# Design of Sanitary Sewer Network for Railway colony, Ratlam Using Sewer Gems V8i Software

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*Abstract :* The present study includes the use of sewer Gems v8i software for the design of the sewage system for the Railway Colony situated in Ratlam, Madhya Pradesh. SewerGems is computer Software Specifically developed for the purpose of design and analysis of the Sewer network. Bentley SewerGmes is the first and fully- dynamic,multi-plateform( GIS, CAD AND STAND-ALONE) sanitary and combined sewer modeling solution. The network consists of pipes of varying diameter, manholes and outfall. The application provides reports, layout, longitudinal or transverse cross section of the pipes network, displayed in an advanced graphics system based on AutoCAD technology. The study has been carried out to know the details of outfalls i.e. invert level, diameter conduit, covered area etc. from the information provided by officials of Ratlam Municipal Corporation and Indian Railway Department. After studying the Exiting scenario, it was identified that there exists no proper sewage system, and the untreated waste water is discharged directly into the city drain. In this work the sewerage network was designed considering the regulations put forth by covering bodies materials and the results obtained are well within the range.

***Index Terms*- Railway colony, Sewerage System, Sewer network design, Sewer Gems v8i, Auto Cade -**

## CHAPTER 1

## *Introduction*

### *1.1 General*

Half of humanity now lives in cities, and within two decades, nearly 60 per cent of the world's people will be urban dwellers. Urban growth is most rapid in the developing world, where cities gain an average of 5 million residents every month. The exploding urban population growth creates unprecedented challenges, among which provision for water and sanitation have been the most pressing and painfully felt when lacking. Drainage and sewerage system in urban areas is an important priority in India because of rapid urbanization, industrialization, and population growth, along with increase in slum population and migration. Thus, planning and designing of the sewer network is very important for metropolitan city.

For any city or town waste disposal is major concern for health and hygiene of people live there, but with the rapid growth of population and improvement in standard of living of people water consumption has also increased rapidly and ultimately leads to increased sewage and disposal of this sewage has become tedious. This has significant effect on humanity, wildlife and environment.

Though, the sewerage system has a very high responsibility of keeping the solids in suspension to avoid choking condition of sewer pipe by maintaining the minimum and maximum velocities as per CPHEEO Manual in each link. The construction of the sewerage system is an expensive task. Sewerage networks are an important part of the infrastructure of any society. The main purpose of providing the sewer network is to carry 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 provides one of the basic 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. A sewerage network is just a reverse action of water supply network. The cost of laying a sewerage system is appreciably high compared to the water supply system. It involves a large cost with need for daily maintenance, and the operational coast is one of the major expenditures. In respect of this view, many research works are being done to design a cost-effective sewerage network with the given constraints and guidelines. These difficult problems can be solved by means of the computer software package SewerGems V8i. The computer software package SewerGems V8i is the most helpful tool for 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 requirement. Considering above mentioned aspects an attempt has been made in present study to design and modify the sewer network for an existing area in Ratlam city. Railway colony area has been considered as case in the present study.

## CHAPTER 2

## *STUDY AREA*

### *2.1 General*

This chapter deals with the city profile of Ratlam, drains in Ratlam. Railway colony has been considered as case in the present study.

*2.2 City Profile*


**Fig-1 Google Earth map of Railway Colony, Ratlam**

Ratlam known historically as Ratanpuri is one of the important cities in the Malwa region in the state of Madhya Pradesh. The new city of Ratlam was founded by caption Borthwick in 1829 which had regular, planned and wide streets and well-built houses. In the year 1892 Ratlam was connected to Mumbai and Delhi through broad gauge railway line. In 1901 the city was connected with mhow and Neemuch using metre gauge line. The zonal office of Western railway was set up at Ratlam, thus providing Ratlam and important position in the railway map of our country. One of the major contributors to the development of the city has been the establishment of Ratlam as a major junction on western railways. Eventually industrial and commercial development has given impetus to the growth of the city.

Ratlam is the third biggest city in the state of Madhya Pradesh in terms of commercial and industrial activity under the Indore Agro industrial region from under the section 4 of City and Country act 1973. Ratlam city is the important centre of the agriculture business providing the intangible advantage to Indore and Baroda region.

