CHAPTER VI
MANAGEMENT PLAN FOR DRAINAGE-SEWERAGE PROBLEM

6.1 CUSTODIAN OF THE SYSTEM

There are five large static water-bodies, i.e. Borsola Beel, Sorusola Beel, Silsako Beel, Bondajan Beel and Deepor Beel within the Guwahati Municipal Corporation Area. These water bodies are not only serving as a reservoir of rain water, but also supporting the diverse fauna like birds, fishes and other forms of aquatic life. Unplanned, unregulated urban expansion and rampant encroachment have been virtually killing these wetlands, thereby resulting in water-logging in the city and waning of the avian and aquatic fauna in these wetlands. Even the wetlands on the outskirts of the city like the Chopaidong Beel and the Khamranga Beel have borne the brunt of the sordid phenomenon. Chopaidong Beel, which once spread over an area of approximately 66 ha, has now been choked by water hyacinth, and its banks are increasingly being occupied by concrete structures. The Khamranga Beel is also facing a similar problem, as a significant portion of it is earth-filled for road construction. The continuous human interference on these wetlands are resulting in shrinking of its area and loss of the wetlands ecosystem as well.

A number of rivulets and streams flow down from the Meghalaya hills in the south of the Guwahati city to the Brahmaputra river. Among those Bharalu, Mora-Bharalu, Bahini and Basistha streams are the important ones. The water-flow and carrying capacity of the rivulets and streams are decreasing day by day due to artificial hindrances like encroachment, blockage and habitual dumping of wastes like thermocols, paddy-hatch, plastic wastes, used packets etc. These natural channels have been getting clogged and are consequently shrinking in size due to human activities. As these natural channels also facilitate storm-water drainage, the situation becomes more aggravated leading to the problems of flash flood and water-logging.

Guwahati has been suffering from heavy urban flooding after every spell of heavy rainfall in and around the city. The State Government in a bid to control
the problem had enacted the **Guwahati Water-bodies Preservation and Conservation Act 2008**. This piece of legislation prohibits encroachment on the notified water-bodies of Guwahati, and has penal provisions of imprisonment upto three years or fines upto rupees fifty thousand or both for people trespassing or encroaching upon such notified water-bodies. All the five major water-bodies have been notified. The District Administration along with the relevant and concerned departments have also been taking up de-silting and cleaning of rivers and drains from time to time to increase the water carrying capacity and minimize the flash flood and water logging problems of the city. In spite of this the city experienced unprecedented floods after a spell of continuous rainfall on the 26th and 27th of June 2014, which resulted in nine number of deaths and total disruption of normal public life and heavy loss of property. The city had in fact, came to a virtual standstill during that time. This is an outcome of the lack and insufficient drainage sewerage systems of the city.

### 6.2 PRESENT SCENARIO OF MANAGEMENT OF THE PROBLEMS

The Guwahati city is located on a unique geo-ecological situation with hills and plains interface along with a prominent water-front, and natural water regime created by different streams, rivers and wetlands which play and significant role in the city’s hydrological condition. The unplanned urbanization of the city landscape has disturbed the water-retention capability and flow-dynamics of these water-sources. Because of inadequate storm-water drainage both in terms of capacity as well as of connectivity, various problems are being faced frequently by the city dwellers.

In addition to other factors, the inadequate and degrading natural drainage has been primarily due to excessive siltation, deposition of solid wastes, and encroachments of portions of the four river channels within the city of Guwahati, namely Bharalu, Mora Bharalu, Basistha and Bahini along with the five notified water-bodies of the city, i.e. Borsola, Sarusola, Silsako, Bondajan and Deepor Beel. The aforesaid factors have resulted in clogging the free flow of storm water and truncating the carrying capacity of the natural channels as well as the natural water-bodies which used to serve earlier as storage and detention ponds of excess storm water till they were drained out in due course.
during the rainy days. In addition to the mighty river Brahmaputra there are a number of wetlands, waterbodies and open channels which have failed to ease the flood and waterlogging problem of the city. Proper management of the problem is possible through the measures like (i) Provision for a comprehensive storm water drainage facility (ii) Installation of separate sewer drainage system and (iii) Adoption of integrated wetland development projects.

6.2.1 Measures taken: Short term and Long term

Short term measures needed to manage the drainage-sewerage problems of the city are -

i. The open drains on both sides of roads should be cleaned and also cleared of siltation and solid garbage dumped therein. The closed drains and the underground drains, i.e. beneath the roads or wherever else they exist shall be opened at the manholes for clearing the silt and solid garbage present therein. These measures are definitely expected to increase the water holding capacity of the drains and also remove any blockage of water-flow, without any structural intervention which has cost and time involvement.

ii. Adequate number of additional sewerage pumps should be deployed in the service in Anil Nagar, Nabin Nagar and Pub Sarania areas so as to pump out the excess water into the Bharalu river. This measure is expected to reduce the water-logging emerged on account of low elevation and consequent effect of gravity.

iii. Encroachments blocking the natural outflow of water should be evicted forthwith, and the cost of carrying out the eviction shall be borne by the encroachers. This measure is expected to reduce obstructions to the natural flow of water.

