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Local Government Division

Operational Handbook on Paurashava Drainage System Development

August 2018

LGD/JICA

Operational Handbook on Paurashava Drainage System Development

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Chapter One: Introduction

1.1 Background of this Handbook

Developing the urban drainage system is now a mandatory issue in most of the Paurashavas of Bangladesh. Due to rapid urbanization, drainage related problems are identified as highly prioritized issue to solve to the Paurashava residents. Therefore, it is important to ensure sustainable drainage system development considering priority-based development resulting optimization of resources used in this purpose.

The functions of drainage system are to collect and carry storm water and domestic used water from urban area and convey it to a suitable outfall. Unfortunately, most of the Paurashavas of Bangladesh failed to develop their drainage systems systematically. Apart from this, there is no useful guideline exists for Paurashava authority describing proper procedure on decision making for development, operation and maintenance of the drainage system.

This handbook provides the guideline to perform regular activities of excavation and re-excavation, construction and re-construction, operation and maintenance of public drains and authorization of private drains and used as tools for monitoring and evaluation for drainage development.

1.2 Importance of Drainage Development

Drains and Drainage System Development

Drains carry surface water from source or household to a designated outfall and comprised with culverts, bridges, water reservoir area for example water bodies, canal and other channels are being used for same purposes are collectively called the drainage system.

Lack of sufficient drainage system will causes immense public sufferings by local flooding. Ensuring sustainable and integrated drainage system developments will reduce those type of sufferings. Achieving complete drainage system requires developing the hierarchy based drainage networks comprises with primary drains, secondary drains and tertiary drains.

Importance of Drainage System Development

A comfortable urban life depends on good urban environment. Among all other urban utilities and facilities, planned drainage system is one of the essential elements of decent urban environment. It is important for our daily life as well as natural consequence.

If storm water is not drained properly, it can cause water logging, inconvenience, damage to infrastructure and health hazard. Urban local flood due to inadequate drain is a major concern for Paurashava of Bangladesh.

Benefits of Drainage System Development

Benefits of the proper drainage system development are stated bellow:

- It will reduce public suffering caused by water logging, spreading solid waste, deteriorating public health and social communication;
- It will save resources by protecting damage to the public and private infrastructure and property;
- It will contribute to improvement of environmental quality by reducing blockage in the drain and longtime water logging problems; and

It will reduce O&M cost resulting savings of Paurashava revenue.

Drainage System and Sewage system

Sewage system is the removal process of human wastes that is generated from health, sewage and collection of industrial waste, pumping, treatment and removal. Such waste is mainly liquid that contains solid elements as a result of serious environmental pollution as well as dreadful condition of Public health. Therefore, sewerage connection should be strictly prohibited to connect with drainage connection.

It has been observed that Paurashava citizens usually connect the sewage line with the drainage system due to unconsciousness, which is serious offense under the law. In this regard, effective measures should be taken by the Paurashava.

1.3 Objectives of this Handbook

The main objective of this handbook is to improve the capacity of the elected representative and concerned officials/staffs in the field of drainage system development. In this handbook included construction of new public drains, reconstruction/rehabilitation of existing public drains, excavation/re-excavation of primary/earthen drains, operation & maintenance of public drains and authorization for construction of new private drain for planned and sustainable development. Specific objectives have been described as follows:

- To orient with preparation of drainage plan, implementation procedure of operation and maintenance to achieve standard drainage system for Paurashava,
- To orient with implementation of a proper drainage plan,
- To orient with approval procedure for authorization of new drain construction by private and other government agencies, and
- To orient on establishing/forming monitoring and evaluation framework to ensure implementation of drainage system development activities confirming proper standard as per the plan.

1.4 Framework of the Handbook

Considering the implementation of the specific objectives mentioned above, this handbook has a total of five chapters:

Chapter One: Basic concept about Paurashava drainage system development and the goal and objectives of the Handbook.

Chapter Two: Legal issues related to the development and maintenance of Paurashava drainage system.

Chapter Three: Technical and other matters relating to regulation and coordination of construction, maintenance, and construction of new drains (government, non-government or private ownership).

Chapter Four: The methodology / strategy followed in the development process of the drainage system.

Chapter Five: Monitoring and Evaluation of Drainage Works

1.5 Target Group of this Handbook

This Handbook has been prepared mainly for capacity development of Paurashava's elected representatives and the officials of Engineering Department. Mayor, Councilors and officials of the Engineering Department of Paurashavas are expected to be able to achieve urban drainage system within the Paurashava area with proper standards through enhancing their capacity.

Chapter Two: Legal Context related to Drainage Development

2.1 Existing Legal Basis

2.1.1 Related Provision in the Local Government (Paurashava) Act 2009

The second schedule of the Local Government (Paurashava) Act 2009 describes Paurashava's detailed functions including drainage, drainage schemes and its offences.

Para 12 “Drainage” of the second schedule of the Local Government (Paurashava) Act 2009

- (1) A Municipality shall, within the limits of the funds at its disposal, provide an adequate system of public drains in the municipality and all such drains shall be constructed, maintained, kept, cleared and emptied with due regard to the health and convenience of the public.
- (2) Every owner or occupier of any land or building within the municipality may, with the previous permission of the Municipality and subject to such terms and conditions, including the payment of fees, as the Municipality may impose, cause his drains to be emptied into public drains.
- (3) All private drains shall be subject to control, regulation and inspection by the Municipality and the Municipality may, in such manner as the by-laws may provide, require the provision, alteration, covering, clearing and closing of private drains.

Para 13 “Drainage Schemes” of the second schedule of the Local Government (Paurashava) Act 2009

- (1) A Municipality may, and if so required by the Prescribed Authority shall, prepare a Drainage Scheme in the prescribed manner for the construction of drains at public and private expense, and other works for the effective drainage and disposal of sewerage.
- (2) A Drainage Scheme prepared under sub-section (1) shall be submitted for approval to the Prescribed Authority, which may approve it, reject it, or approve it subject to such modifications as it may deem fit.
- (3) The Drainage Scheme as approved by the Prescribed Authority shall be executed and implemented within prescribed period.
- (4) A Municipality may by notice require the owner of any building or land within the municipality-
 - a) to construct such drains within the building or land or the street adjoining such building or land as may be specified in the notice;
 - b) to remove, alter, or improve any such drains; and
 - c) to take such other steps for the effective drainage of the building or land as may be so specified.

Fourth schedule of the Local Government (Paurashava) Act 2009 (Offences)

- (10) Without the permission of the municipality, causing or knowingly or negligently allowing the contents of any sink, sewer, drain, or cess-pool or any other offensive matter to flow, or drain to be put upon any street, or public place, or into any irrigation channel or any sewer or drain not set apart for the purpose.
- (11) Lying out a drain or altering any drain in a street without the sanction of the municipality.

(12) Connecting any house drain with a drain in a public street without the permission of the municipality.

2.1.2 Bangladesh National Building Code 2006

According to the Bangladesh National Building Code (2006), a drainage system includes all the piping within public or private premises which conveys sewage, rain water or other liquid wastes to a legal point of disposal, but does not include the mains of a public sewer system or a private or public sewage treatment or disposal plant. The drains shall be designed with adequate slope and section to carry the design discharge of its catchment area. The material used in the drains shall be suitable for discharge of the storage materials. The design of the drain will be so arranged that the drain may be readily cleaned without the risk of health hazard.

2.1.3 Private Residential Project Land Development Rules 2004 (Amendment in 2012 and 2015)

According to the Private Residential Project Land Development Rules 2004 (Amendment in 2012 and 2015) drainage system must be considered with special attention during the preparation of Lay out Plan and green space must be preserved with their own cost. If natural water flow passes over the project area and connect the outfall with natural canal, water body and river or identification of water flowing canal on CS, SA, RS mouza map, in that case such type of land cannot be sold.

2.1.4 Natural Water Body Protection and Preservation of Open Space and Playground Act 2000

Mega city, Divisional Town and District Town's municipal areas including country's all the municipal areas' playground, open space, park and natural water reservoir Conservation Act (2000) states that the places marked as open space, park, playground and natural water bodies can't be used another way, it cannot be rented, leased or cannot be handed over for any other use.

2.1.5 Environmental Conservation Act (1995) and Building Construction Rules (1996)

All kinds of polythene shopping bag are banned on any type of its use under Bangladesh Environmental Conservation Act 1995. Polythene bag and its portion are the main causes of drains blockage. Building Construction Rules (1996) states that all kinds of structure must be followed the land use plan of Paurashava Master Plan. Paurashava Master Plan has clearly stated the location of proposed drainage network.

2.2 Other Relevant Documents

2.2.1 Paurashava Infrastructure Design Manual 2015

Recently LGED prepared Paurashava Infrastructure Design Manual in 2015. Paurashava drainage including drains classification, Manhole, Footpath, Drains Network, Rainfall Intensity, Time of Concentration, Drains Design, and Type of Design have been discussed in detailed form. In the Operation and Maintenance section, routine maintenance, periodic maintenance, emergency maintenance and retrofitting maintenance have been discussed for all type of structures implemented in the Paurashava area.

2.2.2 Paurashava Master Plan (UTIDP & DTIDP) 2012

Master Plan including Drainage and Environmental Plan was prepared for 22 District Towns Paurashavas, 2 City Corporations and 218 Upazila Town Paurashavas under the technical assistance of UTIDP & DTIDP of LGED in 2012.

2.2.3 Master Plan for Greater Dhaka Protection Project 1991

Some basic parameters related to drainage such as gravity drain, pump drain, detention pond, retention pond, IDF curve, unit hydrograph, conservation of the environment etc. have been illustrated in the Master Plan for Greater Dhaka Protection Project prepared by JICA in 1991. The Master Plan suggested 12% of storm drainage area would be preserved as retention pond for multipurpose use including to maintain the minimum water depth to operate the Pump.

Chapter Three: Considerable MattersonPaurashava Drainage System Development

3.1 Introduction

Drainage is a cross-sectoral issue, involving such field as housing, roads, solid waste management, water supply etc. Present trends of urban land development activities, like filling low lands, encroachment of natural drainage, non-existence outfall etc. are major causes behind the water loggings. With the passage of time, the paved area of a Paurashava become large which causes minimum open space to infiltrating water naturally from various sources and thus drainage condition become worse at the same rate.

Paurashava drainage system should be developed by proper utilization of existing natural channels like khals, water reservoirs like ponds, and ultimate outfalls like rivers, etc. Both structural and non-structural measures are involved for Paurashava drainage system. To make a balance between demand and supply of drainage, Paurashava need to take proper decisions for achieving sustainable drainage system considering standards and technical issues, which will minimize the drainage cost also.

3.2 Issues to be Considered for Paurashava Drainage System Development in the Context of Bangladesh

The following issues are important to follow for developing the Paurashava drainage system:

- ⇒ Identification of a catchment area
- ⇒ Identification of existing water bodies, natural canals, rivers and drainage outfalls.
- ⇒ Preservation of existing ponds, low pockets and agricultural low lands
- ⇒ Identification of existing natural and manmade drains
- ⇒ Identification of built up areas, future development areas and land use characteristics
- ⇒ Identification of Land Elevation and Contour
- ⇒ Developing drainage networks by following gravity flow Proposed location for water control structure like culverts, regulators, embankments, etc .Development of hierarchical drainage network
- ⇒ Consideration on Developing line drains and other water controlling structures.
- ⇒ Drainage design consideration.

3.2.1 Identification of a catchment area

The area of land draining into a stream or a water course at a given location is known as catchment area. It is also called as drainage area or drainage basin or watershed. A catchment area is separated from its neighbouring areas by a ridge line called drainage divide or watershed. Location of proposed drain will be determined based on the topography of the catchment area while its size will be determined based on catchment size and characteristics, rainfall intensity, rainfall duration, land use pattern, etc. The areal extent of the catchment is obtained by tracing the ridge lines on a topographic map to delineate the catchment and measuring the area by a planimeter¹. Identification of characteristics of the catchment area and the rainfall intensity and its duration are major parameters to be considered to calculate the amount of peak discharge. Selection of drain without

¹ Planimeter is an area measurement instrument that can be used to measure the area of a catchment of any two-dimensional space in the area.

knowing catchment boundary and peak discharge is a temporary solution for a particular area and ultimate solution is to destroy the temporary drain and implement the integrated network-based drain considering watershed or catchment boundary and all other important parameters. Paurashava can prepare catchment boundary on its base map by considering indigenous knowledge (IK) in storm water flow in rainy season with assistance from local residents. However, such catchment boundary prepared from IK should be verified with the topography map (if available) of that area.

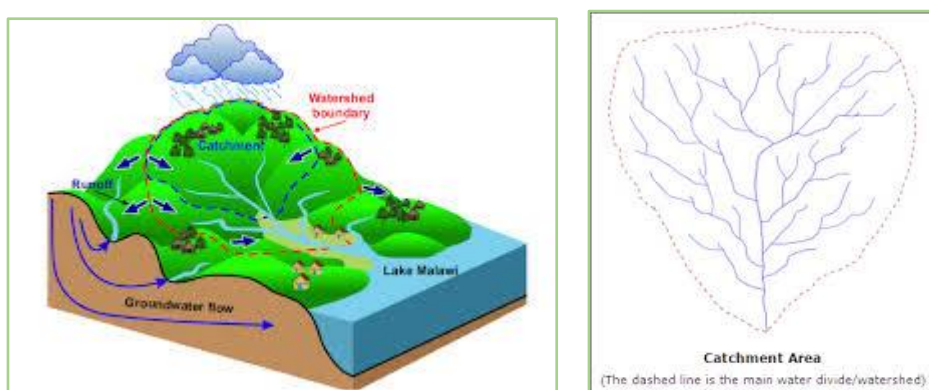


Figure 3-1: Example of a Catchment Area

3.2.2 Identification of existing water bodies, natural canals, rivers and drainage outfalls.

Water logging causes mainly for three reasons. One is obstruction of natural setting by construction of man-made structure and another one is dumping of waste in the drainage and the last one is non-availability of drainage.

Natural drainage, however, is often inadequate and artificial or man-made drainage is required. In order to facilitate the flow of excess water toward the drains an artificial slope is to be maintained throughout the planned area. Each Paurashava have a natural undulation and natural pattern of drainage. Water bodies and its related stream channel like natural canals, rivers play vital role for natural drainage through gravity drainage system.



Figure 3-2: Example of Existing Water Bodies

Existing water bodies are the part of drainage system. It reduces the amount of run-off, makes delay in time of concentration and used as drainage outfall. As a result of urbanization, natural drainage

path is blocked day by day. There is a law against the degradation of natural water bodies and its blockage (Mega city, Divisional Town and District Town's municipal areas including country's all the municipal areas' playground, open space, park and natural water reservoir Conservation Act, 2000).

Paurashavas which have already prepared their Master Plan, have also prepared their maps with location of existing water bodies. Besides, those Paurashavas who have prepared Drainage Master Plan with the assistance from DPHE also have the base map showing existing water bodies.

Paurashava Drainage Master Plan can be prepared with limited fund and short period of time by using GIS (Geographic Information System) and RS (Remote Sensing) technology. RS technology assist to identify different structure, existing drains, canals and water bodies. On the other hand, GIS technology assist to prepare contour lines and integrated drainage network can be prepared by using both technologies.

3.2.3 Preservation of existing ponds, low lands and agricultural lands

Existing ponds, ditch and other low lands usually play the role as retention pond which serves to delay the peak discharge during heavy storm. The short term and long-term storm water preservation is basic function of detention pond and retention pond respectively. They will attenuate the peak discharge and make delay the peak discharge. The drainage size depends on peak discharge. If discharge can be reduced by detention and retention pond, simultaneously, it will reduce the drainage size and the same time the drainage cost.

