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Study on Waterlogging measures for Vithalvadi, Ulhasnagar

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ABSTRACT

Urban runoff increases significantly due to increased impervious area and reduced drainage network. Evaluation of land use in urban area plays a vital role as input to estimation of runoff. The hydrological design standard for water resource planning and management is commonly based on frequency of occurrence of heavy rainfall events. In the area of vithalwadi the life and properties are under the threat of flooding due to heavy rainfall within frequent time interval. In the present study, the occurrence of most frequent heavy rainfall event is investigated for Kathimanavli area, located near the Vithalwadi Railway Station in the State of Maharashtra, India and used for estimation of run off depth . The land use detail for the study area was obtained by integration of GIS and remote sensing. The spatial variation of event rainfall is considered with certain percentage of deviation from base rainfall for each triangle area that contributes to the run-off. The results of the analysis indicate that the study area can produce the run-off volume more than the present condition for water management at an average seasonal rainfall the canal already present, by maintaining the velocity of flow throughout the canal and drain out water into Ulhas river.

Keywords: Hydrology, Runoff, Waterlogging.

CHAPTER 1

INTRODUCTION

1.1 Water Logging:

Water logging is caused by a combination of excess rainfall, poor external drainage (runoff), poor internal drainage and the inability of the soil to store much water.

In the area of Kalyan-Vithalvadi, life and the properties are under the threat of flooding due to heavy rainfall within frequent time interval.

In the present study, the occurrence of the most frequent heavy rainfall event is investigated of katimanavli area located near the vithalvadi railway station in the State of Maharashtra, India. There is natural open drainage line which is across the link roads which is connected to Ulhas river. The chawls get affected every year in rainy season as the storm water gets logged chawls consist of nearby 900 homes.

(Source IMD Mumbai)

As per survey done by us, we get to know that every year average loss from each home is 10-12 thousand rupees that is total cost of damage is 90 lakhs.

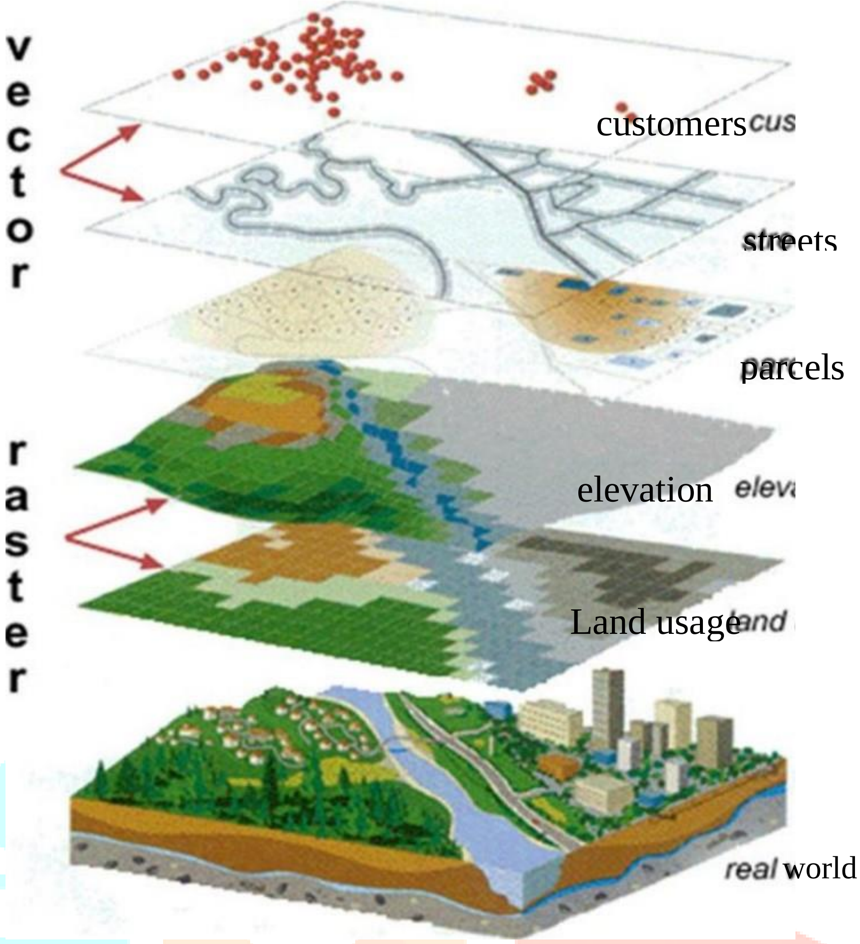
Every year KDMC does cleaning of drainage line but due to inefficient work, the region gets affected of 87448 m.

The land use detail for the study area was obtained by integration of GIS and remote sensing. The spatial variation of event rainfall is considered with certain percentage of deviation from base rainfall for each triangle area that contributes to the run-off. The results of the analysis indicate that the study area can produce the run-off volume more than the present condition for water management at an average seasonal rainfall the canal already present, by maintaining the velocity of flow throughout the canal and drain out water into Ulhas river.

1.2 Geographical Information System (GIS):

Geographical Information Systems is a powerful tool for collecting, storing, retrieval and manipulation of spatial data. It allows integration of spatial and aspatial data and also overlay of layered information that are beyond the capability of manual methods. GIS made it possible to map, model, query and analyze large quantities of data, all held together within a single database. GIS is defined as an organized collection of computer hardware, software, geographic data and personnel, designed to efficiently capture, store, update, manipulate, analyses and display all forms of geo-referenced information. Important components of GIS are: Computer hardware, Software module.

Data input includes all aspects of transforming spatial and non-spatial data into a GIS database. Method of data entry includes digitization, scanning and keyboard entry. Data may be obtained from many sources such as existing analogue maps, aerial photographs and Remote Sensing surveys and other information systems. Hence prior operations like format conversion, data reduction and generalization, error detection and editing, merging, edge matching, rectification and registration etc. have to be performed. Data Base Management System (DBMS) controls the creation of and access to the database itself, Non-spatial attribute information is stored in a relational database management system and the spatial information in a separate sub system that enables to deal with spatial data and spatial queries. Spatial data processing is performed with vector, raster or the combination of these two data formats. The most important feature in a GIS is its ability to manipulate and analyze spatial data. Display and output generation may be in various forms such as statistical reports. Maps and graphics of various kinds depending on the final outputs generated from GIS.



1.3 **Storm water**

Stormwater is water that originates from precipitation events, stormwater can soak into the soil (infiltrate), be stored on the land surface in ponds and puddles, evaporate, or runoff Most runoff is conveyed directly to nearby streams, rivers, or other water bodies (surface water) without treatment. In natural landscapes, such as forests, soil absorbs much of the stormwater. Plants also reduce stormwater by improving infiltration, intercepting precipitation as it falls, and by taking up water through their roots. In developed environments, unmanaged stormwater can create two major issues: one related to the volume and timing of runoff (flooding) and the other related to potential contaminants the water is carrying (water pollution). Stormwater is also an important resource as human population and demand for water grow, particularly in arid and drought-prone climates. Stormwater harvesting techniques and purification could potentially make some urban environments selfsustaining in terms of water. Stormwater is a major cause of urban flooding. Urban flooding is the inundation of land or property in a built-up environment caused by stormwater overwhelming the capacity of drainage systems, such as storm sewers. Although triggered by single events such as flash flooding or snow melt; urban flooding is a condition, characterized by its repetitive, costly and systemic impacts on communities. In areas susceptible to urban flooding, backwater valves and other infrastructure may be installed to mitigate losses.