iv. Resident Welfare Societies should be set up for Anil Nagar, Nabin Nagar, Rajgarh Road and Pub Sarania areas for ensuring better public co-operation and coordination for reducing the effect of floods. The action shall be facilitated by the government persons as well as the departments concerned.

v. System should be devised for regular cleaning of drains by GMC and PWD (Roads). Silt traps shall be set up at strategic places to effectively take out the
silt and other solid garbage from the storm-water, and get them removed manually every now and then.

vi. Wherein no removable slabs are present in the drains concerned, or the man-holes are too far apart to be effective; roads are to be dug up at the sides to expose the underground drains, and then cleaned and de-silted. Removable slabs/ man-holes should be inserted therein after that.

vii. Damaged drains shall be repaired and re-constructed in a systematic manner. The action shall be taken by the department like GMDA, GMC, PWD (Roads) etc. for maintaining the drains.

viii. In the areas wherein gravity cannot ensure outflow of water, sluice gates should be installed and closed as required, so as to facilitate timely operation of the pumps (maintaining roster round the clock).

ix. Steps shall be taken to divert storm-water of at least some areas of Guwahati (e.g. Chandmari) away from the Anil Nagar/ Nabin Nagar areas. Such steps shall involve no major structural change, and shall include measures like effecting alternate connectivity of such storm water. Like, short-circuiting the Basistha river to fall into the proposed alternate drainage channel near the Games Village at Lalmati.

a. diverting the storm water of the entire Bamunimaidam and Noonmati hill-side to Bondajan Channel and therefrom to Brahmaputra by constructing the proposed storm-water drain under Noonmati Drainage Project after obtaining NOC from the Railway Authority, and

b. diverting the Bahini river to fall into Silsako Beel for being discharged via Bondajan Channel into the Brahmaputra.

Long term measures needed to manage the drainage-sewerage problems of the city are-

i. Comprehensive storm-water drainage plan for the city should be examined in details with different consulting agencies along with concerned government departments for developing a cost effective and efficient drainage-sewerage system for the city in the sense of long term. After that, further evaluation with proper ground surveys by technical experts and consultants may be done to
make the plan more accurate. On the basis of that, an effective Urban Drainage Plan should be evolved.

ii. Sewerage system shall be completely separated from the storm-water drainage system of Guwahati city. In the same way, steps should be undertaken to remove all the solid waste materials from the storm water drains, which is creating major problems in the entire drainage-sewerage system within the city.

iii. Storm-waters from the Meghalaya hills in the southern part of the city should be diverted away from the city along a separate drain along the National Highway 37 to discharge into the Khonajan rivulet bypassing Deepor Beel, for ultimately discharging the water into the Brahmaputra during the rainy times. In order to get relief from the impact of flash flood and water logging, the proposal for diverting the storm water from Assam and Meghalaya catchment area in the south to the Pamohi river via a newly excavated channel on either side of National Highway 37, i.e. the Guwahati Bye-pass portion from Khanapara to Jalukbari, ensuring gradient and carrying capacity should be considered. The storm-water from the newly developed channel drain would then flow through that Pamohi River to fall into the Khonajan outfall of Deepor Beel, effectively bypassing that Ramsar Site water-body through a separate connecting drain. It would ultimately discharge into the Brahmaputra river at Khonamukh, which is relatively in the downstream of Guwahati City. For this following steps should be given proper weightage:

**Importance of ground survey**

In order to achieve the goal for flood relief both the sides of the National Highway 37 from Greenwood Resort Point to Pamohi River, near Gorchuk shall be surveyed by Electronic Total Station (ETS) – 100 metres to the north of the Highway and at least 200 to 250 metres to the south of it effectively covering approximately around 10 sq. kilometres. (Sharma, 2013) Although Contour Survey by Digital Elevation Modelling (DEM) of the area was accomplished by TAHAL group while preparing its DPR for Storm Water Drainage, and its data are available in GIS form. Such data should have to be re-verified. Besides, the level survey should have grid planning of 0.5 meters interval for both the
longitudinal section and the cross-section. Because earlier surveys of lower resolution with figures interpolated to 0.5 meters had not yielded accurate results.

Moreover, in addition to the study of the contour and hydrology, the land-use and land-possession of the entire surveyed land shall also have to be ascertained. Land possession includes cadastral data and status of land settlement. Such data would be required for dealing with the question of eviction of the encroachment on Government land earmarked for the purpose of excavating the new channel, as well as that of acquisition of privately settled land selected for the same purpose. Collection of the data can be done by attaching land records staff (Lot Mandals and Supervisor Kanungos) of the Circle Officer concerned with the study team, or can be done parallelly by such staff and then integrated with the data of that study team.

Furthermore, while considering the creation of a new channel in the portion upto the Pamohi river, the feasibility of utilising the existing irrigation canal shall also be taken into consideration. Because the irrigation canal is no longer in use after urbanization of the area, but the land has already been acquired for that purpose and should have. Therefore, the Irrigation Department, Govt. of Assam must have interdepartmental correlation with Guwahati Metropolitan Development Authority (GMDA) for preparation of the management plan to solve the problems.

