"City Sanitation Planning (CSP) Using Geoinformatics Techniques: A Geographical Study of Gwalior City"

A Dissertation Submitted to the

Tilak Maharashtra Vidyapeeth, Pune

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For the Degree of Vidyanishnaat (M. Phil) in

Geography

By

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June 2011

CERTIFICATE

This is to certify that the Dissertation entitled**,** ***"City Sanitation Planning (CSP) Using Geoinformatics Techniques: A Geographical Study of Gwalior City"*** Which is being submitted here with for the award of degree of Vidyanishnaat (M. Phil) in Geography of Tilak Maharashtra Vidyapeeth, Pune, is the result of original research work completed by SHRI**.** ***SAGAR PANDURANG MALI*** **under** my Guidance. To the best of my knowledge and belief the work incorporated in this dissertation has not formed the basis for the award of any degree or seminar title of this or any other university or examining body.

Research Guide:

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Miraj College, Miraj

Date:

Place:

DECLARATION

I here by declare that the dissertation entitled *"City sanitation Planning (CSP) Using Geoinformatics Techniques: A Geographical Study of Gwalior City"* completed and written by me has not previously formed the dissertation for the award of degree or other similar title of this or any other University or examining body.

Sagar Pandurang Mali

(Research Student)

Place: Kolhapur, Maharashtra, INDIA

Date: 29 June 2011

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Mr. Sagar Pandurang Mali

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	ABBRAVATIONS
Short	**Description**
ADB	Asian Development Bank
BPL	Below poverty Line
CSP	City Sanitation Planning
CPHEEO	Central Public Health & Environmental Engineering Organization
DEM	Digital Elevation Model
DSC	Department of Supervision & Consultant
DEBANS	Decentralized Basic Need Services
GDP	Growth Domestic Product
GIS	Geographic Information System
GPS	Global Positioning System
GMC	Gwalior Municipal Corporation
HH	House Hold
HIG	Higher Income Group
HP	Hand Pump
IUSP	Integrated Urban Sanitation Program
LIG	Low Income Group
MoUD	Ministry of Urban Development
MIG	Middle Income Group
MLD	Million Liter Per day
MSW	Municipal Solid waste
MT	Metric Tone
MSWM	Municipal Solid Waste Management
NUSP	National Urban Sanitation Policy
NGOs	Non-Government Organization
NH	National Highway
OHT	Over Head Tank

PPSA	Poverty Pocket Situation Analysis
QC	Quality Checking
RAM	Random Access Memory
STP	Sewerage Treatment Plant
SLF	Sanitary Land fill Site
UA	Urban Agglomeration
WTP	Water Treatment Plant

	MEASUREMENT UNITS
Short	**Description**
^{0}C	Degree Centigrade
Sq.Km	Square Kilometer
Km	Kilo meter
cm	Centi meter
%	Percentage
GHz	Giga Herts
GB	Giga Bite
MT	Metric Tone
lpcd	Liter Per Capita per day

Abstract

1. Introduction:

Today's modern period technology plays major role in social welfare and rapid development in any sector of the world. Urbanization is the important effect of the development in technology at very rapid rate. Urbanization is increasing rapidly due to industrialization and industrialization supports to the growth of population from rural to urban area for getting job and economical development.

According to Census 2001, 27.8% of Indian population i.e. 286 million people or 55 million households lives in urban areas, and in terms of Sanitation, out of them 12.04 million (7.87%) urban households do not have access to latrines and defecates in open. 5.48 million (8.13%) urban households use community latrines and 13.4 million households (19.49%) uses shared latrines. 12.47 million (18.5%) households do not have access to a drainage system. In terms of waste water disposal, 26.83 million (39.8%) households are connected to open drains. More than 37% of the total human excreta generated in urban India, is unsafely disposed. This imposes signification public health and environmental cost to urban areas that contribute more than 60% of the country's GDP.

2. Relevance of Topic:

The situation is alarming in small towns/ cities of the country where there is no planned infrastructure for water and sanitation based on the current population and also the future demand for such services. Many cities in India are not with proper planning hence number of manmade hazards coming up therefore it needs planning, that every city planning must take cognence of CSP. So for proper development of the city and civilian welfare and good health need to the proper planning of the city in the sanitation point of view not only for today but also in the point of view in the future also. GIS and Remote sensing play major role in city sanitation planning and Urban development.

3. Parameters of Sanitation:

City sanitation includes various parameters need to take into the consideration for planning and implementation for city development in futuristic point of view. The major parameters for city sanitation is as follow

i. Water supply:

Water supply is important parameter for city sanitation planning; due to rapid rate of urbanization increasing tress on the water supply system. So for mitigation the water demand of city need proper planning of water supply system. Water supply parameter include the study of various water source, water supply network in the city and study of their capacity of is it sufficient or not to fulfil demand of water of the particular area in the city.

ii. Sewerage System:

Sewerage system means underground network of liquid waste water from the house. It includes Study of current sewerage network of the city and proposed sewerage network. Here need to study the slope of city for the proper making new sewerage network.

iii. Solid Waste Management:

Solid waste is one of the major parameter which belongs to the urban problem. Solid waste have many categories according to their character and location i.e. Community waste, Livestock waste, Industrial waste, commercial waste and Hospital waste etc. In urban area solid waste creates so many urban problems which triggers to the urban pollution hense solid waste management is major element for City Sanitation Planning.

4. Study Area:

The city of Gwalior is located at 26° 12’ N 78° 18’ E and has an average elevation of 212 meters. The city is situated on a rock basin with the Vindhyan hills in the west and the Bijapur hills in the south east.

5. Data & Methodology:

In data Collection phase data basically collect from two sources: 1. Primary data includes GPS survey and 2. Secondary data includes data from various departments of Gwalior Municipal Corporation.

6. GIS Data Base Generation:

Both GPS survey data and data from GMC departments are digitized and make various GIS layers with their proper attribute information. All Sanitation data of Four Sector of sanitation arrange in systematic form and make a proper GIS data Base.

7. Sanitation Study of Slum areas:

I did special study of Sanitation situation in slum areas. In Gwalior 229 slum pockets are in existence. The sanitation facility of Slum area is very poor and Quality of sanitation facility is very low. That all come to know after study the sanitation situation in slum area. Some study is based on PPSA survey.

8. City Sanitation Planning:

After overall study of the sanitation status of the study area then make sanitation planning of the area for futuristic point of view for mitigate the demands of sanitation facilities in the community. After data base generation of various sector of sanitation like water supply, waste water, Solid waste management and Urinal and Toilet study of the city all detail information of the sanitation scenario come to know and after that its easy to idenfy areas and location where sanitation facility needed. Gwalior city divided in 12 clusters or 60 Administrative Boundaries. In this thesis the sanitation planning mainly suggested on the basis of cluster.

Sanitation planning of the Gwalior city plays important role in overall better development of the city in a sanitation sector and minimization of sanitation problems of the city.

Chapter-I

INTRODUCTION

1.1 Introduction:

Today's modern period technology plays major role in social welfare and rapid development in any sector of the world. Urbanization is the important effect of the development in technology at very rapid rate. Urbanization is increasing rapidly due to industrialization and industrialization supports to the growth of population from rural to urban area for getting job and economical development. In last few decades the rate of urbanization is increasing very high all over the world and as well as in India also.

As per 2001 Census, India has been 4378 Urban Agglomerations (UA) comprising of 5161 towns and cities. The constant transformation of urban areas into complex entities has brought fourth new challenges and Opportunities for planners to design and implement a variety of activities in spatial terms. There is to need address problems and issues in the right perspective to assist cities in coping up with economic realities and coming up with better urban policies and solutions.

Urbanization in the country, at 27.78% in the year 2001, was low when compared to developed countries. However, the 28.53 crore urban population, living in 27 metros, 396 cities and 4738 towns was more than the total population of many developed countries for healthy and happy living provision of adequate community facilities an public utility services are essential as they enhance efficiency and economic utilization of time. As a matter of fact, there is wide gap between the resources availability and resource need which is reportedly due to the perennial influx of rural population to urban centers. As a result, the existing infrastructure gets burdened. One of the major reasons leading to migration to these big cities is the lack of services in small and medium towns. In ordered to control such migration, government has undertaken the integrated development of small and medium town's project. Under the project community facilities and public utility services have been considered as the most essential component of urban life. in ordered to prepare development plan of city, there is a need of good and reliable information regarding location of existing facilities, their accessibility, adequacy and

development trend in relation to socio economic structure of the city. The process of planning for urban areas involves use of both spatial and non spatial data. Planners need update accurate maps and other analytical information system has emerged as the central components in the world's environmental information structure and it will continue to play a vital role in the ensuing decades.

1.2 Relevance of Topic:

According to Census 2001, 27.8% of Indian population i.e. 286 million people or 55 million households lives in urban areas, and in terms of Sanitation, out of them 12.04 million (7.87%) urban households do not have access to latrines and defecates in open. 5.48 million (8.13%) urban households use community latrines and 13.4 million households (19.49%) uses shared latrines. 12.47 million (18.5%) households do not have access to a drainage system. In terms of waste water disposal, 26.83 million (39.8%) households are connected to open drains. More than 37% of the total human excreta generated in urban India, is unsafely disposed. This imposes signification public health and environmental cost to urban areas that contribute more than 60% of the country's GDP.

The situation is alarming in small towns/ cities of the country where there is no planned infrastructure for water and sanitation based on the current population and also the future demand for such services. Many cities in India are not with proper planning hence number of manmade hazards coming up therefore it needs planning, that every city planning must take cognence of CSP. So for proper development of the city and civilian welfare and good health need to the proper planning of the city in the sanitation point of view not only for today but also in the point of view in the future also. GIS and Remote sensing play major role in city sanitation planning and Urban development.

1.3 Importance of City Sanitation Planning (CSP):

City sanitation planning is important task for Local, State and Central government. Government spent many funds and work with NGOs for city sanitation plans of various cities in the different states. The sanitation facilities in the state of Madhya Pradesh is a major concern for the good quality of life in the cities, especially in the low-income settlements, where the sanitation services are not adequate. As per the census of year 2001, the urban population in the state was about 16 million, encompassing about 3.2 million households. Over 1 million households (about 31%) in the state do not have access to toilet facilities, due to which they are forced to defecate in the open. The facilities for safe disposal of solid and liquid waste are also not adequate. Inadequate sanitation facilities pollute the environment and have a detrimental effect on health and economy of the country.

The State Government and the Urban Local Bodies (ULBs) have been implementing various programmes dealing with sanitation. However, in the absence of uniform policy guidelines, lack of a progress monitoring mechanism, multiplicity of agencies, overlapping jurisdictions and lack of political will and commitment, low awareness, the results are not encouraging.

The Government of Madhya Pradesh has, therefore, now initiated the *Integrated Urban Sanitation Programme (IUSP)* in line with the Government of India's National Urban Sanitation Policy (NUSP) – 2008. The goal of the programme is to achieve totally sanitized, healthy and livable cities and towns, and to enhance the living standards of the communities with special emphasis on the urban poor.

