

# Mapping of Sanitary Sewer Network for Cherpulassery Town Area using QGIS

Sunaina.K<sup>1</sup>, CHINNAMMA.M.A<sup>2</sup>

<sup>1</sup>PG student, Dept of Civil Engineering, Malabar College of Engineering & Technology, Kerala, India

<sup>2</sup>Professor, Dept of Civil Engineering, Malabar College of Engineering & Technology, Kerala, India

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**Abstract** - India has been undergoing rapid urbanization since independence. In almost all of India's cities, developments in the water supply sector have outpaced those in the drainage sector. With increasing water supply to cities, drainage managers are faced with additional wastewater from the highly populated areas for which the existing drains are totally inadequate. So, the project focuses on the assessment of drainage systems in Cherpulassery municipality town area using Google Earth Software & Q GIS software. Geographical information system (GIS)-supported sewer-system analysis has major advantages over the use of traditional standalone sewer programs, especially with regard to establishing network topology, input of sewage contribution data, querying, displaying and mapping of results. This paper reports on the development of a base map or spatial map for cherpulassery Municipality. Based on primary and secondary data collected, the problems in this area are categorized as mainly construction, management, and design problems. The method used to investigate problems in the existing drainage network of the above-mentioned area is field data collection and site visit. By using Google Earth Software, the catchment area of Cherpulassery has been defined. This project mainly focuses on development a base map for the study area for future reference. Q GIS software allows projects to be accomplished in a short time, with high efficiency and low costs.

**Key Words:** sanitary sewer, Drainage, management, design, Google earth, Q GIS , etc

## 1. INTRODUCTION

Population density and urbanization can create acute problems in urban wastewater management. Proper functioning storm and sewer water drainage systems are the utmost need to safely discharge the runoff water. A scientific drainage system to receive storm water is the lifelong goal of the community, particularly in developed cities. Hydroplaning is the need of the hour, especially for low lying areas. Most significant factor in designing drainage is the intensity of rainfall and the catchment characteristics. The drainage should be designed in such a way that it must have sufficient capacity to control the flood and reduce the pollution impact on runoff. In the design of every drainage system, there are certain constraints with respect to social, environmental, and economic factors. Inappropriate drainage systems give rise to fatal nuisance in public's

everyday life. In drainage design the main purpose is to identify a shape, dimension, and lining materials that will satisfy to allow the peak flow rate at a reasonable cost. And it must also produce enough shear stress on the bottom of the channel to prevent solid accumulation under minimum flow condition. Drainage design is basically based on quantity estimation of excess water/ runoff. Developing countries like India should never be lagging behind in the field of urban drainage. Wastewater management is required to save the preservation of water, health of the public, need to fight for a sustainable environment, welfare and safety of the public etc.

### 1.1 STATEMENT OF THE PROBLEM

In Cherpulassery, population increases rapidly due to urbanization and also the town is developing in an unplanned way. The Previous surface reduces day by day as the city is now in the period of rapid urbanization. For the development, drainage lines and vacant land of the town area are being occupied. As a result imbalance situation can create between impervious and pervious cover. New developments increases impervious area consequently increases peak storm water runoff with its associated problems of flooding, water quality degradation, erosion, and sedimentation.

Lack of proper urban planning can lead to disruption of the sanitary system, resulting in foul odours and mosquito breeding grounds. Some of the drainage structures are not efficient to carry the discharge. Improper drainage systems can create water logging especially in low lying areas. It needs a modification either in the maintenance of proper invert level or provision of required cross sectional area for the flow. Due to deficiency of periodic maintenance, all the drain sections are reduced by sediment deposition. Due to improper management of solid waste some drains are blocked.

### 1.2 SIGNIFICANCE OF THE STUDY

The motive of this project is to evaluate the existing drainage conditions and identify the major deficiencies which create a lot of drainage problems in cherpulassery town area. This study will also help to solve the drainage problem at the study area and contribute better service in future. To understand the causes of blockage of existing drains and water logging in low lying areas and recommend for taking

correct measures to avoid damage to the structure and improve the drainage facility in future.

