagiri	Banaswadi main road near Chowdeshwari layout	0-25	Both side: 25 m. length SSM wall to be constd. On both sides for a ht of about 1.8 m.	0-1000	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be done on both sides to the Ex-drain wall for a ht of about 2.0 m.	0-500	a) 1 No. of 125 mm dia water supply pipeline exists at Ch.100 m.
					700-725	Right side: 25 m. length SSM wall to be constd. On right side for a ht of about 2.0 m.			a) 500-1000	a) 3 Nos. of 300 mm dia water supply pipeline exists at Ch. 225 m. upto 375 m. b) 2 Nos. of 300 & 600 mm dia pipelines exists at Ch. 750 to 825 m. c) 3 Nos. of cables exists.
2	1,000	2000	Banaswadi main road near Chowdeshwari layout	HBR layout 1st block, 4th A cross road	1000-1025	Right side: 25 m. length SSM wall to be constd. On right side for a ht of about 2.4 m.	1000-1200	Both side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be done on both sides to the Ex-drain wall for a ht of about 2.0 m.	a)1000-1500	a) 1 No. of 450 mm dia water supply pipeline exists at Ch.1275 to 1300 m.
									b)1500-2000	b) 2 Nos. of 200 mm dia pipeline exists at Ch. 1875 to 1900 m.
3	2000	3000	HBR layout 1st block, 4th A cross road	Muniswamy layout near Chalkere bus stop			a)2000-2800	Left side: After desilting, cavities to be filled and eroded stones to be restored, pointing & plastering to be done to the Ex-drain wall for a ht of 2.0 m.	a)2000-2500	a) 2 Nos. of 175 mm dia cable line exists at Ch. 2250 to 2275 m. b) 1 No. of 1200 mm dia sewer pipeline exists.
4	3000	5000	Muniswamy layout near Chalkere bus stop	Railway track						

Table 6.15 - Schedule For Improving the Carrying Capacity of Existing Secondary Storm Drain in Hebbal Minor Valley - II (H400)

Sl. No.	Chainage (m.)		Location		Existing Storm Drain – Carrying Capacity Improvements Works (H400)							
					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
	H401 – Kalyan nagar Secondary storm Drain:											
1	0	950	Kammanahalli main road	Sena vihar			0-950	Ex-drain needs to be desilted by about 0.5 m.			0-950	After desilting, bed protection needs to be provided for full length and width. Ex. Av. width: 1.2 m

Table 6.16 - Schedule For Providing Rehabilatation to the Existing Secondary Storm Drain in Hebbal Minor Valley - II (H400)

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
	H401 – Kalyan nagar Secondary storm Drain:									
1	0	950	Kammanahalli main road	Sena vihar	50-125	Right side: 40 m. length SSM wall to be constd. On right sides for a ht of about 2.0 m.	0-950	Both side: After desilting, cavitier to be filled and eroded stones to be restored, pointing & plastering to be done on both sides to the Ex-drain wall for a ht of about 2.0 m.	0-950	a) 2 Nos. of 110 mm dia water supply pipeline exists. b) 1 No. of 300 mm dia sewer pipe exists.

CHAPTER - 7

CHAPTER – 7
TECHNO – ECONOMIC ANALYSIS

7.1 INTRODUCTION:

Hebbal valley is located north of Bangalore, where natural lakes and trees abound. The valley is spread in around 57 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 0.7 million people live in the 16 wards of Hebbal valley area. There are 42,090 residential and 1882 non-residential properties in the area.

Hebbal Lake

A large Tank, Hebbal Lake is located in North Bangalore, on National Highway No.7.The very fact that the lake's water was used for drinking purposes earlier, clearly contrasts its present condition. The lake occupies a special place, as it is a vital habitat for migratory birds. With the growth of greater Bangalore, the Hebbal Lake is under sever strain that includes continuous inflow of untreated sewage and effluents entering the lake from the catchments area including the vehicular pollution on the Bangalore-Hyderabad highway.

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 OUTCOMES 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 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 (LDA)	NGOs
City Municipal Corporations (CMC/TMC)	Funding Agencies
Bangalore Development Authority (BDA)	Government of Karnataka (GOK)
Karnataka State Pollution Control Board (KSPCB)	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 Hebbal and Nagavara lakes
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:

- To rectify current localized flooding problems in the critical low lying areas identified in the study.
- To cope with additional areas being included into the BMP administered area in terms of expansion of the storm water drain network.
- To prevent polluted water getting into lakes and river beds
- Encourage rain water harvesting in institutions, public parks, open grounds, etc
- 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 minimize cost implication on operation and maintenance of the system.
- 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)
- To educate and enforce measures to prevent industries and commercial establishments from discharging toxic and wastewater into drains, lakes and river beds
- 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 Hebbal Valley:

Sl. No.	Description	Amount Rs. In Crores)
	Cost for Remodeling of Primary & Secondary Storm Water Drains, Construction of New Drains near low lying areas, Formation of Service Roads etc.,	159.38
	Cost for Remodeling of Bridges / Culverts constructed across Primary & Secondary Storm Water Drains.	13.12
	Cost for shifting utility lines, footpath improvement works, barricading, traffic diversion, strengthening of diversion routes etc.	8.63
	Construction of Detention Ponds / Retarding Basins	1.74
	Construction of Wells with pumping arrangement in low lying areas	4.00
	Procurement of desilting machine	0.45
	Miscellaneous and rounding off	
	Advisory, Project Management & Establishment charges. (1.5 % of Item 1 to 7)	2.81
	TOTAL	**190.13**
	Annual Operation & Maintenance Cost (1.0 % of Item 1 to 7)	1.87