A sanitation survey commissioned by the Ministry of Urban Development (MoUD) found that no city in India is "healthy and clean" while 40 per cent need immediate remedial action. The survey covered 423 cities with a population of more than 100,000. The rankings were given based on 19 sanitation parameters such as access to community toilets, safe management of human excreta, and solid waste collection and treatment, in which **Gwalior city** ranked 378th out of 423 cities Hence the rank itself highlights that much more needs to be done to improve access to community and public toilets for the urban poor and also most importantly to stop open-defecation.

So improving the city sanitation facilities in the city and in different sates Central government offer so many funds and work with the State government and NGOs for proper sanitation planning of Major cities in the India.

1.4 National Urban Sanitation Policy:

The overall goal of this policy is to transform Urban India into community driven, totally sanitized, healthy and livable cities and towns. The specific goals of the policy can be underlined with the following factors:

- **Awareness Generation and Behavior Change:**

- Generating awareness about sanitation and its linkages with public and environmental health amongst communities and institutions;
- Promoting mechanisms to bring about and sustain behavioural changes aimed at adoption of healthy sanitation practices.

- **Open Defecation Free Cities:**

- Promoting proper functioning of network-based sewerage systems and ensuring connections of households to them wherever possible;
- Promoting recycle and reuse of treated waste water for non potable applications wherever possible will be encouraged.
- Promoting proper disposal and treatment of sludge from on-site installations (septic tanks, pit latrines, etc.).
- Ensuring that all the human wastes are collected safely confined and disposed of after treatment so as not to cause any hazard to public health or the environment.

- **Proper Operation & Maintenance of all Sanitary Installations:**

- Promoting proper usage, regular upkeep and maintenance of household, community and public sanitation facilities.
- Strengthening ULBs to provide or cause to provide, sustainable sanitation services delivery.

The main components of the National Urban Sanitation Policy can be given as:

- Awareness Generation
- Institutional Roles

- Reaching the Un-served and Poor Households
- Knowledge Development and Capacity Building
- Financing
- National Monitoring and Evaluation
- Coordination at national Level.

1.5 Parameters of Sanitation:

City sanitation includes various parameters need to take into the consideration for planning and implementation for city development in futuristic point of view. The major parameters for city sanitation is as follow

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Solid waste management includes study of trenching ground and their location, Location of Waste Bins and Open dumping places etc.

iv. Toilets and Urinals:

Management and planning of Toilets and Urinal locations according to their importance or applicability is important task of any Municipal Corporation. It includes the study of location of community toilet and urinals etc.

1.6 Geographical Importance in CSP:

Geography of the area is one of the important parameter which need to be take into consideration before making sanitation planning of any area. The topography of the area is important for planning of water supply, drainage and sewerage network etc. socio-economic study of the city is also necessary for providing the different sanitation facilities to the area. We can't provide same kinds of sanitation facility to all city in a same rate and type, so to decide to sanitation facility for city we need to the study of geography of the city in both physical and human aspect of the city and then we can make a effective sanitation plan for city. So one has to study the geography of the city before making sanitation planning of the city.

1.7 Importance of Geoinformatics in CSP:

In modern period accuracy and reliability is more important in any planning and decision making applications. GIS is one of the important software application used in Geography for better result, accuracy and reliability. Remote sensing data provide accurate information and GIS software tools provide better results in analysis and provide better maps. GPS survey provides accurate location information for effective monitoring, planning and decision making. Integration of GIS, GPS and Remote sensing is Geoinformatics technology which plays important role in accurate planning and decision making.

1.8 Aim & Objectives of the Research Study:

The major aim of the present research study is to study a sanitation scenario and make a proper city Sanitation plan of the Gwalior city of Madhya Pradesh. In City sanitation Planning have need to proper study and planning of four important sectors which is Water supply network, Waste water Management, Solid waste management and urinal and toilets management. To fulfill the above aim there is some following objectives need to be achieved.

i) Make a Topographical (Elevation) map of the Gwalior city.
ii) Study the Present Sanitation scenario of Gwalior city
iii) Study the Sanitation Status of Slum area in Gwalior city
iv) Prepare a Spatial GIS database of Sanitation for Gwalior city
v) Suggest a Proposed plan for Gwalior City Sanitation Planning

1.9 Literature Review:

In Literature review the study of previous works on city sanitation planning which used in present study. Here are some projects and books which worked on city sanitation planning and used these guidelines in my present research thesis.

1. Bharatpur (Rajastan) city planning report (2010): Bharatpur city in Rajastan state has been make a city sanitation plan. Here I have used this report for my research guideline. In Bharatpur city sanitation planning have not used GIS techniques but have well planned of some important sectors of sanitation. This project report is important in my research work.

2. A report of Pune Municipal Corporation (2009): "Master Plan for Integrating Decentralized Basic Need Services (DEBANS) in Urban Sanitation Planning". This project report is also helpful in present studies which has studied slum areas and make a city sanitation plan consideration with slum pockets in the Pune city.

3. "Sanitation Planning Guide for Small Communities", a project report of State of Alaska, Department of Community and Economic Development (June 1999). This is a international project report on small community level sanitation planning. Here have used various techniques for sanitation planning.

Chapter-II

STUDY AREA

2.1 Introduction:

The city of Gwalior is one of the important historical city of Madhya Pradesh because of its rich historical background. It is also known as Counter Magnet city to National Capital region. It is the fourth largest city in Madhya Pradesh. The city has municipal area of approx. 173.65 Sq. km. and is administered by dividing the city into 60 municipal wards. It is also known as one of the eminent tourist destination in India.

2.2 Geographical location:

The city of Gwalior is located at 26° 12' N 78° 18' E and has an average elevation of 212 meters. The city is situated on a rock basin with the Vindhyan hills in the west and the Bijapur hills in the south east.

Fig: 2.1 Location Map of Study Area

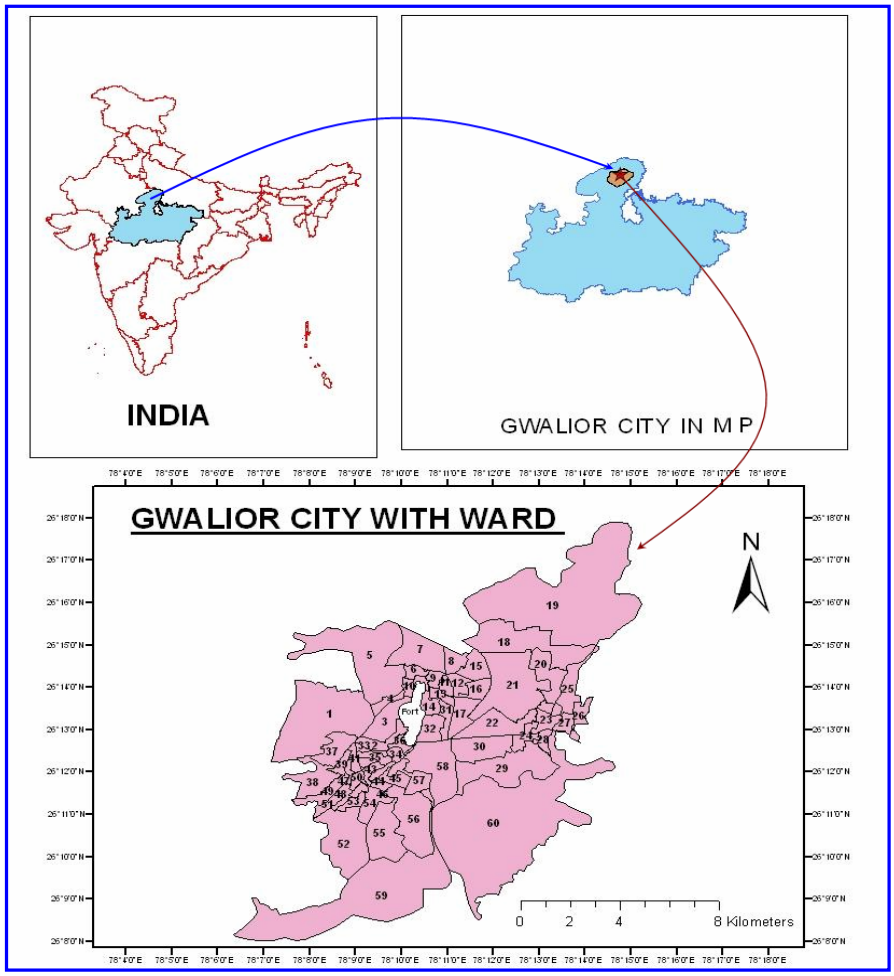


Table: 2.1 Gwalior City Information

City	-	**Gwalior**
District	-	**Gwalior**
Geographic Location	-	**26° 12' N 78° 18' E**
Connectivity	-	**by National Highway : NH-3 and NH-75**
	-	**by Rail: Gwalior Railway Station**
	-	**by Air: Gwalior Airport**
Civic status	-	**Municipal Corporation**
Class	-	**I (as per census 2001)**
Area	-	**173.65 Sq. Km.**
Number of Wards	-	**60**
Population 2001	-	**8,27,026**
Population 2011 (estimated)	-	**9,85,436**

Source:Gwalior Municipal Corporation (GMC)

2.3 Climate & Rainfall:

The climate is typical of central India with mean temperatures ranging between 40 ^{0}C before the monsoon and falling to a minimum of 10 ^{0}C during the winter. The highest recorded temperature was 53^{o}C and the lowest was -1^{o}C. The rainy season lasts from second week of June to September, the winter from November to February, and summer from March to mid June. October sees the transition from rainy to the winter season. The average annual rainfall is around 762 mm, falling predominantly during July and August. The average number of rainy days is about approximately 40.

Wind pattern for in the south west are determined by its bowl-enclosure between the dry hills, resulting in extreme hot winds during pre-monsoon period. In comparison, the more green and flat area of Morar to the east with its considerable vegetative cover present a more comfortable micro-climate during the hot season.

Table 1.2 Overview of climate and rainfall

Maximum Temperature	**53^{o}C**
Minimum Temperature	-1^{O}C
Average rainfall	762 mm

Source: Gwalior Municipal Corporation (GMC)

2.4 Geology & Hydrology of the Region:

The geological formations underlying the Gwalior area are largely sandstone and granite on a rock basin. Areas west of Swarnrekha are gravelly and sandy, while on the eastern side the soil is sandy loam and yellow. The hilly areas in the city have very poor vegetative cover, except for plains to the north east, which are being used for cultivation.

As per the local sources the present ground water level of Gwalior varies from 400 ft to 800 ft, which further goes deeper during summer season.A considerable number of motorised or hand pump tube wells extract groundwater as an alternative to water distribution system.Hence there is a concern about the resultant lowering of the groundwater table. Also Shallow groundwater tends to suffer from localised pollution because of latrines and septic tanks seepage.

