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Development of Sewerage system of developing city using Geo-Informatics Technology

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Abstract—In all developing city, there is a great need of improvement of sewerage system due to population growth and city planning. Therefore, it is required to assess the adequacy and condition of existing sewerage system in the city area and for suggesting improvement in the design and planning of new system. For this a part of Gandhinagar city which is fast developing has been selected for the present study. GIS technology and SewerGEMS software has been used in identifying the sewerage network problem and solving the same considering present and future need of the Gandhinagar City.

Keywords-component: Sewerage System, SewerGEMS V8i, GIS, population growth

I. INTRODUCTION

Sewerage networks are an imperative part of the infrastructure of any society. The main purpose of providing the sewer network is to take away sanitary waste from a municipal area in such a way that it does not cause any public health related problems. It is known that urban sewerage system provide one of the essential infrastructure facilities to transport sanitary waste to sewage treatment plant. Sewerage network infrastructure conveys wastewater used by individuals, commercial and industrial establishments to wastewater treatment facilities, ultimately to be returned to the natural environment. It involves a huge cost with need for daily maintenance, and the operational coast is one of the major expenditures. The existing sewerage system performance should be as per the SLB, 2006. First we have to identify the problems occurred in existing system. The computer software package SewerGEMS V8i is the most helpful tool of the purpose of designing a cost-effective sewer network since it can give the optimum cost and practically feasible layout which can handle a large network. The program selects automatically pipe diameters by considering the flow in the pipe velocity and slope requirements.

II. GENERAL INFORMATION ABOUT GANDHINAGAR CITY

A. Gandhinagar City

Gandhinagar is the capital of Gujarat state, west-central India. Gandhinagar lies on banks of the Sabarmati River. Gandhinagar occupies an area of 57 sqkm. It is about 24 km to the north east of Ahmedabad. The concept of the city is based on the grid iron pattern similar to that of historical Jaipur and Chandigarh, the grid being formed by seven roads in each direction cutting each other perpendicularly. Gandhinagar is known as second planned city in India after Chandigarh. It has a population of 2,92,797 as per the 2011 Census.

Figure 1. Road Connectivity of Gandhinagar City

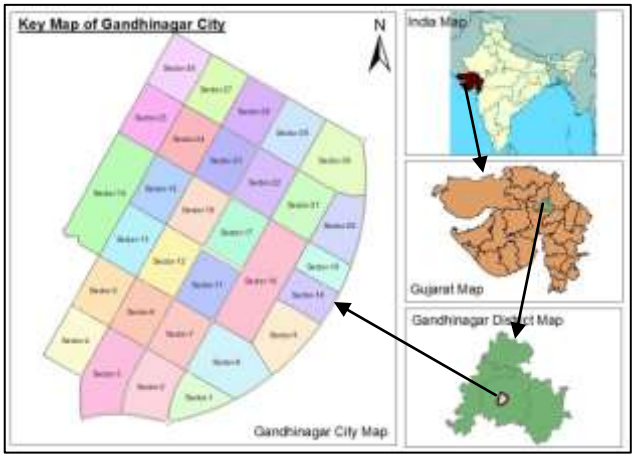

Figure 2. Key Map of Gandhinagar City

B. Existing Water Supply and Sewerage arrangement

As per the information of Capital Project Division, Gandhinagar, the current water supply in the city is 75 MLD. Sewerage system was designed and constructed in 1970 in the city. The whole wastewater from city is taken by underground pipes

and collected in Sargasan Drainage Pumping Station. From this Pumping Station Wastewater is pumped and transferred to Jaspur Wastewater Treatment Plant through Rising Main & Sargasan STP. But Sargasan STP utilizes 50% of its total Capacity.

Table 1 Existing STP Details

STP Location	Capacity	Used by Gandhinagar City	Use of wastewater
Jaspur	90 MLD	55 MLD	Agricultural
Sargasan	10 MLD	5 MLD	Gardening purpose

III. IDENTIFICATION OF PROBLEMS IN SEWERAGE SYSTEM

A. Financial Assessment

The Capital project is responsible for sewerage system of overall Gandhinagar city. Capital Project sewerage system department expenditure shown in the below chart. Last five year average sewerage system department expenditure is 26.28%. Capital project expenditure cost is eleven times more than the revenue generation from sewerage system. It's not a self sustain financial system.