Ratlam district is located on northwest part of Madhya Pradesh. It is one of the important tribal districts of Malwa regions of Madhya Pradesh. Sailana and Bajna blocks are major tribal blocks. The district is bounded by Mandsaur district in the north, Jhabua and Dhar district in the south, Ujjain and Shajapur districts in the east, Banswara district of Rajasthan state in the west and Jhalawar district of Rajasthan state in the northeast. The district area extends between the parallels of latitude 230 05' and 230 52' North and between the meridians of longitude 740 31' and 740 41' East, and it is falling in the Survey of India Topo Sheet No. 46I and 46M.

The total geographical area of the district is 4,861 Sq.Km, with a population of 14, 54,483 according to census 2011.

A Residential Colony known as Railway Kasba is existing near Ratlam railway station which stretches from 'Daat ki Pul' to the Railway Hospital. In the Census, Railway Colony is being considered as a separate Census city and is being administrated by Indian Railways. The maintenance of the colony premises, water supply, road etc is done by Indian Railways. For the purpose of City Development Plan, only the Population under administrative control of Ratlam Municipal Corporation has been considered while the Railway Colony is not included.

*2.3 Existing condition*

**SEWERAGE SYSTEM IN RATLAM**

This facility is available only for a length of 2 km in the Housing Board Colony. Even this small stretch of 2 km is very old, is not well maintained and is over flowing. According to the estimate of the Municipal Corporation, the city generates around 34 Metric Tons of sewage per day and there is no sewage treatment plant in the city. The sewer nallas drain in to the storm water drains without any primary treatment. There is no lined and covered drainage system. The storm water drain also serves as the sewage water drain. There are two main drains; both flow to a small lake nearby called Amrutsagar. The overflow from Amrutsagar Lake drains into river Mahi. Regular flow of untreated sewage has spoiled the natural beauty and biodiversity of the Amrutsagar Lake. The overflow of untreated sewer flow to the Mahi River also threatens the aquatic life of the river and poses pollution threat to downstream villages which use the river as source of drinking water. The open sewer cum drainage system is also a serious threat to the health and hygiene of the city dwellers. It is an open breeding ground for mosquitoes and other parasites. The foul odor from the drain is a nuisance for the city dwellers. It is learnt from the Municipal Authorities that a schema for installation of a sewage treatment Plant (STP) at Amritsagar Lake at an estimated cost of Rs.40 core has been sent to Government of India (GOI) for approval and release of funds. Sanction of GOI is awaited. (Municipal Corporation of Ratlam Master Plan, 2015) The Municipal Corporation had prepared a detailed project report for the development of drainage network with a proposal for nallah extension for 6 km at an estimated cost of Rs. 20 cores. (Ratlam Master Plan, 2015). However, the project is yet to take off. The slum areas were badly affected with no community toilet facility forcing the dwellers to defecate in the open. But at present some community toilets including those maintained by 'Sulabh Sauchalaya' have been opened in the slum areas and other places. However, the number of public toilets is very few to tackle the problem.

## CHAPTER 3

## *DATA COLLECTION AND METHDOLOGY*

*3.1 General*

In this chapter deals with the description of data acquisition. The following data has been required for design a Sewer network of Railway Colony area situated in Ratlam city, the following data were obtained from the municipal corporation, and Ratlam are as follows:

1. Collected the population of last 5 decades of Ratlam city.
2. Collected the ward population of concerned ward of Ratlam city.
3. Collected the existing water supply detail.
4. Topographical map of Ratlam city.
5. Data of existing4.2 Population Forecasting

Population for Ratlam Municipal Corporation and Railway Colony:
As per Census 2001, population for Ratlam Municipal Corporation was 222202; total households were 41544 indicating the household size of 5.3 as compared to the state urban HH size of the male population is 114 370 and the female population is 10 7832. According to master plan prepared in 1990, the projected population.

