

Urban Water Supply Systems - A Case Study On Water Network Distribution in Chalisgaon City in Dhule District Maharashtra Using Remote Sensing & GIS Techniques

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Abstract

During the past decade, GIS and Remote Sensing (RS) have been used wildly in different branch and media of research, especially those researches that involves the geo-referenced spatial data. An increasing demand for water and sewage due to population growth, industrial development and improvement of economic require management of water transfer and improve operation of distributed network systems. Design of water supply systems is one of this issue that can be mapping and analyse using GIS, GPS and RS techniques. this study shows, how to linked GIS and RS facilities the mapping of urban drinking network, positioning of the storage water tank and selection of the source of water for the water supply system, with consideration of ground surface properties. This paper addresses the use of GIS, GPS and RS technology for visualization and network planning and Mapping. In this city Four Storage Tank have connected through the branches of network to supply drinking water to consumers. The information of land use, tin and existing water supply was generated using the Quick Bird Satellite Image (0.6m resolution data) and Survey of India (SoI) toposheets of scale 1:25,000 and integrated them with GIS to identify the distribution supply networks of the study area. The whole water supply network data is collected by GPS Surveyed. The necessary water network maps or information were collected from Chalisgaon Council. A spatial database was designed and created using related database analysis approaches for this project. Results obtained were displayed in GIS maps, tables, and graphics. It has been proved that GIS is a competent and effective tool for managing networks. This paper explains the present water network distributions supply system in and around Chalisgaon city using Remote Sensing, GPS and GIS techniques. In addition, GIS based analysis of the pattern of urban expansion over the demographic change and land use modifications has also indicated that urban growth has mainly taken place linearly along the major roads in the study area.

Keywords: Urban Water Network Distribution Mapping, Land Use Mapping, Geographical Information system (GIS), Digital Elevation model, Zone Wise Water Network Mapping, Global Position System (GPS), and Remote Sensing.

Introduction

Water supply system (WSS) is a complex system that integrates several spatial features. Therefore, it is needed to use multi- support information system to have capability of storing; managing and analyzing the large data set. Design of surface water supply system concerns the locations and capacities of diversion works and storage, as well as the operations of these to meet multiple purposes and objectives. Therefore in order to ensure the availability of sufficient quantity of good quality of water, it becomes almost imperative in a modern society, to plan and build suitable water supply schemes. This may provide potable water to the various section of the community in accordance with their demand and

requirements. Due to the advent of Geographical Information Systems (GIS), it possible to visualize, and model the entire cycle of water supply network from source to household. Geographical Information System (GIS) which provide some of the most comprehensive tools for storing, manipulation and analyzing. The implementation of GIS can not only reduce the time needed for analyzing information but also can ensure a more efficient use of the resource with high flexibility in time and scale. It enables user to store and display large amount of data graphically to greatly enhance the interpretation and analysis. One important GIS capability is in handling both digital spatial features and the associated databases of attribute information for map features (Healey, 1988). GIS also provide the tools for spatial queries, spatial calculations and spatial data modeling and generate the attribute maps. Once all the data are stored, both the digital map and the database can be manipulated simultaneously. This is particularly important in many water planning applications, which require data on a wide variety of physical, geological, social and environmental attributes. This paper discusses some aspects of designing of a GIS-base WSS in urban area.

Objectives

The basic aim of this investigation is to prepare the water network distribution system in Challisgaon city. Objectives of the study are as follows.

- Generation of thematic layers for Chalisgaon city using GIS & Remote Sensing technique.
- Survey of pipe network from source to consumer level.
- Digitization of the water distribution network system for various hydraulic parameters.
- To map the existing water distribution system.

This paper mainly discussed about the creation of data model for water network distribution and its utilities up to the extent of construction of data model, data management, data base system and data linking.

Study Area

Challisgaon lies between in Jalgaon district, Maharashtra state, India lies between 20°28'N, 75°0.5'E and 20°28' N, 75°1'E an average elevation of 360 m above MSL rainfall of 900 to 1000 mm. The general geographical information of the district is simple and flat as well as hill area Girna River is flowing in the district and is dry during the summer season. Challisgaon is bound on its north by Dhule district, on the east by Nashik district on the south by Aurangabad district and west by Jalgaon district. The water supply requirement of Challisgaon was managed by a city council.