1.5 Remote sensing

Remote Sensing is the technique of gathering information about objects without being In physical contact with them. Information is acquired by detecting and measuring changes that the object imposes on the field by it on electromagnetic, acoustic or potential field The human eye with its muscular controls and retina is perhaps the best example of a Remote Sensing system. For example, it is commonly known that an analyst can discriminate only About 8 to 16 shades of grey when interpreting continuous tone black and white image or Photo. If the data were originally recorded with 256 shades of grey, there may be more suitable information present in the image than the interpreter can extract visually. In such cases digital Image processing techniques are found to be more effective. Remote Sensing plays a vital role in natural resources mapping, management and monitoring. It provides accurate, reliable, timely information with repetitive average. Satellite remote sensing techniques are cost effective when compared to a real photography and conventional surveys. Basic principle of remote sensing is to measure and record electromagnetic energy reflected / emitted by the earth's surface and to relate such measurements to the nature of surface material. Remote Sensing is one of the excellent tools for natural resources survey as it possesses unique possibilities of vividly displaying the natural resources that occur on the earth's surface owing. In addition, its multispectral nature provides appropriate contrast between various natural resources, whereas its repetitive coverage provides information on the changes that are taking place over the natural resources and their environment Remote Sensing is becoming an important source of geographical data by providing digital images derived, from space and the air. It also provides techniques for data acquisition and processing anywhere on the globe at low cost While integrated with GIS, remotely sensed imagery can be merged with other data in a GIS environment providing real time spatial information. Remote Sensing affords a practical means for frequent and accurate monitoring of the earth's resources on literally a global basis.

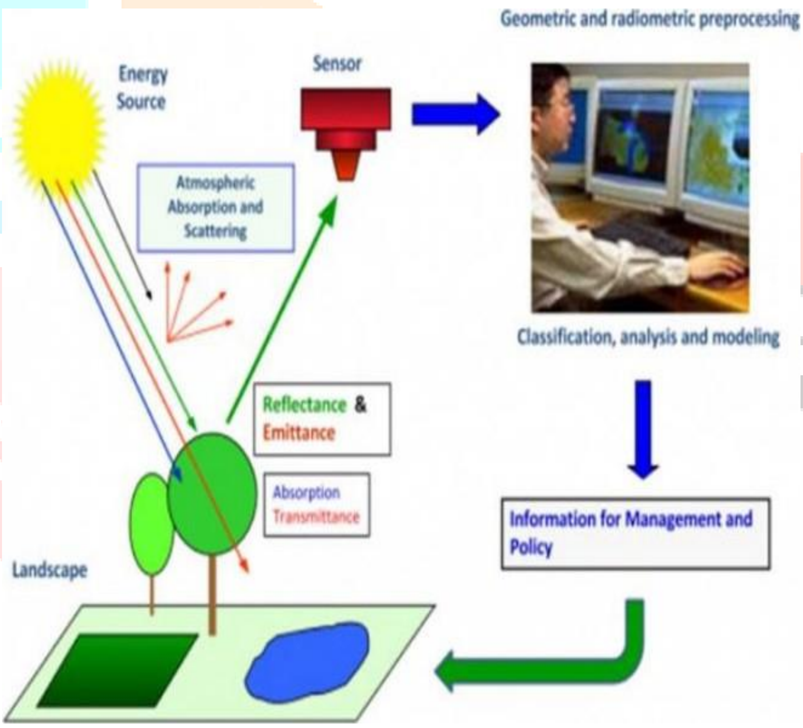


Figure 1.1 - Overview of remote sensing

(Source — https://en.wikipedia.org/wiki/Remote_sensing)

CHAPTER -2

LITERATURE REVIEW

2.1 Rahat sharif, Jawei pan, Published: 4th December 2021 Mechanism of waterlogging tolerance in plants: Waterlogging is one of the main abiotic stresses suffered by plants. Inhibition of aerobic respiration during waterlogging limits energy metabolism and restricts growth and a wide range of developmental processes, from seed germination to vegetative growth and further reproductive growth. Plants respond to waterlogging stress by regulating their morphological structure, energy metabolism, endogenous hormone biosynthesis, and signaling processes. In this updated review, we systematically summarize the changes in morphological structure, photosynthesis, respiration, reactive oxygen species damage, plant hormone synthesis, and signaling cascades after plants were subjected to waterlogging stress. Finally, we propose future challenges and research directions in this field.

2.2 Vanha Dang published, 2020, Predicting urban waterlogging risks by regression models and open internet sources: In the context of climate change and rapid urbanization, urban waterlogging risks due to rainstorms are becoming more frequent and serious in developing countries. One of the most important means of solving this problem lies in elucidating the roles played by the spatial factors of urban surfaces that cause urban waterlogging, as well as in predicting urban waterlogging risks. We applied a regression model in ArcGIS with internet open-data sources to predict the probabilities of urban waterlogging risks in Hanoi, Vietnam, during the period 2012–2018 by considering six spatial factors of urban surfaces: population density (POP-Dens), road density (Road-Dens), distances from water bodies (DW-Dist), impervious surface percentage (ISP), normalized difference vegetation index (NDVI), and digital elevation model (DEM).

2.3 Shubham Roy ,published on 2021 Urban waterlogging risk as an undervalued environmental challenge: Environmental Challenges 4 (2021) 100194 Contents lists available at Science Direct Environmental Challenges journal, Urban waterlogging risk as an undervalued environmental challenge: An Integrated MCDA-GIS based modeling approach Subham Roy, Arghadeep Bose, Nimai Singha, Debanjan Basak, Indrajit Roy Chowdhury Department of Geography and Applied Geography, University of North Bengal, 734013 Siliguri, West Bengal, India. Department of Geography, Cooch Behar Panchanan Barma University, 736101 Cooch Behar, West Bengal, India.