Designing the Drainage

Based on the survey and study of the area concerned, and the consequent identification and confirmation of the route of the drainage channel, the drainage design should be taken up. For that, the flow rate along the proposed channel has to be ascertained. In this regard, the watershed delineation has already been done. However, the water volume and the sediment volume have to be recalculated time to time. The peak flow rate of the water volume (Q) is dependent on the coefficient of run-off (C), the average intensity of rainfall (I) (mm/hour) for the time of concentration (tc), and the catchment area (A). Since the coefficient of run-off (C) has increased with concretisation and resultant imperviousness of the catchment area and the slope of the surface, the time of concentration (tc) have
decreased due to loss of vegetation and increased gradient. Because of such complex process the water volume needs to be freshly calculated for designing the drainage channel. For that, a comprehensive hydrological study of the catchment areas of the Meghalaya hills as well as that of the land surveyed for the proposed alternative drainage channel shall have to be done. Such study should invariably include the topography and landscape of the areas concerned, the rainfall data of Guwahati to be obtained for at least 15 minutes interval from IMD station at Borjhar, Guwahati and the Intensity-Duration Curves to be drawn and interpreted accordingly.

With increased deforestation and resultant holding capacity of the soil in the catchment areas of the Meghalaya hills, the rate of sedimentation has also increased. Therefore, the volume of sedimentation also needs fresh calculation. For the purpose the National Highway Authority of India (NHAI) can measure the sedimentation that has occurred on the service roads of National Highway No. 37 (Guwahati Bye-pass Section) due to storm-water descending from the Meghalaya hills, and provide the figure to the study team and GMDA. Besides, the design should be based on the present land-use, and not some proposed land-use. Moreover, the hydrological path of the drainage channel should be clearly demarcated in the design, and should not involve changing the course of any river/ rivulet/ natural drainage.

**Necessity of Pumping Station**

Natural gradient of the proposed drainage system along the existing rivers and artificially created channels may not be sufficient to ensure regular flow of water therein under the force of gravity at all times. Besides, in case the water-level of Brahmaputra river or any of the intermediate channels remains high, there may be back-flow instead of the expected discharge. Therefore, the need for pumping stations and sluice gates shall have to be assessed during the study.

**Need of Silt Trapping**

On account of the heavy sedimentation volume, the proposed alternative drainage channel shall have to be de-silted regularly in order to maintain its hydraulic carrying capacity. Therefore, silt traps shall have to be inserted along
the drainage channel in order to segregate the silt and other solid waste from the flowing water and trap them in underground chambers wherefrom they can be regularly removed by specially designed trucks/dumpers. The silt trap shall have to be set up at places providing continuous and convenient access to the trucks/dumpers for regular removal of the silt, because overfilling of the trap would negate its very purpose.

The preliminary study including preparation of maps shall have to be completed within a time frame by the technical experts. The study report thus obtained shall then have to be examined by the in-house engineers and consultants of GMDA through ground/on-site verification, hydrological study and other such measures. The DPR shall then have to be prepared within a stipulated time frame. For that, GMDA shall have to act as an umbrella organization coordinating with the different Government departments, agencies and organizations involved in the exercise.

6.2.2 Level of Effectiveness

To minimize the drainage sewerage problems of Guwahati city the above measures are already suggested categorizing them into short term and long term measures depending on the field study, observations and consultation with the concerned departmental experts. But, only after following the measures in a proper way this problem can be managed. For this practical execution of the plans and programmes by the respective departments is utmost necessary. Along with that the publicity of the plans and programmes to the city dwellers and awareness among them should give the priority. Mass awareness and peoples participation can make the plans success to some extent. Regarding the effectiveness of the adopted plans and measures both the short term and long term measures need to be considered.

6.3 SUGGESTED MANAGEMENT PLAN

Management is the most essential component of the success of any kind of plan and problem. Having lots of unmanageable problems on the drainage sewerage systems of Guwahati city, the adoption of proper plan and program both short and long term and their management is utmost necessary. In case of Guwahati, it is the need of the hour. For the management of drainage sewerage problems of the city,
designing of the drains, construction in a proper way and maintenance are very much interrelated. These parameters are to be taken seriously for construction of the drains. For maintenance of drainage sewerage networks, the drains should be designed seriously along with large size manhole covers. The smooth running of the system is dependent on frequent monitoring and cleaning of the drains to make the drains free from debris accumulation, sedimentation, erosion, scour, roadway and embankment, settlement and conduit and channel structure damage. Even in a properly designed and constructed drainage sewerage system, a comprehensive program for drainage maintenance schedule is essential for proper functioning of the drainage sewerage system. The management plan includes a regular inspection for long term changes and also to point out the necessary modifications to ensure safe and continued operation of the whole system. In the management plan of this system should include periodic inspection with supplemental inspections following each and every drain (both open and underground drains). For an effective management plan emphasis should be given to some points for the benefit of the city dwellers and also to mitigate the increasing drainage sewerage problems of the city.