2.5 Network Connectivity:

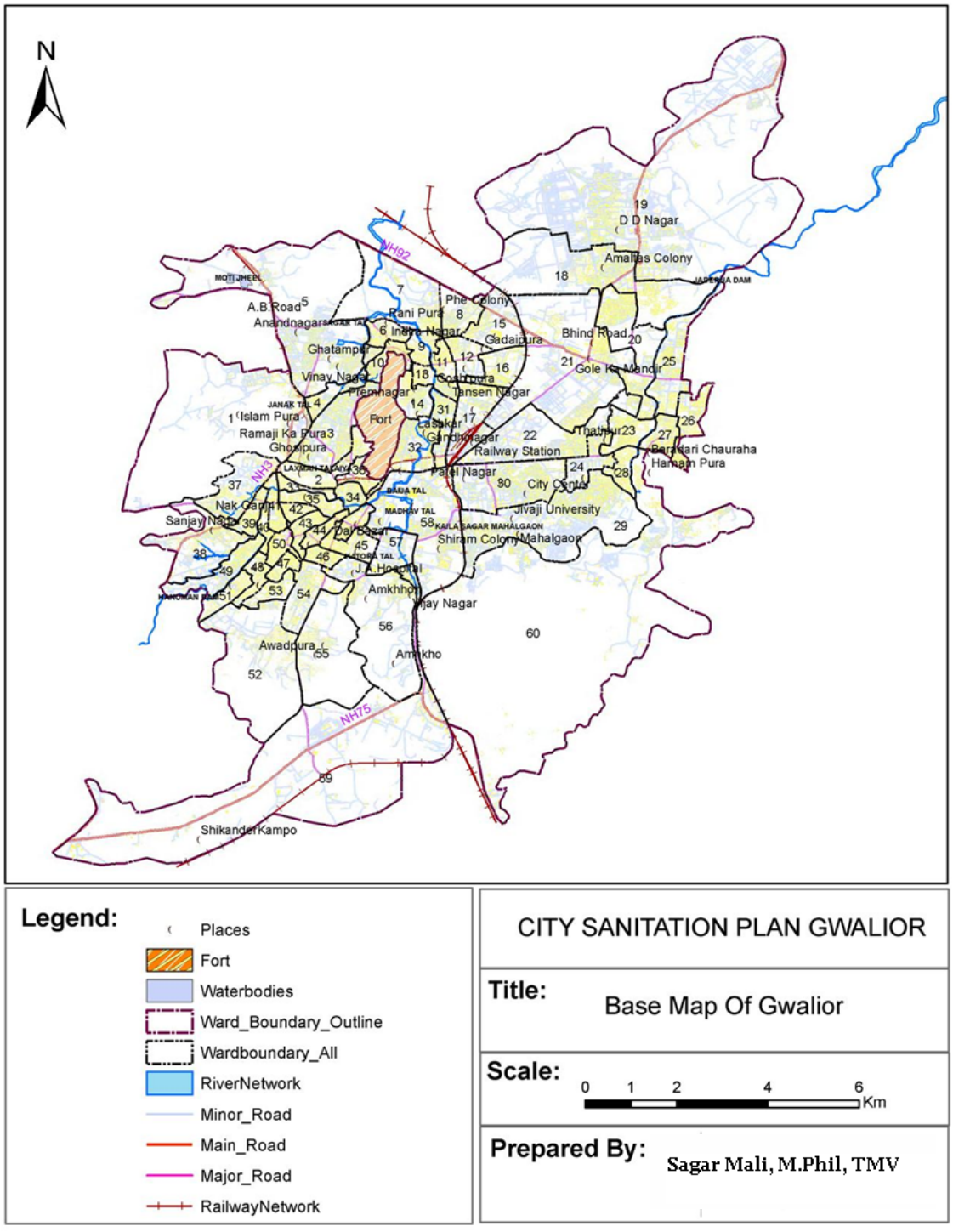
Gwalior city is well connected with roads, railways and airways to different parts of India. It is fairly well connected to other parts of Madhya Pradesh along with national and state highways. The proposed North-south Corridor of the Golden-Quadrilateral Highway project passes through the city.

The Agra-Bombay national highway (NH3) passes through Gwalior, connecting it to Shivpuri on one end and Agra on the other. The city is connected to the Jhansi by the National Highway 75, towards the south of the city.

In the Northern, the city is connected to the holy city of Mathura via National Highway - 3. There are bus services to and from all major and minor cities near Gwalior, including Bhopal, Agra, Delhi, Jabalpur, Jhansi, Bhind, Morena, Datia, Jaipur and Indore.

Gwalior occupies a strategic location in the central parts India, and the city and its fortress have served as the centre of several of India's historic kingdoms. Its continuing strategic importance is marked by the presence of major air base at Maharajpura.

Fig: 2.2 Baseline Map of Gwalior City

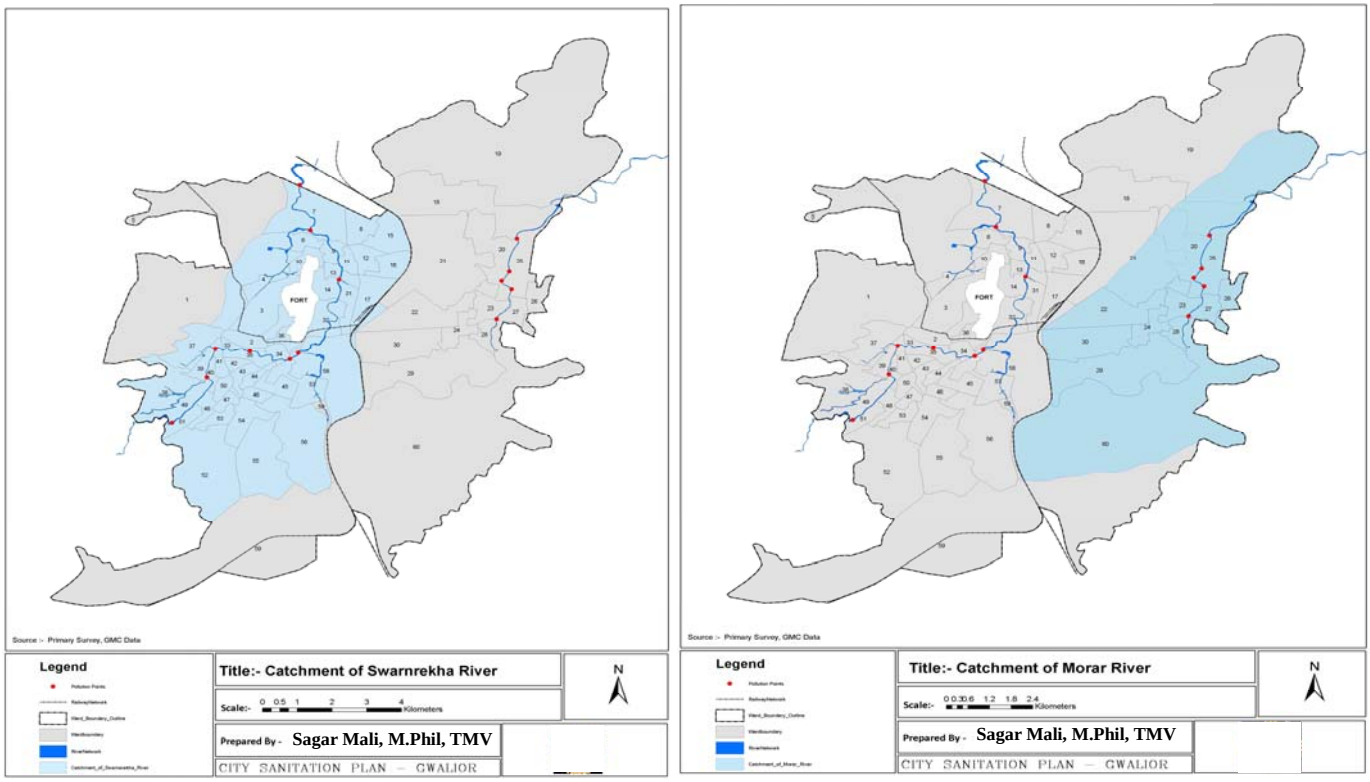


2.6 River Network:

The city of Gwalior falls under Sindh River basin and is settled on banks of river 'Swarnarekha' in the west and River 'Morar' in the east of Gwalior city which is a tributary in **'Sindh'** Basin located in the northern part of Madhya Pradesh.

Following map shows the catchments area of the Swarnrekha river and Morar river. **Swarnrekha** is the major river in the Gwalior which goes in south and central part of the city. This river covers large area of the city. **Morar** is the another one minor river flows from eastern side of the city. Both river flows from south towards the north side.

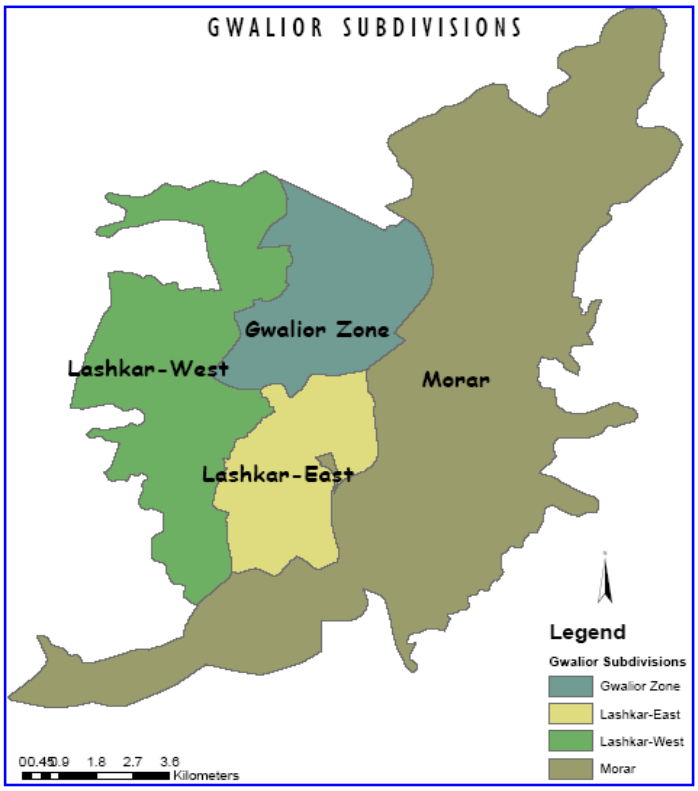
Fig: 2.3 Catchments Area of Swarnrekha & Morar River



2.7 Administrative Boundaries:

Gwalior city is basically divided in to the four major zones which is Gwalior Zone, Lashkar west, Lashkar East and Morar zone. For administrative suitability Gwalior city has been divided in to the 60 Ward or 12 clusters. The present city sanitation of gwalior city is make on the basis of cluster approach which is useful in actual implementation of sanitation planning in the city. Gwalior city Zone wise, ward wise and cluster wise shown in following figures.