Without preservation of existing ponds, ditch and low lands, more run-off will come into the Paurashava drains. Besides, without those, more primary drains will be needed for a paved catchment area. Currently Paurashava preserves its water bodies through Land Use Clearance Certificate, enforcement of existing laws and awareness building program.

3.2.4 Identification of existing natural and manmade drains

Drainage Development planning proposal must be in consistence with existing condition. Existing drainage density should be calculated based on existing drainage length. It is the prime factor for priority fixation.

Without knowing the existing condition, Paurashava may not take any operation and maintenance program for its drainage. Paurashava may prepare their existing drainage condition and drainage data base with drain ID, drain location, length (m), average width, etc.

Paurashava authority may concentrate mainly on primary drain and natural canal/river for the analysis of existing stream channel. If primary channels are ok, then their attention should for designing secondary and tertiary drain.

- At first, find out the natural canal/river that must be preserved and kept obstruction free from any disruption against continuous water flow all the year round. In many times, natural canals are divided into many parts and growing practice of culture fisheries are observed there obstructing natural passage of water.
- Second one is that finding out of all primary drains that may be earthen or metaled. In many time earthen primary drains are found to be functioning in well. Proper measures should be taken for preservation and rescue of those drains from encroachment permanently.

- Third one is to set up the proposed man-made primary drains based on topography and hydrology. It should follow the connectivity or network-based proposal following the contour of that site.

3.2.5 Identification of built up areas, future development areas and land use characteristics

Existing built-up areas, future built-up areas and land use characteristics are the prime factors to be considered for drainage development at Paurashava areas. The volume of runoff proportionally depends on amount of paved surface.

Infiltration and surface runoff are two basic components of rainfall runoff process. The sum of the two components are constant. That is why, there will be large volume of surface runoff for a small scope of infiltration. Figure 3-3 is a hydrograph of rainfall-runoff process of a built-up areas and left figure 3-4 is a hydrograph of rainfall-runoff process of a non-built-up or open space area. A high peak discharge will be achieved within a short period of time if the surface has limited infiltration capacity, i.e. most of the areas are paved. During the hydraulic calculation or design of a drain, a high cross section (more width and more depth) would be required for a high peak hydrograph of a rainfall within a short period of time.

The planning of storm water systems needs to be integrated with land-use planning (e.g. open space) as well as planning for other infrastructure (e.g. water supply) for maximizing benefits of complementary measures.

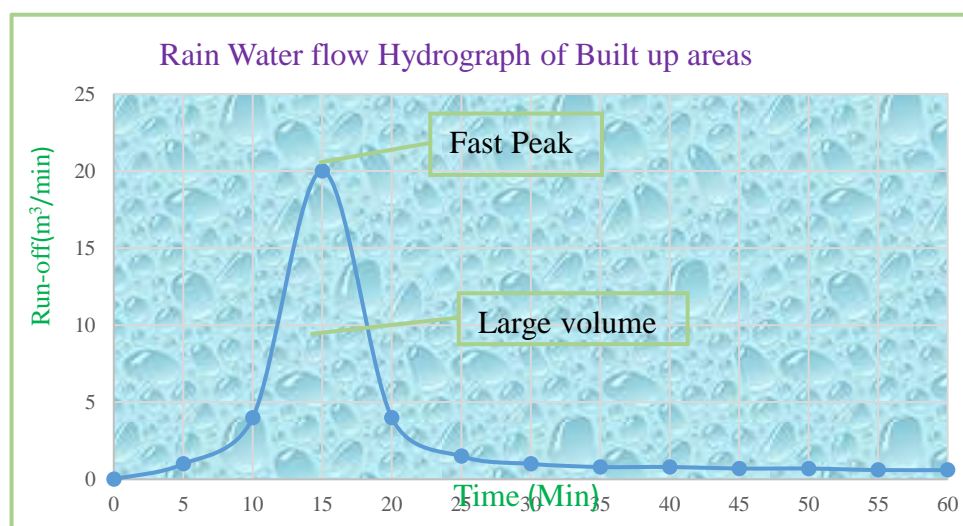


Figure 3-3: Rain Water flow Hydrograph of Built up areas

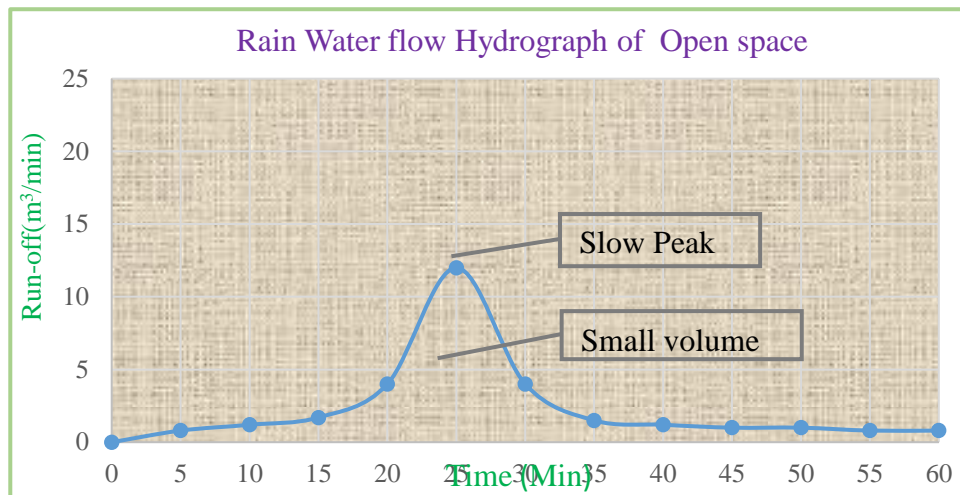


Figure 3-4: Rain Water flow Hydrograph of Open space

Following aspects are important to consider for identifying future built area and land use characteristics under the scheme of rain water removal process:

(A) Analysis of surface runoff

Runoff means the draining or flowing off of precipitation from a catchment area through a surface channel. For a particular storm, a portion of water turning to vapour (Evaporation) and another portion of water go to ground water (Infiltration) through a percolation process. Other than this, some portion stored in detention and retention reservoir that is called depression storage. The balance of water that remains on the earth's surface should release over the surface is called surface runoff. It is the prime consideration for drainage size determination in storm water drainage development process.

By this process, the excess precipitation moves over the land surfaces. The process of overland flow and flow through the channels to reach the catchment outlet is called surface runoff.

Drain as the structure is generally develops to free our living area from household wastewater and storm water. The daily household waste water discharge from a household is negligible compare with maximum rainfall in a day, so for the drainage design it is necessary to calculate the storm water only.

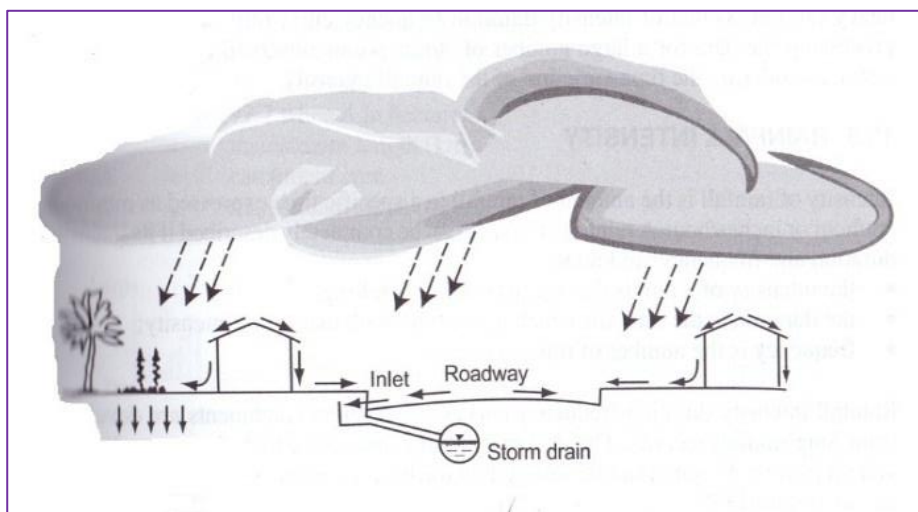


Figure 3-5: Rainfall-Runoff Process

Factors affecting the Quantity of Surface Runoff

The following factors are related to the volume of surface run-off:

Storm Characteristics

- ✓ Storm Intensity and Total Depth
- ✓ Storm Duration
- ✓ Spatial Variation
- ✓ Storm Movement

Hydrography

- ✓ Size of Hydrograph
- ✓ Shape of the Hydrograph
- ✓ Condition of Flow Convenience

Characteristics of the Catchment

- ✓ Size of the Catchment
- ✓ Shape of the Catchment
- ✓ Slope of the Catchment
- ✓ Land Use of the Catchment
- ✓ Soil Type of the Catchment

Antecedent Conditions of Soil

- a. **Extent of rainfall:** The amount of rainfall is not same all over the country. The highest rainfall occurred in the Sylhet Region. In normal case, more volume of rainfall will create more surface run-off.
- b. **Nature of the surface:** For drainage purpose, we have two types of surface. They are paved surface and grassy or non-paved surface. Grassy pavements allow to penetrate some portion of rainfall. Paved surfaces carry total water dropped on it. In the hilly area, surfaces are high sloppy and they have low time of concentration and run-off reached to the outfall point comparatively short period of time.
- c. **Intensity of rainfall:** Rainfall intensity can be calculated through total rainfall divided by time taken for that rainfall and usually expressed in mm/hr. If more rainfall come within a short period of time, it will be high rainfall intensity. For a high rainfall intensity, more surface run-off will reach at outfall point within a short period of time.
- d. **Shape of the catchment:** The shape of the catchment influences the time taken for water from the remote parts of the catchment to arrive at the outlet that is called Time of Concentration. Thus, the occurrence of the peak and hence the shape of the hydrograph are affected by the basin shape. Figure 3.5 explains the shapes of the catchment and corresponding hydrographs.

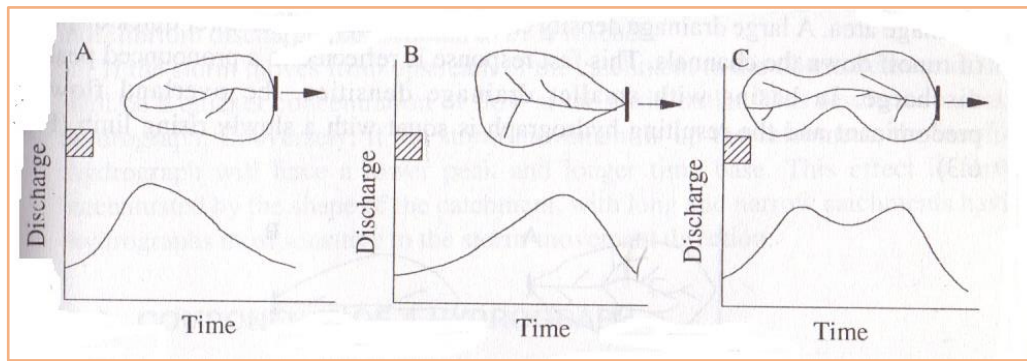


Figure 3-6: Effect of catchment shape on the hydrograph

In catchment A the hydrograph is skewed to the left, i.e. the peak occurs relatively quickly. In catchment B, the hydrograph is skewed to the right, the peak occurring with a relatively longer time lag. Catchment C indicates the complex hydrograph produced by a composite shape.

- e. **Slope of the catchment:** The basin slope is important in small catchments where the overland flow is relatively more important. In such cases the steeper slope of the catchment results in large peak discharge.
- f. **Land Use:** Vegetation and forests increase the infiltration and storage capacities of the soils. Further, they cause considerable retardance to the overland flow. Thus, the vegetal cover reduces the peak flow. This effect is usually very pronounced in small catchments of the area.
- g. **Antecedent Soil Condition/Climatic Factor:** Surface run-off depends on the soil condition. For a wet soil, it will produce a large volume of run-off and for a dry soil, it produces a small volume of run-off.

(B) Land Use Classification in terms of Drainage Development

Considering the drainage development, the total Paurashava land cover can be divided into 3 (three) types as built/paved, non-built/open and water body. Infiltration is possible only for non-built/non-paved area and obviously for water body. Minimum number and small size drains would be required for less runoff condition. Proposals for land cover would be integrated with all land development activities like school with play field, community with Eidgah field, etc.

Integration of water body for any type of land cover would be done as much as possible in such way that it will reduce the urban storm runoff. The proposed land cover would be designed by following compact land cover method. By following this method, the proposed length of drains could be reduced by 50% instantly.

Preparation of existing land use Map

Some Paurashavas have Master Plan, and there is existing land use map. Those Paurashavas not having Master Plan should prepare existing land cover map manually and colour the land type with colour pen or pencil. Obviously existing land cover map should show existing natural and man-made drainage network with outfalls.

Paurashava can prepare land use map by adding it Mouza map together or they collect it from concerned authority like LGED or DPHE. By using Google Earth Technology, they can prepare their map easily. For technical assistance, Paurashava can engaged Consulting Firm to prepare their maps in a professional way.

Preparation of proposed land use Map

Those Paurashavas those have already Master Plan must have a proposed land use map and proposed drainage map by showing proposed drainage network. On the other hand, those Paurashava not having any Master Plan, should prepare proposed land cover map based on existing land use and cover type and showing proposed drainage network. Paurashava provides land use clearance certificate for any type infrastructure implementation. Land use control should be strictly enforced. If settlement and other infrastructure grow in a haphazard way, then it would be complex situation for drainage management. The best way is to control the development in compacted form, not in segregated way. It will help to provide minimum length of drainage.

3.2.6 Identification of Land Elevation and Contour

Sometimes town dwellers should raise their building plinth level (EGL) above the normal flood level (NFL). By analysis 30 years flood level, Paurashava should declare future development level. Without maintaining uniform land elevation level and raising of the crest level of road, plinth level of houses and community facilities like school and community centre, etc. people will face the waterlogging problem. To preserve the natural drainage system, Paurashava should maintain the future land elevation level. In such case Paurashava should declare the future land elevation level by installing Benchmark at least one for one Ward.

3.2.7 Developing drainage networks by following gravity flow

Each Paurashava has a natural drainage system and man-made drainage system. All natural drainage including earthen drainage system must follow the natural gravity that means water move from upland to low land. Preparation of drainage network without considering natural gravity, the depth of drainage will be high and proportionally drainage cost will be more. Land use development without considering natural gravity may block the existing natural drainage pathways. Preparation of base map with contours line may help Paurashava officials for preparation of drainage network system considering the natural gravity. Proposed location for water control structure like culverts, regulators, embankments, etc.

In many times, the roads may bifurcate the natural drainage catchment for a Paurashava. For continuation of smooth movement of water, Paurashava should propose water control structure like culverts, regulators, embankments, etc. Without water control structure it is almost impossible to operate longest drain.

3.2.8 Development of hierarchical drainage network

Paurashava drains can be divided into Tertiary, Secondary and Primary. The hierarchy is that Tertiary drains receive water from household or source. Then it will be connected to Secondary drains and finally dropping to the outfall through the Primary drains.

Tertiary Drain

Tertiary drains collect the surface water from the land surface. Roadside drains, market drains and plot drains are tertiary drains.

Secondary Drain

Secondary drains collect the surface water from the tertiary drains and convey it to the primary drains.

Primary Drain

Primary drains are major khals and drains that drain large areas and convey surface water to the main rivers.

Paurashava may prepare a drainage network plan following the hierarchy on Paurashava contour map. Drains are also classified based on demand and uses like; open drain, closed drain, katcha drain, box drain etc.