6.3.1 Features of the Plan

Regarding the features of the management plan of the drainage sewerage problems of Guwahati city the concerned authority should emphasis on the following points:

I. Planning for the maintenance and operation of the existing underground drains: This includes-

(i) The man holes of the underground drains should be checked twice in a month to detect the problems like damage of the drains, breakage etc.

(ii) The cleaning of the drains should be done in one alternate day throughout the year to make the drains free from garbage and silt.

(iii) Any kind of damage or breakage of the underground drains should be checked by experienced persons from time to time and should be repaired immediately.

(iv) The outlets of the underground drains to the main drains should have to be maintained free from silt and other debris and undesired growth of vegetations by regular cleaning.
If there is any sluice gate at the outfall point of the underground drains, the following points should be given importance. These are-

a. There should be regular greasing on the various movable parts of the sluice gates.

b. To check the damage of the iron part of the sluice gate by rusting frequent monitoring is very essential along with replacement if required.

c. People should be appointed to maintain and operate the sluice gate.

d. The operation key and lift gears of the sluice gates should be checked and greased regularly. Spare key and the important parts of the lifting gear should be kept in hand for any emergency replacement and repair.

e. During winter season, when the gates are not in use, gates should be checked for any damage or fault on priority basis.

II. Planning for the maintenance and operation of the existing open drains

This includes-

i. The cross section of the open drains should be cleared of vegetation growth at least once in a week manually or by any other mechanical means in order to avoid any kind of obstructions that may reduce the normal water flow of the drains.

ii. To check the illegal encroachment along the banks of the sides of the drains, regular monitoring is very important. This checking must be once in a month and authority should frame strict provisions to punish and evict the illegal encroachers, if any.

iii. Cleaning of the open drains should be done at least once in a week, to make the drain garbage free.

iv. If the stretches of the open drains are unlined then they should be made lined as far as possible. For this regular cleaning is utmost necessary.

v. Some roadside drains and drainage inlets should be keep free from any obstructions all the time and specially during summer to minimize water logging.
III. Planning for operation and maintenance of the water pumping stations

There are a numbers of pumping stations on the drains of the Guwahati city. These pumps are used during the rainy days to make the city free from water logging. These pumping stations are required as a part of the storm water drainage system in areas where gravity flow is impossible or not economically viable. To drain out the accumulated water from the depressed low lying areas, these pumps are installed. The pumping stations should have to be maintained very carefully with technical persons or operators round the year so that they can be used continuously during the required time. It is better and advisable to keep one or two pumps as extra as stand by unit in some selected points where the water logging duration is more.

The pumps should have to be maintained by authorized persons as per the instruction manuals attached with them for longer life and optimum performance of the pumps. On the other hand, pumping stations are vulnerable to a wide range of operational problems from malfunctioning of the equipment to loss of power. Monitoring systems such as one side monitoring lights and remote alarms can help minimize such failours and their consequences.

Telemeter is an option that may be considered for maintaining and monitoring critical pumping stations. The operating functions of the pumps may be telemeter from the stations to a central control unit. This will allow the main control unit to initiate corrective actions immediately. If a malfunctioning occurs in power and pump operations, unauthorized entry, evolution of explosive fumes and sudden increase of water level is seen then such problems can be shorted out and monitored effectively. However, the best procedure to assure proper functioning of a pumping station is the implementation of a regular maintenance schedule conducted by trained and experienced technical persons.

A comprehensive maintenance program should be developed for maintaining and testing the equipment so that it will function properly when needed. Instrument like hour meters and number of start meters should be used on each pump to help scheduled maintenance. All the elements of the pumping stations should be carefully reviewed for safety of operation and maintenance. Ladders, stairwells another access points should facilitate use by the maintenance personal. Adequate space should be
provide for the maintenance of the equipment of the pumping stations. Proper attention should be given for guarding various moving components such as drive shafts and providing proper and reliable lighting facilities.

IV. **Planning for operation and maintenance of the existing culverts**

The existing culverts and the newly constructed culverts in the proposed integrated drainage networks should be maintained properly without any blockage for expected effective performance of the system. Weekly cleaning of the culverts must be done by the concerned authorities to maintain the natural flow of the water by the drains throughout the year.

V. **Planning for operation and maintenance of the silt traps**

In Guwahati one of the major problems during flood is large scale siltation on the drains. It is found from the field survey that most of the flood affected areas of the city is prone to siltation. To mitigate this problem silt traps at various locations within the city for retaining silts at those locations is considered to be an important plan to make the drains free from siltation. This silt trapping will not allow the silt to enter in to the drains. Provided, the silt traps should be maintained and kept in a perfect working condition during the dry seasons by carrying out necessary repair works if any for keeping them ready for the rainy season.

The concerned authorities must take steps to clean the silt traps at regular intervals depending on the frequency and intensity of rainfall. On the other hand, though the existing drains may carry some amount of silts which are to be removed manually at least twice in a month in winter and twice in a week in the monsoon season to remain proper grade and alignment of the existing drains for better performance.