Fig: 2.4 Gwalior city Zone Map & Ward Map



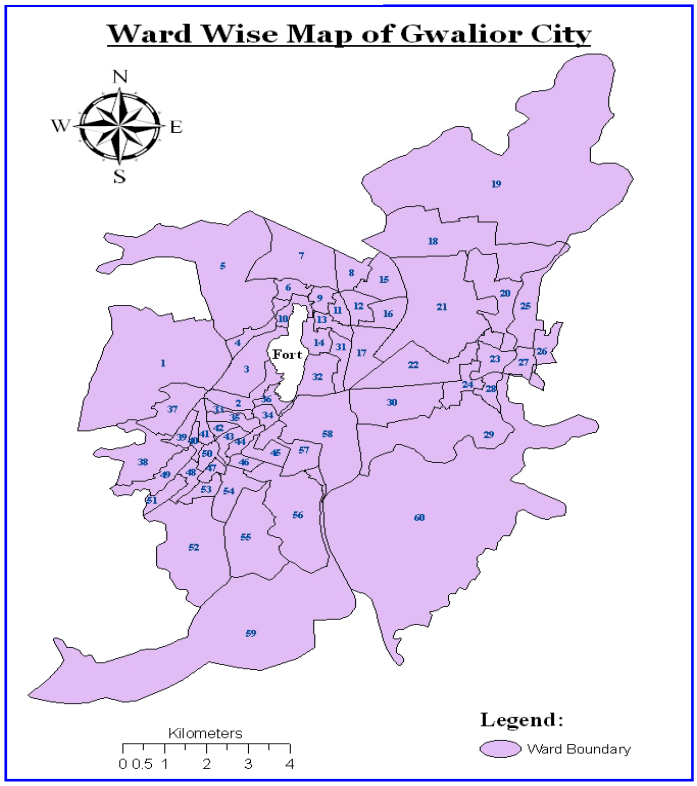
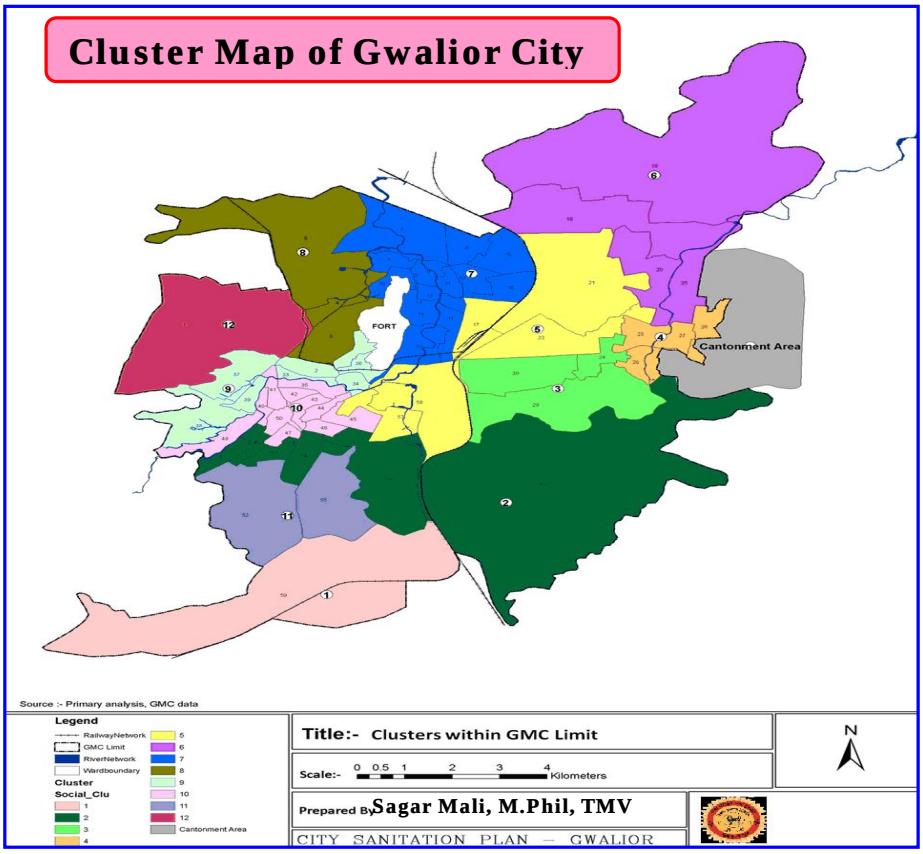


Fig: 2.5 Gwalior City Cluster Map



Source: Gwalior Municipal Corporation (GMC)

Table 2.3 Clusters in Gwalior

Cluster number[1]	Name of cluster	New Ward number[2]	Old wards numbers
1	Upcoming educational hub – Kedarpur area	59	29
2	Mudia Pahad, Chandwadni Naka	48,51, 53, 54, 56, 60	39, 40, 49, 55, 56, 58, 60
3	City center area	24, 29, 30	19, 20
4	Bheemnagar, Kumharpura Rapat	23,26,27, 28	21, 23, 27, 28
5	Railway station	17,21,22,57,58	17, 22, 24, 30, 37, 38
6	Deendayal nagar, Pinto Park area	18,19,20,25	25, 26
7	Ranipura, Indira nagar, Charshar ka Naka	6,7,8,9,10,11,12,13,14,15,16,31,32	6, 7, 8, 9, 10, 11, 12,13, 14,15,16, 18,31
8	Bhahodapur, Anandnagar area	3,4,5	3, 4,5
9	Satyanarayan Hill	2,33,34,36,37,38,39	2, 32, 33, 36, 45, 46, 47, 48
10	Maharaj Bada	35,40,41,42,43,44,45,46, 47,49,50	34, 35, 41,42,43,44, 50, 51,52, 57, 59
11	Guda-Gudi Ka Naka	52,55	53, 54
12	Ramaji ka pura	1	1

Source: Based on geographical area of wards covered in the cluster and visual observation and discussions with GMC

2.8 History:

Gwalior occupies a special mention in India's medieval history and freedom struggle. History of Gwalior Madhya Pradesh dates back to the ancient times. According to some modern research, implements of Paleolithic age have been found in this region of the country. Many cave paintings have also been discovered in this area. Some pottery of the Iron Age has also been found in Gwalior. In the ancient text of Mahabharata a reference has been made about a place called Gopalkaksh. It has been described as the victory place of Bhima. According to some historians Gopalkaksh is Gopadri or Gopagiri, the old name of Gwalior.

In the late period of 2nd century this city came under the influence of the Nagvans Clan. Bimnag , one of the important rulers of this dynasty shifted the capital from Vidisha to Padmavati (modern Pawaya). Pawaya is situated at a distance of 68 km from Gwalior. An important fort and the Dhoomeshwar Mahadeo Temple are areas of interest in Pawaya.

[2] Ward numbers considered for cluster formation are based on revised ward boundaries delineated by GMC

The History of Gwalior, Madhya Pradesh also mentions that in the 5th century the Gwalior Fort came into being during the rule of Suraj Sen, the Kachhwaha Rajput prince. In the 10th century, Vrajdaman of the Kachapghat Rajvans took over Gwalior. In 1021 AD Mahmud of Gazni attacked Gwalior and Malik Bahauddin Tughluq, one of his lieutenants won it after an intense battle.

Around the 11th century Sallachan was given the charge of Gwalior fort. Later on Iltutmish was given the charge to man the fort by Qutbuddin Aibak. During later periods, various rulers of Slave and Tughlaq dynasty ruled in Gwalior in Madhya Pradesh. According to the History of Gwalior , the 14th century saw the Tomar clan coming into power taking advantage of the weak Islamic rulers. The most illustrious ruler of this dynasty was Man Singh who was instrumental in rebuilding the fort of Gwalior.

During the Third battle of Panipat Gwalior came under the rule of Jat ruler Lokandra Singh. In 1761 Mahadji Scindia an able Scindia ruler regained Gwalior. His successor Daulat Rao shifted the capital from Ujjain to Gwalior. The soldiers of Morar Cantonment from this place took active part in the revolt of 1857.For certain period the city was also governed under the British Rule, they had formed their military cantonment in Gwalior. Gwalior has a wealth of building of historical significance with most prominent the Fort, the Tombs of Mohammad Ghaus, Jains culture and Tansen ka Makbura.

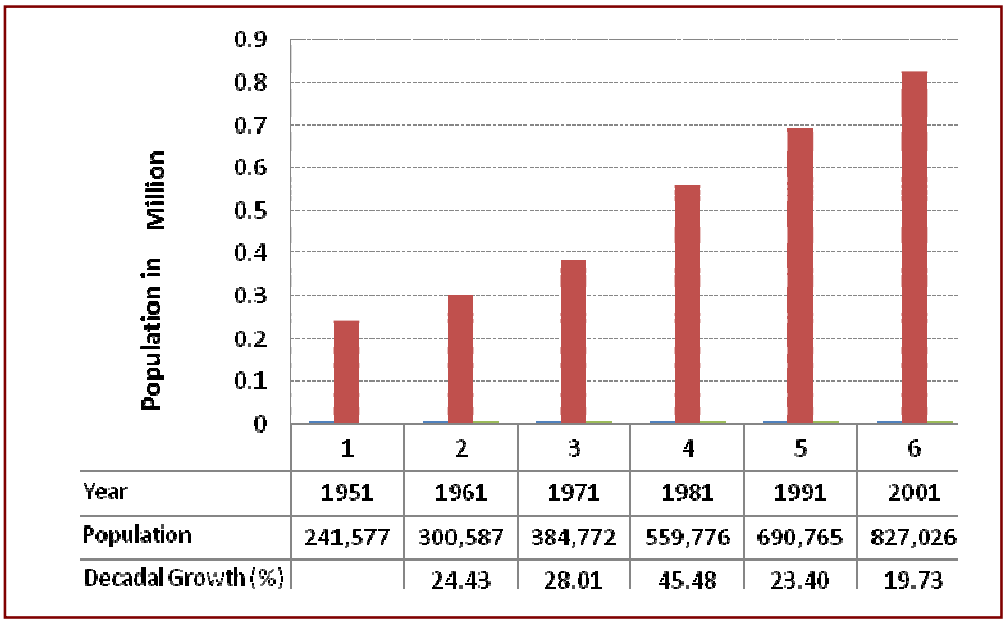
2.9 Demographic Features of Gwalior City:

2.9.1 Population:

As per census 2001, the population of Gwalior city is 8,27,026; where 53% male and 47% female population. The list of ward wise population (after delimitation of ward boundaries) is shown in Annexture -1. Comparing the decadal population growth of the city, the data reveals that there was a positive growth rate of the city from the 1961 to 1981 i.e. from 24.43% to 45.48%. But later on the graph shows a negative growth rate in the city that reflects the slow economic growth and limited livelihood options for the local people.

The graph shown in the next page represents the trend of population growth of the city since 1951 to 2001. It reveals that the city is growing

Fig: 2.6 Decadal population of Gwalior



Year	1951	1961	1971	1981	1991	2001
Population	241,577	300,587	384,772	559,776	690,765	827,026
Decadal Growth (%)		24.43	28.01	45.48	23.40	19.73

Source: Censes of India

2.9.2 Household Size & Sex Ratio:

The average household size in GMC area is about 5.58, the list of ward wise number of HHs is annexed in the report.

` GMC has male population of 442343 and female population is of 384683. And hence the sex ratio of the city is about 870 which is quite lower than Madhya Pradesh's sex ratio of 920 in 2001.

2.9.3 Literacy Level & Education:

Gwalior has an average literacy rate of 69%, higher than the national average of 59.5%: male literacy is 76%, and female literacy is 63%. In Gwalior, 13% of the population is under 6 years of age.