### 1.3 OBJECTIVES

- The goal of this Project work to solve the drainage problem in Cherpulassery region.
- To study the present condition and problem related to existing drainage system at Cherpulassery
- To prepare a base map of the existing Road network system
- To prepare a base map the existing sewer collection system

### 1.4 SCOPE OF THE STUDY

The major scope of work includes the following:

- To develop a digitized GIS map for future maintenance work.
- Improper drainage system can create overflow in sewer lines. This study will help to control the overflow in sewer line

## 2. METHODOLOGY

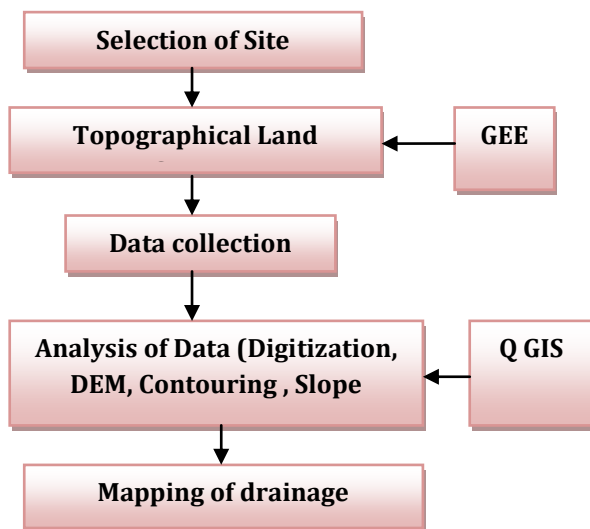


Fig - 1. Flow chart for methodology

### 2.1. SELECTION OF SITE

The Cherpulassery Municipality, Kerala is located at 10° 52' 45.48" N, 76° 18' 53.1" E. It has an average elevation of 66 meters (217 feet) .North region of Cherpulassery municipality is Thoothapuzha (Aliparamb Panchayath, Malappuram Dst). South region includes Chalavara and Thrikkadiri GramaPanchayaths. The west region includes Nellaya GramaPanchayath and the east part is Vellinezhi GramaPanchayath. The Municipality has a total area of 32.68 Sq Km which is divided into 33 wards. As of the 2011India

census, Cherpulassery had a population of 39919. Cherpulassery is one of the populated regions in Palakkad district. Males constitute 48% of the population and females 52 %.

In this paper the cherpulassery town area is the selected study area and it is divided in to 7 zones. The seven zones are situated in Mandakkari WardNo.13,illikottukurussi Ward No.14, puthanalkkal Ward no.15, Secretarypadi Ward No. 24,Cherpulassery Ward no.25, Kaavuattom Ward No.26. The maximum ground elevation of 87.0 m was observed in ward No.25 ( Panniyamkurussi side) and the lowest elevation 40.0 & 39.4 was observed in Ward No.24 & Ward No.15 . The planning has been made to locate the outfall of the sewer in the ward No. 13, 15 & 24.

#### 2.1.1. Detailed description of the study area.

The project covers the 0.947Sq Km, ( Ward No.13, Ward No.14,Ward No.15,Ward No.24, Ward No.25, & Ward No.26. The entire town and environment are plain and the general slope is from north to south. The town is situated at the altitude of 10°52'44.06"Nlatitude and 76°18'40.92"E longitude. The soil of the area is gravel, rocky and a large proportion of sand and gravel. All the aspects of cherpulassery, palakkad climate and topography, its population growth rate is to be considered while designing the project. Population data were collected from cherpulassery municipality. Existing drainage facility, land use and topography details were collected from municipality and other required details were collected from Cherpulassery municipality.

TABLE 1 Details of STUDY AREA

SL NO.	ZONE	NAME	PERIMETER in kilometer	AREA in hectares
1	Zone 1	Ayyappankaau - Cherpulassery school side	2.54 km	14.11
2	Zone 2	Ayyappanka side	1.88 km	16.81
3	Zone 3	EMS - ottappalam road	1.97Km	18.49
4	Zone 4	Mandakkari - puthanalkal road	2.10Km	15.56
5	Zone 5	Kacherikunnu side	1.59 Km	10.26
6	Zone 6	Cooperatie Hospital side	1.59km	11.8
7	Zone 7	Karunys Hospital side	1.11Km	7.06

## 2.2. POPULATION FORECASTING

Design of sewerage system should be carried out using projected population of a city because any underestimated value will make the system inadequate for the purpose intended, similarly overestimated value will make it costly. The population has been forecast for the design period of 30 years using geometric progression method as it was observed that nature of the development of the city is rapid growth pattern. The projected population is shown in Table 1 for the zones.