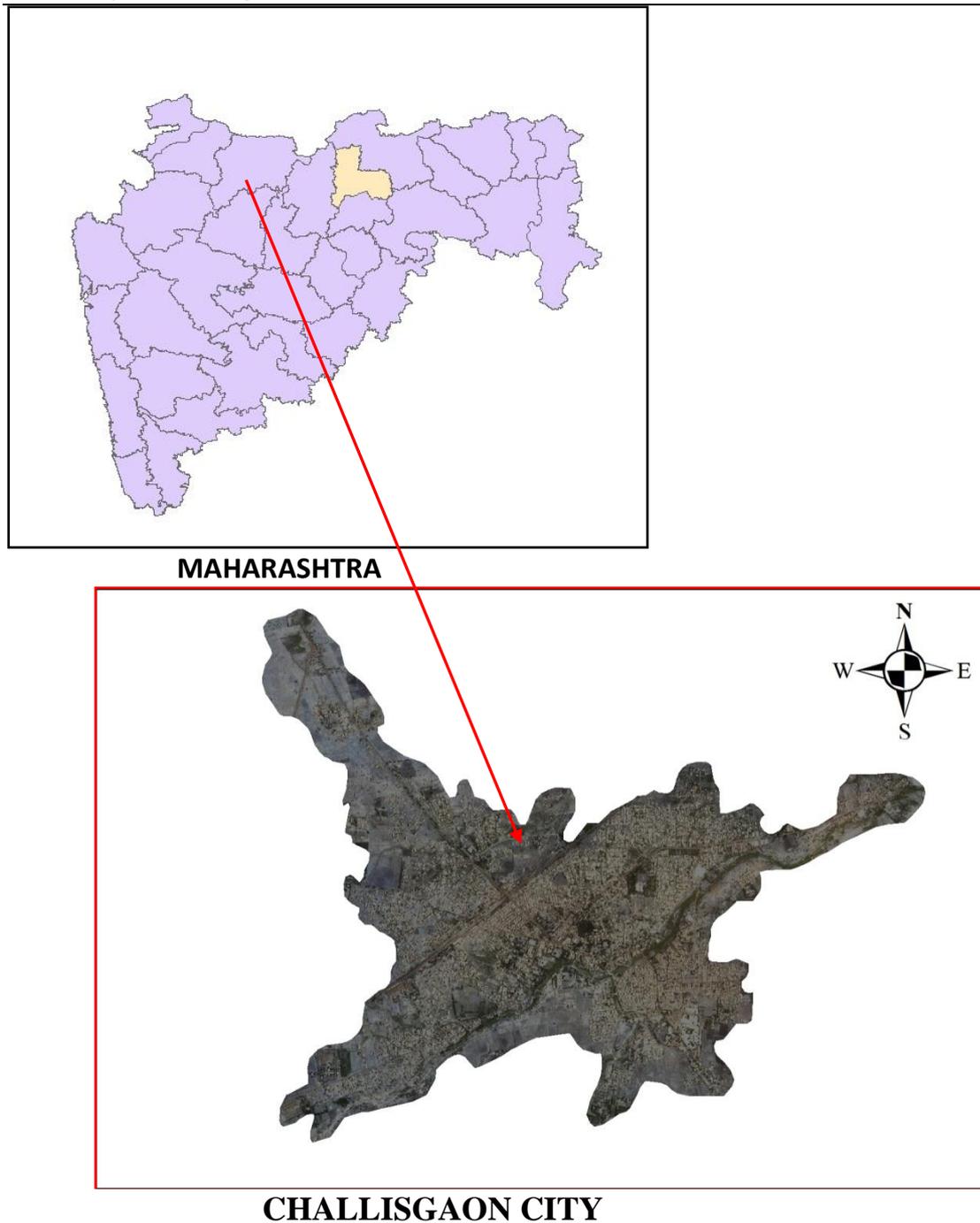


Fig. 1 Location map of the study Area

Data Used

The quick bird satellite imagery 0.6m resolution, ward city development supply distribution data and population data from Challisgaon council.

Software Used

- Arc GIS 10.00 ver. Software.
- AutoCAD Desk Map 2010.

- GPS (Global Positioning System) 7.2 Model.
- ERDAS 9.1 Ver. Software.

Data Preparation for GIS

The data preparation part includes the preparation of various data/layers required for the viz.

- Thematic layers
- Non spatial Database

Thematic Layers

The first step in data preparation is thematic layers preparation. The following thematic layers of Challisgaon study area were prepared by using the collected field data and Remote Sensing Data.

1. Base Map
2. Water Network Distribution Map
3. Transmission Map
4. Land Use/ Land Cover.
5. Digital Elevation Model.

Data Collection for Field Survey

The field data were collected with the help of Global Positioning System (Gramin 7.2 model) survey. The following are the various types of data collected in the study area.