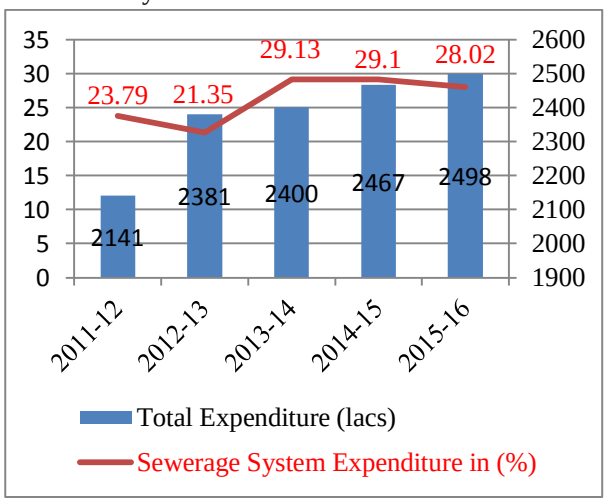

Figure 3 Percentage sewerage system expenditure to total department expenditure

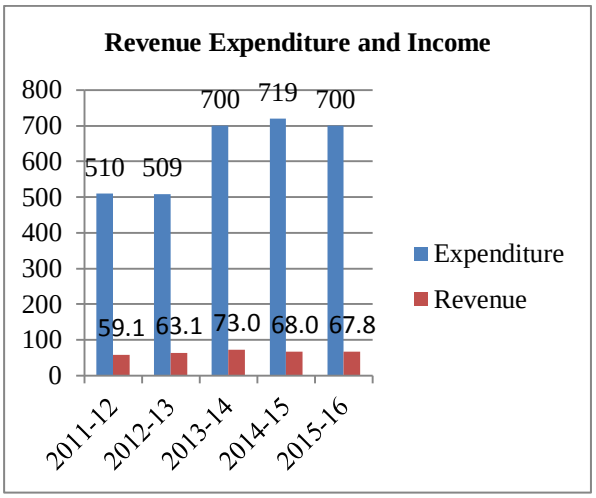

Figure 4 Revenue Expenditure and Income

B. Household Assessment

In Household assessment Quessionary Survey form are made and by local people. From which major problems identified are cleaning of drainage line, sewage chock up in pipeline, drain overflow and sometimes sewer line were overflow and waste water come outside and stagnant for more than 2 to 5 days which creates unhygienic condition for people residing in surroundings.

C. Inquiry Data Analysis

Total 24662 complaints are recorded. From which 14810 complaints are redressed during 24 hours or next working day (data from Performance Assessment made by department in 2015-2016). As per Handbook of SLB, 2006, Efficiency in Redressal of Customer Complaints must be 80%. For Gandhinagar city redressal of complaint is 60.05%. Hence, it is better to reconstruct the existing sewerage system.

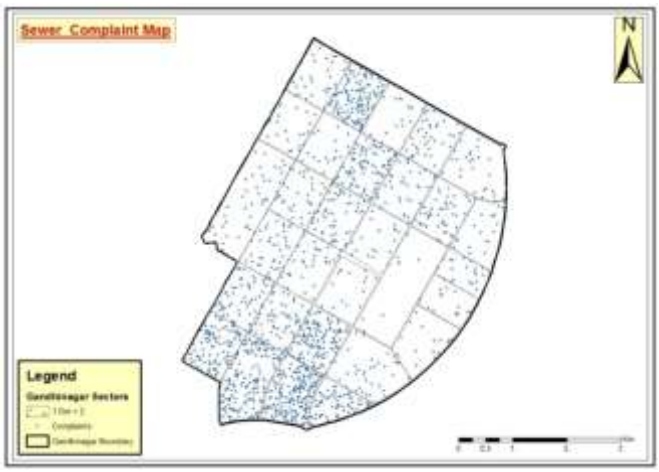

Figure 5 Sewer Complaint Map

IV. GIS ANALYSIS OF GANDHINAGAR CITY

A. Liss-IV Image of Gandhinagar City

The satellite data of study area collected from IRS-P6 (with sensors LISS-IV) for the 3-D visualization.

Figure 6 Liss IV Image

B. Topographical Condition

3D Surface relief map showing conoturs (m) and slope direction shown in below map. Below map clearly show the slope of area and flow direction of Gandhinagar City.