Table: 2.4 Literacy rate in Gwalior city

Description	Population	In %
Male Literate Population	334504	76
Female Literate Population	238232	62
Total Literate Population	572736	69
Total population	827026	100

Source:Gwalior Municipal Corporation (GMC)

2.9.4 Housing Characteristics & Condition:

The housing scenario is characterised by mix type of houses in different parts of the city. In terms of vertical development the houses are generally low rise and with G+1 storied structure. It is observed that the housing pattern in the city is mainly governed by the major economic activity taking place in a particular region and the class of people living in that region. Exhibit 1 MIG housing pattern

Photo: 2.1 Housing Condition in Gwalior City

In case of trade and commercial activities, the areas are densely populated and having narrow lanes which are mainly located in the baada area of Gwalior zone. The houses are of Pucca type and having G+2 stores. In this area some of the houses are very old and are based on the traditional architectural pattern. The peripheral areas of these regions are habituated by low income group of people and their residences are mostly slum. Here houses are mostly semi Pucca but not having adequate quality of sanitation facilities.

Looking to the settlements in Gwalior region, the houses are mainly low rise and are having medium populated densities. This area is particularly characterised with the colonies of M.C.Mill workers.

Morar area which is mainly dominated by the service class of people is having government colonies like Darpan colony, Thatipur and so on. The houses are of Pucca type and mainly G+1 structures.

City centre, a newly developed areas located in the central part of the city, is the only area where vertical development is seen. This area is having apartments and the building developed on modern pattern. The area is also known for good Private colonies.

2.10 Socio-Economic Status:

2.10.1 Economic Activities:

In Gwalior, most of the economic activities are related with commercial and business activities. The present occupational pattern for Gwalior city indicates a slight shift from the manufacturing sector to the commercial sector during the period of 80's and 90's. Once upon a time Gwalior was known to be the hub of textile industrial base that was largely supporting the economy at Gwalior. While the industrial growth within the city limits seems to have slowed down, there is further increase in the trade and commerce activities. The trend also indicates that large increase in unemployed industrial workforce has apparently been absorbed in the neighbouring towns of Morena and Bhind. Also recently, under National Capital Region, the industries of Gwalior are recognized as the counter magnet to the industrial development in the region and will emerge as integrated industrial estates.

2.10.2 Land Use:

As per Master Plan of Gwalior (2005), the total planning area covers 52,652 Ha out of which the current developed area is only 5,842 Ha (11%). It indicates that there may be lack of adequate basic services in the city which does not attracts for peripheral growth in all direction.

Out of the total developed area of the city, maximum area (i.e. 48%) is covered under residential use. Apart from this about 17% of the total developed area is under road network which is followed by Public/ semi Public areas of about 16%, Industrial area of about 6%, commercial area of about 5%, public use/ services is about 4% and green area of about 4%.

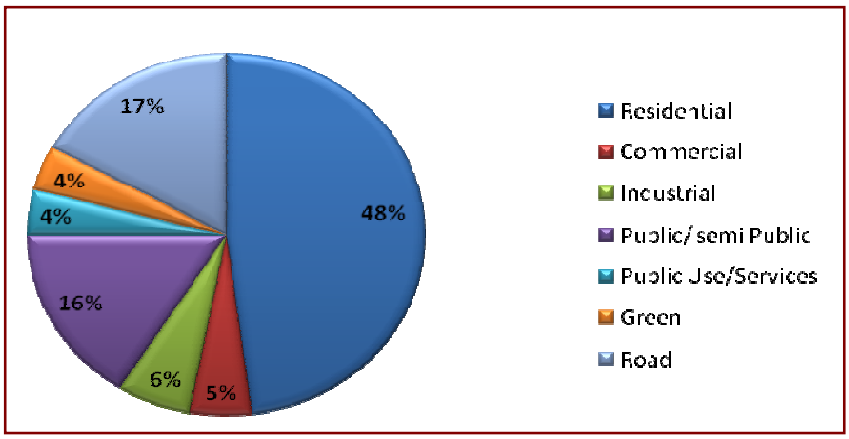
Table: 2.5 Land Use Distribution of Developed area.

Category	Area (in Hectares)	Area (in sq.km)	Percentage (%)
Residential	2803	28.03	48
Commercial	319	3.19	5
Industrial	367	3.67	6
Public/ semi Public	922	9.22	16
Public Use/Services	222	2.22	4
Green	212	2.12	4
Road	997	9.97	17
Total Area	5842	58.42	100

Source: Master Plan, Gwalior, 2005

The land use distribution reveals that Gwalior city is having sufficient public/ semi public area but it is lacking space for public utilities/ services and green belt. There is a need to strengthen and development of public services and green areas in the city. The following pie-chart indicates the land use pattern of the city under various categories.

Fig: 2.7 Land use Distribution



Source: Gwalior Master Plan 2005

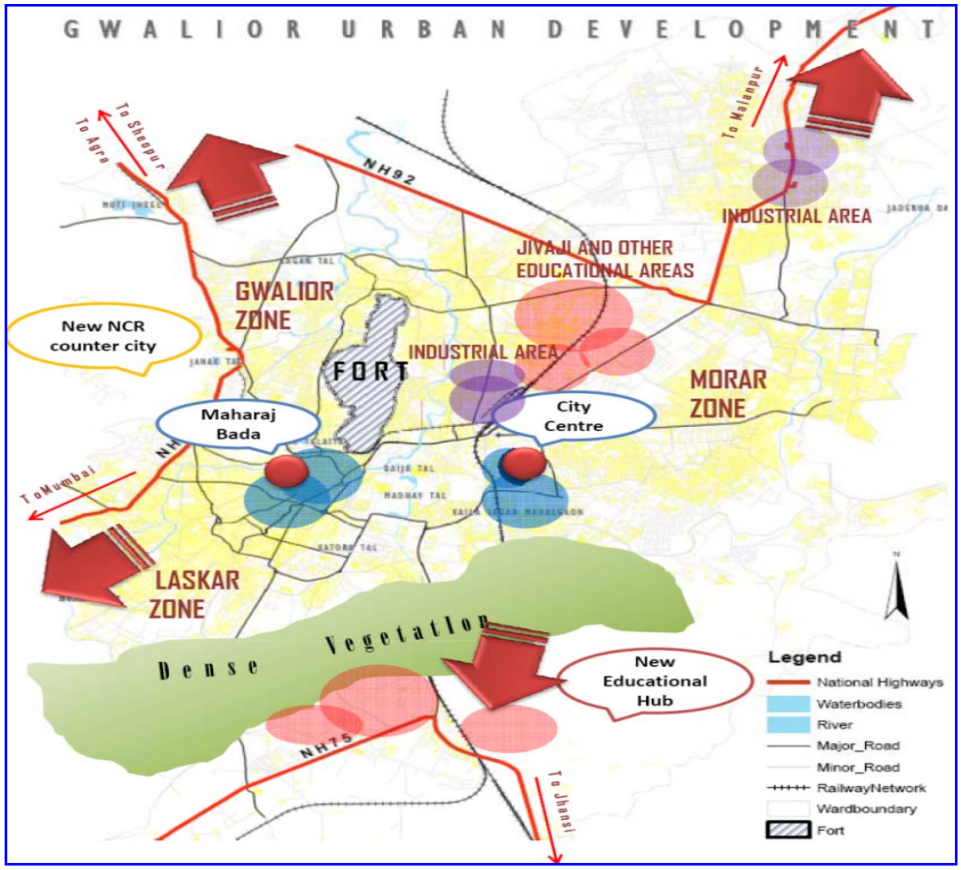
As per existing land use of Gwalior, the major commercial and trade activities are concentrated in *Bada* area situated in the core area of the Laskar constituency. It is one of the oldest commercial zone in the city and also known for whole sale market. The area along Jhansi road is developing as educational hub of the city. Recently many major institutes are coming in this zone.

Under industrial area, the key areas are Malanpur in North-east part of the city and a small scale industrial area is also located at Taraganj area located in South-western part of the city.

2.10.3 Urban Development:

In terms of physical growth, Gwalior is a tri-nodal city consisting of - Old Gwalior settlement around the fort, - area which was developed by the Marathas, Laskar which was also developed by Marathas and Morar – by the British cantonment. These were established at different periods in history. In recent decades, all three settlements have witnessed increase in size and population resulting in almost contiguous urban growth.

Fig: 2.8 Urban Development of Gwalior



Source: Primary Survey

2.10.4 Social Conditions:

The increased urban population has also resulted in the increase of the percentage of urban poor. There are 19,636 Below Poverty Line (BPL) families[3] in Gwalior, which comprise of about 32% of total number of households staying in slums area. The total Schedule Caste and Schedule Tribe population is 137470 and 13539 persons respectively, which constitutes about 16.62% and 1.64% of total population of the city respectively. From the Reconnaissance survey and visual observations, it has been seen that majorly the settlements located around the areas like, Morar and on Janshi Road (Laskar), are deprived of basic services like, adequate water supply, drainage and sanitation and were found extremely unhygienic. The situation near Gwalior fort being little better than these zones.The major localities/ Mohallas in the above mentioned regions are as follows:

Table: 2.6 Division wise underserved localities in Gwalior

Sr. no.	Divisions	Name of localities/ Mohallas
1	**Fort area (Old Gwalior)**	Noor Ganj, Gudhari Mohalla
2	**Morar**	Rasal Bazar, Harnampura, Aryan nagar, Hanuman colony, Harijan Basti
3	**Janshi Road (Laskar),**	Gudi-Gudiya ka Naka, Chandvardayni Naka, Khajanchi baba

Source: Primary Survey

These areas are characterized by medium density, low rise development with Pucca, Semi Pucca housing (temporary shades as well as houses with brick and mud plaster). As per PPSA (Poverty Pocket Situation Analysis) survey Gwalior is having 217 slums within Municipal area which constitute about 45% of the total population of the city and out of which few slums are developed on the hilly terrain where predominantly low-income group of people are residing. These areas are lacking basic infrastructure and having poor quality of life.

2.10.5 Slum Profile in Gwalior City:

In the year 2011, about 83,855 households are staying in various slum pockets located within Gwalior Municipal Corporation (GMC) limit; where as in 2006 about 60,787[4] households were stayed in the slums and out of which about 32% (i.e. 19636) of the households are reported to be BPL. The total slum population accounts for about one third of the city population. It is also observed that the household size in the poor pockets of the city got decreased from 6.76 to 5.92 in the past 5 years.

Presently, the city is having 229 slum pockets out of which 217 slums are within Gwalior Municipal Corporation (GMC) limit and rest of the slums are located in Morar cantonment area which is outside GMC limit.

Chapter-III

DATA & METHODOLOGY

3.1 Introduction:

Data is heart or soul of any kinds of geographical research. The Quality and reliability of the research depend upon the Quality of data and techniques or methods used for the analysis. To develop application which covers data pertaining to various sectors is a complex task. Taking this as a challenge, in order to provide precision solution we focused our approach on ward level, hence we tried to collect maximum ward level of the city.