TABLE - 2 Details of Population forecast

Year	Population	Incremental	Incremental
1991	23462		
2001	30730	7268	
2011	39919	9189	1921
Average		X=8228.5	Y=1921

$$P_n = P_0 + n \cdot X + \{n(n+1)/2\} \text{Base period as } 2020,$$

$$P_{2020} = 39919 + .9 \times 8228.5 + \{(.9 \times 1.9/2) \times 1921\} P_{2020} = 48967.105$$

$$\text{Intermediate period as } 2035 \quad P_{2035} = 39919 + 2.4 \times 8228.5 + \{2.4(2.4+1)/2\} \times 1921 = 67505.08.$$

Ultimate design period as 2050,

$$P_{2050} = 39919 + 3.9 \times 8228.5 + \{3.9(3.9+1)/2\} \times 1921 \quad P_{2050} = 90365.305$$

At design period of 30 years the forecasted population of the entire cherpulassery municipality is 91000 and the population of the project area is 27000.

## 2.3 GOOGLE EARTH ENGINE (GEE)

GEE provides an online coding environment that can guarantee relatively rapid, distributed-cloud geospatial processing and analysis of large satellite image datasets that are convenient for everyone. It provides access to publicly available Sentinel-2A images and large-scale remote sensing analysis algorithms. Therefore, GEE is used to code, analyze, and generalize the principal rivers, lakes, and reservoirs that could be derived from Sentinel-2A imagery of the cherpulassery town area. Corresponding to the latest temporal resolution and highest spatial resolution data available freely in GEE, Sentinel-2A OLI images that completely covered the whole cherpulassery municipality were collected from November 20 to 31 June 2021. Sentinel-2A images, obtained from the GEE platform throughout, were considered to be Level 2 products and archived as top-of-atmosphere reflectance collections. The preprocessing work, including stitching images and masking clouds, was

coded and executed through the developed application programming interface (API) in the GEE platform. To reduce the influence of seasonal variability on the identification of waterbodies, satellite images in summer were preferred, because plentiful water contributed to the extraction of rivers and lakes during this period. A total of three rows and four paths in the Sentinel-2A images, and approximately 15 scenarios in 2020-21, were obtained and used to satisfy the basic coverage needs of the cherpulassery municipality.

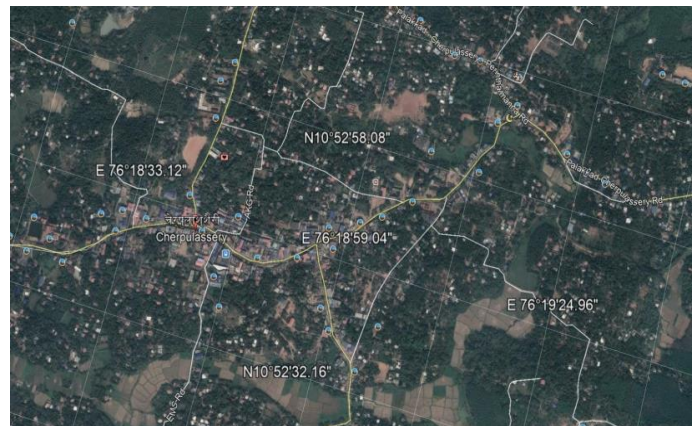


Fig. 2. Google Earth engine Arial view of study area

## 2.4 TOPOGRAPHICAL LAND SURVEY

Using the Q-GIS 3.16.7 software, the location of the study area is delineated and thus delineated map is developed. Next input was the terrain of the study area. The Digital Elevation Map (DEM) was developed with the help of Google earth and QGIS. From the DEM, flow of river, direction of flow and watershed in DEM could be produced. Our study area is digitized and delineated in Q-GIS. The delineated .tiff file of the study area was converted to metafile was the reference map for sewer pipe design projects.