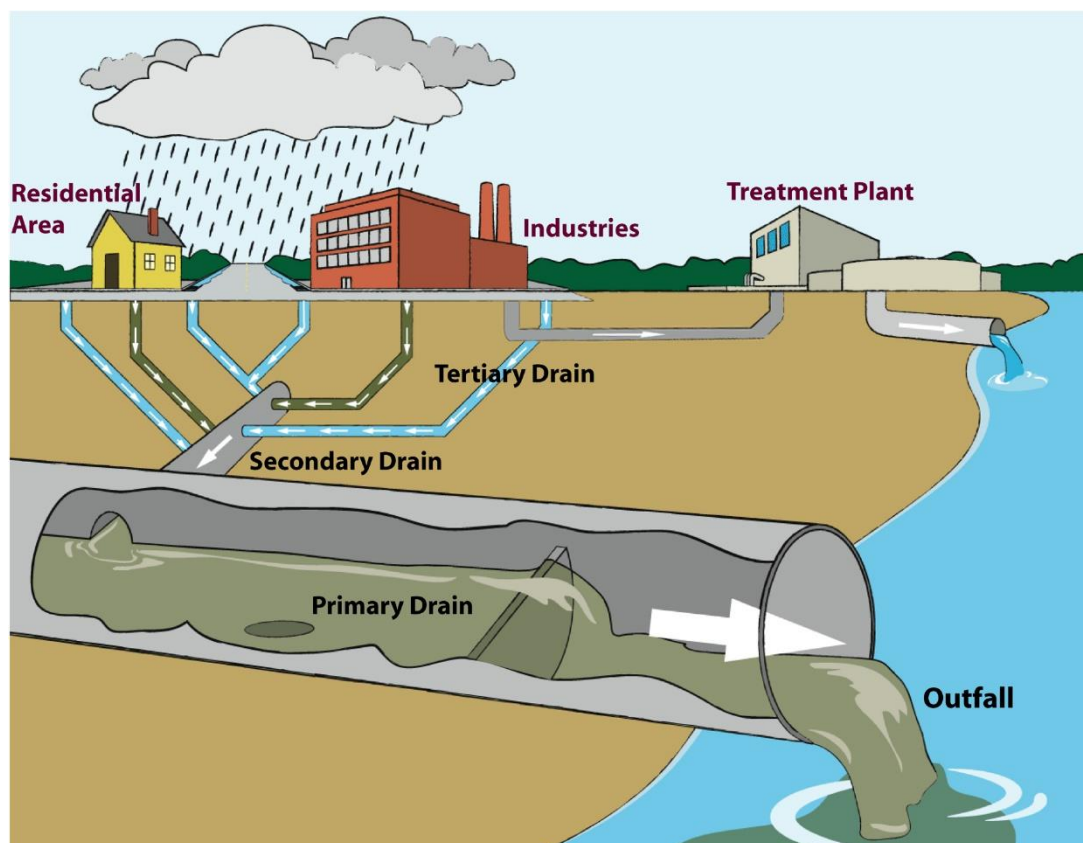


Figure 3-7: Drainage system comprise of tertiary, secondary and primary Drains

3.2.9 Essential Considerations for Construction and Re-construction of Lined Drains and Other Water Control Structure

Officials of the Engineering Department will need to conduct field visit to know the actual situation for the proposed site. Engineering survey would be conducted after conducting direct field visit to identify the main problematic areas. It is essential to involve and participation of local stakeholders during the survey period. Assessment of the extent and frequency of the problems and preparation of contour maps based on engineering survey are of paramount importance.

It essential to consider following aspects for construction and re-construction of lined drains and other water control structures-

- h. storm water/ wastewater characteristics and quantity
- i. subsoil characteristics linking drainage channel
- j. economic /environmental balance in relation to surface water size and transmission
- k. availability of local construction materials

1. effect the scheme on ponds, rivers and agricultural areas

3.2.10 Preparation of Drainage Design

Paurashava engineers design their drainage system based on existing demand or existing situation. As the rate of urbanization is going on in a progressive way. So, at first, forecasting the future demand or future situation and considering all other aspects, drainage would be designed keeping its sustainability in mind.

Design of drains can be set by considering the nature of the drainage system. If there is adequate space then 'V' type drain can be made, which ensures to carry of large water flows and the infrastructure remains long-lasting. On the other hand, if there is little space then 'U' type drain can be made of any depth besides of the road. To protect the road components especially the bituminous of the road 'L' type drain can be made for quick removals of water. This type of drainage are usually made on besides of the roads of hilly area.

3.3 Formulation of a Drainage Plan to Develop the Drainage System

Development of comprehensive drainage network to meet the present demand as well as future demand.

A general practice at Paurashava level is that to make a drain on ad hoc basis or drains proposal based on existing demand. Proposed drainage plan must be consistent with proposed land use plan. To estimate the future runoff of any area, proposed land use will be one of the major indicators.

Based on existing natural drainage system on a Paurashava base map, a comprehensive drainage network should be proposed. Without comprehensive drainage network, mere having a long route single drain and the system may not function at all and water logging may recur.

Development of various alternatives to solve the problems and to select the most appropriate ones.

To solve the drainage problem for a particular drainage catchment, there are so many alternatives. One option is to consume all storm water through rainwater harvesting. Another option is to make a drain and convey substantial storm water. But most plausible option could be the combination of these two option with preservation of water bodies, integration of unpaved area into the catchment, gardening which may reduce the drainage size and length and at the same time the drainage construction cost.

In most of the cases, Paurashavas are very much interested to construct a new drain and almost ignore the maintenance aspects. Compare with road network, they construct less drains and approve less budget for drainage maintenance. By initiating appropriate measures like plantation, preservation of water bodies, Paurashava can achieve a portion of its target for drainage development.

3.4 Close co-ordination with DPHE, LGED, BWDB, BIWTA and other organization

Each organization has specific area of activities in our country. As per mandate, Paurashava will develop their drainage system within its jurisdiction area. LGED as a technical department under the Ministry of LGRD&C, together with Paurashava, has been playing a vital role for preparation of Drainage Master Plan and drainage construction since 1991. In the recent time DPHE has prepared drainage planning and modeling for 148 Paurashavas. BWDB has already constructed a

lot of town protection embankment around the Paurashava. Some projects have already been implemented jointly by Paurashava, LGED and BWDB like STIFPP-1 and STIFPP-2 and drainage planning and construction components were in there. Paurashavas located on bank of the river should be collect approval from BIWTA for any construction works within BIWTA jurisdiction area.

Paurashavas also construct drains from their own fund. Therefore, it has been a crucial requirement to establish coordination mechanism among the Paurashava, LGED, DPHE, BWDB, BIWTA etc. for development of effective drainage network.

3.5 Implementation Supervision and the Ensuring Quality Control

All construction works are needed to be under quality control as far as possible for healthy existence by ensuring any construction work's utility as per its design life. It is now the bare truth that no construction work is scientific without the provisions of quality control. In civil engineering works, a laboratory with modern equipment is essential, and to run it well, skill engineers and technicians are needed. LGED has taken the lead to make an all-out effort regarding quality control for the construction works of Local Government Institutions (LGIs). Paurashava may follow LGED rate schedule, Govt. circular, PPR 2008 or latest documents for Quality control, Cost estimate, Tender document preparation, appointment of contractors and other tasks.

Any creation by mankind without quality control remains in the vortex of dubiety so far as its sustainability and acceptability are taken into consideration. In the art of engineering, no construction is acceptable without quality control. From the view point of this conception, a number of organizations like ISO, ASTM, AASHTO, BS, TRL, IRC, etc. have been evolved all over the world specially in the developing world. Paurashava may take assistance from LGED District Laboratory for ensuring quality control of its civil works.

3.6 Operation and Maintenance of Drainage System

The Executive Engineer (XEN)/Assistant Engineer (AE), as the head of Engineering Department of Paurashava, takes responsibility for Operation and Maintenance of all infrastructures in Paurashava. To establish proper drainage management system, regular inspection by routine visit to the site is must and it is mandatory to reporting the Parishad about the existing condition of drains. Decision that will be taken by the Parishad to develop the drainage management system based on the inspection report also needs to be followed strictly.

Maintenance involves a variety of operations from planning, programming, actual implementation and monitoring, whatever be the approach, the essential objective is to keep the infrastructure in good order and to extend its life. Maintenance is a continuous operation and it never stops.

Though the needs and methods must ultimately be identified by the person responsible for the maintenance, it is suggested that the following guidelines should be followed for initial development of the staffing and equipment for drain cleaning as a part of maintenance program:

- ↯Solid waste from the drain should be cleaned once per week; but not less frequently than once per month.
- ↯Cleaner/sweeper should be involved to clean primary/secondary/tertiary drains almost every day.

↓Supervisors need to be provided for should be provided for Cleaners/sweepers and one drainage inspector can be involved to supervise all works.

Adequate equipment should be provided for efficient operations of cleaning crews, including wheel barrows and miscellaneous hand tools for each drain cleaner, 3-ton dump truck for waste transport and disposal. In this case the cleaners need to be provided with the different tools that are supportive to protect health and support them about uses of those tools also to ensure the use of them.

Sufficient amount of financial investment is essential to provide drainage related service by proper drainage management. However, proper management and routine maintenance can ensure effective results of the investments. For this, it is considered as a major challenge for the Paurashava to ensure proper management and maintenance of drainage system by introducing effective and efficient management practices.

Routine Maintenance and Periodic Maintenance

The task routine maintenance and periodic maintenance would be implemented by adopting separate method. Routine maintenance task would be done by Paurashava's own cleaners (normally part time engaged labour/cleaner and it would be a better way to conduct periodic maintenance task through engagement of contractors. Responsibility of construction and periodic, emergency and corrective maintenance of khal/drains rests with Engineering Department. However, the responsibility of cleaning of drains lies with the conservancy section under health & family planning department. Moreover, for the proper functioning of the drainage system it is essential to have an appropriate maintenance program. The program must include inspection, enforcement, cleaning and repair. The frequency of inspection and cleaning will be dependent on the season of the year with more frequent inspection and cleaning at the start of the rainy season and on the importance of the drain.

Inspection

- Open metal drains-monthly in general; weekly in market areas.
- Covered metal drains-monthly.
- Earthen drains-monthly.
- All drains-following first heavy rainfall in year.

Cleaning

- Open lined drains on day to day basis.
- Covered lines drains, as and when required; but mandatory cleaning prior to rain in February.
- Earthen drains and culverts- mandatory cleaning during January to February prior to rains.
- All drains-as revealed by inspection.

The inspections will also show where repairs are required and where encroachment into the drain and deliberate blocking of the drain is taking place. Appropriate action to enforce the act, rules and regulations must be initiated immediately. The cleaning of permanently closed metal drains and small culverts is difficult and time consuming. New drains should have removable covers to facilitate cleaning.

Excavation and Re-excavation of Primary and Secondary Earthen Drains

Considering the Paurashava financial situation, the total drainage system of the Paurashava is not possible to build in a day. That's why; we should avail some earthen drainage even for secondary

drains. For newly created Paurashava, no drainage system was existed before 10 years and earthen like Khal or natural channels were performed quite well. Appropriate measures have been taken against the encroachment of the natural channel that would be a good way to solve the drainage problem with adequate and timely cleanliness. No drain would be constructed inside the natural canal because it will reduce flow capacity of drains and in the long run major portion of the natural canal land would be encroached.

Essential considerations:

- Earthen drains carry not only rain water and domestic waste water; but also sediment including solid waste.
- Preparation of inventory of earthen drain following LGED's computer program
- Taking decision on the frequency of re-excavation based on findings of the inventory.
- Conducting per-work survey and designing post-work section.
- Determination of technical specification.
- Preparation of cost estimate and tender document.
- Conducting frequent field visit by Paurashava officials of engineering department during implementation period.
- Taking post-work measurement and bill payment.
- Conducting regular field visit throughout the year by officials of engineering department to check encroachment of primary/earthen drain which is a regular occurrence.

Making a budgetary provision for re-excavation of earthen (primary/secondary) drain. Otherwise this task cannot be implemented.

Budget Allocation for Operation and Maintenance of Public Drainage

Maintenance of infrastructure includes drains also, Paurashava shall earmark some specified amount for O&M of infrastructure from their revenue income. Paurashava collects 7% as conservancy rate on the annual valuation of property. Routine maintenance (cleaning) of drain and solid waste management is supposed to be done from this revenue. Paurashava should declare the amount of money for Drainage Operation and Maintenance during the preparation of budget for each year.

Cleaning of Private Drainage According to the Paurashava Guidelines

According to the Second Schedule of Local Government (Paurashava) Act 2009 in Para 12, "All private drains shall be subject to control, regulation and inspection by the Paurashava and the Paurashava may, in such manner as the by-laws may provide, require the provision, alteration, covering, clearing and closing of private drains". Private drainage would be cleaned by its owner. Paurashava Sanitary Inspector and Conservancy Inspector visit its jurisdiction area in interval basis. Private drainage or Paurashava drainage has been used in mainly two purposes. One for used domestic waste water and another is runoff water from the rainfall. So, special measures may be taken before rainy season for both private drainage and Paurashava drainage.

Paurashava Solid Waste Management System

People usually carelessly throw their solid wastes, including kitchen wastes, around the dustbins creating an unhygienic situation and untidy environment conditions. Launching of community participation program by motivating the community through campaigns for keeping the Paurashava

town neat and clean, disposal system of wastes and knowledge on health and hygiene, informing the community about health, hygiene, diseases and impacts on environments can be considered as part of solid waste management system. There is a conventional way for primary collection of waste from door to door and transferring the wastes to the community bins/vans and then transferring the wastes to the final disposal sites. At least two solid waste disposal sites should be selected and reserved so that when the first site is filled up, the second site will be used.

3.7 Development Control and Authorization Aspects for Drainage Development

The following restrictions and controlling issues would be considered for preparation of effective & efficient Paurashava drainage development:

- a) No drain should be constructed inside a natural channel. Because it will reduce its flow capacity and encroachment in future.
- b) Land use should be properly maintained to construct the planned drainage system.
- c) Strictly prohibit the dumping of solid waste into the drains
- d) Strictly prohibiting direct septic tank connections to the drainage system by enforcing By-Laws or similar other regulation.
- e) Remove all un-authorized structures constructed on the existing drainage system;
- f) Protect natural canals, big ponds, flood retention pond.
- g) Provide adequate land for right of way for storm water drainage.
- h) Create buffer zones along canal and river banks
- i) Ensure enforcement of existing laws and regulations

3.7.1 Construction of Private Drainage according to the Paurashava Guidelines

Prior approval is required from Paurashava Authority for construction of private drainage in Paurashava area. Usually plot drains are tertiary drains. In that case, private drains may be constructed in such a way that the water level of private/tertiary drains must be higher than Paurashava constructed secondary or primary drains. Experience from the field visit reveals that by showing private drainage, Paurashava residents connect their latrine's sludge into Paurashava constructed drains Paurashava authority should strictly enforce its rules regarding this issue.

Set Action Based Activities to Control and Monitor Private Drainage

- └Design would be approved from Paurashava authority prior to private drainage construction;
- └Oath letter would be received from Paurashava residents not to connect latrine's waste and into any drain (Private/Paurashava).
- └Cleaning of private drainage is solely the responsibility of its owner. Paurashava Sanitary/Conservancy Inspector will visit at regular interval to control and monitor private drainage.
- └Private residential area would be approved and developed in such a planned way that set back rules ought to be followed to set up drainage and other municipal utilities and facilities.