2.4 Raji Pushpalatha , E.uma, Jshyla, published on 2018 Rainfall runoff analysis of a compacted area: Ongoing droughts and water scarcity problems indicate the significance of conservation of natural water resources. Rainwater harvesting is going to be the most applicable method to eliminate water scarcity and to meet the escalating demand. Hydrological analysis is unavoidable in any water harvesting structural designing. A study was conducted to analyze the rainfall-runoff characteristics by selecting an area of 1.23

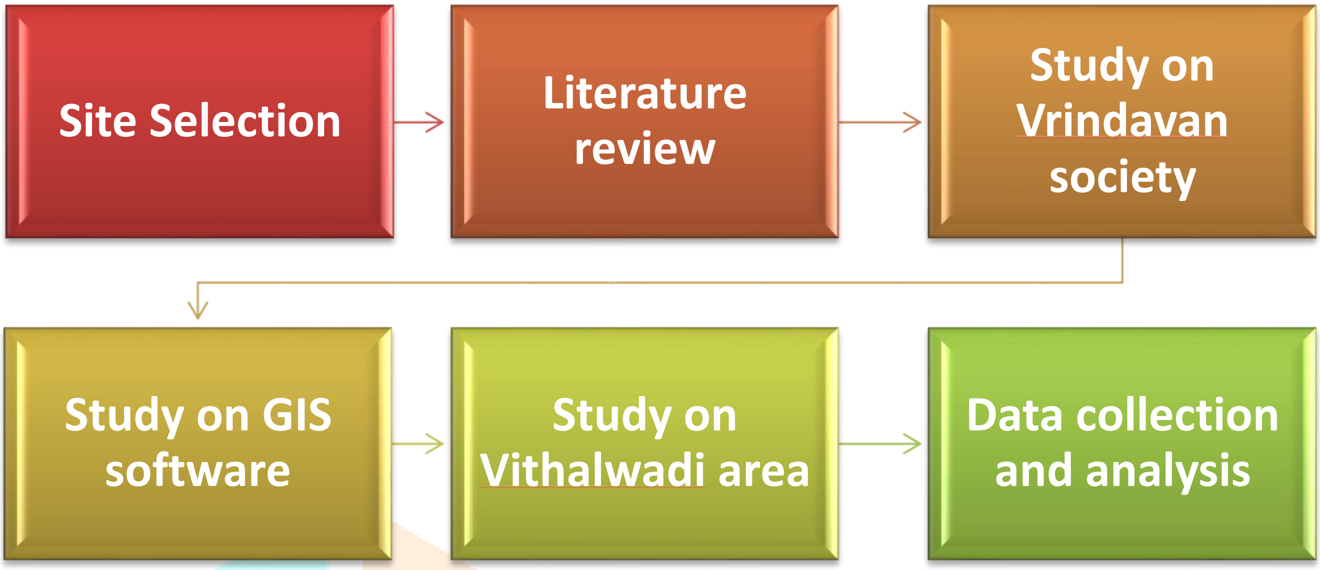
ha as the study area, where prominent runoff occurred during the rainy season. Runoff for seven storms were measured using a rectangular notch and a relation between discharge and corresponding head for the notch at the downstream end of the study area was calculated. The R 2 value obtained was 0.98 and the runoff coefficient for the study area was 0.12.

2.5 Chitresh saraswat Lal, published 2016 Several methods of avoiding ground waterlogging: As human history is changing on many fronts, it is appropriate for us to understand the different perspectives of major global challenges, of which, water is a major priority. The water resources in urban areas are either approaching or exceeding the limits of sustainable use at alarming rates. Groundwater table depletion and increasing flood events can be easily realized in rapidly developing urban areas. It is necessary to improve existing water management systems for high-quality water and reduced hydro-meteorological disasters, while preserving our natural/pristine environment in a sustainable manner. This can be achieved through optimal collection, infiltration and storage of stormwater. Stormwater runoff is rainfall that flows over the ground surface; large volumes of water are swiftly transported to local water bodies and can cause flooding, coastal erosion, and can carry many different pollutants that are found.

2.6 K.M. Atikur Rehman, published on 2015 Water logging and losses in Ecosystem: The paper attempts to explain the serious effects of water logging on ecology, especially the influences of DND embankment on the environment and lives concerned. This aspect hampers severely the living standard as well as the total environmental networks. Economic and business activities are being damaged along with the deteriorations of human health and educational services. It is investigated that 77 percent of the people living in Dhaka-Narayangonj-Demra (DND) area have been sufferings from different diseases, whereas educational losses are about 68 percent. In addition, 55 percent of businessmen are affected by water logging of DND embankment area in the rainy season of 2015.

2.7 Chitresh Saraswat et.al.(2016) Stormwater runoff is rainfall that flows over the ground surface; large volumes of water are swiftly transported to local water bodies and can cause flooding, coastal erosion, and can carry many different pollutants that are found on paved surfaces. The field of stormwater management planning is to understand the significance and role of remote sensing and GIS in designing optimal capture measures under the threat of future extreme events and climate change. The effects of different facilities such as water harvesting, reuse, ponds and infiltration are explored to establish adaptation strategies that restore water cycle and reduce climate change- induced flood and water scarcity on a catchment scale.

CHAPTER-3



DISCUSSION

3.1 Scope:

- To Study The Area Making Flooded Region.
- To Compute The Rainfall Data For The Study Of Area.
- Analyze The Rainfall Data Of Previous 10 Years.
- To Applicate GIS Software For The Study Of Waterlogged Area
- To List The Solution Of Water-Logging In Vithalvadi Ulhas Nagar.

3.2 Objective:

- To Find Out The Reason Of Water-Logging In Vithalvadi Station Area.
- To Minimize The Loss Of Property Of Chawl Near Railway Station.
- To Understand The Functioning Of QGIS Software And Its Applications In Management Of Storm Water.
- To Analyze Drainage Data Of Vithalvadi Area With The Help Of Rainfall & Terrain Maps.

Proposed Methodology

First, We have selected the site, after that we studied on the research paper related to our topic, then we studied on the case study of Vrindavan Society, then We'll study the software which is known as GIS software, then we will interpolate the same case study on the Vithalwadi area, after that we will collect and analyze all the data using rainfall and terrain maps.

Discussion and Expected Outcome

- With the help of research papers, we study many reasons due to which waterlogging takes place in urban cities.
- We study the details and sources of waterlogging at Vrindavan society (Thane). With the help of this case study and different research papers we listed out many remedies which can reduce the water logging at good level.
- In future after visiting the main site Vithalwadi and with the help of QGIS we would look after the causes and the sources of waterlogging.

CHAPTER-4
QGIS Framework

5.1 Creation of DEM from Google Earth pro

Step 1: Create a points cloud of the study area in google earth

- Use the path tool to create the points cloud.
- Click on the map and drag the cursor to draw a continuous line.
- Draw the lines that cover the maximum points on the map.
- Click 'OK' to validate the paths.
- Save the path as 'KML' file

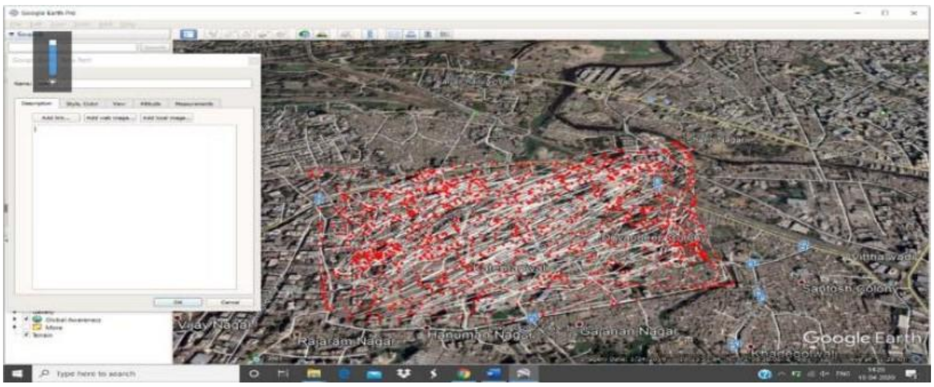


Figure 5.1 - Marking points (Source - Google Earth pro)

5.2 Marking building points, roads and canal line in QGIS

Study area is consisting of congested houses which are very difficult to identify their floors as we all units, for making it simpler we did survey of complete area to identify the number of floors and pattern of houses. we got to know that, there is one alley in two row housing connected back to back and on every alley have small drainage line on both side of alley which are directly connected to main drainage line. Further we found in visual inspection that there is no retaining wall at the residential side of drainage line which is very dangerous at the time of flooding. After survey we marked all those points and roads in QGIS

3.4 by means of vector points marking in order to justify the affected buildings from waterlogging.