VI. **Planning for operation and maintenance of the detention and retention structure**

The drainage system management facilities must be properly maintained if they are to functions as intended over a long period of time. The following types of tasks should be performed periodically to ensure that storm water management facilities function properly.
These are-

i. Inspection: Storm water storage facilities should be inspected periodically for the first few months after construction and on an annual basis thereafter. In addition to this all the facilities should be inspected during and after major storm events to ensure that the inlet and outlet structures are still functioning as per the original design and that too without any damage or clogging.

ii. Mowing: Impoundments should be mowed at least twice in a year to discourage woody growth and to control weeds.

iii. Debris, sediment and litter control: Accumulated debris, sediment and litter should be removed from detention facilities at least twice in a year. Proper attention should be given to removal of sediments, debris and grass around the outlet structures to prevent clogging of the control device.

iv. Nuisance control: Standing water or soggy conditions within the lower stage of a storage facility can create nuisance conditions such as odors, insects and weeds etc. Systematic and scientific drainage system will minimize all these problems.

VII. Rehabilitation of the existing drains

During field survey it is observed that the existing drains of the city do not have proper linkage among them. Those drains should have to be connected to an integrated drainage system covering the entire city. In this respect the direction of flow of water of the drains should be as per the contours of the Guwahati city. The required modification of the drains is very essential to make the drainage sewerage system effective.

VIII. Construction of new drains

As the city does not have any comprehensive and systematic drainage sewerage system, it is comes to light that a planned scientific drainage network is very essential for the city. By considering the contour map, land use land cover map, existing water bodies, outlets of the drains new drains should be constructed by following proper technical guidelines. Construction of sub branch drains and branch drains and their connection to the main drains needs
to taken under consideration for solving the problems related to lack of drainage sewerage system.

IX. **Pumps and other electro-mechanical components**

At present Guwaahati has a numbers of existing drains that have outfall point at Brahmaputra river, through which they use to carry storm water from various parts of the city. But it has been observed that during summer( Monsoon season), when the HFL of Brahmaputrr exceeds FSL of these drains, water from Brahmaputra back flows through most of the drains causing flood in the adjoining areas. It is also observed that some drains like Bharalu, Khanajan, Bondajan etc experienced back flows from the main drains i. e. Brahmaputra during Monsoon periods. To check this problem some sluice gates and pumping stations should be constructed in the required areas. The following table shows the proposed location of sluice gates and pumping stations of Guwahati.

Table 6.2: Proposed sluice gates and pumping stations on the drains of Guwahati

<table>
<thead>
<tr>
<th>Name of the drain</th>
<th>Required sluice gate/ pumping stations</th>
</tr>
</thead>
<tbody>
<tr>
<td>At the outfall of Khanajan river</td>
<td>Pumping station</td>
</tr>
<tr>
<td>At the outfall of drains passing through Roopnagar RCC bridge</td>
<td>Pumping station</td>
</tr>
<tr>
<td>At the outfall of Lachit nagar under ground drain near B.T. College</td>
<td>Both sluice gate and pumping stations</td>
</tr>
<tr>
<td>At the outfall of Anil Nagar Nabin Nagar under ground drain at Bharalu river near Bhangagarh</td>
<td>Both sluice gate and pumping station</td>
</tr>
<tr>
<td>At the outfall of under ground drain passing through Gobindapur near colcony Bazar</td>
<td>Both sluice gate and pumping station</td>
</tr>
<tr>
<td>At the outfall point of Bondajan</td>
<td>Both sluice gate and pumping station</td>
</tr>
<tr>
<td>At Nabin Nagar on Bharalu river at Rajgarh area</td>
<td>Pumping station</td>
</tr>
</tbody>
</table>

Source: Field study, 2014, 2015 and GMC

(182)
Sluice gate and pumping stations are very essential at various location to drain out the excess water from the low lying areas to make the area free from water logging and flash flood. Being the most flood affected area, Nabin Nagar, Tarun Nagar, Anil Nagar area pumping stations are very essential with high power pump sets. On the other hand, the outfall points of the drains like Khanajan, Bondajan, Bharalu both sluice gate and pumping stations are required.

X. Improvement of natural water bodies

There are a number of natural water bodies scattered in Guwahati city. Noted water bodies are- Deepar Beel, Silsaku Beel, Borsola Beel, Sorusola Beel etc. But due to encroachment these water bodies are gradually shrinking. Therefore conservation of these water bodies with defined boundary is most important. It should be reserved to balance the ecosystem of the city as well as to storage of excess runoff of the nearby areas to make the areas free from water logged and flash flood. Development and conservation of the water bodies will check the encroachment and it can be used as recreational purpose and pisiculture also.

The above mentioned points clearly explain about the features of the management plans for an effective drainage sewerage system in Guwahati City.

6.3.2 Remedial Measures Suggested

Basic Problem and Remedial Measures

Water logging in the city is the serious problem that the Guwahati Metropolitan Region is facing, especially during monsoons. Poor drainage system in the city is one of the causes for the water logging during the heavy rainy days. The drainage system in the city is not fully developed and is not been updated for the past few decades. The drains are narrow, aided by soil siltation at the bottom of the drains, and blocked outlets of the drains at the river due to thrown garbage in the river. As a result, the floodwater overflows over the streets.