Notice Issued for Private Drainage Construction, Removal, Alter or Improvement

As per Local Government (Paurashava) Act 2009, Paurashava has the right to issue notice regarding private drainage construction, removal, alter or improvement. Paura Parishad with the officials of engineering department may play a vital role for approval, construction and maintenance of private drainage.

3.8 Region based Drainage System

Paurashavas of our country can be divided into three broad groups based on topography and hydrology. Based on the intensity of rainfalls our country can be divided into three distinctive regions. They are:

Low rainfall regions: Rangpur and Rajshahi region,

Heavy rainfall regions: Sylhet and Chittagong region, and

Coastal and climate change affected regions: Barisal and Khulna region.

On the other hand, based on topography, total country can be divided into three parts. These are- Plain land, coastal land and hilly land. Paurashava drains usually carry storm water and domestic water. The rate of discharge of domestic water is not same all over the country. In general, it depends on economic condition of the town dwellers and varies from town to town.

Considering the all above conditions, for decision making in storm drainage purpose, total Paurashavas in our country have been divided into three groups as:

1. Paurashavas situated nearby the river as outfall,
2. Paurashavas situated far distance from the outfall, and
3. Hill areas Paurashavas.

Considering the above issues three Paurashavas were taken as case study purposes and those three Paurashavas are:

1. Nowapara Paurashava under Jessore district (situated nearby the river),
2. Lalmonirhat Paurashava under Lalmonirhat district (situated far distance from the outfall), and
3. Matiranga Paurashava under Khagrachari district (situated in the hilly area)

Case study-01

A Case Study of Nowapara Paurashava under Jessore District [Paurashava Located Just Beside the River]

Nowapara Paurashava was established in 1996 has an area of 25.11 sq.km divided into 9 wards with a population of 85,856 (BBS, 2011). Now it is an “A” category Paurashava. Bhairab river is flowing from north-west to south-east of the Paurashava. Nowapara Paurashava have a Drainage Master Plan prepared in 2007 showing the detail network and length, depth and width of each proposed drain. Paurashava current officials have no idea about Drainage Master Plan (DMP). After the establishment of Paurashava, it received MSP, UGIIP, CRDP and IUIDP projects. Paurashava have constructed drains with project fund and also ADP & own revenue fund. Total length of the Paurashava is 14.00 km. Main outfall Bhairab River passes eastern side of the Paurashava. It may be mention here that the 60% discharge from Paurashava is directed to outfall into Bhairab river and 30% discharge is directed to outfall into Railway borrow pit and 10% discharge is directed into Vaboda and Amdanga khal.

Paurashava have a regular program for operation and maintenance of lined drains. They clean a particular drain one month interval basis. Before the rainy season, they clean all drain at a time. They have some earthen drain and they perform no activities for Operation and Maintenance of earthen drain. At present Paurashava have no standing committee responsible for the drainage program. Routine maintenance (drain cleaning) works is supervised by the Secretary under Administrative Section.

Paurashava have some private drains mostly owned by private industries and those are used for discharging outfall including industrial waste. Paurashava have no idea and practice about authorization, approval process and charges about private drains. Operation and Maintenance activities of drainage system is not quite enough at this Paurashava and they have no guideline for Operation and Maintenance of Drainage System.



Case study-02

A Case Study of Lalmonirhat Paurashava under Lalmonirhat District [Paurashava Located far away from the Outfall]

Lalmonirhat is located in the Rangpur Division, close to Bangladesh border with Assam in India. Lalmonirhat Paurashava was established in 1972 has an area of 17.40 sq.km divided into 9 wards with a population of 60,322 (BBS, 2011). Now it is an “A” category Paurashava. Lalmonirhat Paurashava have a Drainage Master Plan prepared in 2007 showing the detail network and length, depth and width of each proposed drain and Paurashava current officials have no idea about that Drainage Master Plan (DMP). Paurashava have no master plan and they have no control over the land use planning.

Within the Paurashava, there is no river. The minimum distance of outfall from the Paurashava boundary is 11km. After the establishment of Paurashava, it received some large projects like UGIIP. Paurashava have constructed drains with project fund and also ADP & own revenue fund. Total length of the Paurashava is 33 km.

They have some earthen drain and they perform no activities for excavation and re-excavation of earthen drains. As per our discussion with Paurashava officials, they have not intensive program on Operation and Maintenance. With the direct supervision of Conservancy Inspector, Paurashava cleaner conduct routine maintenance work within the Market area. Paurashava have some private drains but they have no idea and practice about authorization, approval process and charges about private drains.

At present Paurashava have no standing committee is responsible to take over the drainage program. Routine maintenance (drain cleaning) works is supervised by Secretary under Administrative Section. As no outfall is existed within Paurashava boundary, water logging problem at some locations create quite sufferings in terms of communication, goods lost and environmental degradation. They have a future plan to solve the problem. They will construct a long drains starting from Paurashava CBD to 11km away outfall. Operation and Maintenance activities of drainage system is not quite enough. Paurashava have no guideline for Operation and Maintenance of Drainage System.



Case study-03

A Case Study of Matiranga Paurashava under Khagrachari District [Paurashava Located on the Hilly Area]

Matiranga Paurashava represents hill area drainage characteristics. It is located in Khargachari District under Chittagong Division. Paurashava was established in 2002 has an area of 25.50 sq.km divided into 9 wards with a population of 23,846 (BBS, 2011). Now it is an “B” category Paurashava. As a hilly region, this Paurashava is not affected by flood but due inadequate drainage system, water logging problem in the Paurashava area is prevailed

Ethnically citizens are different from the plain land and land related problem is a major issue in there. To set up a drain, land related issues like resettlement problem may be solved with potential involvement of elected representatives. After the establishment of Paurashava, it received no project fund except ADP for drainage purpose. Only 3.47 km drain existed in this Paurashava. Outfall related problem is not existed in this Paurashava.

Usually administrative type works like meeting with elected representative, contractors and others, conducted by Assistant Engineer. He invites the Tender through publication into the National Newspaper. He instructed to his subordinate about the construction management. No survey equipment is existed in this Paurashava and no surveyor is employed now. Design of the drain is prepared by AE. He also prepares estimates and Bill of Quantities (BOQ). Full time supervision works are conducted by Work Assistants.

Paurashava have some private drains mainly operated by Government offices but they have no idea and practice about authorization, approval process and charges about private drains. Matiranga Paurashava have a Master Plan prepared by LGED. They do not follow the Master Plan. Stair Type and L Type drain used in hill area Paurashava. Stair type drains are used to reduce drain water velocity. L type drains are used as road side drains main to rescue to road from water logging. As storm water flowing over the land, a huge sediment come into drains and especially at outfall site. In such case maintenance program is adequately needed.



Chapter Four: Steps for Paurashava Drainage Construction, Operation and Maintenance

Drainage are part of essential infrastructures of the Paurashava which will need proper planning and development to achieve the integration with other infrastructural development by forecasting future physical developments. Mayor (including all the members of the Paura Parishad) must be informed about the existing situation of drainage such as whether any Drainage Master Plan exists or not, required detail improvements, total length of existing drains, major problems related to water loggings, required maintenance to be done, detailed development activities to be completed within the tenure of the existing Parishad.

For better understanding, the entire process of drainage development has been set into following steps by Figure 4-1.

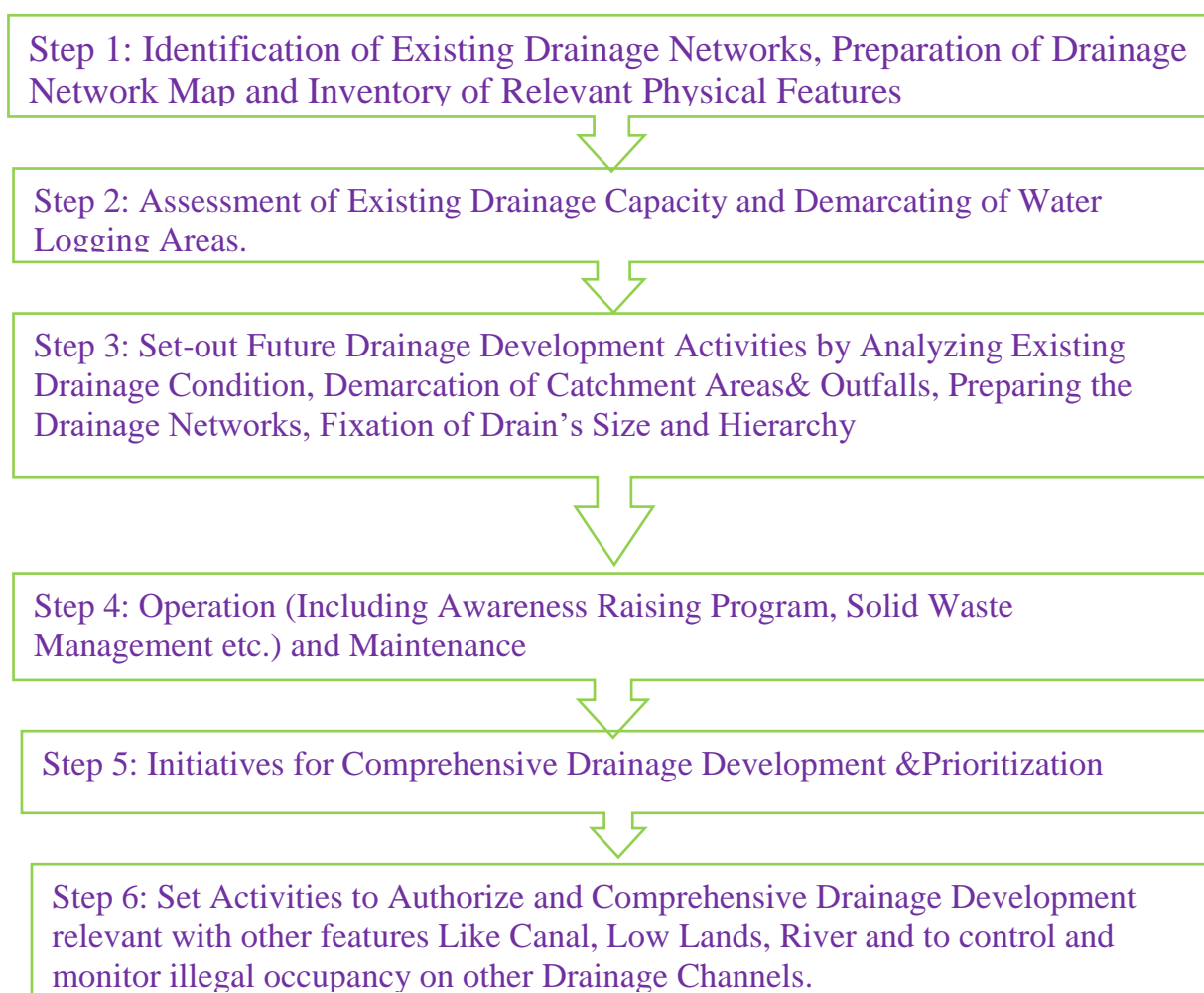


Figure 4-1: Flow Diagram of Drainage Development Process

4.1 (Step-1): Identification of Existing Drainage Networks, Preparation of Drainage Network Map and Inventory of Relevant Physical Features

Reconnaissance and Physical Feature Survey also need to be done for preparing the inventory of existing drainage system. At this stage, the Mayor needs to make an announcement with respect to any of the following two possible circumstances.

- A. Paurashavas Having Master Plan/Drainage Development Plan

If the Paurashava already has a Master Plan or any Drainage Development Plan, it should follow Drainage Development Plan. to prepare the inventory of the drainage following the existing drainage network shown in the existing physical feature map of the Plan. The Paurashavamay need additional field survey to check the exact drainage situation of the Paurashava.

B. Paurashava Does not have any Master plan/Drainage Development plan

The steps for Paurashavas having no master plan to prepare the map and inventory are as follows:

The process of preparing the map and inventory of physical features are detailed out below:

a.Preparing a Base (Mauza) Map

Concern officials of Paurashava Engineering Department needs to prepare a blank base map by joining Mauza Maps together.

b. Drawing Physical Features on the Map

If the Paurashava doesn't have the map, they conduct a survey to put the physical features on the blank base map that they prepared earlier. The survey would be carried out by the officials of ED under the guidance and supervision of XEN/Town Planner/AE (for A category Paurashava) or AE/SAE (for B&C category Paurashava).

c.Preparing Inventory of Drainage through Physical Feature Survey

During this assignment, concerned officials of ED prepares the inventory of physical features of the drainage. For this purpose, the ED will need to conduct a survey and inventory work. The survey work may also be done by outsourcing.

However, ED may use the sample standard format to record the details of physical features of the Drainage System as shown in sample Table 4-1 (Sample Standard Table to Prepare Inventory of Drains) and Table 4-2 (Inventory of Existing Bridge & Culvert of the Paurashava).

Table 4-1: A Sample Table to Prepare Inventory of Drains

Serial No.	Drain ID	Natural/Manmade	Name of the Drains		Length		Avg. Width (m)	Avg. Depth (m)	Type (Earthen/ Pucca)	Materials	Outfall Point		Location Feature		Remarks
					Total Length (m)	Paura Part (m)					Type	Highest Flood Level (HFL m)	ID/Name of the Streets attached with Drain	Attached Land Uses	
			From (Up Strem)	To (Down Stream)											
1	Primary-1 (Ward No 1,2, 9)	Natural	Uttar para khal		1200	500	4	1.5	Earthen	Mud	River	5.20m	Secondary street no-2	Residential, Commercial, Agricultural Lands	
			Hatkhola	Fulkumar River											
2	Secondary-2 (Ward No 1,6, 9)	Man made	Kaliganj Khal		750	750	2	1.25	Pucca	Block lining	River	5.34	Secondary street no-2	Residential,Commercial	
			Rajganj Moor	Harihar River											
3	Tertiary-3 (Ward No 1,6)	Man Made	Hazipara Drain		320	320	1	1	Pucca	Brick wall	Low land	5.5	Tertiary street no-1	Residential	
			South side of Hazipara	Srimonto river											
4	Tertiary-4 (Ward No 3,9)	Man Made	Paurashava Bazar Drain		500	500	1	1	Pucca	Pipe Drain	Secondary-02	5.34	Tertiary street no-5	Residentia	
			PAurashava Bazar	Kaliganj Khal											
	---	---	---										---	---	

³Others related information, such as whether the drain below footpath , whether covered/ openetc.

Table 4-2: Inventory of Existing Bridge & Culvert of the Paurashava

Serial no	Identification No (ID)	Adjacent street (ID)	Location/ Chainage ⁴	Structure Type	Structure construction Material	Span (m)	Lane no	Condition/ Remark
1	B-1 (Ward no-7)	Primary-1	Besides of Hazipara secondary Street/ 250 m	Bridge	R.C.C Brick	25	2	-
2	B-2 (Ward no-7)	Secondary-2	Besides of Upazila to Bazaar Street/123 m	Culvert	R.C.C Brick	5	1	Reconstructi on is needed
3	C-1 (Ward no-7)	Tertiary-5	Infront of Kali Bari/320 m	Culvert	Pipe	0.9	1	
	--	--			--	--		--

4.2 (Step-2): Identification of Existing Drainage Capacity and Demarcating of Water Logging Areas

To identify the existing condition of drainage system, ED of the Paurashava needs to prepare a list of development activities for each of the drain understanding the existing problems and future forecasting. For this purpose, following condition survey need to be done to understand existing situation and needs based demands.

The condition survey includes:

- ↵ Demarcating the water logged (seasonal and regular) area and identification of nearby drains, low lands, outfalls etc.
- ↵ Determine the causes of water logs for both case (seasonal and regular)
- ↵ Identification of the causes of decreasing the discharge capacity of existing drainage (both natural man-made drains)
- ↵ Identification of existing water reservoirs (ponds, ditch, borrow pit, etc.).
- ↵ Extent of damaged of manmade and earthen drains.
- ↵ Identification of existing outfalls.