For plotting buildings we have to use 'Point' feature.

- In toolbar select layer > Create Layer > New Shape file Layer. • Select Type = point
- A default fid' integer attribute is created. Attributes are used to store information and label features.
- Add a new Attribute of 'No of Storey' of Type 'Integer' and click OK and save the file in shape file format.
- As we are plotting the buildings open the google earth layer in QGIS.
- Zoom in to the location. To digitize the buildings select the building layer and place it in 'Edit' mode.
- Select 'Add Feature' and select points option.
- Use the cursor to digitise the buildings.
- Give the Number in 'id attribute' and enter the no of floors of the building in 'no of stories attribute' (we calculated the no of stories during the site survey) and click OK.
- Point appears on the building layer.
- Repeat the procedure for all the buildings and save the file.

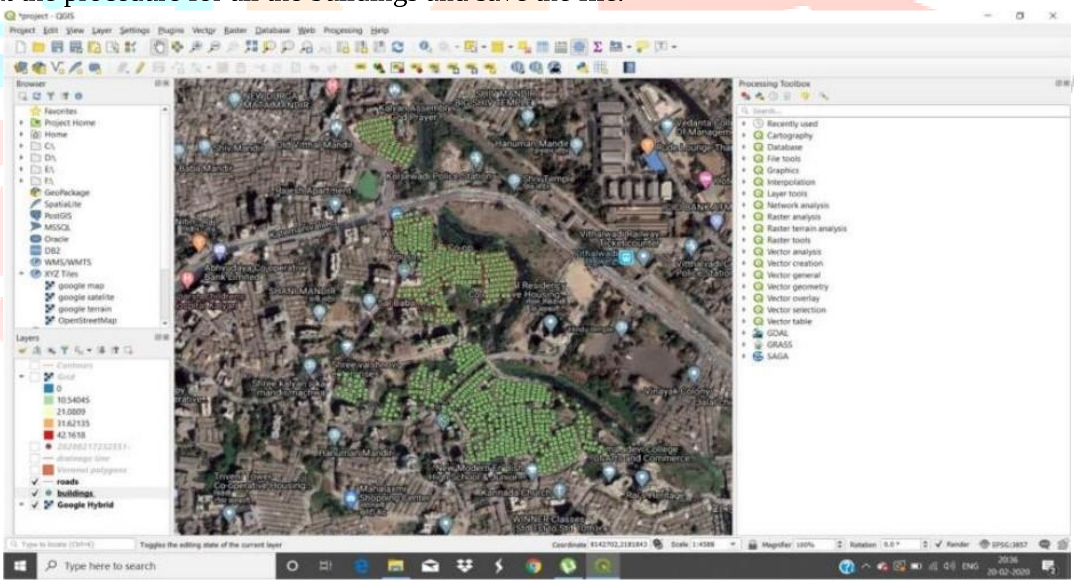


Figure 5.6 - Marking of Buildings by points in QGIS

(Source - QGIS 3.4)

Plotting the 'Roads' we have to use 'Line' feature.

- In toolbar select layer > Create Layer > New Shapefile Layer. • Select Type = line
- A default 'id' integer attribute is created. Attributes are used to store information and label features and click OK and save the file in shape file format.
- As we are plotting the roads open the google earth layer in QGIS.
- Zoom in to the location. To digitize the road select the building layer and place it in 'Edit' mode.
- Select 'Add Feature' and use the right mouse button to digitise the roads and use left mouse button to end feature.
- Give the Number in 'id attribute' and enter and click OK.
- Line appears on the Road layer.

- Repeat the procedure for all the Roads and save the file.

Plotting the 'Canal' we have to use 'Line' feature.

- In toolbar select layer > Create Layer > New Shapefile Layer. • Select Type = line
- A default 'id' integer attribute is created. Attributes are used to store information and label features and click OK and save the file in shape file format.
- As we are plotting the canal open the google earth layer in QGIS.
- Zoom in to the location. To digitize the canal select the building layer and place it in 'Edit' mode.
- Select 'Add Feature' and use the right mouse button to digitise the canal and use left mouse button to end feature.
- Line appears on the Canal layer.
- Repeat the procedure for all the Roads and save the file.

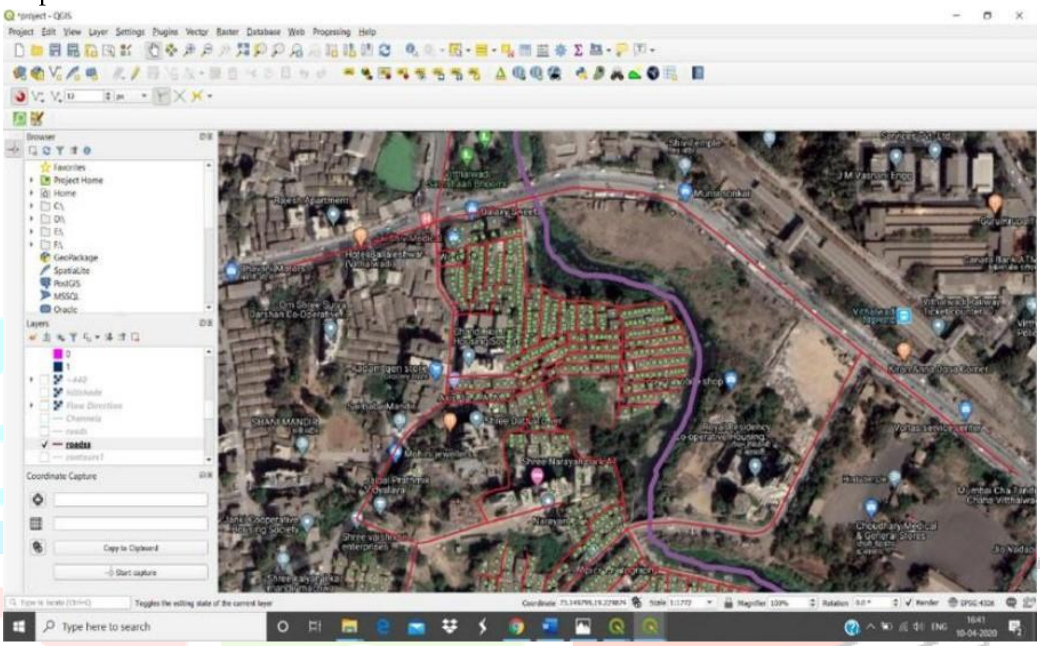


Figure 5.7 - Marking roads and drainage line
(Source - QGIS 3.4)

In above fig 5.7 the purple line indicates the drainage line and the red indicates the roads. The roads are interconnected by using object snap in order to make the accuracy in presentation.