## METHODOLOGY

### *3.1 General*

The methodology adopted for this study is presented in chart shown in fig. below

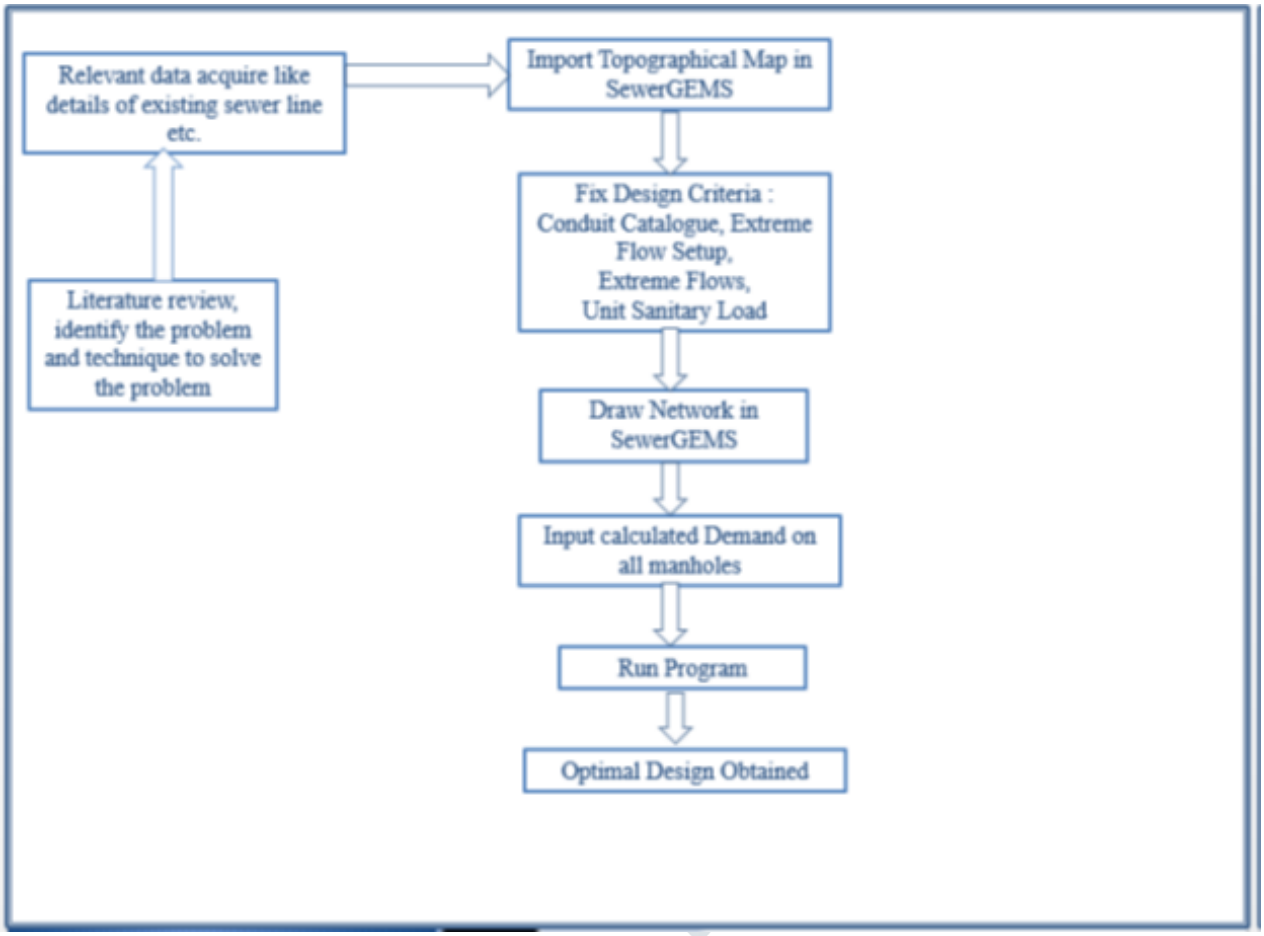


***Fig 3.1: Stepwise Procedure of Design in SewerGems Software***

The initial step was the literature reviewed which has been mentioned above. Following are the methodologies to be adopted in the process:

1. Identification of a suitable technique for optimal sewer network analysis through literature reviewed.
2. To study the available software SewerGems V8i.
3. Data acquisition for the study.
4. Analysis of the acquired data and to process it to prepare input to the Sewer Gems V8i.
5. Interpretation and comparison of the results and deriving conclusions.

### 3.2 About SewerGems V8i Software

#### *3.2.1Design methods provided by SewerGems V8i Software*

The SewerGems V8i software is efficient for sanitary sewer network design. SewerGems V8i takes minimum time to create the drawings. It is also used 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. This process is easy and simple for the design of sewerage networks. A map containing pipe details,

velocity, elevations and flow can be directly obtained from SewerGems V8i. SewerGems V8i will maintain the minimum and maximum velocity condition.