(To analyze and understand about all of the existing situation (damaged, etc.) photographs may be taken.)

Findings of the condition survey of the drainage can be tabulated by following the sample Table 4-3 (Problem Identification of Existing Drainage System and Required Maintenance Works) and Table 4-4 (Sample Table to identify the Water-logged Areas).

Paura Parishad should update these table (Table 4-1 to 4-4) in regular interval (within One year).

⁴ Chainage should consist with road

Table 4-3: Problem Identification of Existing Drainage System and Required Maintenance Works

Serial No.	Drain ID	Type	Materials	Description of Problems	Required Development Works to do	Projected Expenditure (Lakh tk)
1	Primary-1 (Ward No 1,2, 9)	Earthen	Mud	➤ Local floods occur in the rainy season, due to some parts of the canals being illegally occupied and some parts are filled up	➤ Rehabilitation of 50-meter portion and illegal occupied of 10 meter portion should be free. ➤ Re-excavate of Canals with the coordination of Water Development Board	17.00/=
2	Secondary-2 (Ward No 1,6, 9)	Earthen	Mud	➤ Local flood occurred due to filled up some parts during rainy season ➤ Lining of some portion has been damaged ➤ Drain has partially blocked due to damage of Bridge-2	➤ Re-excavate 350 m is needed ➤ Reconstruction of 50 m is needed ➤ Reconstruction of Bridge -2 by removal	15.00/=
3	Secondary-2 (Ward No 1,6, 9)	Brick drain	Brick	➤ Some parts of the drain have been blocked due to collapse of brick works ➤ Fraction has been found in some parts ➤ The drain has been fully filled up by brick coarse, sediment and solid waste management	➤ Reconstruction of Brick work up to 20 m part ➤ Repair the crack with plaster up to 50 m part ➤ Cleaning the whole drain ➤ Increase public awareness not to throw waste into drain	1.50/=

Table 4-4: Sample Table to identify the Water logged Areas

SI No	Name of the Area	Cause of Stagnant/Water logging (Drainage over flow/storm water,etc.)	Area of water logged (acre)	Affected Population	Duration of Water stagnant	Highest flood level of the area (RL, mPWD)	Depth of the Water logged area (m)	Height of nearby Streets (RL, mPWD)	Distance from nearby Outfalls (m)	Highest flood level of Nearby outfalls (m)	Type of Nearby Outfalls ⁵	Actions to remove waterlog	Projected Expenditure (Lakh tk)
1	Rupatoli (ward-7)	Non availability of drain	20	500	3 Months	5.50 m	1.5 m	5.30 m	500	5.2	Primary Drain-1	Construction of a new drain	25.00/=
2	Amtoli	Blockage of existing drain	25	650	5-6 hours	5.50 m	1.4 m	6.00 m	600	5.2	Canal	Rehabilitation of existing drain	75.25/=

⁵Primary drain, river, waterbodies etc

4.3 (Step 3): Set-out Future Drainage Development Activities by Analysing Existing Drainage Condition & Demarcation of Catchment Areas and Outfalls, Preparing the Drainage Networks, Fixation of Drain's Size and Hierarchy.

Existing drainage condition is the first considerable issues for future drainage development plan. Detail information about the existing drainage system is the requirement to merge the existing condition into the future condition. Bottom RL (invert level) of existing drain must be coincided with the bottom RL (invert level) of future drain. Decision maker of a Paurashava can make any decision like drainage density, deficiency, priority ranking with the availability of drainage information. Sufficient information would be accumulated for both earthen drain and manmade drain.

Engineering Department should take the following activities to develop the comprehensive drainage development

- Identification of catchment area and outfalls;
- Identification of flow direction of rain water;
- Considering the existing and future land use to set up drainage size and hierarchy of drains; and
- Formulation of ultimate drainage network.

4.3.1 Demarcation of Catchment Area & and It's Outfall

ED needs a contour map to identify the catchment area and the outfall. If it is not possible to get the contour map, then Key Informant Interview (KII) can be very useful tool to identify the Catchment area.

In this case ED needs to visit the area with the base map and will consider following issues to demarcate the catchment area for Outfall.

1. ED needs to identify all outfalls of the Paurashava demarcate as Outfall number and need to be marked in the Map with outfall number (for example- OF1, OF2....)
2. ED needs to identify the overland water flow network and demarcate its influenced area in the Map. If any other drainage network is connected with that drain ED also needs to identify that influence area and demarcate the boundary in the Map as sub-catchment area.
3. ED needs to denoted catchment number as C1, C2, C3 and for the sub catchment area need to be denoted as C1.1, C1.2, C2.1 etc.
4. Ed also needs to verify the land uses of each catchment and sub-catchment area.
5. After identification of the catchment area ED needs to calculate the area of each catchment and also sub catchment area. ED needs to calculate the area identifying its geometric shape. The geometric shape may be irregular pattern which need to be arranged by comparing with the rectangular shape by identifying the maximum width and length of the area.

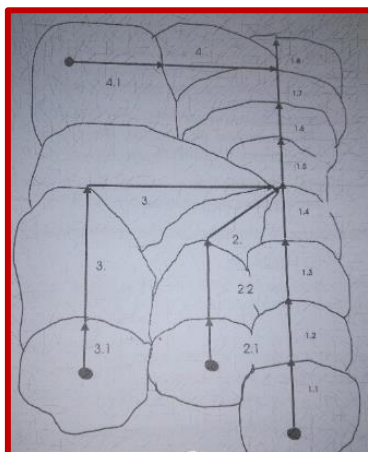


Figure 4-2: Selection of Drainage Hierarchy considering field condition

ED may need the following sample Table 4-5 for this purpose.

Table 4-5: Sample Table for Identification of Catchment

Outfall ID	Connected Drain/s				Details of Attached/nearby street				Demarcation of Catchment Area ⁶	Area of Catchment (Acre)	Land Use categories
	Drain ID	Length (m)	Type ⁷	Avg Width/Dia (m)	Road ID	Road W (m)	Road type ⁸	R/L			
Outfall (OF) -1	Tertiary-3 (Ward no-1,6)	300	Brick built, open	1.5	Secondary-3 (Ward-1,3)	7	BC	5.4	C1	5.5	Mixed
Outfall (OF) -2	Tertiary-4 (Ward no-3,8)	420	Brick built, open	1.25	-	-	-		C2.2	7.7	Mixed
-	-	-	-	-	-	-	-		-	-	-

4.3.2 Identification of flow direction of rain water

Naturally rain water flows towards gravity direction. In this situation to find out small scale catchment area follow this procedure.

However, if there is no drainage for catchment, considering the flow direction of water in the rainy season, the current road direction, the type of settlement, the use of future land use and the direction of future road direction, will be identified with the discussion with the local people to identify the drainage direction. Rain water of the built area flows through the drain of the tertiary level, following the direction of the adjacent road.

⁶C1 = Sadar Ward no 2 & Part of Ward no 3 etc.

⁷Earth, Brick work, RCC etc.

⁸RCC, HBB, BC, Macadam etc.

4.3.3 Ultimate Drainage Network Analysis

One of the key responsibilities for the Engineering Department of the Paurashava is to identify future drainage networks. As a complete system, the tertiary drain will flow into the secondary drain, then primary drain outflow towards river. According to the drainage outflow the water level of the river water should be below the invert level of the primary drain. Sequentially secondary drainage invert level should be above the primary drain and the invert level of the tertiary drain will be higher than the secondary drain.

ED needs following consideration to start preparing the Drainage Network:

- ↳ To identify the drain networks ED needs catchment and its outfall, existing alignment & RoW of natural canals & manmade drains, alignment of existing and proposed streets, future land use, exiting water reservoirs (pond, ditch, borrow pit, etc.) and undulation (ground slope), etc.
- ↳ Total catchment area should be considered though the catchment area is outside of the Paurashava jurisdiction.
- ↳ According to the Expert Opinions, cover drains are appropriate for Paurashava level in terms of accident, clean, opportunity for walking, good environment and aesthetic efficiency. Again, it is easy to set the alignment of line drains parallel to the Road alignments following the outfall of the catchments.
- ↳ The existing drainage systems should be inter-connected with the proposed new drains on the priority measures of the Drainage Master Plan.
- ↳ The canal network, pucca/kutchra drains and borrow-pits need to be up-graded to act as the main framework for improved and integrated as well as viable drainage system of the Paurashava which will serve the drainage need during the peak monsoon period when the drainage stands critical.
- ↳ Primary water channels also need to be considered for multiple purposes like recreation, aquaculture, irrigation, other domestic uses etc.
- ↳ Need to be considered necessary water opening like culvert, bridge, etc. whenever it across any streets.
- ↳ Need to be considered the average height considering the Normal Flood Level (NFL) of that area for construction or reconstruction of streets and other infrastructure to avoid the flooding.
- ↳ Need to be identified present and future volume of domestic used waste water from the households to proper drain out to nearest outfalls.
- ↳ Need to consider construction work starting first from the outfall to the Catchments.

ED will follow consequent steps to prepare a complete drainage network for the Paurashava.

- **Step 1:** Ed will need to identify the distance between the outfall and farthest point of its catchment and sub catchments.
- **Step 2:** Furthest distance should be considered for first network identification as it will act as the input for other catchment/sub-catchments discharge calculation. Then the convenience capacity of existing drainage (if existed) channels (both natural and manmade) for that catchment should be assessed and development measures should be taken to remedy of blockage, siltation, encroachment, decreasing the width, collapsed of side walls and other barricades.

- **Step 3:** If there is no drainage for that catchment, then drainage alignment needs to be identified analyzing the storm water passing path during the monsoon and also by discussing with local citizen considering the alignment of existing streets, settlement pattern, future land use & proposals of future street alignment. To identify the size of the drain ID will need to calculate discharge amount following section 4.3.2. and situation.
- **Step 4:** If any waterlog existed in the catchment/sub catchment area then ED needs to identify the possible alternative options (Option 1, Option 2.....) considering water log area demarcation, duration of stagnation, measuring property and environmental losses. Those alternative options may be measured as filled up the low lands, connecting with the nearby drain/ water reservoirs etc.
- **Step 5:** Other drainage networks and further development works need to be identified for the catchment of second highest distance between the catchment and the outfall by following steps 1 to 4.
- **Step 6:** New drainage alignment need to be drawn on the existing map. Now total networks of drainage system need to be rearranged by considering shortening the length, water harvesting, avoiding jig jag, etc.
- **Step 7:** After re arranging drainage network ED needs to consider connecting tertiary (plot drains) for the built-up area. In this stage development measures need to be considered for the existing tertiary drains. To construct new tertiary drains ED needs to identify existing alignment of streets to connect those drains with nearby secondary drain.

ED also needs to consider drop drain⁹ according to the requirement considering huge slope. Water pump may need to be considered to install for the area where existing slope is not enough at all to drain out the runoff. Sometimes water gate may require to install in the outfall point joined with the drain to protect from the back flow of water from outfall.

Considering the above general guidelines and following the specific steps mentioned above, ED prepares the following sample table of the Drainage Network.

Table 4-6: Proposed Drainage Networks of the Paurashava

Catchment (Code)	Existing Drain		Drain ID for new Proposed	Proposed Drain				
	ID	Natural/ Manmade		Length (m)	Starting and Ending	Outfall	Required Length for Development Measures (m)	Required Development Measures
C1	Tertiary (ward no- 1,6)	Manmade	Secondary-1	500	Central Mosque to Shaheed Minar	Kaliganj Khal	200	Reconstruction of 200 m drain
C3	-	-	Tertiary-3 (ward no- 8,9)	350	Sribordi Abashan to Maddhapara khal	Modhapara Khal	350	Drain Construction

⁹The drop-down is to create a drain in vertical form adjacent to the wall at a very low point from the high point.

Catchment (Code)	Existing Drain		Drain ID for new Proposed	Proposed Drain				
	ID	Natural/ Manmade		Length (m)	Starting and Ending	Outfall	Required Length for Development Measures (m)	Required Development Measures
-	-	-	-	-	-	-	-	-

4.3.4 Calculation of Drainage Size

ED should calculate in details considering overall matters related to identify the drainage size. Size of Catchment area, volume of water and Land use is required to calculate the drainage size. To calculate drainage size, following process need to be done by ED:

- Identification and analysis of catchment area is the first tasks. Catchment area have a single outlet for storm water discharge. The longitudinal distance (From the dropping place to outfall) of a catchment need to be divided by a proposed velocity (Table 4.7) to get the value of time of concentration. The amount of storm rainfall can be get against a specific time of concentration values from an established Table 4.10 for drainage purpose.
- Total discharge amount of water can be measured through Rational Formula in which parameters of runoff coefficient (C), rainfall (I) and area (A) are involved. Values of Runoff coefficient varies with different land use. The amount of discharge should be passed through proposed drainage.
- Drainage size should be calculated through Manning's formula in which parameter of Manning coefficient (n), Hydraulic Radius (R) and bed slope (S) are involved. Drainage volume must be greater than discharge volume. For safety purpose, freeboard should be calculated.

In point of management option, if citizens would follow rain water harvesting technology then discharge amount would be reduced. Also, there are other option to reduce amount of storm discharge.

Calculation of drainage size has shown by following process:

(1) Estimation of Time of Concentration (Tc)

Time of concentration represents the travel time of water dropped in the farthest point of any catchment to come to the outfall of that catchment. Time of concentration divided into two parts-

- Entry time (Te), means travel time to pass the over land to meet with nearby drain;
- Travel Time (Tt),means the travel time to travel through the drain to reach the outfall. Therefore, Entry time (Te) and Travel Time (Tt) together represents the time of concentration (Tc).

To calculate the Time of concentration, ED will follow the following formulae for both Entry Time and Travel time separately.

For calculating the Entry Time (Te), ED may follow:

Kirpich Equation.

$$T_e = 0.019621 L^{0.77} / S^{0.385}$$

Where, L = Maximum Length of overland flow (Maximum distance from the drain of the catchment border)

S = Average ground slope (average difference between RL Value)

Besides this if ED may consider entry time as 10 minute for all Paurashava of Bangladesh which has been considered as thumb rules for preparing Drainage Master plan for Paurashava. For preparing Drainage Master plan for bigger city like Dhaka, it can be considered as 20 minutes.

It is the time taken for runoff from the farthest point in the contributing area to flow over the ground and into the drain. Entry time has been calculated by the following

For calculating the TravelTime (Tt), ED may follow newton's law of motion [distance (L)= velocity (v) * time (t)]

$$T_t = L/V$$

Where, L = Length of Drain (m)

V = Proposed Design Velocity (m/s)

According to the design hand book of Drainage Master Plan prepared by LGED, minimum velocity and minimum gradient/slope for different type of Drains of Paurashava have been considered as follows:

Table 4-7: Velocity and slope of Drains

Drain Type	Minimum Velocity	Minimum Gradient/ Slope
Tertiary	0.7 m/sec	1:500
Secondary	1.0 m/sec	1:1000
Primary	1.0 m/sec	1:2000

The figure of the above indicator is shown in the picture below. Specifically, it is important that the maximum speed in the case of tertiary, secondary and primary drain is 3 meter / second, but for the municipality should be limited within 1.9 meter / second.

Above parameters are shown in the following Figure.