5.3 Marking of flooded region

The marking of flooded region is performed by using several steps which are quite similar to the delineation of watershed boundary. The downside region can be identified by
Topographic map and hence the several steps are performed to identify the flooded region.

5.3.1 Using Google hybrid map

For ease of identification of all roads and buildings the google hybrid map is used by using plugin 'Quick map setting' major roads and the shops were identified in this map The coordinate reference system is set to EPSG: 4326.

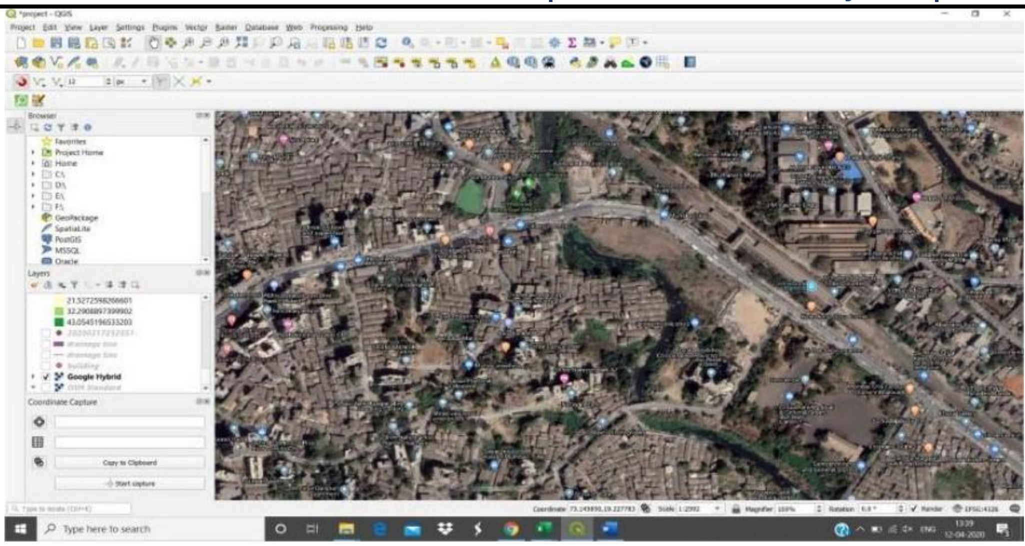


Figure 5.8 - Google hybrid

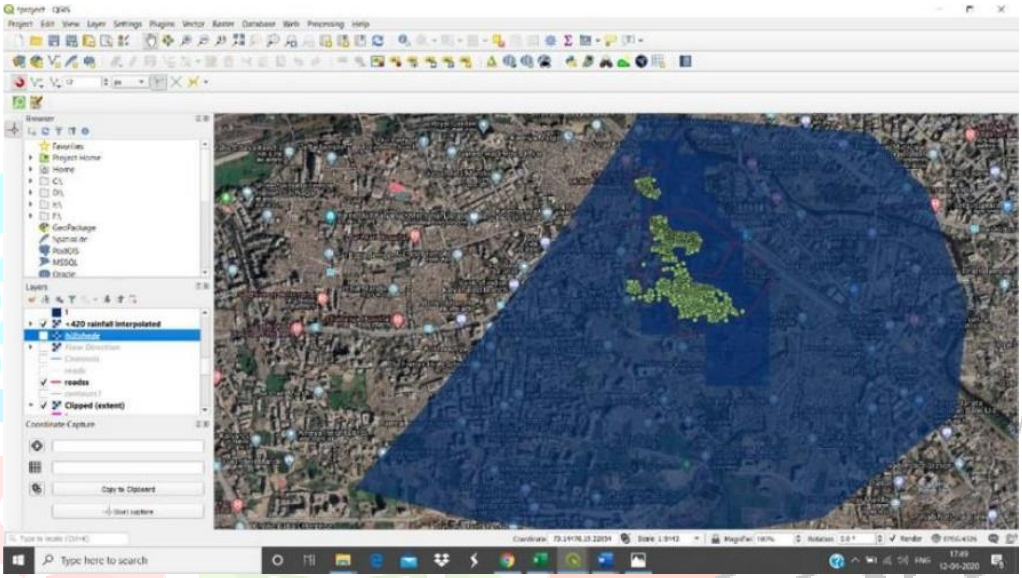


Figure 5.13 — Interpolation of rainfall Data > 420mm
(Source - QGIS 3.4)

1) On other side, the manually calculation of depth of canal was carried out. The depth of canal IS 2m. Therefore in order to check the affected residents, due to waterlogging we used the command of raster calculator in which we input the command of highlight the region of"=< 9 m

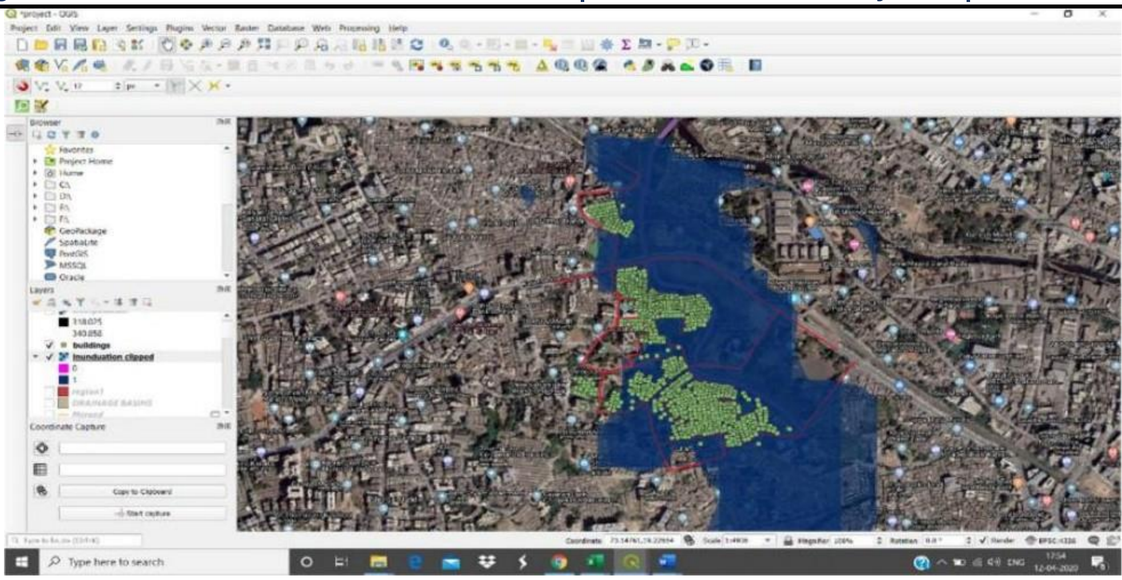


Figure 5.14 - Flooded region (Source - QGIS 3.4)

2) By doing those all steps it can seen that the residents are living on reclamation site which were constructed in haphazard manner. Hence due to congested areas the depth of canal is to be increased in order to avoid waterlogging. The intensity of rainfall for

^{2} flood discharge computation IS taken as 420 mm and the area computed is 1.54 km ..