Presence of improper gravity flow of water to the river is another cause for the water logging in the city. During monsoons, the water level of the river rises above at which gravity flow takes place through their the three outlets- Bharalu channel, Bonda Jan, Khona Jan, where sluice gates are used for prevention of
backflow of water. Quite frequently, the sluice gates are kept close during the seasons of heavy rain; hence, the storm water is discharged by the set of pumps installed at the Bharalu sluice gates, which is a very dangerous condition.

In addition, the underground drains that carry wastewater from the residential, commercial, etc. areas should conceptually have gone to a sewerage system for treatment, instead is been discharged into the storm water drainage channels. Additionally, due to uncontrolled constructions, there have been encroachments in the natural drainage system. (Adopted from: CDP and Master Plan-2025).

**Remedial measures**

1. **Providing vegetative cover**
   
   This should be the first step for controlling urban flood of Guwahati. Removal of sediment here and there from the drains will not be effective if the sediment yield from the watersheds cannot be stopped. The vegetative cover must be provided at least in two canopy layers; one the grass and other is the tree cover. While the tree leaves will reduce the eroding capacity of raindrop by reducing its kinetic energy, the grass cover will protect the erosion by surface water. The surface runoff and hence the peak discharge will also be reduced by the grass cover as it will reduce the flow velocity and promote infiltration. Grass plantation must be done with proper land preparation. Geotextile may have to be used in some steep hill cutting if flattening of the slope is not possible due to other constraints. In the private sector regulation must be formulated to compel people not to keep bare land.

2. **Desiltation of the drains**

   After providing the vegetative cover the drains must be cleared starting from the downstream end of the 20 routes mentioned above along with the drains carrying runoff from a single watershed directly to the water body.

3. **Providing Silt Trap**

   Silt trap with a provision of regular clearing system is a must for arresting that part of the silt, which will continue to flow even after putting the vegetative cover in the surrounding hills. Reconnaissance survey carried out under this study with the officers of town and country planning has shown that it will be difficult to get a large
area for constructing silt trap in the foot hills of the surrounding hills. The volume of sediment yield computed in this study has shown that silt yield due to a heavy shower is so high that a small size silt trap will get filled up within a day or two. Therefore, a platform must be constructed on the side of these silt trap so that a vehicle mounted dredger can be driven conveniently to remove the deposited sediment from the trap and be carried to suitable areas.

4. Rainwater Harvesting

Rainwater harvesting in the form of roof harvesting, or pond harvesting in small scale but in large number will be helpful in reducing the surface runoff, particularly the peak runoff. A calculation carried out in the pilot watershed on the basis of the observed rainfall data has shown that from a five-hour duration rainfall an average size roof (say 150 sqm) can accumulate maximum of 12.75 m³ of water. Therefore, a tank of 4 m x 4 m x 1 m will be sufficient to detain the rain that falls directly on the roof. This will provide water for use as well as will help in reducing the flood peak. On the other hand if use of roof-harvested water is not felt necessary this water can be drained to a shock pit prepared for the purpose directly. This will also reduce the peak runoff. However, a shock pit may not be very much efficient in a low-lying area during the rainy season depending on the level of water table in that area at that time. Therefore, significant amount of rainfall can be retained by roof harvesting having dual benefit of flood peak reduction and rainwater utilization. However, this will require an initial investment by the house owner. Government subsidy can be provided in this regard considering this as a part of major flood mitigation project.

5. Improving drainage network

The drainage network must be improved considering the total network as a single system. This is because link channel either natural or man made do exist in many points, which can divert water of one basin to the other basin. As many low-lying areas have already been filled up the storage capacity of the existing wetland must be increased by increasing the depth. Slopes of the drains in the valley portion being very flat pumping system at several critical points must be installed and must be operated in proper sequence as and when required. The following are some of the suggestions towards the improvement of the drainage system of Guwahati City:
i. Increase storage capacity of the Deepar Bill by increasing the depth. Ensure performance of the sluice gate located at Khanajan and provide gate in other outlet channels also to prevent backflow from the Brahmaputra during high flood period.

ii. Install a pumping station on the Bashistha River at the upstream of Deepar Bill. Construct marginal bund on the Eastern side of the Deepar Bill to prevent submergence of locality having habitation.

iii. Mara Bharalu channel should be restored and water from Mara bharalu should be pumped to Bashistha channel with a provision of sluice gate.

iv. A pumping station with a sluice gate should be provided at the downstream confluence of Bashistha River and Bashistha diversion located at Dakhin Gaon to pump out the storm water accumulated in the original Bashistha River and to prevent backflow from the Bashistha diversion.

v. The storage capacity of Deear Bil, Silsaku Bill, Damal Bill etc. should be increased by deepening.

vi. Channalize the water from Damal Bill and Bunda nala to River Brahmaputra with necessary pumping.

vii. Installation of high capacity pumping station in the Bharalumukh with proper sluice gate.

viii. Install pumping station at the confluence of Zoo Tiniali drain and Bharalu River near Zoo with a gate arrangement to prevent backflow from Bharalu to the drain. Provision of gate should be there on the upstream of Bharalu River itself near Zoo with a pumping arrangement for worst situation.

ix. Diversion tunnel can be provided in Noonmati area to divert the flow from that area to Brahmaputra directly. A graded canal around the hill can also be planned with a connecting steep canal from the northern side of the hill to the River Brahmaputra.

x. All the channels draining directly to a water body (Brahmaputra, Bharalu, or a wetland) should be provided with a proper sluice gate arrangement with an adequate pumping station.
All the pumping station and the sluice gate mentioned above must be operated in proper sequence and in proper time as per the information of rainfall in different watersheds.