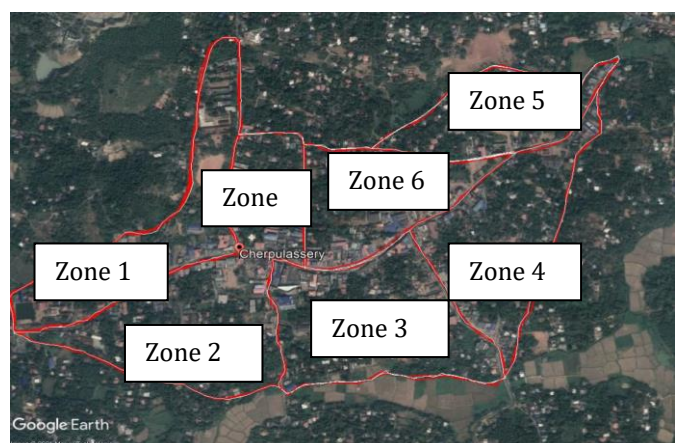


Fig 3.study area

### 2.4.1 Elevation

Using Google earth engine software, the slope elevation profile can be generated. In the toolbar, select add path, then first choose the starting point and end with the last point

.after that click the edit tool, select show elevation profile. Now we can understand the sloping nature of the terrain.fig 3.4.shows the details of elevattions from ayyappankaavu road to kacherikunnu road.

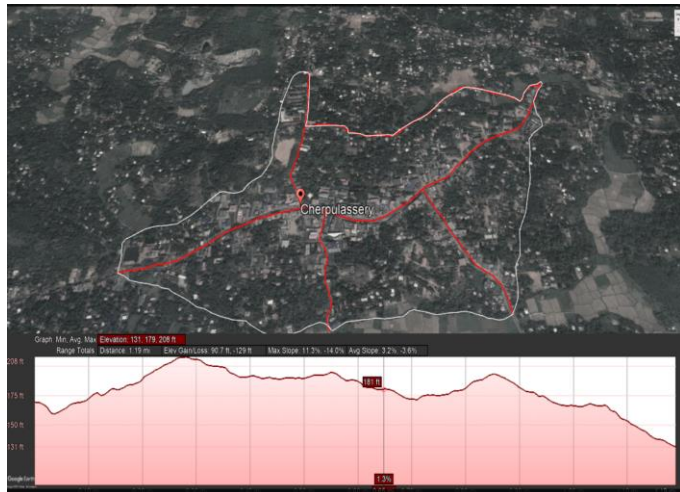


Fig 4. elevation profile details – ayyapankaavu to kacherikunnu main road

## 2.5 RASTER TERRAIN ANALYSIS

Certain types of raster’s allow you to gain more insight into the terrain that they represent. Digital Elevation Models (DEMs) are particularly useful in this regard. In this project ,we use terrain analysis tools to find out more about the study area. Terrain analysis tools to derive more information about the terrain.

### 2.5.1 DEM in QGIS

Creating DEM in QGIS using height point data is quite straight forward by using Natural neighbour tool from SAGA. The following steps will guide you how to do that using the tool.

1. Add elevation point’s data to QGIS as in figure 5

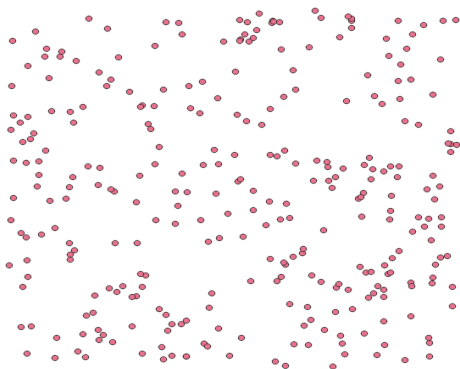


Fig 5. Elevation Points Data

2. Open Natural neighbour tool. The tool can be found in the processing toolbox. In the search field, just type *Natural*, the tool will be shown under SAGA as in figure 6.