For the purpose of seeking external funding only the core capital expenditure of Rs. 190.13 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 16 wards in the city. The demographic details of them are provided herewith:

7.8 WARD AND DEMOGRAPHIC DETAILS OF HEBBAL VALLEY:

Description	Ward No	Ward Names	Population	Properties	
				Residential	Non-Residential
Hebbal Main Valley (H100)	96	Hebbal	73,772	5443	132
	97	Jayachamarajendra agara	37,965	3855	170
	98	Ganganagara (RT Nagar)	52,521	5432	237
Hebbal Main Valley – I (H200)	1	HMT	27,486	1084	153
	2	Jalahalli	36,118	3526	210
	3	Yeshwanthpura	46,468	3583	228
	4	Matikere	54,635	4490	240
	100	Sanjaynagar	52,189	6215	135
Hebbal Minor Valley – I (H300)	87	Lingarajapura	55,993	2093	38
	89	Kachanakanahalli	32,883	2900	106
	90	Sagayapura	43,399	1281	96
	93	Devarajeevanahalli	51,544	522	39
	94	Kadugondanahalli	60,606	2088	86
	95	Kavakbairasandra	85,989	3744	112
Hebbal Minor Valley – II (H400)	84	Benniganahalli	31,842	397	14
	88	Banaswadi	25,846	880	18
Total			**695,484**	**42,090**	**1,882**

CHAPTER - 8

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 projec****t:* 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

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

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

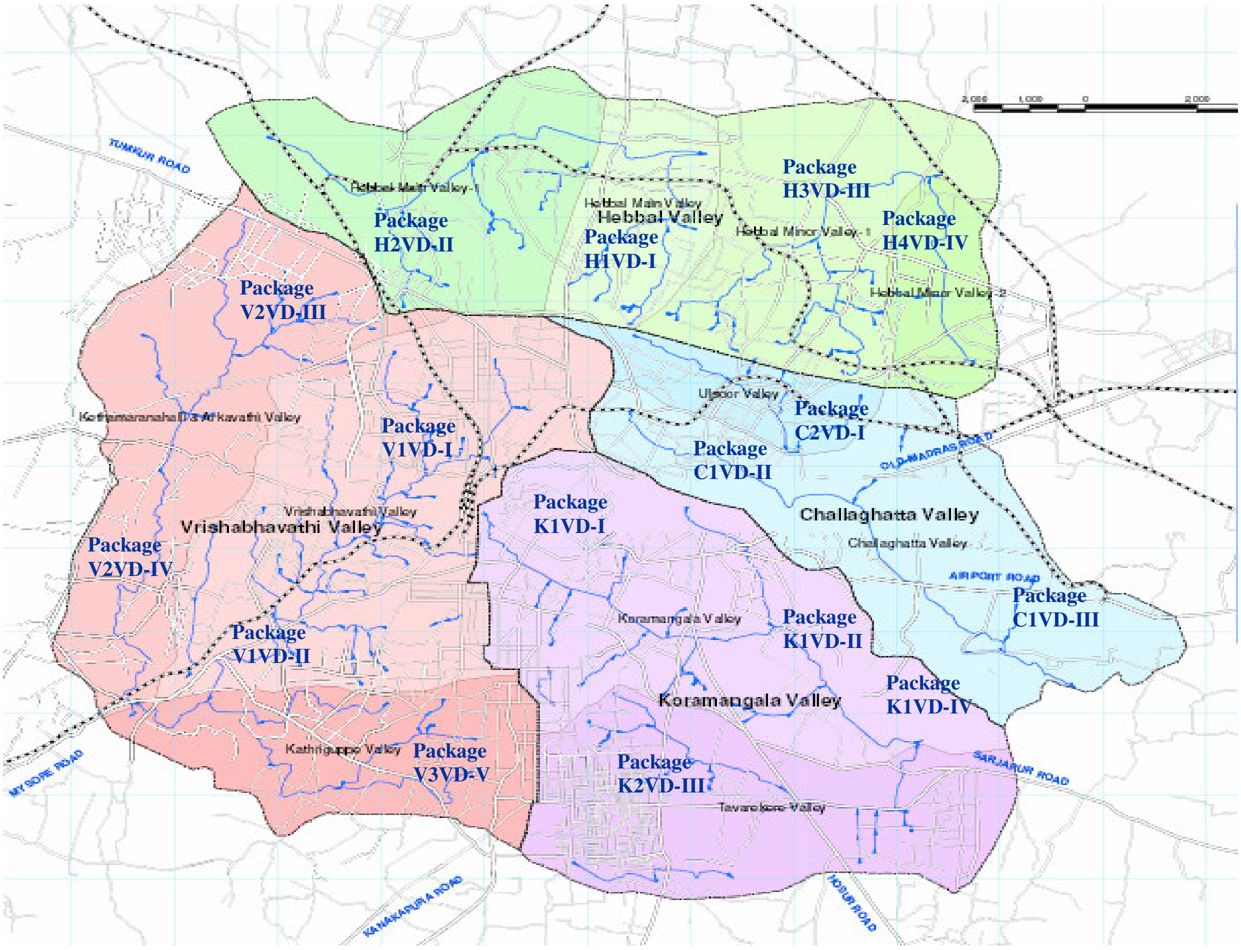

Figure 10.4 Packages Details

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.