3.2 Research Methodology Process:

Any Research work can be fulfill with proper way of data collection, Proper research methods, Analysis and fruitful result for solving real world problems or for planning and decision making; this process is called Research methodology. In this present research also have completed with following phases:

- **Pre-field Work**
- **Field Work (Primary Data Collection)**
- **Data Collection (Secondary data collection)**
- **Data Processing**
- **GIS Database Generation**
- **Analysis and**
- **City Sanitation Planning (CSP)**

3.2.1 Pre-field Work:

Pre-field involves study of literature review, study of State and Central governments policies of City sanitation planning, and different projects on city sanitation planning. Meet with Gwalior Municipal Corporation officers and commissioner and discussed with them about city Problems and slum areas in city. In Gwalior Corporation there was much work done on city sanitation under the "Project Uday" and "Project Uthan" so we discussed about these both project officers and got some information, ideas for Gwalior City Sanitation Planning. Then make some field survey plan and format for field survey. That all did the Pre-field work Phase

3.2.2 Field Work (Primary Data)

- **GPS Survey:**

GPS Survey is the primary source of data collection which provides the Location information of features. While talking about spatial data, actual location of features plays important role because it gives clear idea about it and problem become easy to solve. Hence apart from other data collection we also conducted GPS survey to collect exact locations of Dust bin, Hand pump, well, Tube well, Community Toilets, public Urinals, OHT, Open Dumping areas, Open defecation areas and major landmarks etc. collected their other related information with current status and further following maps were prepared:

1. Ward wise Solid waste Map (Open dump and dust bin locations)
2. Ward wise water supply Maps (Hand Pump, Well, Tube well and OHT locations with their status and use)
3. Ward wise community toilets and Public Urinal locations (status of each community toilets with their numbers)
4. Major Land mark locations in the city (Hospital, School, govt. offices, temples, Banks and ATM centers etc)

3.2.3 Data Collection (Secondary data):

Some data was collected by visiting various departments like Revenue department, Pollution Control Board, Asian Development Bank (ADB), GMC Project Office (Project UDAY & Project Utthan office) Town and Country Planning office, Health office, Water supply department, and Department of Supervision and Consultant (DSC) etc. With the help of these departments received demographic, Institutional, Technical, Social, Financial, Sanitation as well as GIS data. This data was in different formats like hard copy maps, reports, documents and softcopy maps was in AutoCAD and Shape file format. After getting these data next some process done on the data collection phase. Basically this is secondary data collection process in both soft and hard copy data collection from different departments of GMC.

3.2.4 Data Processing:

While working with variety of data, it's always a good practice to bring it at some common format so that it becomes easy for further processing. Hence we processed entire data as follows,

All shape file data which get from GMC was not georeferanced and also was without attribute information. Hence following operations were performed in GIS environment using GIS application tools like ArcGIS 9.3 GIS desktop application.

1. Scan the Hard copy maps which provide from GMC & Other department.
2. Digitized maps in the different layers
3. Geo-Referencing of all layers
4. Map Error Cleaning and Topology generation
5. Non-Spatial data attachment to the ward boundary layers for analysis (Population, slum, economical, survey, population data, sanitation data)
6. Preparation of various thematic layers as needed. i.e. Land use, Land cover, Toilet facilities, slum Clusters, Water Supply map, Elevation map, sewerage network map etc.
7. Took SRTM data from internet for showing Elevation map of the city.

3.2.5 GIS Database Generations:

After collecting the data from primary and secondary sources next process was done to preparation the spatial and non-spatial data. Make a different maps from spatial data and arrange the non-spatial data in to the logical form. Among that data make the GIS database from spatial data which collect from both primary and secondary data sources.

In GIS database basically digitized maps and makes the GIS layers of Road network, River network, Settlements, Water bodies, Ward boundaries of GMC, landmarks, Government Buildings, locations of Well, Bore well, Hand Pumps, OHT, Community Bins, Open Dump areas, water logging area, Community Toilets, Urinals and Open defecation areas etc. After making spatial layers then non-spatial data arranged in to the logical form and attach to the spatial layers and then cross check the data then GIS database will be ready for analysis.

3.2.6 Data Analysis:

After data attachment next work is to data analysis. Various thematic layers makes in analysis phase like Ward wise Population map, Population density map, Elevation map, Contour map, Ward wise Economical status map etc. which is very useful to study before city sanitation planning of Gwalior city.

3.2.7 City Sanitation Planning:

This is a final stage in which used various geographical interface using GIS and Remote sensing techniques are used. In this phase next 20 year city sanitation plan of gwalior city with special study of slum areas was prepared basically four sectors for sanitation planning that is Water supply, Sewerage, Urinal and Toilets and Solid waste Management are made

3.3 Hardware Used:

3.4.1 Computer Hardware Used:

- Intel Pentium 4 (4.92 GHz) Micro Processor
- 160 GB Hard Disk
- 1 GB RAM
- 19" Color Monitor

3.4.2 GPS Receiver Hardware Used:

- GPS Name- GARMIN eTrex GPS Receiver
- Receiver Capacity-12 Channels (12 Satellites can Visible)
- Update Rate – 1 Per Second, Continuous
- Position Accuracy: 5 /6 Meter
- Antenna – Internal Patch
- Display Size – 2.1 by 1.1 Inches

3.4 Software Used:

3.4.1 General software:

- Microsoft office 2003 (MS Word, Excel & Power Point)
- PDF Creator
- Paint
- Google Earth5.2
- Garmin (GPS software)

3.4.2 GIS software:

- AutoCAD Map5
- Global Mapper 9
- ArcGIS 9.3

3.5 Research Methodology flow charts:

Research methods means the overall scientific flow for completing the research project and methods means the different techniques used to complete the specific operations. Here I present two methodologies according to the specific purpose are presented. Following methodology is for GPS survey and general methodology.

3.5.1 GPS Survey Methodology:

This is primary data collection methodology used for GPS survey on the field, the format for spatial and non-spatial data collection. In spatial data collection take sector wise GPS readings like in Water supply take locations of Water supply sources (Well, Bore well & Hand pumps), OHTs etc. with their non-spatial data like Ward No, use of water, capacity of OHT, Status & Remark etc. In Sewerage system we just identified the areas or colonies where sewerage is exist or not and we take readings of these areas in GPS which useful for update in map for make a sewerage network map, in solid waste sector take the GPS location of waste bin, Open dump area & trenching ground as well as land fill side etc. In Community toilet and public urinal sector take GPS location of open defecation area, public urinals and community toilets with their ward number, quantity and quality data etc. These are the flow which used in GPS survey. The GPS survey methodology show in flow chart.

3.5.2 General Research Methodology:

The research methodology flow show detail steps of research. Data was collected from GPS survey and from various departments of GMC. Then spatial data digitized makes in layers and non-spatial data arrange in logical form in excel and then after data verification and remove all spatial data errors and topology generation, then integration of both spatial and non-spatial data. After data attachment data will be the ready for analysis & CSP process. In analysis process make some DEM layer, Population density etc. and in sanitation planning process make a sector wise study for mitigation sanitation planning for Gwalior city. The general research methodology showing in below chart.

Fig: 3.1 GPS Survey Methodology

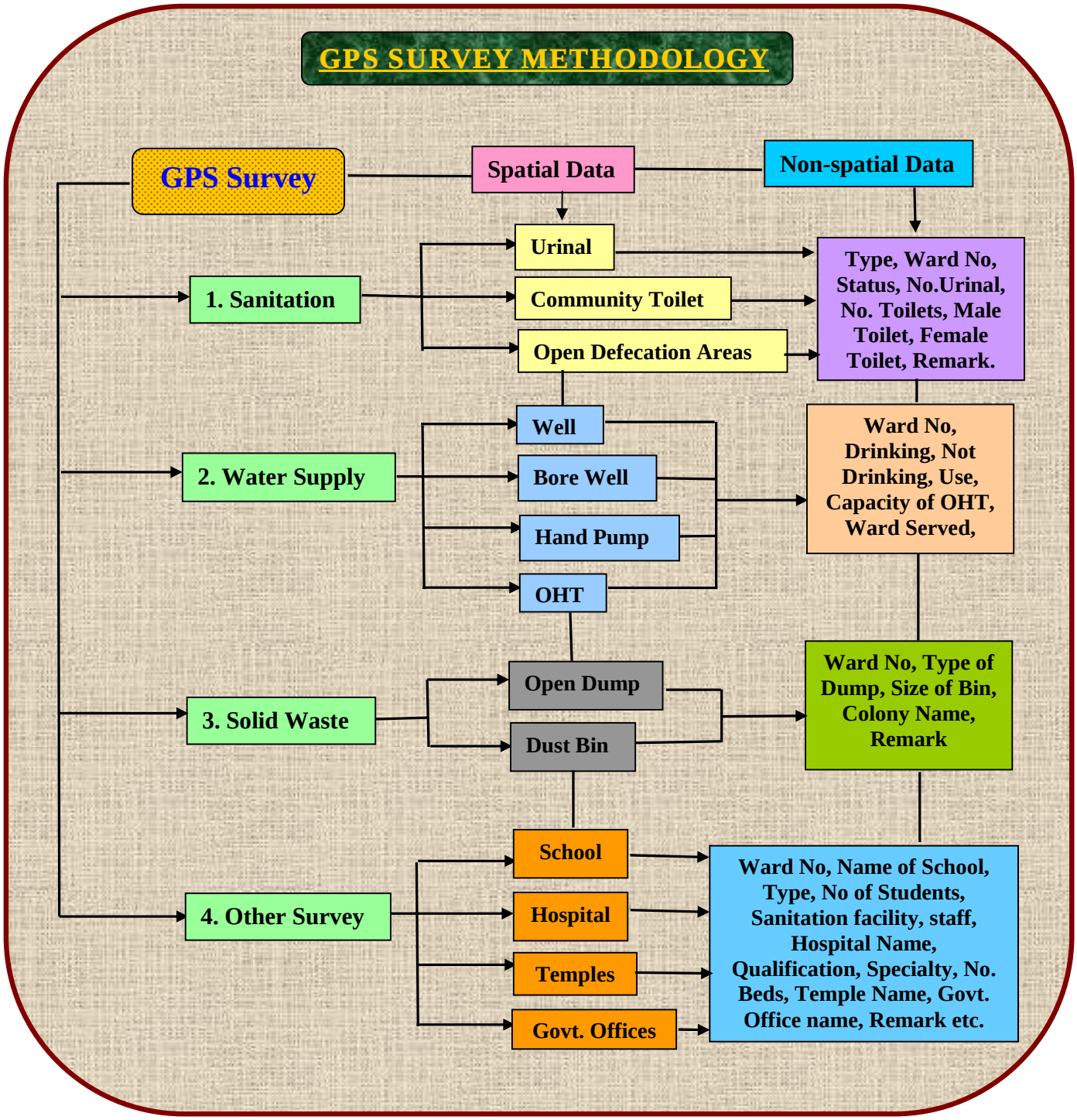
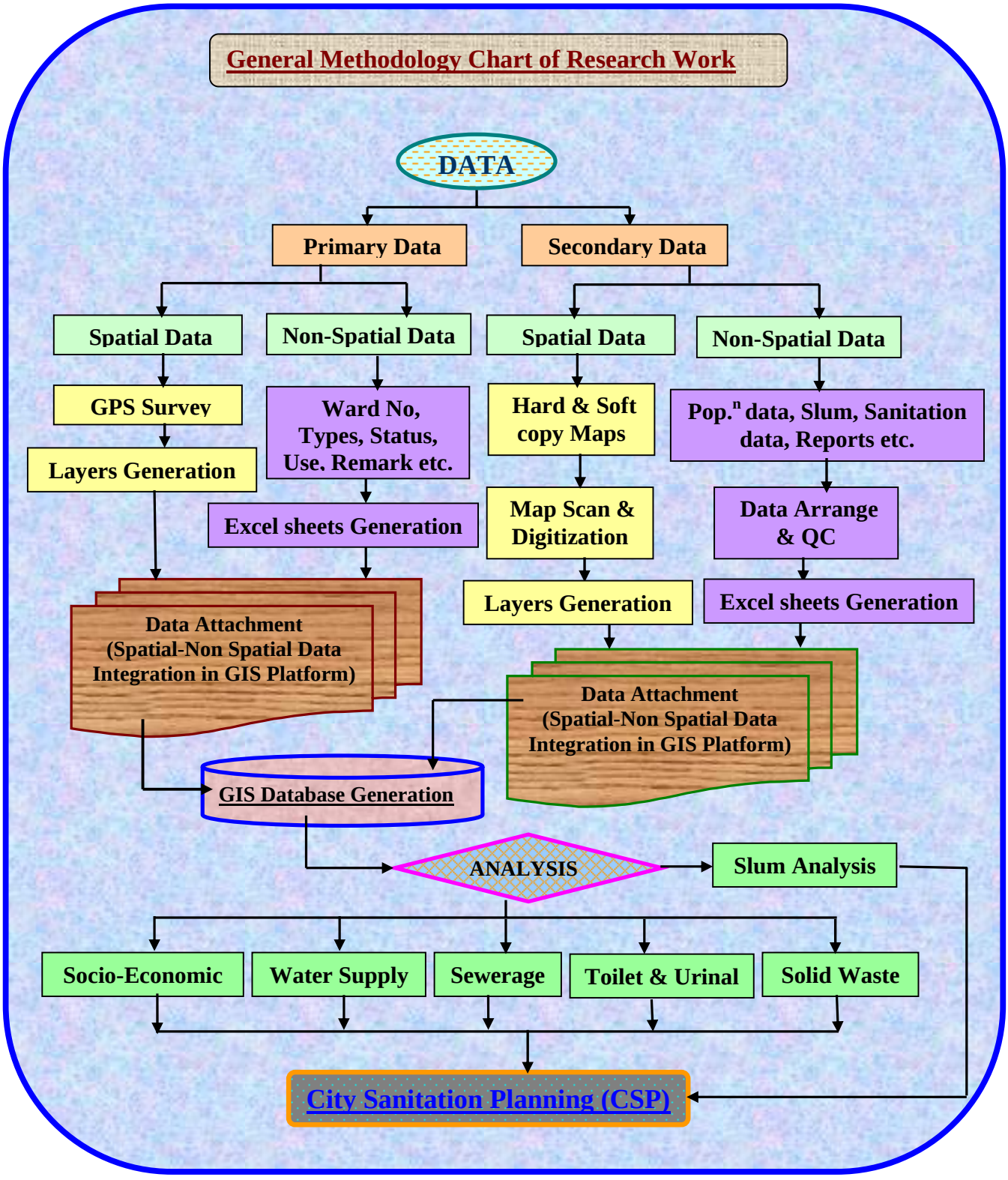