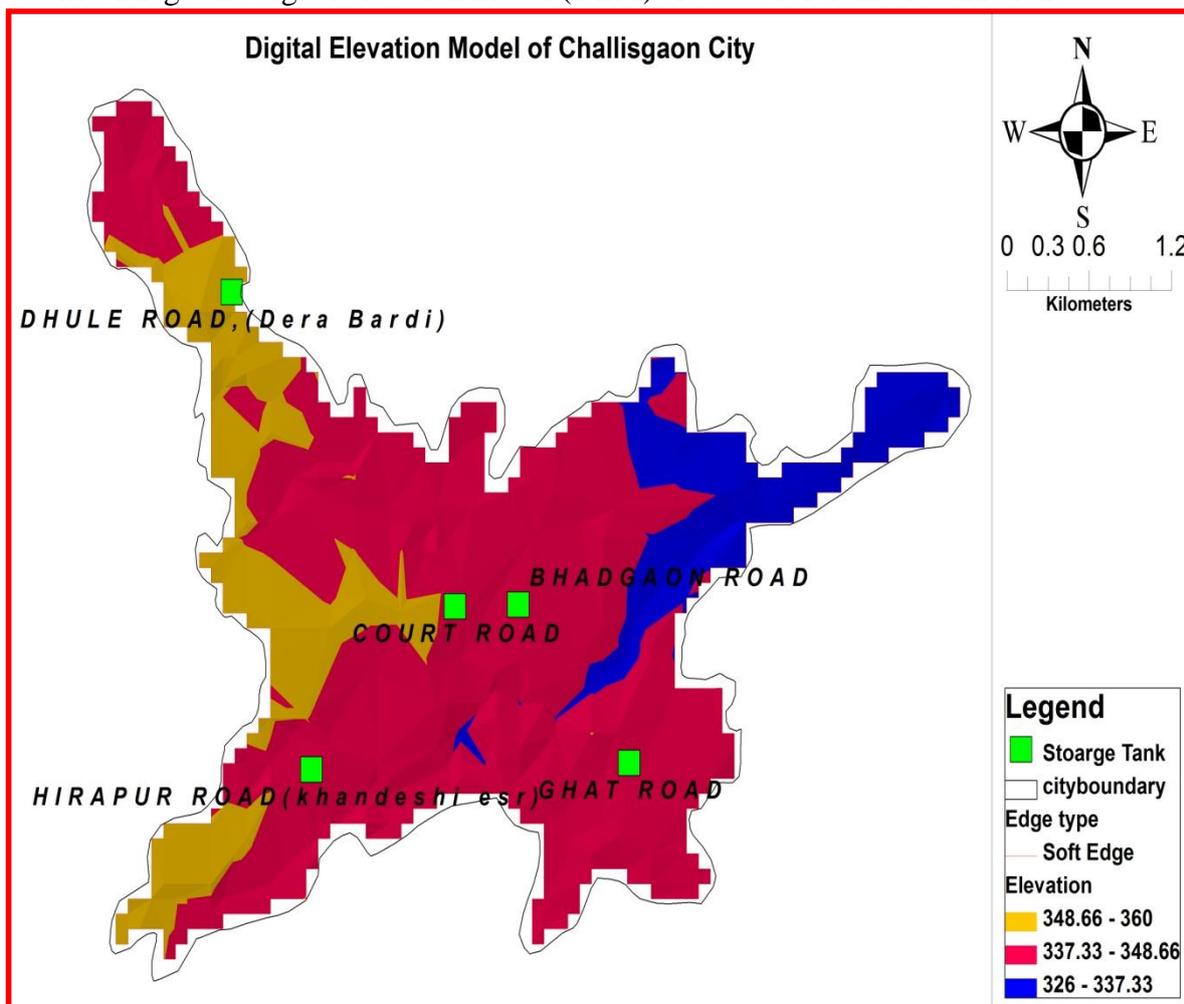
1. Pipe data
2. Source data.
3. Valves data.
4. Water Tanks
5. Pump Data
6. Jack well Data.

Methodology

The methodology was developed according to the needs and requirements for the studies based on the overlaying the features on the LULC map and to determine the water distribution network. As WSS uses spatial database, GIS technology can act as important rules in collecting, storing, managing and analyzing of spatial data set that are used in designing of WSS. Data collection is an important part of the GIS projects. GIS Base WSS is used multi objects and data sets Data collection is done based on satellite images are used to distinguish the best path of water supply network. Satellite image are very useful to find the best alternative to conducting the water pipes with taking ownership and land use in to consideration. This paper addresses the WSS in Chalisgaon city as case study. Branch layout is the distribution system and operation system is pumping system as shown in figure. Quick

Fig. 2 Digital Elevation Model map of Chalisgaon City

Bird satellite Image was used collect some ground update data such as service roads, farm land and barriers such as Water Tank, City Source and settlement boundaries. Also, Satellite image and digital elevation model (DEM) are used for train visualization.



Step-by-Step Methodology:-

The step-by-step approach followed for the study is as follows

- Collection of field data on the existing water supply distribution system and transmission network system, elevation by various survey methods & survey equipments such as Global Position System Garmin 7.2.
- Preparation of various thematic layers viz. Road Networks, Rivers, Railway line, Buildings, Building groups etc. Maps are prepared from existing vector based NRSA map (1:2000scale).
- Development of network layers via, Road network, Water Distribution Network, transmission network system, and preparation of input data for the data models by incorporating field attribute data.
- Generation of data model from GIS.
- Generation of Digital elevation Model from SRTM data in Arc GIS Software.