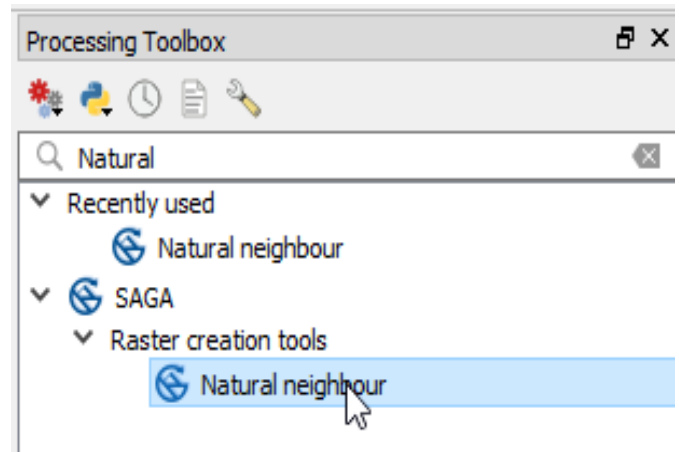


Fig.6. Natural neighbour tool

3. After opening the tool, a window as in figure 3.7 will appear. In this window we setup some parameters such as attribute for height value, method, output extent, cell size, etc.

4. After running the Natural neighbour tool by clicking the Run button. It will take sometimes, depends on the number of points. After finished, the DEM will be added to QGIS map canvas as in figure 3.8.

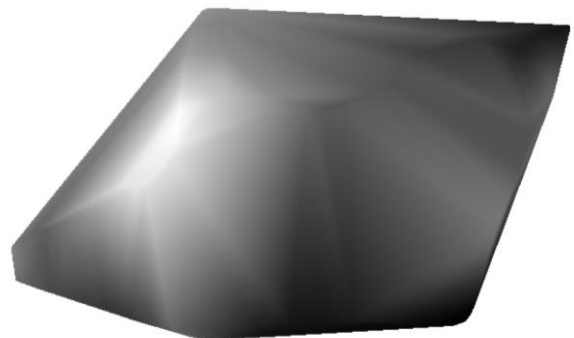


Fig .7.Digital Elevation Model of Study area

### 2.5.2.Slope

Another useful thing to know about the terrain is how steep it is. To do this, you need to use the **Slope** mode of the **DEM (Terrain models)** tool.

- Open the tool as before.
- Select the **Mode** option **Slope**:

- Set the save location to `exercise_data/residential_development/slope.tif`
- Enable the **Load into canvas...** checkbox.
- Click **OK** and close the dialogs when processing is complete, and click **Close** to close the dialog. You'll see a new raster loaded into your map.
- With the new raster selected in the **Layers list**, click the **Stretch Histogram to Full Dataset** button. Now you'll see the slope of the terrain, with black pixels being flat terrain and white pixels, steep terrain:

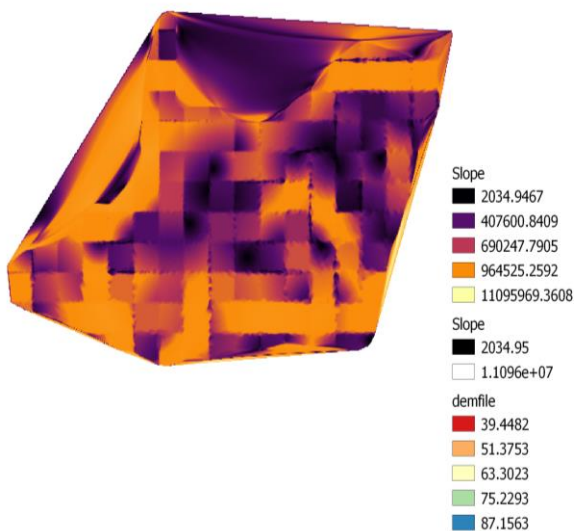


Fig. 8 Slope in Pseudo color

### 2.5.3. Hill Shade

The hillshade function produces a grayscale 3D representation of the terrain surface, with the sun's relative position taken into account for shading the image. Hillshading is a technique for visualizing terrain determined by a light source and the slope and aspect of the elevation surface. It is a qualitative method for visualizing topography and does not give absolute elevation values. This function provides two options for generating hillshades: traditional and multidirectional. The traditional method calculates the hillshade using an illumination source from one direction using the altitude and azimuth properties to specify the sun's position. The multidirectional method combines light from multiple sources to represent the hillshaded terrain. The advantage of the multidirectional hillshade method is that more detail is displayed in areas typically affected by

oversaturation and deep shadows than when using the traditional hillshade method.