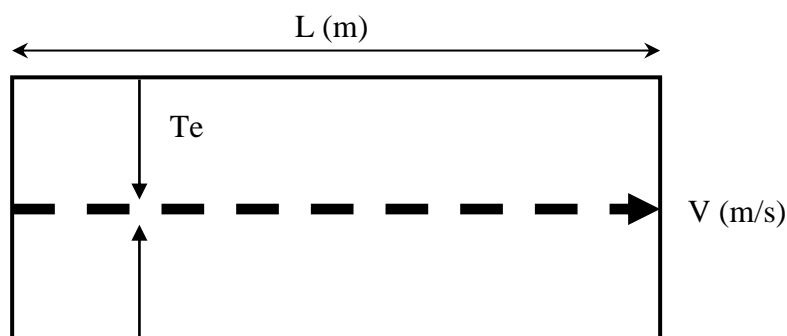


Figure 4-3: Illustration of Parameters of Time of Concentration

Time of Concentration is the sum of entry time and travel time. Time of Concentration is the maximum time taken by water to travel from the extreme catchment boundary to the catchment outlet.

$$\text{So, Time of concentration } T_c = T_e + T_t$$

$$= T_e + L/V$$

Where, T_c = Time of Concentration (minutes)

T_t = Time of Travel

T_e = Time of Entry (min)

L = Length of Drain (m)

V = Design Velocity (m/s)

Examples to calculate Time of concentration a sample table has been provided below:

Example: Determine the Time of Concentration for a 100 m long Tertiary drain.

$$T_c = T_e + L/V = 600 + 100/0.7 = 743 \text{ seconds or } 12.38 \text{ minutes or } 0.21 \text{ hr.}$$

Table 4-8: Calculation of Time of Concentration (T_c)

Catchment No #	Type of drain	Entry Time (T_e) [minute]	Length of the catchment (L) [m]	Velocity of Drain (V) [m/s]	Travel Time (T_t) [minute]	Time of Concentration (T_c) [minute]
1	2	2	3	4	$5 = 3/4$	$6 = 2 + 5$
C1	Tertiary	10	100	0.7	2.38	12.38
C2	Secondary	10	200	1.0	3.33	13.33
C3	Primary	10	500	1.0	8.33	18.33
-	-	-	-	-	-	-
-	-	-	-	-	-	-

$$I = \frac{a}{T^b + c}$$

Where, I = Rainfall Intensity (mm/hour)

T = Time of Concentration (in hour)

a , b and c are constant and the values are pre-defined as mentioned the following Table

Table 4-9: Parameters to calculate Rainfall Intensity at Paurashava level

Drain Hierarchy (Considered Return Period)	a	b	c
Tertiary (consider 1.1 year)	72.0	1.29	0.81
Secondary (consider for 2 years)	110.6	1.02	0.95
Primary (consider for 5 years)	153.8	0.95	1.12

Reference: Drainage Master Plan Handbook prepared by LGED, 1998

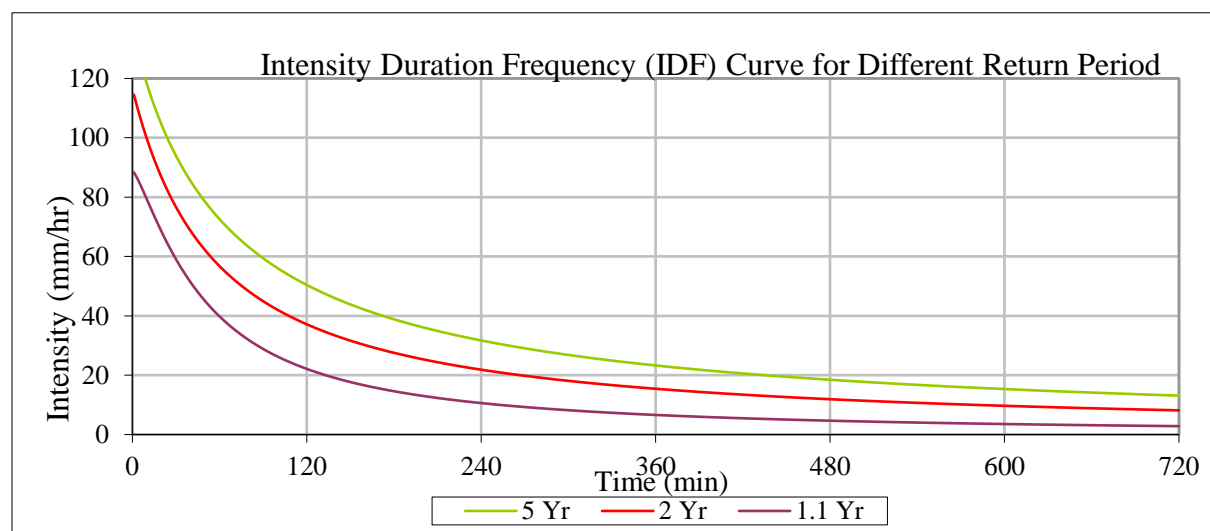


Figure 4-4: Intensity Duration Frequency Curve for Different Return Period

With the help of above formula [I], ED calculates Rainfall Intensity value for primary, secondary and tertiary drain corresponding different time of concentration values. A sample table presented below:

Table 4-10 : Predicted Rainfall Intensities

Duration / Time of Concentration [minute]	Rainfall Intensity (mm/hr) in given duration		
	Tertiary Drain	Secondary Drain	Primary Drain
1	88.33	114.57	134.86
2	87.55	112.73	132.64
3	86.65	110.92	130.55
4	85.67	109.16	128.56
5	84.65	107.45	126.65
6	83.60	105.79	124.82
7	82.51	104.17	123.05
8	81.42	102.59	121.34
9	80.31	101.06	119.70
10	79.20	99.57	118.10
11	78.08	98.12	116.55
12	76.97	96.71	115.05
13	75.87	95.33	113.60
14	74.77	94.00	112.19
15	73.68	92.69	110.81
16	72.60	91.43	109.48
17	71.53	90.19	108.17
18	70.48	88.99	106.91
19	69.44	87.81	105.67
20	68.42	86.67	104.47
21	67.41	85.56	103.30
22	66.41	84.47	102.16
23	65.44	83.41	101.04
24	64.48	82.37	99.95
25	63.53	81.36	98.89
26	62.61	80.37	97.85
27	61.70	79.40	96.83
28	60.80	78.46	95.84
29	59.93	77.54	94.87
30	59.07	76.64	93.92

(2) Estimation of Peak Runoff

To analyze the volume of water to be discharged by drain, ED needs to estimate the run off volume. This discharge amount will be equal to total storm rainfall minus the volume of infiltration and volume of water shocked/attached with various features on earth, like trees, buildings, grasses etc.

To calculate the runoff water from a particular catchments Rational Method can be used which is internationally recognized formula specifically for this purpose.

The Rational method calculates the peak runoff using the following formula:

$$Q_P = CIA/360$$

Where	Q_P	=	peak runoff (m ³ /sec)
	C	=	runoff coefficient (defined)
	I	=	rainfall intensity (mm/hr)
	A	=	area (hectares)

Noted that Rational method is only used to calculate peak runoff and this method is applicable for areas less than 60ha. Hydrographic Method is used to calculate peak runoff for areas more than 60 ha.

Runoff Coefficient (C):

A runoff coefficient is used in the Rational method, as not all of the rainfall falling on the ground flows off into the drains. Some water infiltrates into the ground and some go into storage in ponds or tanks. The runoff coefficient represents the ratio between the volumes of rainfall to the volume of runoff. In Bangladesh taking into account the fact that at the time of intense rainfalls in the Monsoon period the ground is normally saturated, the following coefficients should be used:

Table 4-11 : Runoff Coefficients

Type of area	Coefficient	
Paved areas – roads and markets	0.9	90%
Areas of paddy (flooded)	0.8	80%
Densely built up areas	0.7	70%
Central areas mixed commercial and housing	0.6	60%
Residential areas with detached houses	0.4	40%
Walled areas and gardens	0.3	30%
Large permeable areas (e.g. dry paddy land)	0.3	30%

Rainfall Intensity is described above in the sub section 4.3.2.

Contributing Area (A) means the total catchments area upstream of a drain that can contribute flow. The contributing area is measured in hectares.

Example: To determine the peak discharge for a 2.0 ha densely built up catchment area where the rainfall intensity is 130 mm/hr.

$$Q_p = CIA/360 = 0.7 * 130 * 2.0/360 = 0.5 \text{ m}^3/\text{s}.$$

Calculation procedure peak runoff is mentioned in the sample table 4-12

Table 4-12: Calculation of Peak Runoff

Catchment No #	Catchment Land Use	Runoff Coefficient (C)	Rainfall Intensity (I) [mm/hr]	Catchment Area (A) [ha]	Peak Discharge (Q_p) [m^3/s]
1	2	3	4	5	$6 = 3*4*5/360$
C1	Densely built up area	0.7	130	2.0	0.5
-	-	-	-	-	-
-	-	-	-	-	-

(3) Estimation of Drain Size

After estimation of the volume of storm runoff, ED needs to consider the detail design of drains. To design the drains ED needs return period, freeboard, land use type, velocity of drain water.

Return Period and Freeboard

Return period is the period of time in year defined as the probability of occurrence of the same magnitude of rainfall return the same after the first one. e.g. over a 100-year period, rainfall with a return period of 5 years will occur approximately 20 times.

Freeboard is used as a safety factor to avoid overflow of the designed drain. It is measured as the distance between normal water level and the top of the drain structure (Figure 4-2). Drains and culverts are designed to flow full with the additional capacity available when the flow depth is just below the top of the drain.



Figure 4-5: Examples of Freeboard

The Return Periods of rainfall and freeboard for the design of size of different types of storm drains are given in following Table 4-13.

Table 4-13: Return Period of Rainfall and Freeboard

Drain Type	Return Period	Freeboard
Tertiary	1.1 Years	100 mm
Secondary	2 years	150 mm
Primary	5 years	200 mm

Design Discharge

At this stage ED will need the formula to calculate the volume of drain. For this purpose, Manning's equation can be used. Manning's Equation is recommended for the calculation of the flow velocity and drain capacities. The Manning's equation is :

$$V = 1/n * (R^{2/3} * S^{1/2})$$

$$Q = A * V = A * 1/n * (R^{2/3} * S^{1/2})$$

Where,

- V is velocity (m/sec)
- Q is Capacity (m³/sec)
- A is flow area (m²)
- S is hydraulic gradient (m/m) (Defined in the Table 4-6)
- n is Manning's roughness value (defined in the Table 4-12)
- P is wetted perimeter (m) (Other than Freeboard)
- R is hydraulic radius = A/P

It is noted that velocity is considered for all drains from 0.7 to 1.0 m/s. For this purpose, ED may consider Table 4-6 to use the velocity for different type of drains rather using the formula.

Hydraulic Roughness

The hydraulic roughness 'n' values to be used in the calculation of capacities are dependent on the type of material used to construct the drain and, the standard of maintenance. The values of Manning's 'n' to be used in the equation are set out in the following Table 4-14.

Table 4-14: Drainage Roughness Factors

Type of Drain	Roughness Factor 'n'
Concrete drains	0.014
Plastered brick drains	0.014

Brick drains (un plastered)	0.016
Katcha drains (grass, without shrubs)	0.025
Kathca drains (grass, with shrubs)	0.030

(4) Calculation of Drainage Size:

To develop any drain ED needs to consider to maintain the standard ration between depth and it's width. Following three conditions should be considered while calculation of Drainage size.

- ⇒ The depth of drain including freeboard should not exceed three times of width ($D \leq 3W$).
- ⇒ Drain less than 0.6m in width should not exceed 1.2m in depth (if $W < 0.6\text{m}$, then $D \leq 1.2\text{m}$) to allow access for cleaning.
- ⇒ Secondary drains then it must have a minimum depth of 0.50m.

Drainage Size Consideration for Household Used Waste Water

ED should also estimate the drainage size considering the house hold waste water which is designed to flow by the line drains. For this purposes ED needs to consider following estimation:

According to the study conducted by WHO at 1987 that 115 lpcd (Liter Per Capita Per Day) is consumed by a person. In that case total consumed water can be calculated of one Paurashava.

From the study it is observed that total return factors of this consumed water is 70% in which pick volume of water flows in the morning (8 am to 9 am). That is why ED needs to consider the drainage size only for the peak period discharge. And this peak period discharge rate is estimated as $0.02 \text{ m}^3/\text{s}$ for per square km area or $0.0002 \text{ m}^3/\text{s}$ per hectare.

Table 4-15: Calculation of Drain Size

Catchment No #	Type of drain	Peak Discharge (Q_p) [m^3/s]	Velocity of Drain (V) [m/s]	Area of Drain (A) [m^2]	Drain Width (W) [m]	Actual Drain Depth (D) [m]	Drain Depth (D) [m]
1	2	3	4	$5 = 3/4$	6	$7 = 5/6$	$8 = 7 + \text{freeboard}$
C1	Tertiary	0.5	0.70	0.71	0.50	1.4	1.5
-	-	-	-	-	-	-	-

4.3.5 Hierarchical Structure of Drainage

After calculation of drainage size, it is important to set the hierarchy. A long thoroughfare drain must be a primary drain, plot connecting drain would be tertiary drain and in between drain would be secondary drain. It is a wise decision to construct primary drain following a natural canal.

ED determines the hierarchy of Drains by following the sample table considering the network map, size of all new drains from the table 4-16. In this stage ED should consider the hierarchy of drains by measuring the followings:

Primary drains considered the drain of width more than 2.0 meters, natural canals as the primary drain, Primary drains are called as the main drains. Primary drains cover larger storm drainage than tertiary and secondary drains.

Secondary drains considered the drain of width from 1.01 to 2 meter. Secondary drains collect discharge from tertiary drains. One secondary drain may receive drainage discharges from

several tertiary drains in its course. Size and capacity of secondary drain is much bigger than tertiary drains, its catchment area is also bigger than tertiary drains.

Tertiary drains (Plot drains) considered the drain of width from 0.3 to 1 meter. Tertiary drain carry run-off or storm water received from the above mentioned plot drains and block or Mohallah drains. Their catchment area or storm water contributing area is bigger than Mohallah drains.

Following the Table 4-16, the Engineering Department will develop a drain list containing the criteria for Paurashava Drainage Development.

Table 4-16: Hierarchical Structure of Drainage

Drain ID	Length of Drain (m)	Natural/ Manmade	Width of Drain (m)	Depth	Start and ends	Considered volume of Storm Runoff ¹⁰	Considered hierarchy
Tertiary-03 (ward no-1, 6)	500	Manmade	1.50	2.50	Paurashava Bazar to Kaliganj Khal	Moderate	Secondary
-	-	-	-	-	-	-	-

4.4 (Step-4): Operation (Including Awareness Raising Program, Solid Waste Management etc.) and Maintenance

For Operation:

- ⇒ Proper connection and channelizing is very much important following hierarchical setup otherwise drainage may not play the actual purpose. It will create odor and hub for mosquitos. So network based drainage system would be considered under the top supervision of construction management works.
- ⇒ Construction cost for straight road along with drainage system is low compare to a zigzag road. Considering the budget issue, it is better to start the construction works from outfall point.
- ⇒ Different alternative options are available to solve the drainage problem for a particular area. Excavation and re-excavation of earthen drain is one of them. Considering the climate change and environmental issues, forestation is a vital way to solve the drainage problem. Implementation of Land Use Plan under Paurashava Master Plan is one of the potential solution under management options. Because green area disposes low storm water compare to paved area.
- ⇒ Paurashava has the opportunity to raise the awareness about the drainage system to its citizen. One of the platform to disseminate the information related to drainage and Solid Waste Management (SWM) is TLCC. Another potential media is Cable TV Network. Signboard adjacent to the constructed drain is very effective for prohibited dumping waste into the drain. Amount of construction cost and its purposes clearly should be mention on the sign board.