6. **Garbage Control**

   Strict regulation must be made to prevent throwing of garbage to the streams and drains. Industries that can help recycle of plastic product, reuse of kitchen waste etc in the form of fertilizer or biogas should be promoted.

7. **Possibility of Detention Reservoir**

   With an understanding with the Govt. of Meghalaya, construction of two detention reservoirs can be planned; one at the confluence of Umtringa, Umtashu and Bahini, and the other on the downstream of Sarupani and Barpani. These reservoirs must be maintained, monitored and operated in a proper scientific way to eliminate chances of artificial flood in the city due to sudden release of water from these reservoirs due to erroneous operation.

8. **Up to date collection**

   To minimize the drainage sewerage problems of Guwahati Before the construction of the drains and tunnels collection of aerial photographs for different time periods are very essential. This photographs collected in the summer season will provide the clear picture of the water logging areas of the city and the photographs of the winter season will be helpful to construction work as per the need of the plan on the required areas.

9. **Excavation of the wetlands**

   All the water bodies including wet lands and river bed should be excavated to enable them to absorb the excess water during rainy days. Because of high siltation the water bodies of the city, which are considered to be the natural reservoirs of the water became shallow. Therefore excavation is the only way to keep the water bodies deep so that water will automatically flow to the wetlands. This will minimize the water logging and flash flood problems of the city.
10. **Maintenance of the existing manholes**

The existing manholes of the footpath cum underground drains are not adequate. More manholes are required to clean the drains as well as quick disposal of silt and garbage’s that block the drains. The size of the holes should be re-oriented. Frequent monitoring of the underground drains is utmost necessary.

11. **Monitoring and maintenance of the drains**

Non-degradable solid wastes like plastics, polythlenes, thermocol, rubber and matels and garbage etc should not be thrown to the drains. This acts as garbage stores in the drains and become hindrance to the free movement of the sewerage. Drains should be garbage free.

6.3.3 **Justification of the Measures**

The growth and development of the Guwahati city from all the aspects leads to a numbers of geo-environmental problems. Among the problems most importantly the city is experiencing recurrent flood inundation and severe water logging in the occurrence of storm events during the rainy seasons. As mentioned in the earlier chapter that the intensity of this problem is increasing day by day with the inundation of the new areas. Though Government and the concerned departments have been adopting various measures to tackle and manage the impact of this problem, but the result is not satisfactory enough. In this chapter various measures have already been suggested to manage these flood and water logging problems after conducting an extensive survey as well as study of the problem at different locations. The best remedial measures is the adoption the strict rules by the respective department along the people’s participation. The GMC, GMDA, GDD and other departments must have to practically follow the action plans and all the measures suggested. Strict monitoring of the management plans irrespective of situation and location for the greater benefits of the city dwellers and make the city free from the unwanted problems.

During the survey it is found that, the drainage system of the city is piecemeal and unsystematic and maintained by different Govt. departments and organizations like GMC, GMDA, WRD, PWD (Roads). As such, there is disrupted connectivity of the storm-water drainages; and the profile and gradient of the existing drains is not as per hydrological requirements. Besides, size of the branch and sub-branch
drains is also inadequate. Therefore, these departments have to take necessary actions suggested by the experts from various fields to for the proper planning of the city. As categorized the remedial measures as short terms midterm and long term depending on the nature of the plans, to plan Guwahati with a separate drainage sewerage system these measures should be given due importance without delay. On the other hand, to check the intensity of these problems in the near future scientific and systematic planning of the drainage sewerage system is most essential. Because of the lack of this planning in the early phase of the growth of the city the city becomes one of the most unplanned and chaotic in its nature.

6.3.4 Implementation and Expected Benefits

1) All branch and sub-branch drains, across the city has been given under the care of Guwahati Municipal Corporation (GMC). GMC shall ensure maintenance of the drains with adequate storm-water carrying capacity, proper connectivity and free-flow on Public Private Partnership (PPP) mode. Accordingly, GMC has to float tender for minimum period of 3 years. Prior to that, the drainage network has to be delineated, drainage design formulated as per internationally accepted norms, and the network divided into specific inter-connected segments for awarding of contracts separately. This will make the drainage sewerage system more efficient and effective for the city.

2) To augment the flushing out capacity of flood-waters i.e. the stagnant storm-waters, 38 numbers of additional trolley mounted pumps is required 20 pumps by GMDA, 8 pumps by Water Resources (Mech) Deptt., and 10 pumps by GMC. The pumps have to be installed before the onset of the monsoons. Operation and maintenance of all such pumps shall be done by Water Resource Department. 4 additional pumps shall be procured by Water Resource Department on getting financial clearance from Assam State Disaster Management Authority. (Based on GMDA consultation). The installation of these pumps will definitely help the
authority to make the areas free from water logging as well as from flash
flood.