- Click on the menu item **Raster > Analysis > DEM (Terrain models)**.
- In the dialog that appears, ensure that the **Input file** is the **DEM** layer.
- Set the **Output file** to `hillshade.tif` in the directory `exercise_data/residential_development`.
- Also make sure that the **Mode** option has **Hillshade** selected.
- Check the box next to **Load into canvas when finished**.
- You may leave all the other options unchanged.
- Click **OK** to generate the hillshade.
- When it tells you that processing is completed, click **OK** on the message to get rid of it.
- Click **Close** on the main **DEM (Terrain models)** dialog.

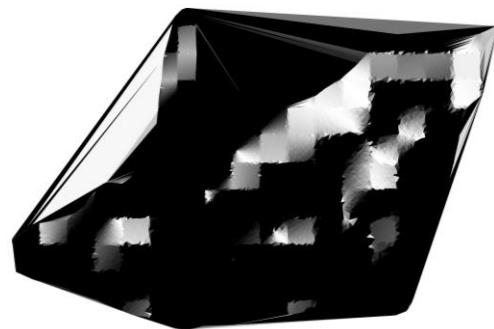
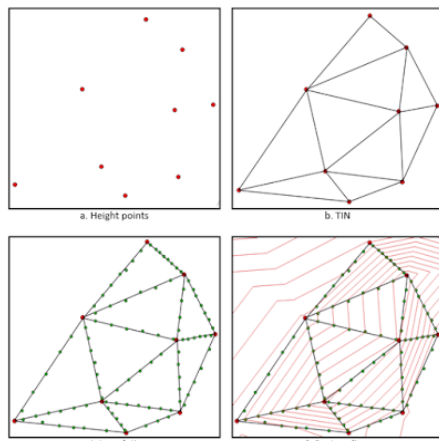


Fig 9. Hill shade

### 2.5.4. Contouring

The basic method in drawing contours line is interpolation from a point dataset. The simplest interpolation method is linear interpolation which is frequently used in drawing contours lines manually. In drawing a contour line with linear interpolation, at least three steps need to be done:

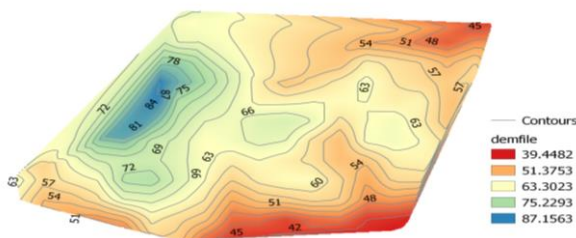
- Connecting each point to form a TIN (Triangular Irregular Network) structure.
- Do interpolation for each line in the TIN.
- Connecting the interpolation point with the same elevation. In drawing contour line from connecting each point to form TIN, do interpolation along the TIN line and drawing contour line by connecting the same elevation of interpolation points.



**Fig .10.contour line drawing**

Making of contour lines from points dataset with the following steps:

1. Add the points into QGIS map canvas as in figure 3.6.
2. Open the Contour plugin by clicking the icon. The contour plugin window will appear as in figure 3.12.
3. Select the point's layer name and the elevation data field. In the contouring menu, we can choose to create contour line, filled contour or both. Next, we have to define the number of contour lines.
4. Next we can specify the output name. The output will be written to memory, so we need to export to it to a GIS file to keep it permanently.
5. In the next setting we can specify the precision and unit for the contour label. Furthermore the color graduation for the contour lines can be changed by selecting a color ramp for the output contour lines.
6. When finish click the Add button. The result can be seen in the QGIS map canvas without closing the contour plugin window, therefore we can switch back to change a parameter if the result not looks as we want. Figure 3.14 shows the result of contour lines.