¹⁰Heavy/Moderate/ Low

- ⇒ A good solid waste management system is a prerequisite for a good drainage system of a Paurashava. Without belonging the dumping site, a Paurashava may not provide satisfactory level performance against the existing citizen demand. Community Based Solid Waste Management System is an appropriate technique to rescue the drain from dumping the waste instead of carrying storm water and also used waste water.

For Maintenance:

- ⇒ Routine maintenance works are done by the Paurashava cleaners and periodic maintenance works are performed through tendering process and at least one time before the rainy season.
- ⇒ Paurashava drains perform two major roles. First one is to carry storm water and second one is to carry domestic waste water. For any interruption of Paurashava drainage system, it will hamper both storm water and domestic water. As drains carry waste water, environmental issues are related to the drainage system. UPCSD Standing Committee may take over the program, Engineering Division and Administrative Division assist them in this regard. This issue is so important that involvement of Paurashava Mayor is urgent one.
- ⇒ Paurashava cannot spend any money without budget approval. Periodic maintenance works are usually done through tendering process. So, it is a wise decision to make it confirm for availability of fund during the tendering process of periodic maintenance works. To run the drainage system smoothly, Operation and Maintenance program is a mandatory one that moves ahead along with budgetary provision in the municipal budget. UPCSD Standing Committee would check and confirm regarding this issue.
- ⇒ The Paurashava engineering division (Executive Engineer and Town Planner) shall form a survey team to inspect the condition of each drain along with street lights, footpaths and roadside drains and the team will prepare a monthly report and recommend for the type and extant of maintenance work required with costing. The report may be done in the following format.

Table 4-17: Inventory for Maintenance Work of Drainage

Drain ID	Start-End	Type (Brick Built, RCC, CC, Earthen)	Location of damage (chainage)	Extent of damage (quantity)	Proposed remedial measures	Estimated cost	Remarks
Tertiary Drain-4 (Ward no-3,9)	Paurashava Bazar to Kaliganj Khal	Brick Built	Ch 240 to +600	Blocked with house hold waste	To be repaired by Brick	Tk. 85,000	
			Ch. 160 to Ch. 200	Damaged 40 m ²	re construction	Tk. 25,000	
			Ch. 200 to Ch. 600	Bottom is damaged	To be replaced	Tk. 50,000	
			Ch. 300 to Ch. 500	Silted-up 150 m ³	Re- excavation	Tk. 15,000	
-	-	-	-	-	-	-	-
		-	-	-	-	-	-
		-	-	-	-	-	-
		-	-	-	-	-	-

Intensity and interval for routine maintenance and periodic maintenance for a private drain is same as a Paurashava drain. Storm water management options like plantation, gardening, detention pond, rain water harvesting are encouraged to the citizen as storage water may be used for domestic purposes. This awareness issue may be delivered to the citizen during the approval process of building and also private drains.

Operation and Maintenance cost for a private drain would be imposed to its owner. If the drain is used for industrial purpose, especial attention would be given by the Paurashava. Because this drain may carry industrial effluent. ETP for an industrial unit is considerable issues for Paurashava as well as Department of Environment (DoE).

4.4(Step-5): Initiatives for Comprehensive Drainage Development & Prioritization

Considering budget constraints and other issues, drain would be constructed from the outfall point for Paurashava level resource management condition. Type of drain like V, U or L type drain would be selected considering availability of land, construction cost, availability of workers, volume of discharge and others. ED prepares the priority list following sample table 4-18.

Table 4-18: Total Development Activities

SL N o.	Name of Scheme	Identification ID	Existing Status	Hierarchical Framework	Beneficiaries ¹¹ (%)	Required Development Activities of the project	Project cost (Tk. in Lakh)	Possible source of Fund
1	Paurashava Bazar to Bakhkhal i Khal	Tertiary-3 Ward no-1,6)	Poor	Tertiary	1500 (25%)	Maintenance	60.00	Revenue
2	Bashantapur Primary school to Kopottak ho River	Secondary -2 (ward 2,4)	Moderate	Secondary	2500 (35%)	Maintenance	20.00	Revenue
3	Natun Eidgah Field to Petbhora Moddhap ara	New Proposed-1	Water logging & Worst Environment	Tertiary	2000 (20%)	New construction	40.00	Revenue
4	Paurashava Bazar to Bakhkhal i Khal	New Proposal-5	Water logging & Worst Environment	Tertiary	1500 (25%)	New construction	60.00	Revenue
-	-	-	-	-	-	-	-	-

¹¹Must specify how many percentages (%) of the population will be benefited

Based on the analysis of existing condition and forecasting the future demands of Drainage, Paurashava needs to formulate the Drainage Development vision statement with target time of its achievement.

4.4.1 Vision of Drainage Development Activities:

For this purpose, standing committee on UPCSD organizes a one day workshop comprising members of the standing committee concerned officials of the ED and head of other departments.

A vision statement can be developed in the following steps:

- ED makes a presentation of the existing conditions/situations based on different Analysis (Reconnaissance survey, condition Survey, etc.) conducted earlier, analysis on development activities, development priority (new drains) & future development demands, financial situation, available human resources, etc.
- Holding discussion on the presentation to prioritize the maintenance of drainage; to prioritize excavation of natural canal including provision for footpath and drain;
- Holding a detail discussion on existing financial condition of Paurashava and it's projection over 10 to 20 years and required manpower.
- Development of a Paurashava vision statement of drainage.

The participants would discuss the following issues in a few groups and considering the results of Step 1, 2 & 3 would propose draft vision statement:

- ⇒ What should be the period to be considered for vision realization (10 to 20 years)?
- ⇒ What kind of Drainage Development Plan do the Paurashava want to create?
- ⇒ What changes in the Drainage Development do the present Paura parishad want to see in the next 10-20 years?
- ⇒ What issues are the most important for the overall benefit of the citizen (maintenance, construction, monitoring of the existing drain development) for next 10 to 15 years?
- Formulation of draft vision statement by each group and presented in plenary, hold discussion and finalize the vision statements for drainage development.

Note: A vision statement should be clear, short, and realizable. The examples of drainage

Sample of Drainage Development Vision Statement

“By the Year 2027, thePaurashava will able to provide reasonable level of drainage development facilities ensuring the connectivity among all catchment area, maintenance and development of authorization.”

4.4.2 Prioritization of Drainage Development Scheme

Priority among all drains would be determined based on drainage availability, water logging condition, population suffering, damage characteristics and social (poor) vulnerability criteria.

Adequate budgetary provision should be ensured in the Paurashava Budget for Drainage Construction, Operation and Maintenance.

Out of the list prepared as above, the ED and the standing committee prioritize the work which will be implemented during next 5 years considering the following aspects:

- High priority should measure based on existing worst situation, where citizens suffers for water logging, environmental pollution etc.
- The proposed drainage development work will not give benefit to a small group of people only, but instead a large population of the Paurashava will be benefitted.
- The work will not be barricade for any future developments; like streets and other infrastructure, land uses, environmental aspects, etc.
- The schemes are implementable on technical and financial consideration.
- The work will not have any adverse impact on environment or on a group of people like women, etc.
- The work will have long term impact on draining out both household discharge and storm water.
- The work will give privilege to women, poor and other marginal population.

Considering aspects mentioned above, some quantitative criteria for prioritization can be developed. Table (4-18) containing factors, weightage/marks and marking criteria can be used for this purpose. Scoring can be followed by following Figure 4-5

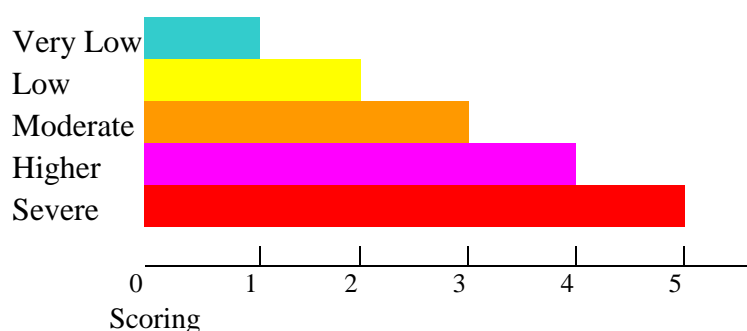


Figure 4-6: Scoring for the Factors to Prioritizing

Table 4-19: Selection Criteria for Prioritization of Drainage Development Work;

Factors	Marks	Marking Criteria
Highest suffering area (catchment) on Water loggings	10	The more suffering on water loggings, the more mark would be given
Less or no drains in the catchment area	10	No drain will get higher score
Number of Population suffering by absence of drains	10	High percentage considering total population of the Paurashava will get high score
Consideration of physical damages	10	The more damage will get more score
Consideration of Social vulnerability	10	More Poor residence/slum area will get more scores
Consideration of Environmental Impact	10	More impact will get more score
Estimated cost of new construction, re-construction and repair	10	The highest cost of drain would get Lowest weight, lower cost of street would get higher weight (Basis on Available of fund)
Amount of Community Services/ institutions within the Catchment area	10	More institutions under water logged will get high score
-----	10	
-----	10	
Total	100%	

Analyzing above issues for each street, ED will prepare the following Table 4-19 to list down about all development schemes analyzing Tables from 4-1 to 4-18 for both existing and new streets stating the demands and required activities including prioritization.

4.5(Step-6): Set Activities to Authorize and Comprehensive Drainage Development relevant with other features Like Canal, Low Lands, River and to control and monitor illegal occupancy on other Drainage Channels.

There are large number of canals, ponds and ditch as usually exists in the Paurashava area which need to be protected and sometime need to be revived to keep protect the drainage system functional. The responsibility of protecting those natural canals (khals) lies Paurashava Authority (*playground, open space, park* and natural water reservoir *Conservation Act, 2000*). They can enforce the law on protection of water body/water channel protection in this regard. Besides, action should also be taken to maintain the natural canals regularly to keep them functional for drainage.

Table 4-20: Selection Criteria for Prioritization of Drainage Development Work

SL No.	Name of Scheme	Identification ID	Existing Status	Beneficiaries ¹² (%)	Hierarchical Framework	Required Development Activities of the project				Project cost (Tk. in Lakh)	Possible source of Fund	Scoring for Prioritization for development works	Prioritization
						Development Type	Proposed length	Width (m)	Materials				
1	Paurashava Bazar to Bakhkhali Khal	Tertiary-3 Ward no-1,6)	Poor	1500 (25%)	Secondary	Maintenance	340	1.5	RCC	60.00	Revenue	80%	3 rd
2	Bashantapur Primary school to Kopottakh o River	Secondary-2 (ward 2,4)	Moderate	2500 (35%)	Tertiary	New construction	550	0.3	Brick	20.00	Revenue	75%	5 th
3	Natun Eidgah Field to Petbhora Moddhapara	New Proposed-1	Water logging & Worst Environment	2000 (20%)	Tertiary	New construction	450	0.3	Brick	20.00	Revenue	95%	10 th
-	-	-	-		-					-	-		

¹²Must specify how many percentages (%) of the population will be benefited that passes through the Wards

Other Public Drain Development

Following public agencies are also responsible for planning, designing, construction, operation and maintenance of drains in Paurashavas

Bangladesh Water Development Board (BWDB)

Sometimes BWDB need to prepare drain besides of the town protection embankment which also need to be adjusted with existing drainage development plan. For this purpose, Paurashava should make liaison with BWDB to ensure the above requirements. Paurashava drain may be connected with canals, rivers made by BWDB.

Public Works Department (PWD)

PWD is a public department under the ministry of Housing and Public Works. PWD usually construct the Drainage network within compound of Government Building structure (Upazilla Office Complex, DC Office, Judge Court, Government Hospital, Government Quarter etc.) which need to be connected adjusted with Paurashava Total Drainage System. For this purpose, Paurashava should make liaison with PWD to ensure the above requirements and provide them with terms and conditions of constructing internal drains including the responsibilities of operation and maintenance.

Roads and Highways Department (RHD)

RHD also provides drains along of the national or international highway. If the drain considered in the Paurashava area, then it also needs to be adjusted with exiting Paurashava drainage network. For this purpose, Paurashava should liaison with RHD to ensure the above requirements. Paurashava should also be provided with necessary TOR to be followed by RHD in planning, design, construction and maintenance.

National Housing Authority (NHA)

National Housing Authority (NHA) is another public organization under the ministry of Housing and Public Works to develop satellite township at Paurashava level. The township includes plot developments, internal road and drainage system & other civic facilities. In this case also, Paurashava should ensure that the drainage are laid with standard inconsistency with requirement of Paurashava drainage network system and also constructed with proper size, gradient and invert level connecting the drainage network system of the Paurashava. For this purpose, Paurashava should be liaison with NHA to ensure the above requirements and to provide the TOR for construction of their internal drains.

Private Drain Development

It is understood from the provision of the Paurashava Act, 2009 as stated above that the Paurashava has the following authority to supervise and establish control over construction and laying out private drains. Paurashava can formulate terms and conditions for development of private drain to be followed by any private individual, private developer/organization.

Sample Terms of Condition is stated as below:

- ↵ The depth of the drain should not more than three times of its width.
- ↵ If the width of drain is less than 0.6m, then depth of drain would be less than 1.20m.

- ↵The invert level of proposed drain must be higher than the invert level of Paurashava drain.
- ↵The technology of Rain Water Harvesting will attenuate the surface water discharge and also reduce drain size and construction cost as its consequences. Adaption of this technology will give high priority for private sector.
- ↵In any way or means, private drain must be restricted to connect with drain.
- ↵For private residential project area, drainage would be developed in such a way that the amount of discharge for the project area must be same for before development and after development. To achieve such target, local pond or water storage area would be developed within the project area.
- ↵For the development of non-Paurashava drainage system, concern person/organization must not destroy the existing water bodies, existing natural channel or reduction or encroachment of existing drainage width in any means.
- ↵For design purpose, one can follow Paurashava Infrastructure Design Manual, 2015.
- ↵Private drainage must be compatible with Paurashava Master Plan (if existed).
- ↵The drain which will carry the industrial effluent, must be comply DOE rules and regulation.
- ↵The responsibilities of Operation and Maintenance of Private Drains are deployed under concerned person / organization.

The terms and condition can be circulated in the form of notice stating methodology of drain development, etc.

Paurashava shall supervise by its official to make sure that the drain is constructed following the term and condition set by the Paurashava.

In case; of any faults, the Paurashava may have the necessary work done through its agency, and the cost incurred thereon by the Paurashava shall be deemed to be a tax levied on the person concerned under the act.

To exercise the above authorities Paurashava can develop necessary notice defining terms of reference for construction of private drains, forms and check lists to establish control over the private drain development. Sample application forms and check list, etc. are given in Annexure 1, 2, 3&4.

Chapter Five: Monitoring and Evaluation of Drainage Development

5.1 Introduction

Monitoring is the process of measuring the implementation, identifying obstacles, and reviewing the means to achieve its desired goals as a plan of action. Evaluation is measured by the expected outcomes that have been achieved in a particular purpose. Merits and demerits perimeter identified by the means of evaluation report, which later help an organization to make the proper decision.

It will stagnant in planning stage if the activities not properly implemented that would be identified from monitoring and evaluation which is very important. Necessary consideration of monitoring and evaluation to coordinate with all development activities and other development systems which have direct impact on drains should be considered.

Updating information is important for monitoring and evaluation activities. Drainage map and Inventory list of Paurashavas should update in the context of the current situation.

5.2 Objectives of Monitoring and Evaluation

Objectives of monitoring and evaluation activities for drainage development are:

- To complete the scheme of any project related to the drainage development expenditure, and complete the pre-activities for it,
- To follow the Drainage Development Plan to ensure real and sustainable development through systematic development,
- to identify problems on construction, operation and maintenance that lead to take necessary actions for solving the problems, and
- Considering the existing condition of the drainage system and ensuring the controls on private drainage development by analyzing the future land use of the Paurashavas.