Base Map Creation

The methodology was developed by conceptualized the water supply system. To delineate the boundary first step is digitize the ward map with reference to city development plan and satellite image. The whole water supply network data has collected by GPS surveyed and all GPS point data was converted to shape file in Arc GIS 10.00 software. The necessary water network maps or information were collected from Challisgaon council. The boundary by means of creating a shape file and overlaid on the quick bird 0.6 m resolution and city development plan and then the boundary on the Quick bird 0.6m resolution and city development plan and then the boundary is extracted. The extracted boundary map was imported to GIS software for digitization purpose several features such as settlements road water bodies, vegetation and industrial areas are digitized map several thematic maps are prepared according to the necessity.

Land Use/Land Cover Map

Most converting definition have land cover relating to the type of feature on the surface of the earth such built-up land water body, road , etc. land use associates the cover with a socioeconomic activity such as water network , school, park . Urban hydrology often uses the term land cover and land use interchangeably because the inputs to the models require elements from each definition. Land use mapping was used to identify the existing

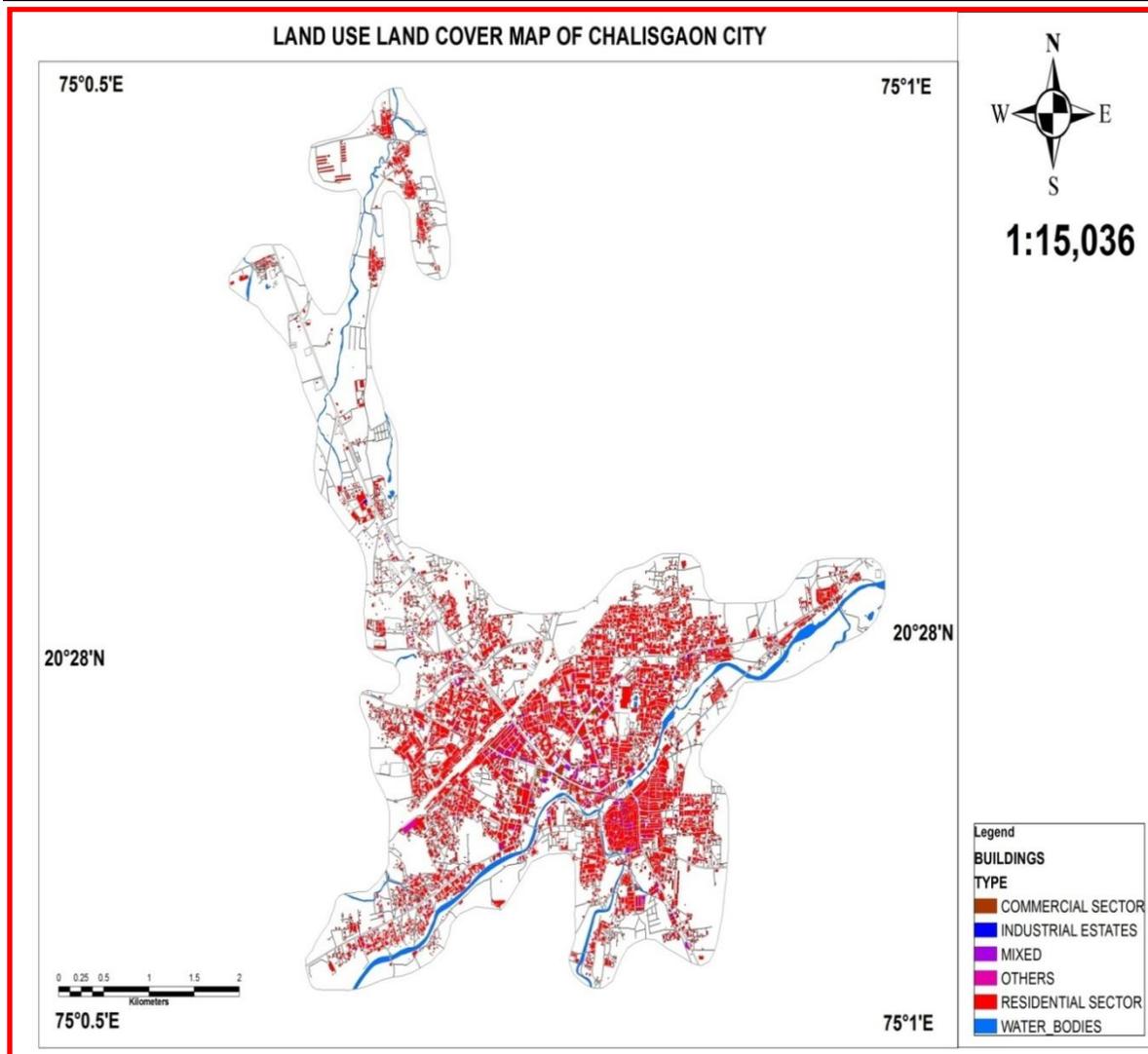


Fig. 3 Land use/Land cover map of Chalisgaon city

and expected feature land uses. The timely information about the changing pattern of urban land use plays significant role in urban land use planning and sustainable urban land use/land cover require a land use classification system. The most significant contribution in this respect has been made by the human settlement. The land use map is generated by means of digitizing the feature like settlements, roads, water bodies, and vegetation etc. for the identification and interpretation of land use pattern of the image interpretation through remote sensing data (Quick bird 0.6m resolution) were adopted and the various land use classes has been delineated.