CHAPTER-5

Flood Estimation

6.1 Overview of Rational method

The rational method represents a steady inflow-outflow condition of the watershed during the peak intensity of the design storm Any storage features having sufficient volume that they do not completely fill and reach a steady inflow-outflow condition during the duration of the design storm cannot be properly represented with the rational method. Such features include detention ponds, channels with significant volume, and floodplain storage.

6.1.1 Assumptions and Limitations

Use of the rational method includes the following assumptions and limitations:

- The method is applicable if toc for the drainage area is less than the duration of peak rainfall intensity.
- The calculated runoff is directly proportional to the rainfall intensity.
- Rainfall intensity is uniform throughout the duration of the storm.
- The frequency of occurrence for the peak discharge is the same as the frequency of the rainfall producing that event.
- Rainfall is distributed uniformly over the drainage area.

- The minimum duration to be used for computation of rainfall intensity is 10 minutes. If the time of concentration computed for the drainage area is less than 10 minutes, then 10 minutes should be adopted for rainfall intensity computations.
- The rational method does not account for storage in the drainage area. Available storage is assumed to b

6.2 Procedure for using the Rational Method The rational formula estimates the peak rate of runoff at a specific location in a watershed as a function of the drainage area, runoff coefficient, and mean rainfall intensity for duration equal to the time of concentration. The rational formula is:

$$Q=CIA/Z$$

Where:

Q = maximum rate of runoff (m3/sec.)

C = runoff coefficient

I = average rainfall intensity (in/hr or mm/hr)

A = drainage area

6.2.1 Rainfall Intensity

The rainfall intensity (I) is the average rainfall rate in in/hr for specific rainfall duration and a selected frequency. The duration is assumed to be equal to the time of concentration. For drainage areas in Texas, you may compute the rainfall intensity using Equation below, which IS known as a rainfall intensity-duration-frequency (IDF) relationship
(power-law model).

$$I = \frac{b}{(toc + d)^e}$$

Where:

I = design rainfall intensity (in/hr)

toc = time of concentration (min) e, b, d = coefficients based on rainfall IDF data.

6.2.2 Time of Concentration

Time of concentration (toc) is the time required for an entire watershed to contribute to runoff at the point of interest for hydraulic design; this time is calculated as the time for runoff to flow from the most hydraulically remote point of the drainage area to the point under investigation. Travel time and toc are functions of length and velocity for a particular watercourse.

A long but steep flow path with a high velocity may actually have a shorter travel time than a short but relatively flat flow path. There may be multiple paths to consider in determining the longest travel time. The designer must identify the flow path along which the longest travel time is likely to occur.

6.2.3 The Kerby Method

For small watersheds where overland flow is an important component of overall travel time, the Kerby method can be used. The Kerby equation is

$$toc = K(LXN)^{0.467}S^{-0.235}$$

Where:

toc= overland flow time of concentration, in minutes

K = a units conversion coefficient, in which K = 0.828 for traditional units and
K =1.44 for SI units
L = the overland-flow length, in feet or meters as dictated by K

N = a dimensionless retardance coefficient

S = the dimensionless slope of terrain conveying the

6.1 — Kerby Equation Retardance Coefficient Values

Generalized terrain description	Dimensionless retardance coefficient (N)
Pavement	0.02
Smooth, bare, packed soil	0.10
Poor grass, cultivated row crops, or moderately rough packed surfaces	0.20
Pasture, average grass	0.40
Deciduous forest	0.60
Dense grass, coniferous forest, or deciduous forest with deep litter	0.80

6.3 Calculation of Flood Estimation

First we calculate time of Concentration with the help of kerby method as our area is small and this method is most suitable.

1. Calculation of Time of concentration

K = 1 44

IF 1400 m taken from QGIS

N= 0.02 (pavement region)

S= 0 001 the existing slope of canal

toc=1.44(1400x0.2)001

toc = 34.60 mins

The of drainage area	Runoff coefficient
Downtown areas	0.70-0.95
Neighbourhood areas	0.30-0.70
Residential	
Single-family areas	0.30-0.50
Multi-units, detached	0.40-0.60
Multi-units, attached	0.60-0.75
The of drainage area	Runoff coefficient
Downtown areas	0.70-0.95
Neighbourhood areas	0.30-0.70
Residential	
Single-family areas	0.30-0.50
Multi-units, detached	0.40-0.60
Multi-units, attached	0.60-0.75
Suburban	0.35-0.40
Apartment dwelling areas	0.30-0.70
Industrial:	
Light areas	0.30-0.80
Heavy areas	0.60-0.90
Parks, cemeteries	0.10-0.25
Playgrounds	0.30-0.40
Railroad yards	0.30-0.40
Unimproved areas:	
Sand or sandy loam soil, 0-3%	o. 15-0 20
Sand or sandy loam soil, 3-5%	0.20-025
Black or loessial soil, 0-3%	o. 18-0.25
Black or loessial soil, 3-5%	025-0.30
Black or loessial soil, > 5%	0.70-0.80
Deep sand area	0.05-0.15

6.3 - Rainfall-duration-frequency coefficients

Duration of T	2 years	4 years	6 years	8 years	10 years	12 years
e	0.8014	o. 7898	0.7872	0 7828	0.7824	o. 7779
b (in.)	61.43	65.72	68.67	79.33	90 90	101 22
d (min)	8 02	7.69	7.67	7 80	7.62	7 36

2. Calculation peak rainfall intensity

For this values of e, b, d are taken from IDF rainfall data table, the values taken considering 2 years of flooding the values are mentioned above.

e = 0.8014.

b = 61 43 inches. d = 8.02 min.

$$I = \frac{61.43}{(34.60+8.02)^{0.8014}}$$

I = 304 inches/hour.

3. Calculation of discharge.

4. Here C = 0.95 considering downtown region value

A = 156 5 Hectors

Z = 36 for SI unit

$$Q = \frac{0.95 \times 3.04 \times 156.5}{36}$$

Q= 12.55 m3/sec.`

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CHAPTER-6

Hydraulic Design of Drainage Canal

7.1 Design of Canal

For design of Storm drainage system in katemanavli road, vitthalwadi region, the lined canals are not designed making use of Lacey or Kennedy Theory because the section is rigid. Generally Manning's equation is used in design. To carry a certain discharge number of channel sections may be designed with different bed widths and side slopes. But it is clear that each section is not equally good for the purpose.

The section to be adopted should be economical and at the same time it should be functionally efficient. It has been found that the most suitable cross-section of a lined canal mentioned in IS code 10430-2000 as:

a) Trapezoidal with or without rounded corners - This section can be used for all types of lined canals.

b) Cup shaped - It may be used for distributaries/minors for discharge up to 3m'/s as far as possible.