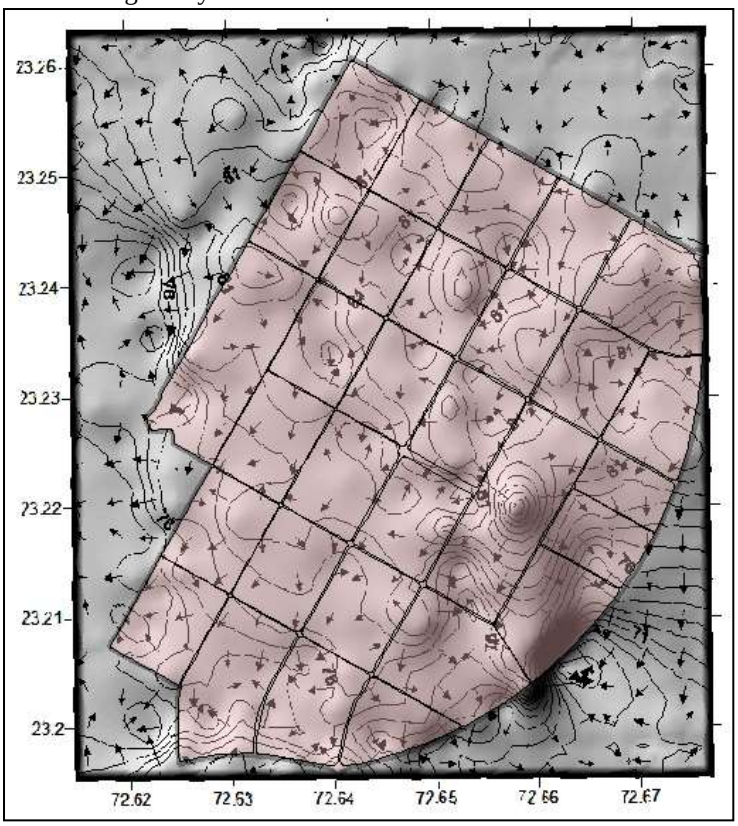

Figure 7 Topographical Map

C. Slope Map

Slope map has been prepared from DEM and analysis has been done to find out various categories of slope and their percentage.

Figure 8 Slope Map

D. Population Growth and Population Forecast

Gandhinagar population has grown from 24,055 in 1971 to 2,92,797in 2011. The projected populations for the design horizons for 2016, 2031 and 2046 are 3,79,541, 8,49,111 and 19,78,618 respectively. For design purpose only sector-2 is considered as pilot project. As per the growth of population of Secotr-2 for design purpose population forecasted by Geometrical progression method is considered.

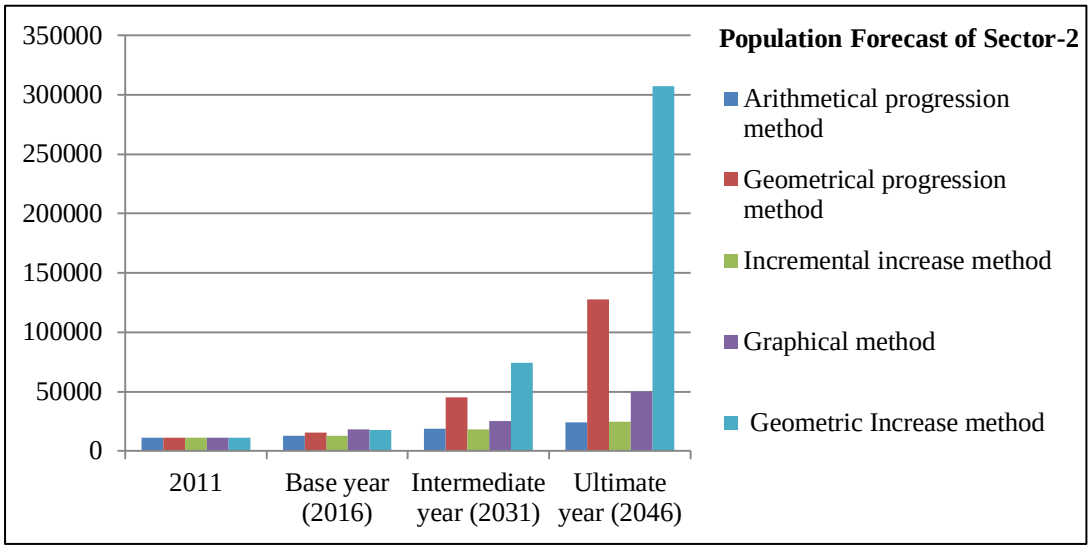

Figure 9 Population Forecast Sector-2

V. RESULTS AND DISCUSSIONS

SewerGEMS V8i is an extremely efficient tool for laying out a sanitary sewer network. It is easy to prepare a schematic or scaled model and let SewerGEMS V8i take care of the link-node connectivity. In constructing the network for this lesson, you do not need to be concerned with assigning labels to pipes and nodes, because the software assigns labels automatically. A schematic drawing is one in which pipe lengths are entered manually, in the user defined length field. In a scaled drawing, pipe lengths are automatically calculated from the position of the pipes 'bends and start and stop nodes in the drawing pane. Sector-2D, Gandhinagar city has designed for the large network of 4376 meters, in that 313 meters of sewer network of Manhole 19-35 can be shown Fig.9 and the results are tabulated in table 2.