Water Distribution Mapping

In Chalisgaon city there are five Storage tank such as Court, Dera bardi, Ghate road, Bhadgaon and Khandesi Tank the frequency of water supply is once in two days and the

population covered is 85% percent. The total area considered is 111.78 km which covers Challisgaon city for which water supply system is designed and pipe network has to be Overlay in satellite image. The main transmission line is km from Girna River to Challisgaon city. The situation becomes worse in summer season with reduced per. Capita supply. These deficiencies in the water supply sectors are mainly because of inadequate treatment capacity, inadequate summer storage, need for source augmentation and need for asset management action plan. It is also noticed that simultaneously water is distribution areas without any system of regulation due to this operation, even consumers' reading near to the service reservoirs do not get water at sufficient pressure. The water distribution mapping is done through the process of digitizing network features and then it is overlaid on land use and land cover map.

There are Five Storages Tanks in Challisgaon City such as

1. Court ESR
2. Dera bardi ESR.
3. Ghate road ESR.
4. Bhadgaon ESR.
5. Khandesi Tank ESR.

TABLE 1:- Details of Storages Tank of Challisgaon City

Sr. No	ESR NAME	LOCATION	CAPACITY	Inlet	Outlet	ALTITUDE	GL	LSL	FSL	STG_ HT	ESR SHA PE
1	Court ESR	DHULE ROAD,(Dera Bardi)	10,50,000 LK	150M M	300MM	352.00	352M	362 M	366 M	15.00 M	Circu lar
2	Dera bardi ESR	HIRAPUR ROAD(Khan desi esr)	13,50,000 LK	450M M	400MM	335.00	335M	347 M	352 M	17.00 M	Circu lar
3	Ghate road ESR	COURT ROAD	13,50,000L K	450M M	400MM	343.00	343M	352 M	357 M	15.00 M	Circu lar
4	Bhadgaon ESR	BHADGAO N ROAD	12,50,000L K	450M M	450MM	334.00	334M	346 M	350 M	16.00 M	Circu lar
5	Khandesi Tank ESR	GHAT ROAD	14,0000LK	450M M	450MM	333.00	333M	343 M	349 M	16,00 M	circul ar