Fig: 3.2 General Methodology Flow Chart



Chapter- IV

Scenario of City Sanitation

4.1 Introduction:

City sanitation planning is the core part of present research which is made not only for today but for it's a planning of next 20 years and have suggested many plans in different sectors for better development and progress in health, urban utility and better administrative purpose. This sanitation planning is useful for civilians and administration for minimization the problems in city sanitation sector. City Sanitation Planning is studied basically in following sector.

4.2 Sectors of City Sanitation:

There are four major sectors which are more problematic in urban areas and more difficult to solving for Municipal Corporation due to increasing population and increasing demand of different urban facilities like water supply, electricity, sanitation, land availability etc. because in city area the available resources are limited and demand for that resources in more hense many city problems crop up. For better city sanitation planning and to minimize the city problems there are four major sector which are taken for City Sanitation Planning (CSP). These are below.

i) Water Supply

ii) Sewerage & Waste water Management

iii) Solid Waste Management

iV) Public Urinals & Community Toilets

4.3 Water Supply Network of Gwalior city:

Presently the city is mainly relying on two types of water sources,

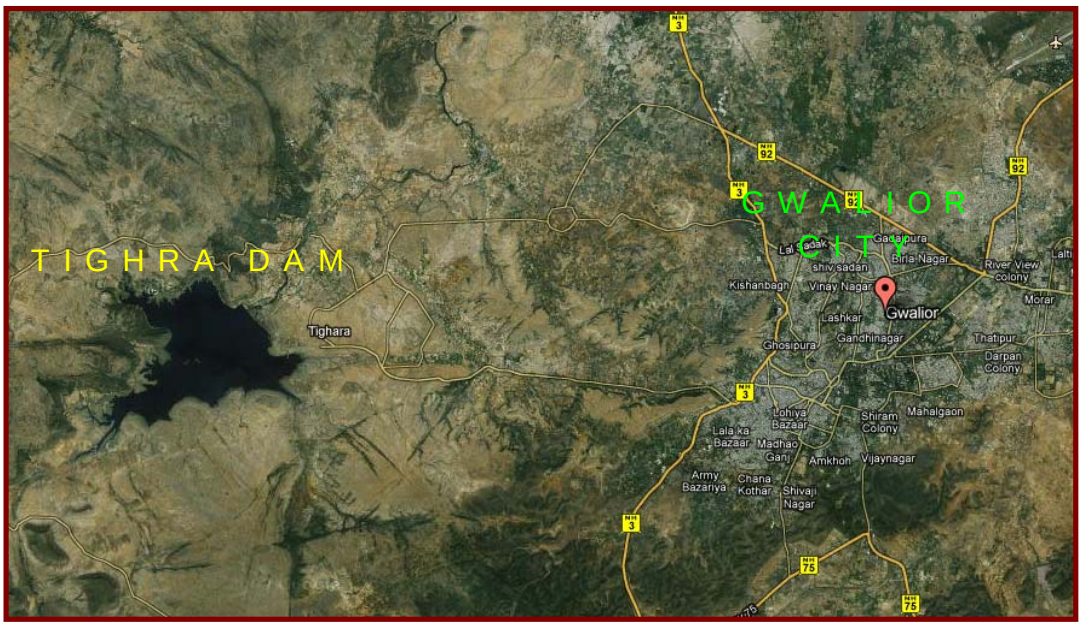
a) Surface water sources

b) Ground water sources.

4.3.1 Surface water Source:

The main source of water supply is Tighra Dam (Fig:4.1)on Sank River. The total availability of water was 144 MLD and the population covered is about 79% of the city. Now the existing WTPs and CWPSs have been rehabilitated and working with enhanced capacities under project UDAY.

Fig: 4.1 Google Image of Tighra Dam



The storage capacity of the present OHTs, UGTs system is about 47.5 MLD, which will be fulfilled by existing 15 numbers of OHSR. Apart from this, there is a proposal to increase the storage capacity by adding 12 new OHSRs. Thus water supply would be increased by 189 MLD in future. The existing length of water distribution system is about 700 kms, covering 142 sq.km area of GMC. About 10.8 km of transmission main from Moti-jheel to Amkho OHSR is being rehabilitated under the project UDAY.

4.3.2 Ground water Source:

A significant volume of ground water is also extracted through a network of bore wells and hand pumps. It is reported that the quantity of ground water used for daily supplies is around 27 MLD (6 MGD).There is a huge uncertainty in the quantity of water supplied from these ground sources, depending upon ground water table. Almost 12360 trips are made by tankers per month for additional water supply

4.3.3 Water Availability:

The present availability of water to the city is about 178 MLD. The quantity of water available from Tighra Dam is about 144 MLD. The water from the Tighra dam is treated at water treatment plants located at Moti-jheel. Apart from this Municipal Corporation are also fetching water of about 34 MLD from the ground water sources, such as; bore-wells and private tube-wells.

Table: 4.1Municipal water supply system

Type of Source	Installed Capacity (in MLD)	Volume served (in MLD)
Surface water		
Moti-jheel WTP (Tighra Reservoir)	144.00	144.00
Ground water	34.65	34.00
Total	178.65	178.00

Source: Gwalior Municipal Corporation (GMC)

At present the GMC is providing 93536 of water connections to various types of consumers. The MC is maintaining at about 91,542 domestic water supply connections and about 1088 commercial connections..

At present, the GMC has a total length of water distribution system of about 700 km, which serves for an area of about 80% of the total Municipal limits. The average duration of water supply in the city is about 0.5 – 4 hours per day and the per capita availability of water at the consumer end is about 109 lpcd. In terms of storage capacity of water GMC has 12 nos. of overhead Tanks in different localities, apart from this 15 Overhead Tanks are proposed under Project UDAY, in order to improve the storage capacity of the water supply system (total of 47.5 MLD).

4.3.4 Existing Water Supply Network:

GMC is also serving in low income group pockets (slums) through 900 public taps located in different areas of the city. But these Public Taps are not maintained properly which leads to water contamination and wastage.

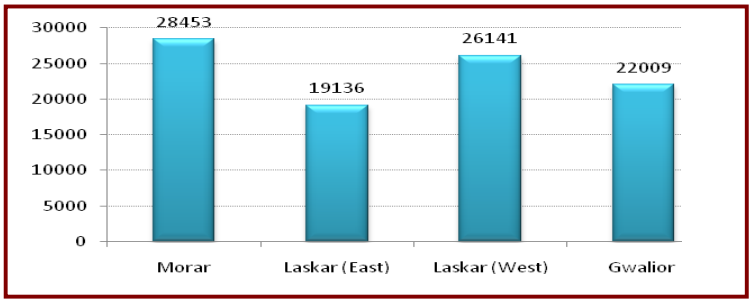
Table: 4.2 Type of water connections in GMC as on March 2009

Type of connection	Metered	Unmetered	Total
House service	0	91542	91542
Public taps	0	900	900
Commercial	860	228	1088
Industrial	0	0	0
Institutional	0	0	0
Bulk supply	6	0	6
Total	**866**	**92670**	**93536**

Source: Gwalior Municipal Corporation (GMC)

In terms of no. of zone wise water supply connections, the following graph represents the zone wise no. of individual connects as on March 2010. Morar zone is having the highest number of individual water connections where as Laskar (east) is having the least nos. of tap connections.