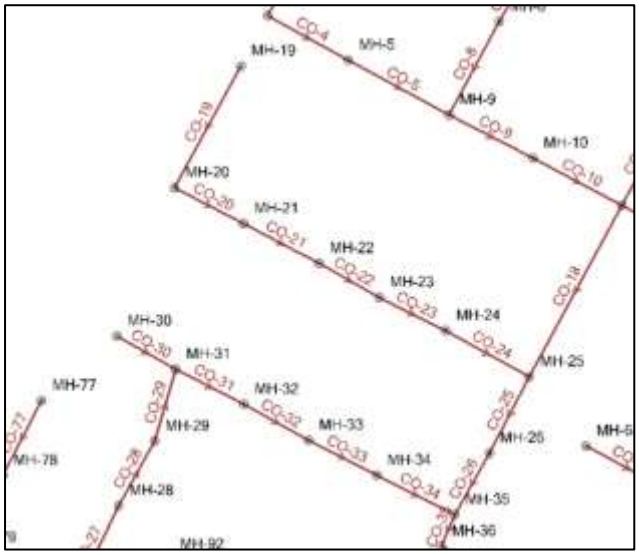

Figure 10. Network Layout in SewerGEMS

Table 2: SewerGEMS V8i results

CO-19	MH-19	74.93	MH-20	74.89	31.8	1000	Circle	150	0.013	0.18	0.03	4.82	11.8
CO-20	MH-20	74.89	MH-21	74.65	17.9	73.006	Circle	150	0.013	0.6	0.04	17.82	8
CO-21	MH-21	74.65	MH-22	74.46	19.6	106.923	Circle	150	0.013	0.6	0.05	14.73	15.4
CO-22	MH-22	74.46	MH-23	74.35	15.8	138.072	Circle	150	0.013	0.6	0.06	12.96	24.1
CO-23	MH-23	74.35	MH-24	74.25	17	174.548	Circle	150	0.013	0.6	0.06	11.53	37
CO-24	MH-24	74.2	MH-25	74.09	22	189.436	Circle	200	0.013	0.6	0.06	23.83	21.5
CO-25	MH-25	73.99	MH-26	73.95	19.8	527.433	Circle	300	0.013	0.6	0.15	42.11	52.6
CO-26	MH-26	73.95	MH-35	73.92	16.2	540.576	Circle	300	0.013	0.6	0.15	41.59	55.3
CO-27	MH-27	75.93	MH-28	75.9	23	1000	Circle	150	0.013	0.2	0.04	4.82	17.7
CO-28	MH-28	75.9	MH-29	75.73	17	96.686	Circle	150	0.013	0.6	0.04	15.49	12.8
CO-29	MH-29	75.73	MH-31	75.58	17.2	118.165	Circle	150	0.013	0.6	0.04	14.01	18.3
CO-30	MH-30	76.93	MH-31	76.91	15.5	1000	Circle	150	0.013	0.2	0.03	4.82	17.7
CO-31	MH-31	75.22	MH-32	74.93	17.6	60	Circle	150	0.013	0.88	0.05	19.66	21.7
CO-32	MH-32	74.87	MH-33	74.78	17	198.48	Circle	200	0.013	0.6	0.07	23.28	23.2
CO-33	MH-33	74.78	MH-34	74.71	17.6	229.453	Circle	200	0.013	0.6	0.08	21.65	30.2
CO-34	MH-34	74.71	MH-35	74.63	20.1	243.066	Circle	200	0.013	0.6	0.07	21.04	33.8
CO-35	MH-35	73.87	MH-36	73.86	7.9	658.943	Circle	350	0.013	0.6	0.19	56.82	54.5

Here, the highlighted rows show that velocity is not as per CPHEEO manual criteria. This all manholes are starting manhole. As per CPHEEO manual, if we cannot get proper velocity we should provide flushing manhole at particular manhole. Hence, MH-19, 27 and MH-30 are provided as flushing manhole.

I. CONCLUSIONS

Following conclusion are made from the above study-

1. The performance of existing sewerage system is very poor as it is not a self sustain financial syste.
2. The system is not give a proper service as fixed in SLB, 2006 considering the criteria Efficiency of redressel of customers' complaint which is 60% and required 80%.
3. For analysis of the area Cartosat Liss IV and DEM is used in ArcGIS to identify the area, locality and topography of the area.
4. Designing of Sewerage System can be done most techno-economically by using "SewerGEMS" Software.
5. Less time spent to make the drawings by using the tools for labeling the system parts, updating data automatically for layout and longitudinal profile with the modifications we make along the designing process, calculating the pipe diameters automatically, using the features for creating the plotting drawings.
6. Due to the flat topography of Gandhinagar city there are many manholes where the adequate velocity cannot be get and mainly all are starting manholes. For getting proper velocity flushing manholes are provided.

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