As far, our Discharge by Rational Method = 12 67 m^3/sec so we must consider different parameters for design purpose.

7.2 Parameter for Design of Lined Canals

Different parameters that are used as follows:

7.2.1 Side Slopes

I. Inner Slopes of Lined Canals

Lining is usually made to rest on stable slopes of the natural soil; so slopes should be such that no earth pressure or any other external pressure is exerted over the back of the lining. Sudden drawdown of water level in the lined canal should be controlled by strict operation rules and regulations to avoid external pressure on the lining. However where chance of sudden drawdown in the canal IS considerable, the canal slopes should be checked for stability using slip circle analysis as given in IS 7894. In addition, other suitable measures like adequate drainage should be provided before lining work commences.

Il. Outer Slopes of Lined Canal

Engineering properties of soil shall govern the design of outer slopes giving due consideration to stability of slopes for functional situations (like moist conditions of fill, etc.) The need for introduction of berms will also be kept in view where the fill height is in excess of 6 m.

Table: 7.1 — Recommended Side Slopes

Sr.No.	Type of Soil	Side Slopes (Horizontal: Vertical)
	Very Light loose sand to average sandy soil	21 to
11.	Sandy Loam	1.5: I to (in cutting) 2: I (in embankment)
	Sandy gravel/murum	1.5: I (in cutting) 1.5: I to (in embankment)
	Black cotton	1.5: I to 2.5: I (in cutting) to 3.5: I (in embankment)
	Clayey soils	1.5: I to (in cutting) 1.5: I to 2.5: I (in embankment)
	Rock	0.251 to 0.5: 1

(Source- IS Code 10430:2000)

7.2.2 Free Board

Free board shall be measured from the full supply level to the top of lining. Minimum free boards for various canal discharge-ares given below:

In deep cut reaches of canals with discharge capacity exceeding 10 cumecs, it is desirable to provide berms of 3m to 5 m width on each side for stability, facility of maintenance, silt clearance, etc. In such sections, the inner sides above the berms may be provided with turfing.

Table 7.2 — Recommended Free Board

Canal Discharge	Free Board
More than 10 cumecs	0.75
Between 3 to 10 cumecs	060
I to 3 cumecs	0.50
Less than I cumecs	0.30
Less than 0.1 cumecs (Water Course)	0.15

(Source - IS code 10430:2000)

7.2.3 BankTop Width

The width of the banks may vary according to the importance and capacity of the canal. In case of distributaries, service road should be provided on one bank for inspection and maintenance purpose. However, in case of main and branch canals service road should be provided on both the banks. The minimum values recommended for top width of the bank are as follows:

Table 7.3 —Recommended Top width

Discharge (m3/s)	Minimum Bank Top Width	
	Inspection Bank/ Wider Bank (m)	Non Inspection Bank/Other Bank (m)
0. 15 to 1.5	4.0	1.5
1.5 to 3.0	4.0	2.0
3.0to 10.0	4 0 + dowel	2.5
10.0 to 30.0	5.0 + dowel	4.0
30 0 and above	6 0 + dowel	5.0

(Source - IS 10430:2000)

7.2.4 Dowla (Dowel 'DwarfBund')

Suitable dowels may be provided on the canal side of the service road, on one or both the banks depending upon the type and size of the lined canal. From economic consideration, dowels may be replaced by parapets particularly in case of high embankments. However, the parapet should not be considered additional free board. To check the ingress of rain water behind the lining of the side slopes of the canals, horizontal cement concrete coping 100 mm to 150 mm thick, depending upon size of canal should be provided at the top of lining. The width of coping at the top shall not be less than 225 mm for discharge up to 3 cumecs, 350 mm for discharge more than 3 cumecs and 550 mm for discharge more than 10 cumecs.

7.2.5 Cross-Section, Discharge and Velocity

The cross-section of lined canal may be:

a) Trapezoidal with or without rounded corners. This section can be used for all types of lined canals.
b) cup shaped It may be used for distributaries/minors for discharge up to 3m/s as far as possible.

The discharge that can pass through a canal section is calculated by

Q = A X vmean (m^3/s)

where

A - area of cross-section in m2

Vmean- mean velocity in m/s.

The mean velocity Vmean is given by:

$$\frac{R^{2/3} \times S^{1/2}}{} \text{ m/s}$$

Where,

R= hydraulic mean depth (= A/P) (m);

A= cross sectional area (m^2);

P= wetted perimeter (m);

S= longitudinal slope of water surface

n= rugosity coefficient as given in Table 7.4 below:

Table 7.4 — Recommended Rugosity Coefficients

Sr. no	Surface Characteristics	Value of 'n'
1.	Concrete with surface as indicated below:	
	a. Formed, no finish tiles or slabs.	0.018-0.020
	b Gunited finish	0.015- 0.018
	c. Float finish	0.018-0.022
	d Float finish some gravel on bottom	0 018-0.020
	e. good section	0.024-0.026
	f. Gunite, wavy section	0.018-0.022
2.	Concrete bottom float finished sides as indicated below:	
	a. Dressed stone in mortar	0.015-0.017
	b Random stone in mortar	0 017-0.020
	c. Cement rubble masonry	0.020-0.025
	d. Cement rubble masonry plastered	0.016-0.020
	e. Dry rubble (rip rap)	0.020-0.030
3.	Gravel bottom sides as indicated below:	
	a. Formed concrete	0.017-0.020
	b Random stone in mortar	0 020-0.023
	c. Dry rubble (rip rap)	0.023-0.033
4.	Brick	0.014-0.017
5.	Asphalt	
	a. Smooth	0 013
	b Rough	0 016
6.	Wood Planed Clean	0.011-0.013
	Concrete lined excavated rock with	
	a. Good Section	0.017-0.020
	b Irregular section	0.020-0.027

(Source - IS 10430:2000)

The critical velocity ratio should be aimed at higher than unity or by any other method, it should be ensured that silting will not take place in the lined canal. The minimum average velocity is between 0.6 m/s to 0.9 m/s. In this range it will prevent growth of vegetation that might decrease flow carrying capacities

Limiting Velocities in Different Types of Lining:

The maximum permissible velocities for guidance for some types of lining are given below:

a) Stone-pitched lining 1 5 m/s

b) Burnt clay tile or brick lining 1.8 m/s

c) Cement concrete lining 2.7 m/s

B/D ratio is provided under the following table 7.5

Table 7 . 5 — Wood's Table for B/D ratio Fixation

Discharge		B/D Ratio					Slope 1 in....		Mean V	
Cusecs	Cumecs		ft						ft./sec.	m/sec.
10	0.283	2.9	4.75	45	1.60	0.49	3333	0.92	13	0.344
25	0.708	3.4	7.25	221	2.15	0.66	3636	1.0	.39	0.424
50	1.416	3.7	10.25	3.13	2.75	0.84	4000	1.00	.56	0.476
100	2.832	4.2	14.50	4.42	3.40	1.04	4444	1.00	.82	0.555
250	7.079	4.5	22.00	6.70	4.70	1.43	4444	1.01	2.30	0.700
500	14. 158	5.7	32.00	9.75	5.65	.72	5000	1.00	2.54	0.775
1000	28 315	7.6	50.00	15 28	6.50	.98	5000	1.03	2.89	0.880
2000	56 630	11 3	83.50	25.41	7.40	2.26	5714	1.03	3.10	0.945
5000	141.575	22 5	185.00	56.50	8.20	2.50	6666	0.98	3.20	0.975
10000	283.150	41.0	345.00 360.09	05.00 110.00	8 50 8.80	2.59 2.68	6666 8000	I .02 0.93	3.38 3.13	1.030 0.955
20000	566.300	780	696 00	212.00	8.90	2.72	8000	0.94	3.20	0.975