1) COURT ESR-

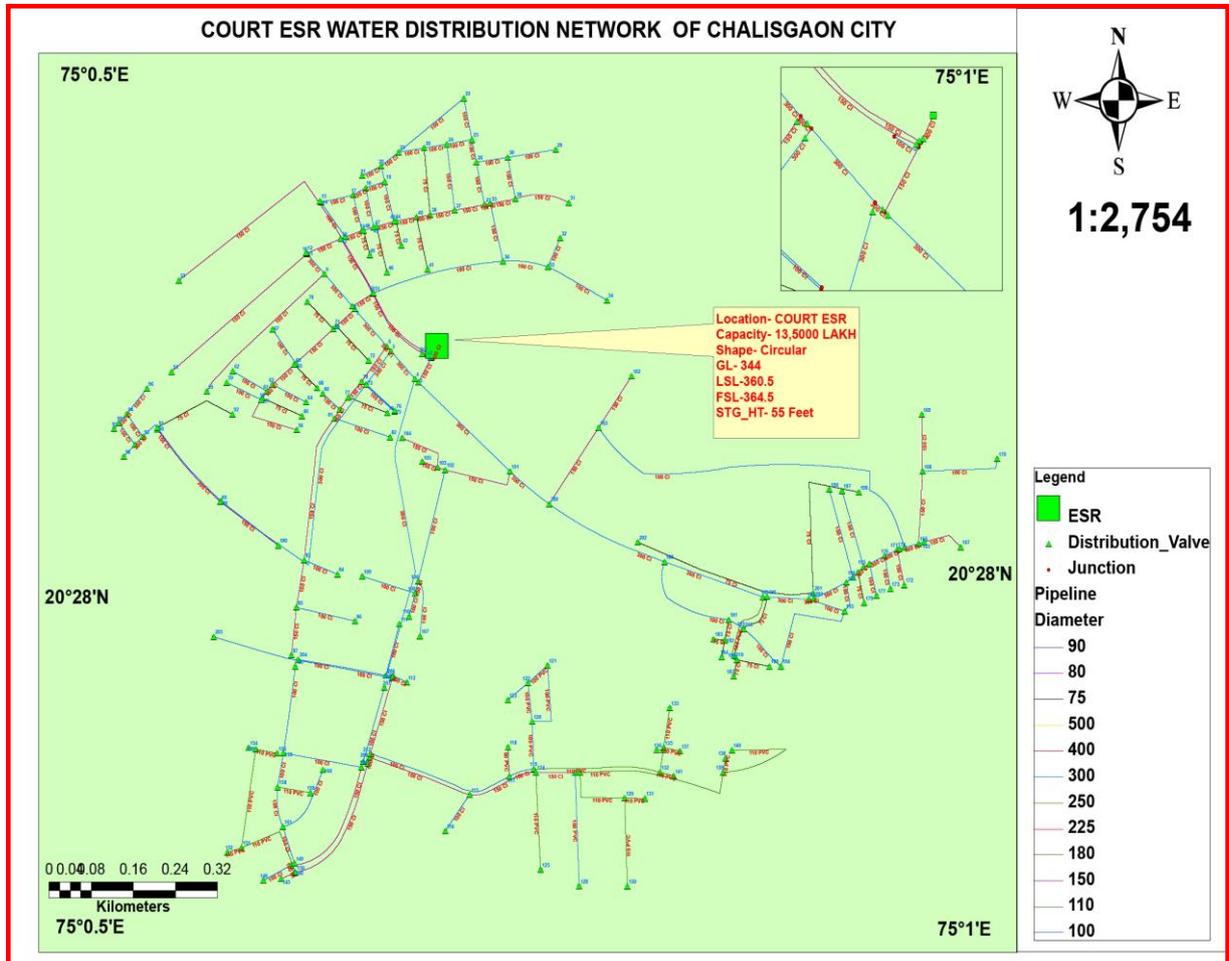


Fig. No. 4 COURT ESR Water Network Distribution Of Chalisgaon City

2) DERA DARDI ESR:-

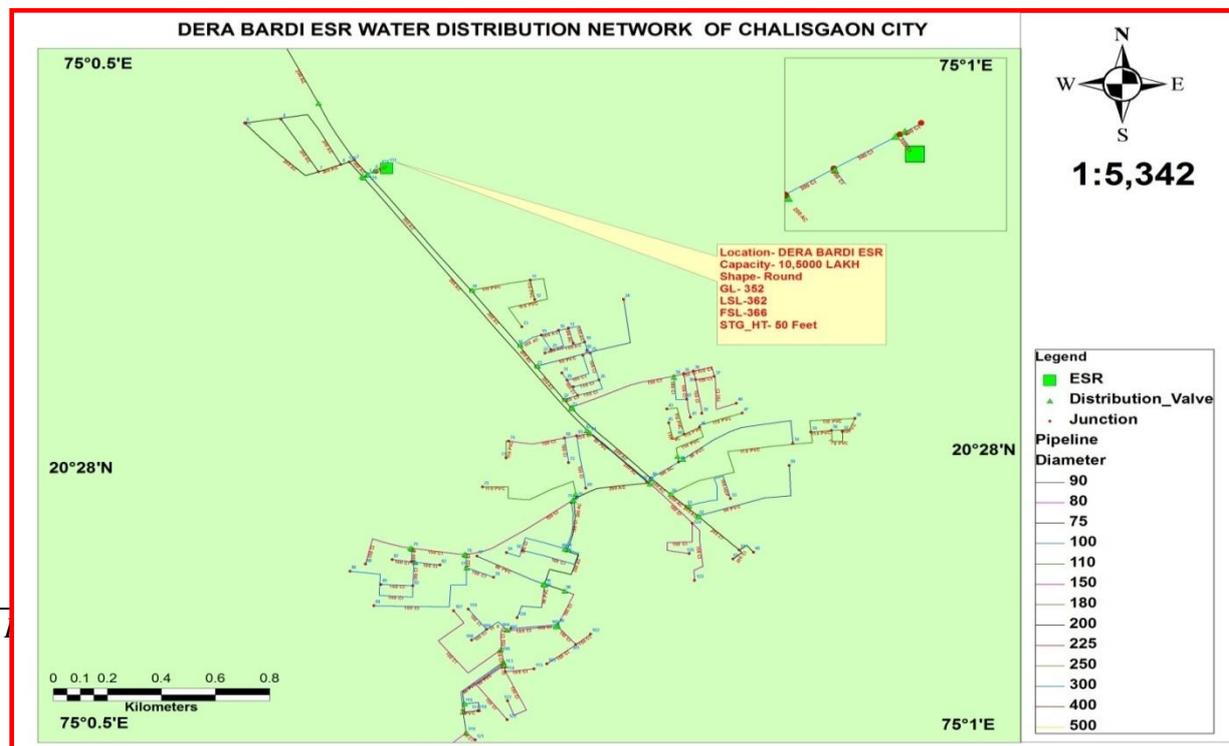


Fig. 5 DERA BARDI ESR water network distribution of Chalisgaon city