**Fig. 11.countour lines**

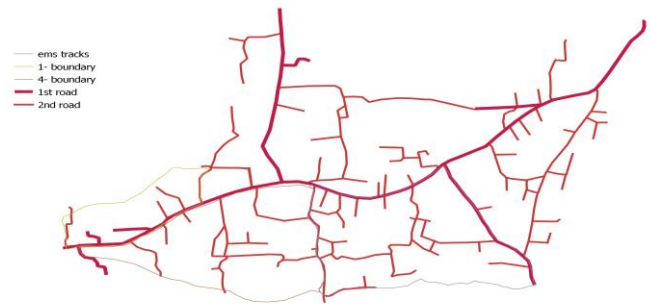
### 3. RESULT & DISCUSSIONS

A GIS map was derived from Google Earth which was converted to shape file format in QGIS environment. Such maps contained the spatial information on road network & drain lines within the ambit of zone 1 TO 7. An intensive GPS enabled field survey was used to obtain information of geographic coordinates and altitudes of all

the drains using (android version) GPS essentials. Additional information on the length, breadth and width of the drain lines were physically verified in field. The necessary manipulations were done, while maintaining the appropriateness of the data. From the study, it was observed that are in total 119 drains are mapped from Google Earth. The proposed STP locations is in between EMS road & ottappalm road .This place is more economical than other because it is the lower area. it's in low area, more space and existence of the town and also covered more area to collect wastewater. And the STP is near to kormba channel. It means treated of wastewater is poured into the channel for agricultural purposes .

### 3.1. ROAD NETWORK MAPPING

With the help of Google earth engine & Q GIS the mapping of road network was done quickly.



**Fig 12.Road network map**

**Table 3. important main road & branch road details**

SI NO.	Road	Name	Length in km
1	Main road 1	Ayyappankaavu to kacherikunu	1.93
2	Main road 2	Ottappalam Road	0.53
3	Main road 3	Schoolroad	0.66
4	Branch road 1	EMS road	0.43
5	Branch road 2	Devi theatre road	0.17
6	Branch road 3	Municipality side Road	.23
7	Branch road 4	AKG road	0.4
8	Branch road 5	Cooperative hospital side road	0.1

9	Branch road 6	Mandakkari side road	0.65
10	Branch road 7	Cherpulassery road 1	0.43
11	Branch road 8	Akg road2	0.23
12	Branch road 9	Lakshmi auditoriumside road	0.53



Fig 14. .Digitized Map - Details of road, buildings & boundary

### 3.2.DRAINAGE NETWORK

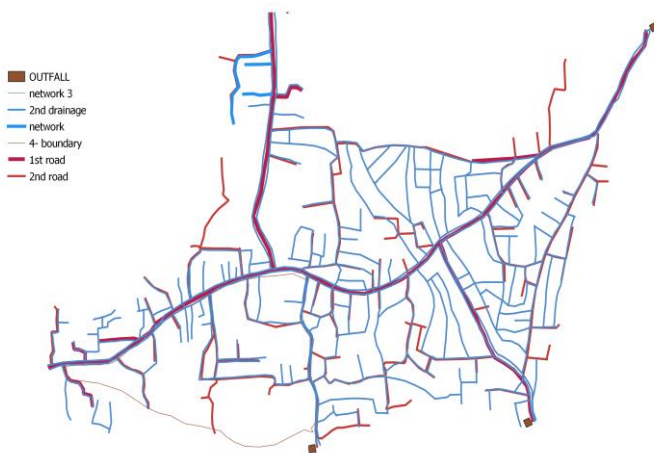


Fig 13. Drainage network

SlNo.	Drain	Place	length
1	Main drain1	Ayyapankaavu to kacherikunnu	1.975 km
2	Main drain 2	Ottappalam road	0.5626km
3	Main drain 3	Ems side	.447km
4	Main road 4	High school side road	0.66km
5	Sub drain1	Ayyappankaavu side	0.17km
6	Sub 2	Lakshmi auditoriumside	0.21km
7	Sub 3	dharmasastha	0.52km
8	Trunk pipe	Ems road - ottappalam road	0.41km

### 4. CONCLUSIONS

The mapping of sanitary sewer network for Cherpulassery town area using GIS has been successfully conducted. The main objective of this project is to prepare a base map of work area, contour road network which is also useful for sewer line as sewer lines are located in the centre of road. And the STP locations are also important part of this project.

#### 4.1. Future scope

The data is well created such that upgrading is easier.

- User can quickly identify features by simple querying.
- If a fault happens in the network and if the concerned engineer knows the place of fault then he can obtain all the information about the network by querying GIS and can rectify the problem at the earliest.
- Using a GIS you can enter new data or modify existing data. This example shows a GIS interface that allows easy editing of geographic data and the display of related documents.

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