(Source — Irrigation and water power Engineering by B.C. Punmia)

7.3 Calculation Of Cross Section and Velocity

Now, as per the design of canal the channel is nonstable and non-regime because silt which is entered the channel is not carried by suspension. For sandy loamy soil which is 7 to 20% clay, more than 52% sand therefore silty factor will be for 0.45mm mean diameter of soil will be as follows,

According to lacey's factor, f = 1.76V171d

-1 76 Vo.45 = 1.2

Taking the Value of n = 0.018 from IS 10430.2000

Therefore, mean velocity of flow

R2/3 xs1/2

______m/s

$6 \times R^{2/3}$X sl/2

The discharge is given by Q = Ax V

8 1

Q = 0.725 x r; x SZ

12.67= $0.725 \times r^{\frac{8}{3}} \times S^{\frac{1}{2}}$ X f = 0.603 X rl/3 X sl/2

1 0.603 X rl/3 X sl/2

1.2	1	1.99
0.603	rl/3	7-1/3

8 1.99

12.67= 0.725xrä x

12.67=1 0223xr 2 •5

r = 2.737m

s—2.22— —— 1.423m in 1000m 2.7371/3

Hydraulic mean Radius, R= 0.5r

R= 0.5 2.737=1 37m

v=o.556x1 37²/³ x1.423 ¹/²

V=O.81 m/s

The maximum permissible velocity for cement concrete lining is 2 7 m/s > 0.81 m/s Therefore, safe.

$$Area\ of\ canal = \frac{(B + 3D + B)}{2} \times D$$

Fixation of B/D ratio using Wood's Table,

For discharge of 12.67 cumecs, the B/D ratio will be 5.45 by interpolation of data.

Put, B- 5.45 D A = 7.45 1)^2

Q= A× V

12 67=7.45 D^2 xO.81

D = 1.45m-Take D= 2m

B = 7.89 m Take B= 8.5m

Therefore, Provide Freeboard = 0.5m from IS 10430•2000

As the Discharge capacity is greater than 10 cumecs. According to IS 10430:2000, Provide berms = 4m.

Provide dowels on the canal side of the service road, Width of coping should be 550mm.

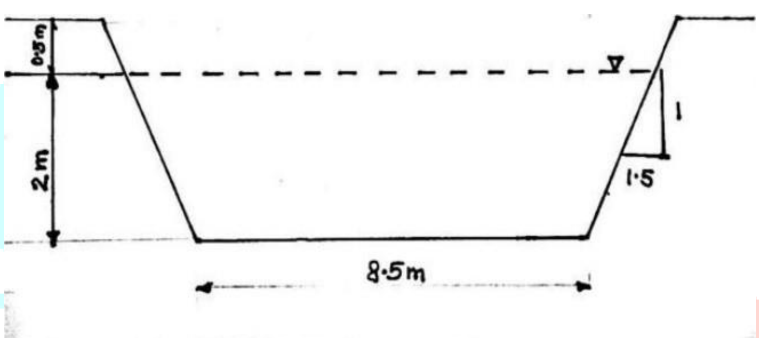
Provide Inspection Bank/ wider Bank to satisfy minimum Bank top width = 5.55m.

For Minimum Radius (Rm) of the curve allowable would be in following cases

In firm soils, Rm = width in m

In loose soil, Rm = 30 to 50 width in meter

Therefore, Minimum Radius or curve of canal (Rm) = 30 x 8.



8.3 Cost Estimation for drainage Canal

Item No	Item	Unit	Rate (Rs)	Quantity	Cost (Rs)
	Excavation in different types of soil and rocks in canal bed and side slopes for lining sleepers, dressing to the profile and disposal of excavated material	Cum	504	24,150	1,21,71,600
	Tamping in canal bed and sides including saturation upto 30cm depth for preparation of earthen subgrade.	Sq.m	10.50	630	6,615
3	Providing and laying free drainage sand bed and side slopes including compaction as per specification.	Cum	105	9,660	0, 14,300
	Concreting work for wall with 40mm stone ballast including formwork, cleaning, vibration, etc.,	Cum	8,213	5,250	4,31 18,250
5	Concreting work for slab with 40mm stone ballast including formwork, cleaning, vibration, etc.,	Cum	8,213	9,660	7,93,37,580
6	Steel work, bending , binding and cracking of bar a) For walls b) For slab	Kg Kg	42 42	676,147.42	1,03,04,788 3,31,02,221
7	Specialized Workers	Per day			
8	Providing a waterproof coat in canal surface	Sq.m	1 1.90	23,415	
	TOTAL				18,12,33,992

CHAPTER - 7

Conclusion

The present study was successfully employed for assessment of spatially and temporally distributed waterlogged areas in order to evaluate the impact on urban area of Vithalvadi Ulhasnagar day by day the amount of water logged areas are increasing. Due to rapid urbanization with unplanned construction, most of the storm water drainage have been encroached, filled up, diverted and caused obstruction to the smooth flow of water to the outfall-rivers, creating severe water-logging in the city every year during monsoon incurring huge loss in terms of adverse social, physical, economic cost. With the help of GIS technology the acquisition of recent information about water logging studies aimed at solving urban problem. In future there is always a possibility of experiencing heavy rainfall causing water logging in many areas.

The region of Vithalvadi Ulhasnagar was experiencing losses during heavy rainfall in recent years frequently. The quantification of the area vulnerable to waterlogging of different frequency of occurrence has been studied. The study conducted includes application of Geographic Information System (GIS) systems for estimating the runoff and region affected. With the help of these data, it has been concluded that the region affected requires drainage channel of size 8.5x 2.5m. The cost of construction of drainage canal computed is around 18 crores. According to survey the average loss is of approximately 80 lacs each year which include losses of life and property also. Thus the provided solution is most viable in such cases. The use of QGIS has proved beneficial and to carry the work smoothly. As a result of proposed RCC canal, the water logging, silting, the maintenance cost can be significantly decreased consequently flow velocity, conveyance efficiency can be increased. The initial investment of RCC canal seems to be very high but proves to be helpful in long terms benefits for a city like Vithalvadi.) Total runoff of the study area has been calculated based on the topography and rainfall data. Total length and width of the canal has been proposed using manning's formula. The proposed modified drainage system using GIS technology will help in proper draining out of storm water from the study area. This study can be applied for the designing of the storm water system of other cities.

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