3) GHATE ROAD ESR:-

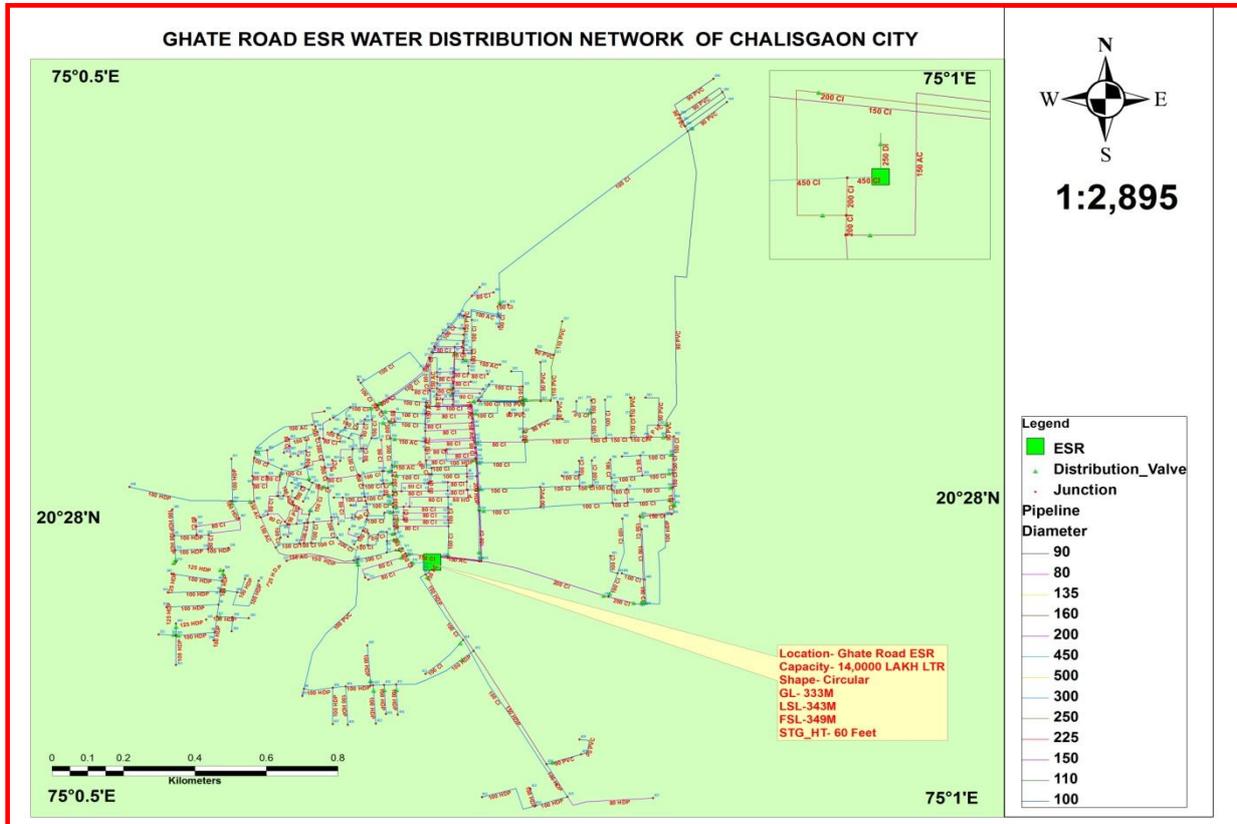


Fig..6 Ghate Road ESR water network distribution of Chalisgaon City

4. BHADGAON ROAD ESR:-

Fig. 7 Bhaddgaon Road ESR Water