### *3.2.2Modes in SewerGems V8i Software*

#### 1. MICRO-STATION MODE

Micro-station mode lets user create and model your network directly within primary drafting environment. This gives access to all of Micro-stations drafting and presentation tools, while still enabling you to perform Bentley SewerGems V8i modeling tasks like editing, solving, and data management. This relationship between Bentley SewerGems V8i and Micro-station enables extremely detailed and accurate mapping of model features, and provides the full array of output and presentation features available in Micro-station. This facility provides the most flexibility and the highest degree of compatibility with other CAD-based applications and drawing data maintained at any organization.

#### 2. ArcGIS Mode

ArcGIS mode lets user create and model network directly in Arc Map. Some of the advantages of working in GIS mode include:

1. Full functionality from within the GIS itself, without the need for data import, export, or transformation
2. The ability to view and edit multiple scenarios in the same geo database
3. Minimizes data replication
4. GIS custom querying capabilities
5. Let's you build models from scratch using practically any existing data source
6. Utilize the powerful reporting and presentation capabilities of GIS

#### 3. AUTOCAD MODE

AutoCAD mode lets user create and model network directly within primary drafting environment. This gives access to all of AutoCAD's drafting and presentation tools, while still enabling you to perform Bentley SewerGems V8i modeling tasks like editing, solving, and data management.
Some of the advantages of working in AutoCAD mode include:

1. Layout network links and structures in fully-scaled mode in the same design and drafting environment that we use to develop engineering plans.
2. Use native AutoCAD insertion snaps to precisely position Bentley SewerGems V8i elements with respect to other entities in the AutoCAD drawing.
3. Use native AutoCAD commands such as ERASE, MOVE, and ROTATE on Bentley SewerGems V8i model entities with automatic update and synchronization with the model database.
4. Control destination layers for model elements and associated label text and annotation, giving us control over styles, line types, and visibility of model elements.
5.

## CHAPTER 4

## *ANALYSIS OF DATA*

### *4.1 General*

All our designs generally conform to the latest edition of the CPHEEO 'Manual of Sewerage and Sewage Treatment' with a minimum of modifications to account for project specific needs. (Refer Annexure).

### *4.2 Design Procedures*

#### *4.2.1 Calculation of Sewer Flows*

In order to design a sewerage system which will carry out the flow from nonfunctional existing sewer as well as newly designed sewerage system, the study has been carried out to know the details of outfalls i.e. invert level, diameter conduit, covered area etc. from the information provided by officials of Ratlam Municipal Corporation and Indian Railway Department. After studying the Exiting scenario, it was identified that there exists no proper sewage system, and the untreated waste water is discharged directly

into the city drain (nallas). Considering the area density method flow generation from the existing form the existing sewage system was calculated and same is used for assigning the design of the proposed sewage system.