3) To facilitate flood-forecasting and proper drainage design, 60 numbers of
electronic rain gauges, preferably tipping bucket shall be installed ward
wise by Water Resources Department and installed at strategic places
across the city. Operation and maintenance shall be accomplished by the
civic body i.e. Guwahati Municipal Corporation.

The installation of the rain gauge will provide the necessary
rainfall data of Guwahati at various locations and of course it will benefit
the concerned departments to prepare action plan for the future based on
the collected data. On the other hand, it will help the people to understand
the nature of rainfall upto some extent, so that they can adopt necessary
measures.

4) The Water Resources Department shall float tender for the maintenance
of the 5 numbers of main drainage drainages i.e. Bharalu, Bahini,
Basistha, Mora Bharalu and Pamohi, within the city up to their respective
confluence points. They should design specifically the respective cross-
sections and long-sections of the channels concerned, which shall be so
formulated as to ensure free flow and make their water retention capacity
capable of absorbing maximum storm-water from their respective
catchment areas. The concerned authority will be responsible, in case of
any channel shall have to achieve the given cross-section and long-section
by widening and deepening that channel while maintaining the gradient,
and maintain that cross-section and long-section for 2 years by regular de-
silting operations. The cross-section and long-section shall be checked by
inspecting personnel of the Water Resource (Civil) Department, at regular
temporal and spatial intervals, after every heavy showers (which increases
the probability of siltation), and even randomly.

5) The storm-waters of Meghalaya shall be diverted away from the city by:

i. The excavation of an alternative drainage channel south of the
   National Highway 37 from Koinadhara Hills to Bahini Culvert
Point and from behind Games Village (Nidhi Bhawan) to ISBT Point in order to fall its outfall onto the Pamohi River therein by the Water Resources Department; and

ii. The reconstruction with adequate capacity, connectivity and gradient the side-drains along the service roads of the NH 37 Guwahati Bypass, or by the side of the NH 37 (where no service roads are present), by NHAI as per design made by Water Resources Department (WRD) and GMDA.

This diversion of water will minimize the risk of flash flood and water logging problems of Guwahati. Along with that this diversion will definitely decrease the amount of silt deposition on the inundated and flood affected areas. As the drains of the city are unable to carry all the waters coming down from the Meghalaya, therefore, this plan will be so much beneficial for the city.

6) Long term measures like installation of new sluice gates at Bharalumukh, Bondajan, Khanajan and comprehensive drainage system with grand storage sumps etc. should be adopted by the respective departments to solve the problems of drainage sewerage in Guwahati. Along with this overall measures for improvement of the civic infrastructure of the city shall be taken up with strategic planning way.

7) The planning and actions for the short term measures as mentioned in the earlier chapter, shall be immediately prepared and adopt by the concerned Departments. The experienced technical persons and planners should be appointed to make the plan success.

8) Transformers and other essential electrical equipments shall be raised in height above the high–flood–level (HFL) by ASEB/ APDCL so that electricity supply doesn’t get disrupted during floods. It should be set in such a way that, even at the time of unprecedented rains there will not be any chance of risk from this. This measure will improve the level of safety among the civic communities.
9) Standard Operating Procedure (SOP) for operating pumps for flushing out flood waters shall be prepared by the Water Resources (Mechanical) Department. It should be installed in the required places so that during the monsoon season the flood affected areas will be get relief soon. This will also minimize the level of damages in those areas.

10) A detailed Flood Contingency Plan or Flood Management Plan should be prepared by the Kamrup (Metro) District Administration in association with all the relevant Govt. Departments, NGO’s, local agencies and with the people from the localities for tackling urban floods during emergency. Awareness among the people will also help to short out some problems emerged during flood.

11) The Expert Committee for Urban Flood Mitigation must be formed. Review and meeting among the concerned Departments and authorities to mitigate the problems emerge from poor drainage sewerage system of the city. If required necessary modification and finalize the long term measures for urban flood mitigation incorporated in the prepared Action Plans. Inclusion and implementation of experts views, technical supports, models from various sources will make the drainage sewerage management plan more effective. Contour Survey at 0.5 m interval to get detailed relief characteristics of Guwahati, Installation of Tipping Bucket Rain Gauges in all the wards, Side Drainage along NH 37 and review of the Departmental Plans are some of the points taken under consideration for the better effectiveness of the plans.

12) The river as well as major drainage channels within Guwahati have to be barricaded in order to prevent encroachment and solid waste disposal therein. This action will keep the drains clean throughout the year and it will help the free flow of the water to its outlet. This kind of plan will comparatively minimize the duration of water logging and flash flood within the city. GMDA has to complete the work by following the proper guideline.
13) The notified water-bodies have to be de-silted and which is most essential to check the water logging and flash flood in the city. Both Manual and advanced mechanism can be used to desilt the water bodies. Concerned departments like, GMDA and Water Resource Department has to complete the de-siltation of Borsola Beel, Sarusola Beel and Silsaku Beel by using the Amphibian Dredger (Water master) and Barge Mounted Excavator.