Network Distribution Of Chalisgaoncity

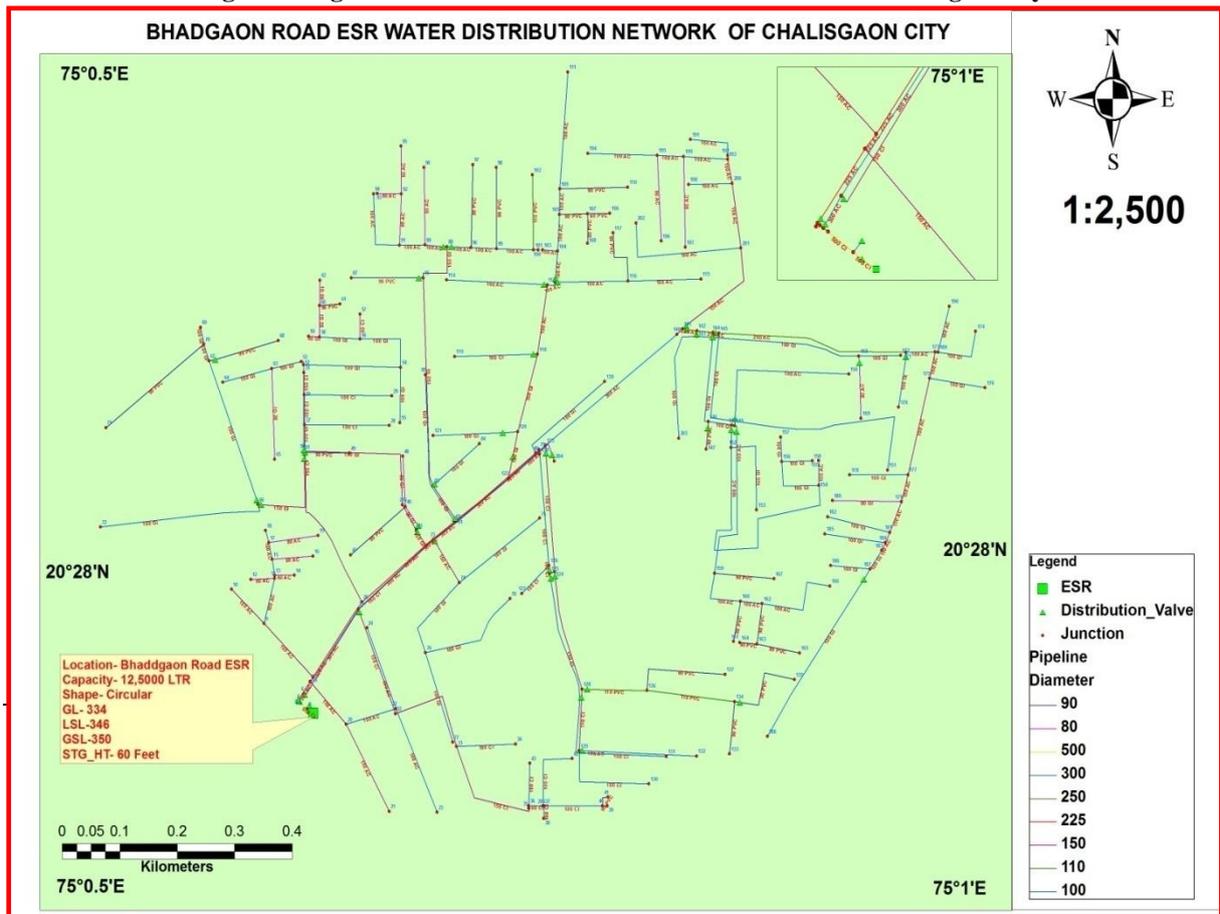
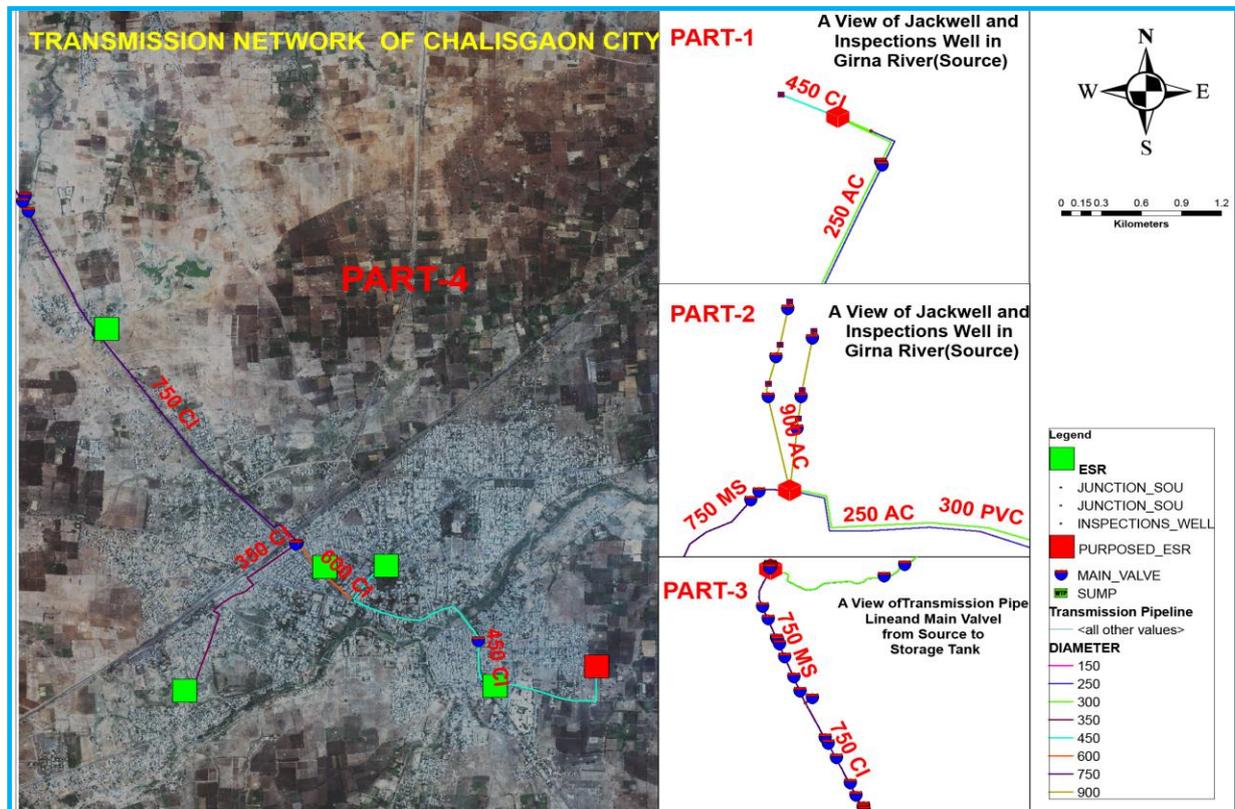


Fig. 10 Transmission network of Chalisgaon City



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