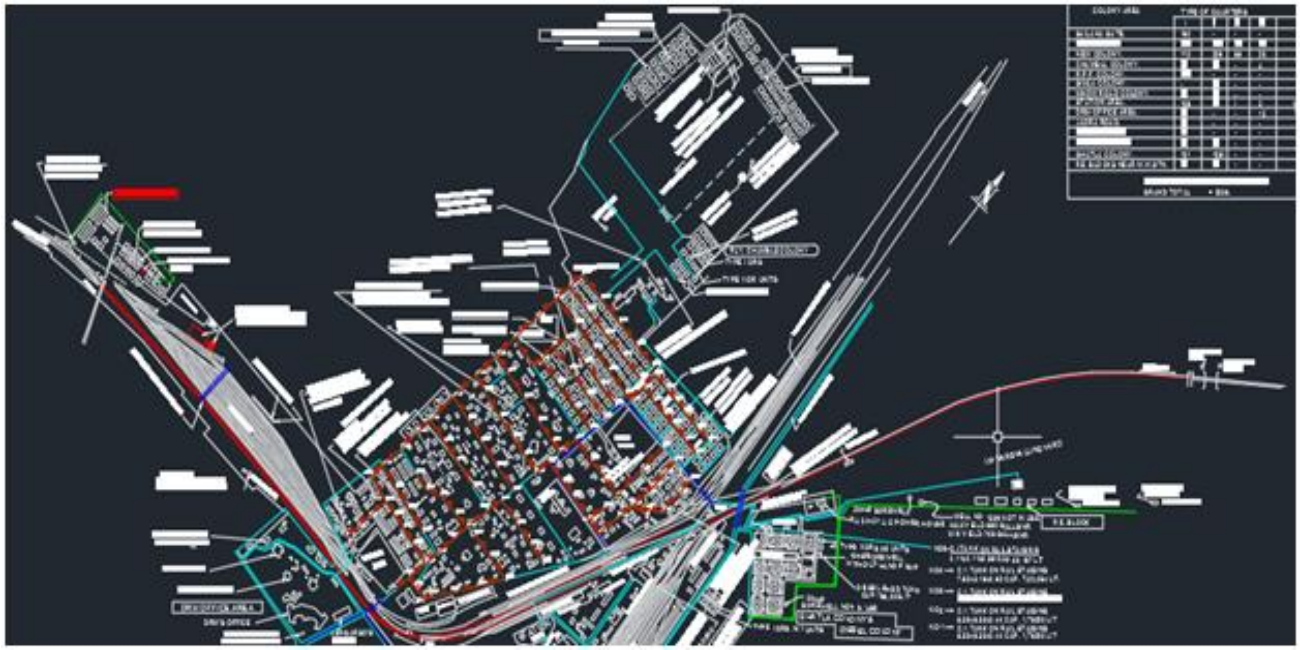

**Fig 4.1 Designed Sewer Network**

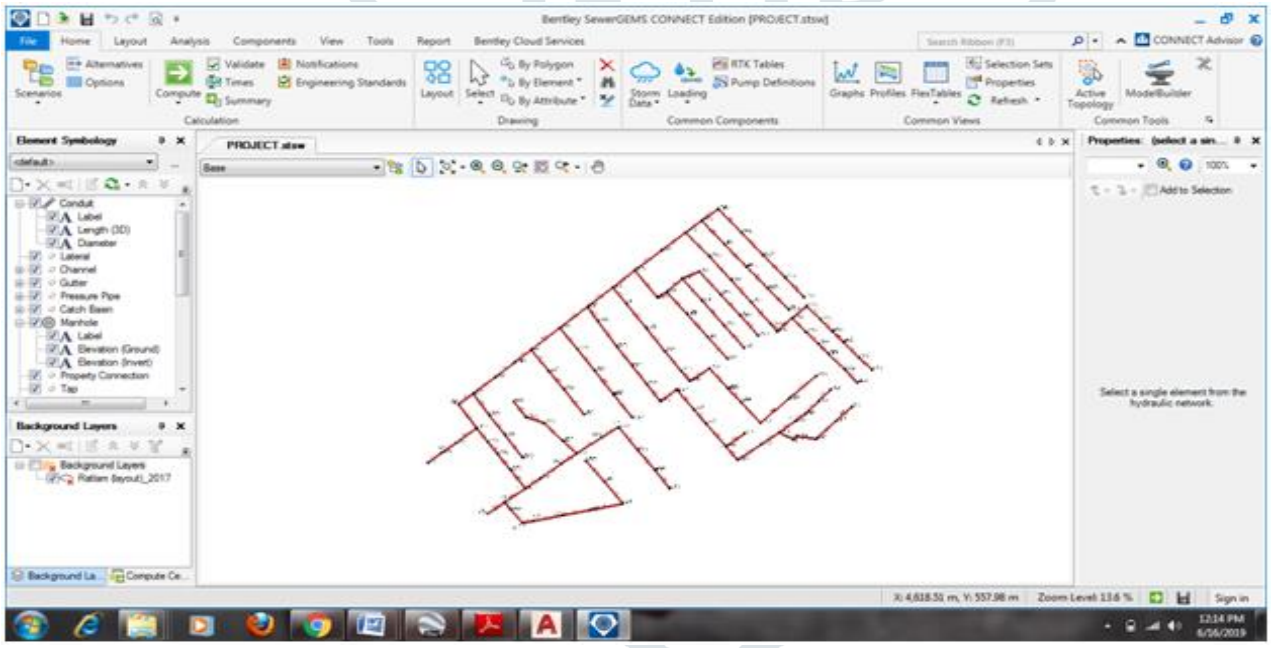

**Fig 4.2 Line Diagram of sewer Network**

After designing most feasible sewer network it was observed that at some nodes self-cleansing velocity was not achieved. To attain the self-cleansing velocity two options were found feasible at the site either provision of Small Bore Sewer or frequent flushing of manhole.

## CHAPTER 5

## *RESULTS AND DISCUSSION*

### *5.1 General*

This chapter details the results obtained from designed sewer network and the optimization of the network. The results include the length and diameter of sewer network, details of small-bore sewer and flushing manhole.