5.3 Monitoring Activities considering Drainage Development

(a) Standard Design Based on Topographical and Hydrological Consideration

The amount of rainfall and domestic waste water are not same for Paurashavas of all over the country. Drainage Design in terms of drainage size should be considered Topography and Hydrology. Frequency of water logging may increase due to wrong design and inappropriate development projection. For this purpose, a check list would be suitable to monitor those activities prior to achieve suitable design of drainage.

(b) Natural Flow of Surface Water, Water Reservoirs, Location of Outfalls, Preservation of Green Space, Land Use Plan etc.

It is a wise decision to consider the gravity drainage for sustaining the natural flows of storm water. Preservation of green space, water reservoirs and policy to store the household storm water will help to reduce volume of surface water and its consequence as reducing the drainage size. Drainage development activities should be integral part of other development activities of the Paurashava. Each drain should have an outfall as without any outfall the drainage system will be irrational.

(c) Operation and Maintenance

Engineering Department prepares the monthly progress report (presented in Table 1) and submit the report for verification in the Parishad meeting.

The concerned Standing Committee organizes an annual meeting to assess the development activities of the drainage system and prepare necessary suggestions for presenting in the council meeting.

Engineering Department prepares and compilation of Annual Progress Report (sample table 5-1 and 5-2 can be presented in the report) and prepare the report for discussion in the Parishad meeting. Some tools may be mentioned below for monitoring purposes:

- m. Monthly Progress Report,
 - i. Regular Monitoring
 - ii. Regular Parishad Meeting
 - iii. Yearly Progress Report
 - iv. Yearly Meeting

5.4 Evaluation of Monitoring Activates

For drainage construction, operation and maintenance works, evaluation report may be prepared at least once in a year. It will guide the decision maker whether all works related to drainage are in right track or not.

Financial year starts from July and end at June. But hydrological year start from April and end at March. Therefore, Monitoring and Evaluation works and its reports related to drainage should be done considering Hydrological year. All drains may be cleaned before the monsoon of each year as a part of periodic maintenance. Some basic aspects of existing drainage condition and its progress might be highlighted in each year through evaluation report.

Drainage construction, operation and maintenance evaluation report should be comprised with some essential aspects like:

- ⇒ Introduction
- ⇒ Monitoring of Paurashava Drainage Development activities (Continuous operation and Maintenance)
- ⇒ Monitoring Private Drainage Development
- ⇒ Monitoring of Drainage Development of the other Public Department
- ⇒ Evaluation Findings
- ⇒ Lesson learned
- ⇒ Recommendation
- ⇒ Annexures

The brief aspects of evaluation report may be discussed in TLCC to incorporate the citizen into the process. The findings and recommendation of drainage construction, operation and maintenance, will reflect the vision aspects of drainage systems. Sample tables E1, E2 & E3 has shown under the Annexure 6 to present the evaluation report.

Table 5-1: Regular Progress Report

Fiscal Year: 2017-2018

Reporting Month*: July 2018

SL No.	ID	Name of the Schemes	Agreement Year of Implementation		Extension time	Progress (%)	Brief description of incomplete tasks	Remark
			Start	End				
1	Construction of new drain no-1	Construction of Drain Paurashava to Kumar River	June, 2017	January, 2019	--	10	Eviction work of illegal occupancy is on going	Remaining work will start after eviction
2	Primary Drain no-3	Maintenance of Srimontopur Khal	December, 2017	June, 2018	--	45	It was not possible to start the renovation work because the illegal occupation of canal could not free from eviction.	--
-	-	-	-	-	-	-	-	-

Table 5-2: Target Base Progress Report

Fiscal year: 2017-2018

Reporting Month*: July, 2018

SL No.	ID	Name of the Schemes	Yearly Target & Progress		Quarterly Target & Progress								Causes not to achieve the target
					1 st Quarter		2 nd Quarter		3 rd Quarter		4 th Quarter		
			Target %	Progress %	Target %	Progress %	Target %	Progress %	Target %	Progress %	Target %	Progress %	
1	Construction of new drain no-1	Construction of Drain Paurashava to Kumar River	50	33	5	3	15	20	20	10	10		Illegal occupancy
2	Primary Drain no-3	Maintenance of Srimontopur Khal	100	70	10	5	30	40	--	20	--	--	--
-	-	-	-	-	-	-	-	-	-	-	-	-	-

*Reporting Month means the last update month of the progress

Annexure 1 : Application form for Construction of New Drain by Private/ Non-government Agency

Form- 'A'

Application form for Construction of New Drain by Private/Authority

Form SL No.:

--	--	--	--

(Filled up by office)

Voucher No.:

--	--	--	--

(Filled up by office)

Date: -----

To

Mayor

----- Paurashava.

----- District.

1. Description of the Applicants:

a. Name :-----

Address :-----

NID No. :-----

b. Name :-----

Address :-----

NID No :-----

For Institutions :

a. Name & Designation :-----

Applicant's NID No. :-----

Organization's Name & Address :-----

Trade License/Registration No.(if Applicable):-----

2. Detail Description of the Proposed Drain:

Ward no.: Para/Maholla name:Upazila :.....

Road ID, adjacent to Drain: Name:

3. Detail Description of the Proposed Drain:

a. Alignment of the proposed

Drain:

.....

..

b. Purpose of the drain

construction:

.....

.....

.....

c. Information Table (If necessary, this table can separately provide as annex)

Drain Alignment		Drain Length (m)	Description of the Proposed Drain			
From	To		Width & Depth	Built up/ Open	Construction Type (CC/ RCC/ WBM/ HBB/ Earthen)	Distance from the Centre of the Road

d. Existing landuse of the adjacent proposed

drain:
.....
.....

e. Outfall - description of River, Canal, Boropit t
.....

f. Tentative cost of the proposed drain and source of

fund:
.....

4. Following documents are attached with this application:

- a. Cross-section of the adjacent road and proposed drain.
- b. Proposed Drain and adjacent road alignment along with the Maps.
- c. Consent letter of the land owner(s) of proposed drain.
- d. Original copy of the application form purchase receipt.

I/We declared that all information provided in this application, as per my/our knowledge, are correct.
In this circumstances, requesting to provide the drain construction approval.

Applicant's Signature (1) :.....

Name:.....

Date:.....

Applicant's Signature (2) :.....

Name:.....

Date:.....

Annexure 2 : Field Verification Report of Paurashava for the approval of New Drain Construction by Private/Non-government agency

Form 'B'

.....Paurashava,District

**Engineering Department
Field Verification and Verification Report by Paurashava for the approval of
New Drain Construction**

Name and designation of the Inspector:

I am the signatory, have visited following site onand collected/verified information regarding the site that has given below through observing and verifying information provided by the applicants:

Brief description of Proposed drain :

Alignment of the proposed drain:

Street ID of Adjacent Drain:and Street name t.....

Ward no.: Para/Maholla: Sl. no
of the Application: Receipt no. : Date of form purchase:.....

Field verification report on provided information regarding Location of the proposed Drain:

Criteria	Observation (Yes/No)	Remarks
Information regarding the location of the proposed drain mentioned in the application found correct.		
Description of proposed drain mentioned in the application found correct.		
Documents attached with the application found correct.		

Effectiveness of the proposed drain to Paurashava's overall development:

Criteria	Observation (Yes/No)	Remarks
The proposed drain, so far my knowledge, found compatible with Paurashava Master Plan/Development Plan.		
The proposed road, so far my knowledge, found compatible with Development Plans of other development authorities or not?		
Invert Level of the proposed drain is high/ equal from the connecting drain/outfall or not?		
Is there any kind of obstruction to construct future utility services at both underground and surface level?		
Is there any kind of objection from neighborhood/any development authority regarding construction of the proposed drain?		
During construction of the proposed drain, is there any possibility creating financial liability of Paurashava?		

Recommendations:

.....
.....
.....

Signature and Date

(Name:)
Field Inspector (Work Assistant/Sub-
Assistance Engineer/Assistant Engineer)

Annexure: 3 Sample of the Authorization Letter by Paurashava for New Drain Construction by Private/Non-government agency

Seal of the
Paurashava

Form 'C'

-----Paurashava, -----District

Ref No.:

Date:

1. Mr./Ms.
.....
.....
2. Mr./Ms.
.....
.....

Subject: Regarding approval/clearance of drain construction

Considering your (s) application dated onapproval/clearance letter for the proposed road located in Paurashava area is given with terms and conditions.

- | | |
|-------------------------------|---|
| 1) Drain alignment | t |
| 2) Drain length | t |
| 3) Drain Width | t |
| 4) Adjacent Road
name & ID | t |
| 5) District | t |
| 6) Zila | t |
| 7) Thana | t |
| 8) Name of Mahalla | t |
| 9) Paurashava's Ward No | t |
| 10) SL no. of the form | t |
| 11) Receipt no | t |

Terms and Conditions:

1. The Drain must be constructed according to the alignment specified in the Application;
2. All expenditures regarding this drain construction should bear by the Applicant(s);
3. Should inform a construction plan with mentioning start and ending time of the construction earlier than the commencement of construction work;
4. Should follow the Paurashava specified standard while construction of the Drain and later on it's repair;
5. It should be strictly prohibited that Sewerage connection should not allow with the Drainage connection;
6. For the sake of supervision and quality control, Engineering Department of the Paurashava should be notified at every step of the construction;
7. Officers of the Engineering Department of Paurashava can inspect the Drain construction works at any time and development related information should be provided to the inspector/visitor; and
8. After completion of the construction, should notify immediately to the Engineering Department of Paurashava in written about the completion.

Paurashava deserves the right to cancel this approval at any time if found disorder of all or any one of the mentioned terms and conditions or found the proposed drain incompatible with the development plan to be prepared in future by other development authorities.

Signature & Date

(Name to be printed)

Mayor, Paurashava

Copy:

01. President, Standing Committee on Urban Planning, Citizen Services & Development,
.....Paurashava
02. CEO/Secretary, Paurashava
03.
04. Office copy

Annexure- 4 : Completion Report by the Private/Non-government Agency after Construction of New Drain

Farm - ÔDÕ

-----Paurashava, -----District

Engineering Department

Completion Report after Construction of New Drain

Name and designation of the Authorize person:

As per instruction of the section head, I the undersigned, have visited/inspected construction works of the ongoing/completed drain as per street development approval/clearance no.: dated: I have submitted this report based on that inspection.

Observation Issues	Observations (Yes/No)	Remarks
1) Construction works of the drain has been implemented as per approved alignment.		
2) Outfall of the drain found correct as per proper drainage connection		
3) Drain has been constructed according to the approved design;		
4) Width and depth of constructed drain found correct as per approval		
5) Slope of the drain found appropriate level;		
6) Construction materials for drain construction found according to the approved design;		
7) There has scope to provide future utility services		
.....		

**** If one or more answer found no/negative, then necessary remedial measures can be taken through providing show cause letter to the applicant.**

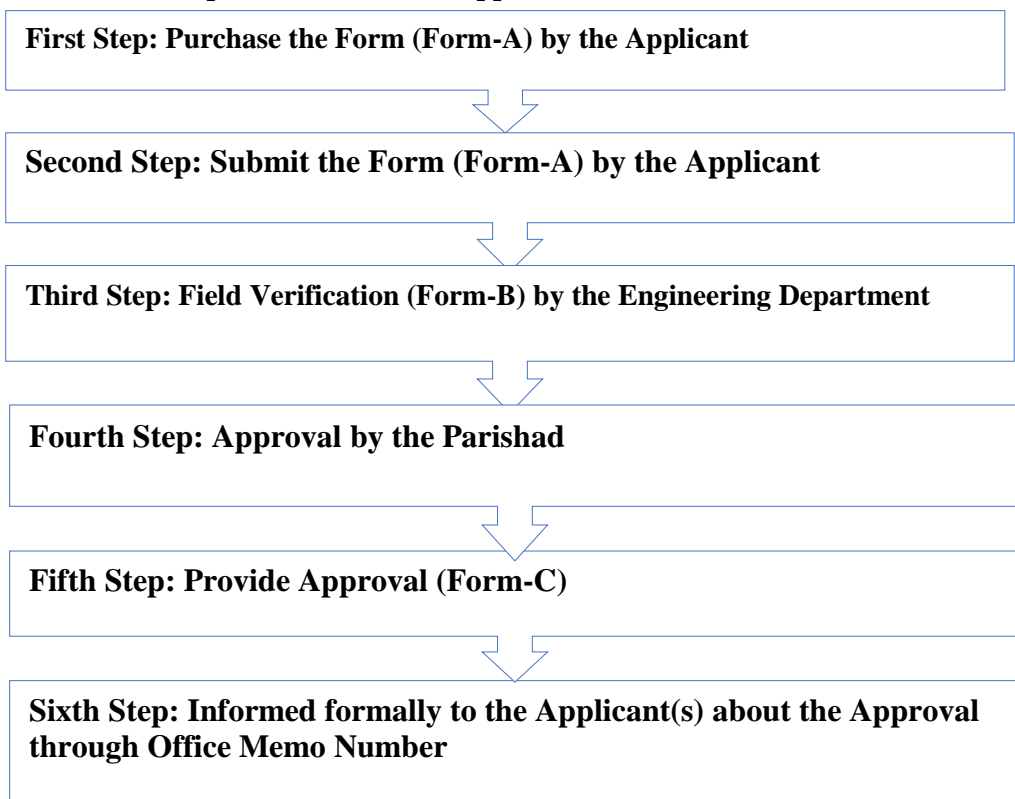
Other comment (if

any):
.....

Signature and date

(Name :.....)
Assistant Engineer/Executive Engineer

Annexure 5 : Steps to be followed in Approval Process



Good Practice on Infrastructure Development

Trainings on both 'Street Development' and 'Drainage System Development' have provided to the Mayor, Councilor (Chairman of Urban Planning and Citizen Service Development related standing committee), Engineers, and (work) assistants of Kanaighat Paurashava. After participating in training, some positive changes were noticed among mayor, councilor and the concerned officials of engineering division of the Paurashava.

With the support of Ward Councilors, asst. engineer started to prepare of existing networks both for street and drainage system. Unique identity, name, information on existing situation and its importance have mentioned in the Inventory lists and the base map was aligned with the inventory list. To prepare a future network map (both for street drainage system) Paurashava has started to follow the prepared base maps. According to the guideline mentioned in the handbook, engineering division is now trying to follow the direction of hierarchy based Right of Way for gradual extension of exiting Street-Width during construction and re-construction of Paurashava streets. Understanding the trend of future urban growth and requirements to meet the demands of drainage system developments they are trying to protect the natural drainage system also. Besides of those activities, Paurashava has taken initiatives to apply priority-based scheme selection for the development works following the directions mentioned in the handbooks.

As a part of follow-up activities, a team of consultants (infrastructure) used to visit Kanaighat Paurashava regularly and have guided Paurashava concerned officials about the process to follow relevant handbooks during developments of street and drainage system. SPGP team consulted with the Mayor, Engineers and Councilors about decisions making process regarding selection of priority-based development schemes to achieve integrated developments on Paurashava infrastructures (Street and drainage). The Engineering Division is now able to prepare and regular update the network map by ensuring ID for each of the streets and drains along with necessary information based on existing situation as well as following the future demands also. That information will help to find out missing links by analyzing existing situation and future land use direction to establish the future network plans. That information will also support during preparation of drainage system development by analyzing the functionalities of existing drainage system identifying the catchment area, water logged areas, current and future uses of natural drains, etc.