### *5.2 Designed Sewer Network*

Railway colony, Ratlam area has been designed for the total network of 2728.9 meters,

***Table 5.1: Length of Different Pipes Provided***

| Diameter (mm) | DWC PE |
|---|---|
| **150** | 2388.4 |
| **200** | 85.4 |
| **300** | 255.1 |
| **Grand Total Length (m)** | 2728.9 |

***5.3 Recommended Process for Treatment***

Railway Colony drain could be protected from untreated sewage which is now meeting directly to it without any treatment. After studying the Exiting scenario, it was identified that there exists no proper sewage system, and the untreated waste water is discharged directly into the city drain (nallas) so as to prevent pollution a Decentralized STP is proposed. The maximum portion of slope is from North to South, so the proposed STP is towards South of the Railway Colony.

There are many other treatment processes available in the market and we can choose any of the treatment process which is proven one and has successful experience and which suits to their requirement. But the land requirement is less and energy consumption factor also needs to be kept in mind while selecting the process technology treatment which are upgrading rapidly now a days. Considering above facts, SBR technology is selected as it requires small space and having better quality output as per desired Norms as based on successful operational experience in India.

***Advantages***

1. It uses 50% less power consumption.
2. It uses 50% less land area compared to other conventional process.
3. It is capable to handle variable flow & load conditions.
4. It should fully automatic, computer controlled.
5. Excellent life 6 times better than conventional.
6. Low life cycle cost.

***Disadvantages***

1. High peal flow can disrupt operation unless accounted for in design
2. Batch discharge may require equalization prior to disinfection
3. Sludge must be disposed frequently.
4. Higher maintenance skills required for instruments.


**Fig 5.1 Location of STP**

Proposed STP in open ground of Indian Railway, 1.3 MLD in Intermediate Phase (2020 - 2035) & 2 MLD in ultimate Phase can be accommodated in existing premises. Area Required for Construction will be 1.02 ha.

### *5.4 Project Cost Estimation*

*Table 5.2: Cost Estimation of Sewerage System*

| Description | Unit | Quantity | Rate | Amount in Rs | Amount in Cr |
|---|---|---|---|---|---|
| **Sewer Network** | Meter(m) | 2728.9 | RS 5000/m | 13644500 | 1.36 |
| **STP Proposed** | MLD | 1.3 | RS 12,000,000/unit | 15600000 | 1.56 |
| **Total Cost of Project** | | | | 2.9244500 | 2.92 |

a. Total 2728.9-meter sewer of size ranging from 150 mm to 300 mm is required to make a complete sewer network system.
b. Total length of sewer network is 2728.9-meter out of this 2388.4-meter small sewer of size 150 mm is provided which 21% is of total sewer network.
c. Total manhole 123 having velocity less than 0.61 m/s which are 17.21% of total manhole.
d. By deploying two tanker of 12000 litres capacity 8 manholes can be flushed in a day.
e. The frequency for flushing for these manholes about 10 days.
f. The total estimated cost of the project is 2.92 Cr.
g. The effluent will be utilized for the flushing of sewer, gardening and fire fighting etc.

## CHAPTER 6

## *CONCLUSION AND SCOPE FOR FURTHER STUDY*

### *6.1 Conclusions*

Based on the results derived and interpretation were following the major conclusion can be made:

1. Small bore provide improvement in the sewage network especially in constraints area.
2. Flushing option helps in cleaning of the pipeline to avoid choking and acquire self cleansing velocity.
3. A sewage treatment plant based on SBR technology is helpful in reducing the effluent BOD to reduce load.
4. Cleaning of sewer should be done frequently to achieve the efficiency in working of the sewer network. .
5. Operation and maintenance cost can be reduced by adopting the proposed methodology of the study.
6. Less time spent to create the drawings by using the tools for labelling 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.
7. A map containing pipe details, velocity, elevations and flow can be directly obtained from Sewer GEMS V8i. Sewer GEMS V8i will maintain the minimum and maximum velocity condition.
8. Customized representation and information shown both in the layout and longitudinal profile that can be used for any of our projects.
9. After completion of this sewer system approx. 50 thousand people will be benefited.

### *6.2 Scope for Further Study*

The recommendation for future study is described in this chapter:

1. Similar study can be conducted for other areas in Ratlam city
2. Models can be developed to know the combined BOD at the discharge point in Azad Nagar area.
3. Flushing of manhole can be considered through alternative options.
4. Optimization model can be clubbed with the outcome of the study.
5. Other feasible option for the sludge management for the sludge collected from the SBM.

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