Fig: 4.2 Zone wise no. of water supply individual connection



Source: PHED, Gwalior

As per current data on number of water supply individual connects as on March 2010 are 95,739. The water supply network in Gwalior city has been divided into four zones: Gwalior, Morar, Lashkar (east) and Lashkar (west). The zone wise number of water supply connections is mentioned in the following table:

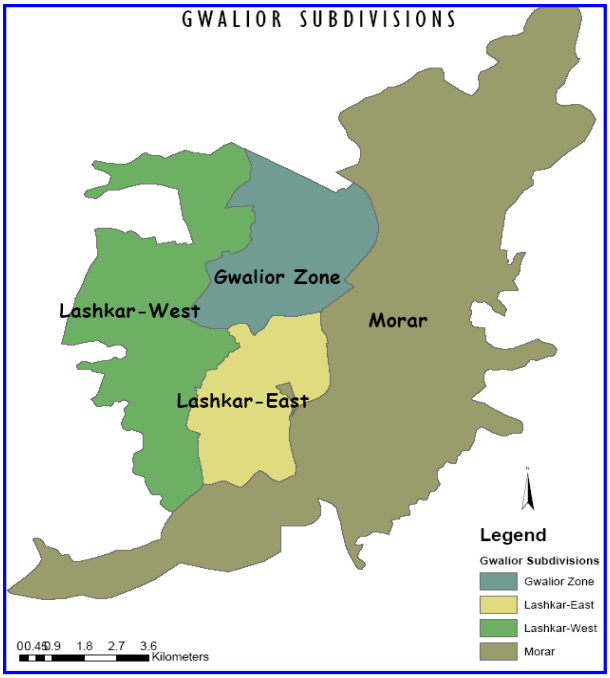
Table: 4.3 Zone wise no. of water supply connections as on March 2010

Sr. no.	Admin. Zone	Total no. of connection
1	Morar	28453
2	Laskar (East)	19136
3	Laskar (West)	26141
4	Gwalior	22009
	Total	**95739**

Source: PHED, Gwalior

The data also reveals that the present extent of non-revenue water is about 43% which is mainly due to leakages in the age-old distribution pipes and illegal connections in the existing system. Initiatives have been taken under ongoing project i.e. Project UDAY in order to reduce the gap in the existing system and to strengthen the water supply ,catering the future water supply demand of the city.

Fig: 4.3 Gwalior Zone Boundary



Poor O&M of water supply facilities in the slum areas. In peak summers water is supplied by Municipal/ Private tankers.

i) Gwalior Zone:

It lies in the central city and comprises of 17 wards. The water supply for this region is mainly based on supplies from the rakkas tank and Noorganj tank.A large volume of water is also supplied through tube wells (300 no's) which is also connected to distribution network. Hand pump supply is also provided in this zone through about 565 hand pumps. Besides these water tankers are also utilised to supply water in case of shortages. The entire distribution network in this zone is estimated to be about 400 km which covers almost 95% of Gwalior zone.

The total numbers of households in this area is about 21,379 and total number of connections is 18287 of which 5100 connections falls in JC mills which have been closed down. About 3325 (about 16%) illegal water connections are been reported in this zone.

ii) Morar Zone:

Morar zone lies in the north east part of the Gwalior city. Water to this zone is majorly supplied from new treatment plant at Motijheel and then into two OHTs in Morar and Thatipur areas. The pressure at which water is supplied to the OHTs is 68 m (6.8 Kg /cm2) for these

areas but however the pressure available at tail end user of the distribution network is very low and hence these areas receives only 15 minutes. Of water supply in a day, this is to be enhanced under project uday. Water connections in these areas are found to be approx. 17,544 legal connections and 1318(about 7 %) illegal connections.

Ground water is also supplied through tube wells to this zone with 189 tube wells in this zone. New Ward no 17 and 26 are supplied majorly through ground water. The number of functional hand pumps is 336 out of which 25 are dried or not working properly.

iii) Lashkar East:

Laskar east lies in the south eastern region of Gwalior and has population of 1, 67,089 (2001) spread across 13 wards. The main source of water supply for Lashkar east was Old treatment plant at motijheel, but now covered under water treatment plant at tighra, under UDAY. At present water is supplied majorly by OHTs at Amkhoah, Jayendraganj and laxman tallaiya. New OHTs are being constructed at Guda pahad and Awadpura under project Uday.

There are 287 tube wells and 134 hand pumps. In totals there are 19,257 legal connections while 1538(About 8%) are illegal ones.

iv) Lashkar West:

Water is supplied mainly from new treatment plant at Moti-jheel through 4 OHTs which includes old Gorakhi, new Gorakhi, Sikander kampoo and Sanjaynagar tanks. Now under project UDAY water supply is augmented through new water treatment plant at tighra, and few new OHTs are being constructed under UDAY as ekata colony tank, hanuman tekdi water tank.Groundwater exploration is high in this zone with around 248 tube wells in this zone.

4.3.5 Water Distribution Network:

At present, the GMC has a total length of water distribution system of about 700 km, which serves for an area of about 80% of the total Municipal limits. The average duration of water supply in the city is about 0.5 – 4 hours per day and the per capita availability of water at the consumer end is about 109 lpcd. In terms of storage capacity of water GMC has 12 nos. Of Overhead Tanks in different localities, apart from this 15 Overhead Tanks are proposed under Project UDAY, in order to improve the storage capacity of the water supply system (total of 47.5 MLD).

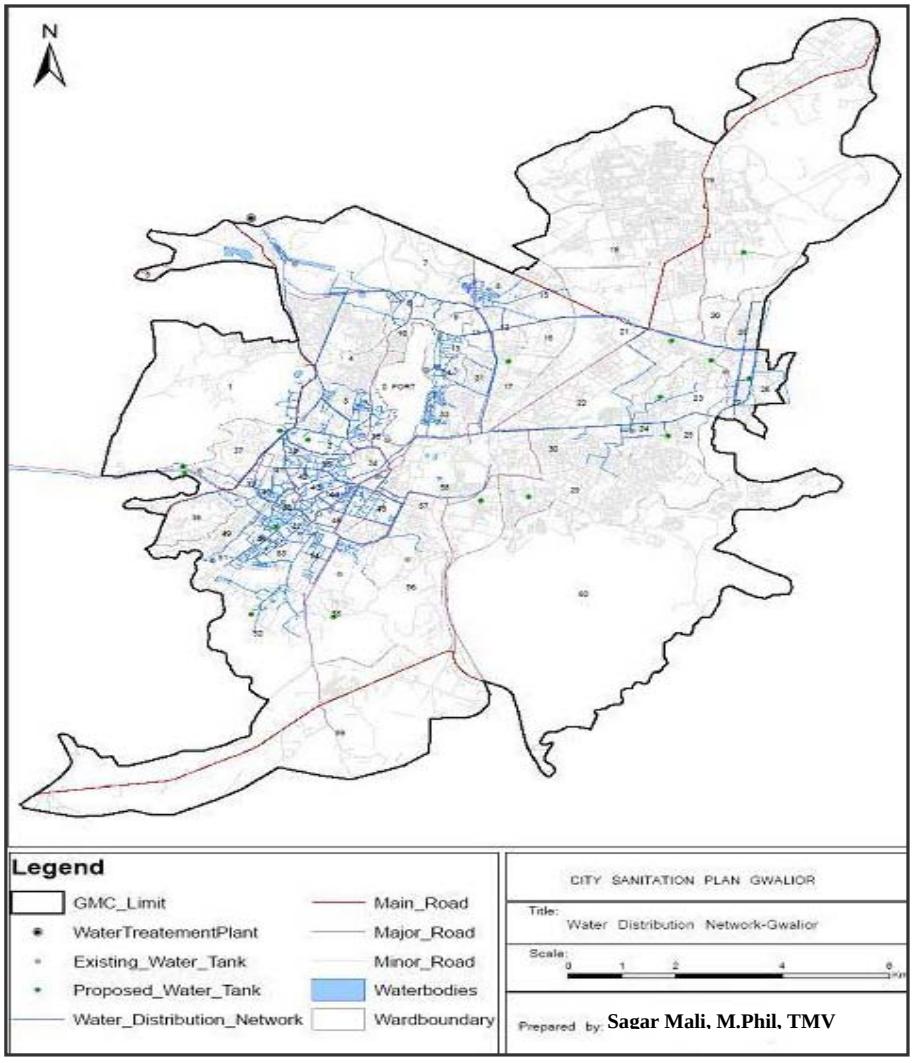
Table: 4.4 Municipal water supply system

Indicators	Details
Distribution System: **Total Length** **Coverage** **Total service storage capacity** **Duration of supply** **Per capita available of water at consumer end**	 700 km 142 sq. km. (80%) 45 Million Liters 0.5 to 4 hours/ day 109 lpcd
Extent of Non Revenue Water	43%
Public Stand Posts	900 No's
No. of Bore Wells **Public**	 Total 1,451 Bore wells

Source: Gwalior Municipal Corporation (GMC)

The following figure illustrates the present level of water distribution network system and storage facilities in Gwalior Municipal Corporation.

Fig: 4.4 Water distribution network for Gwalior



4.3. 6 Water Treatment Plant & Their Distribution:

I) Moti Jheel treatment plant:

a) Old Treatment Plant:

The old treatment plant was commissioned in 1928 and its capacity was further augmented in 1972. The present installed capacity of the plant is 77.28 MLD (17 MGD). However based on flows measured at the inlet of this WTP, it is estimated that this plant supplies 57.1 MLD (12.5 MGD) of treated water to Gwalior. It is estimated that there is a huge loss from this WTP on account of its treatment efficiency and losses during water conveyance within the WTP. The processes involved in the treatment include sand filtration and disinfection.

b) New Treatment Plant:

The new treatment plant commissioned in 1986 has an installed capacity of 68.19 MLD (15 MGD). While the treated water supplied by this WTP was measured to be 63.8 MLD (14 MGD). Water supplied from Tighra directly reaches the plant through another 17 Km long PSC pipe line (diameter 1200 mm / 47.25 in), which runs parallel to line supplying to the old treatment plant. This new WTP comprises of two treatment units. The first is a sand filtration unit of 18.92 MLD (4.16 MGD) and the second has a clari-flocculator cum sand filtration unit of 37.85 MLD (8.33 MGD). The treated water is pumped through 5 pumps of 22.7 MLD (5 MGD) each (3 operational at a time). It is reported that about 13.6MLD (3 MGD) and 50MLD (11 MGD) of water is respectively supplied to the Rakkas tank and different reservoirs and riders of the city (covering Gorkhi (new and old), Noorganj, Thatipur, Morar, Sikandarpur and Sanjay Nagar).

Fig: 4.5 water Distribution Network of Tighra Dam

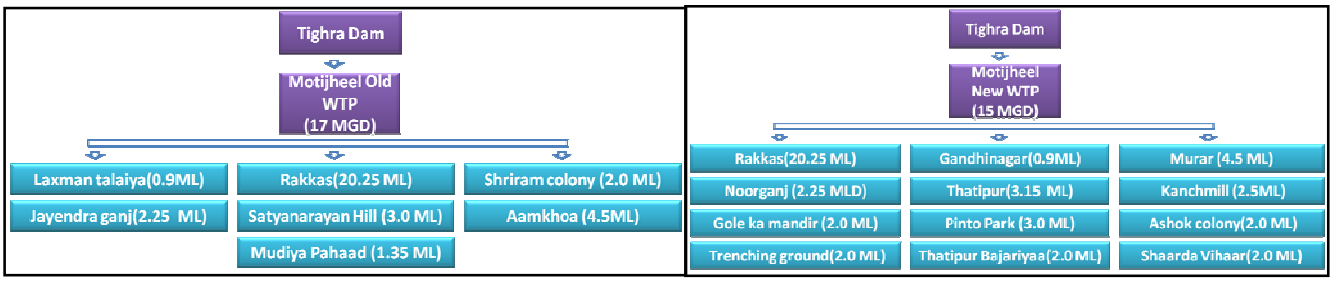
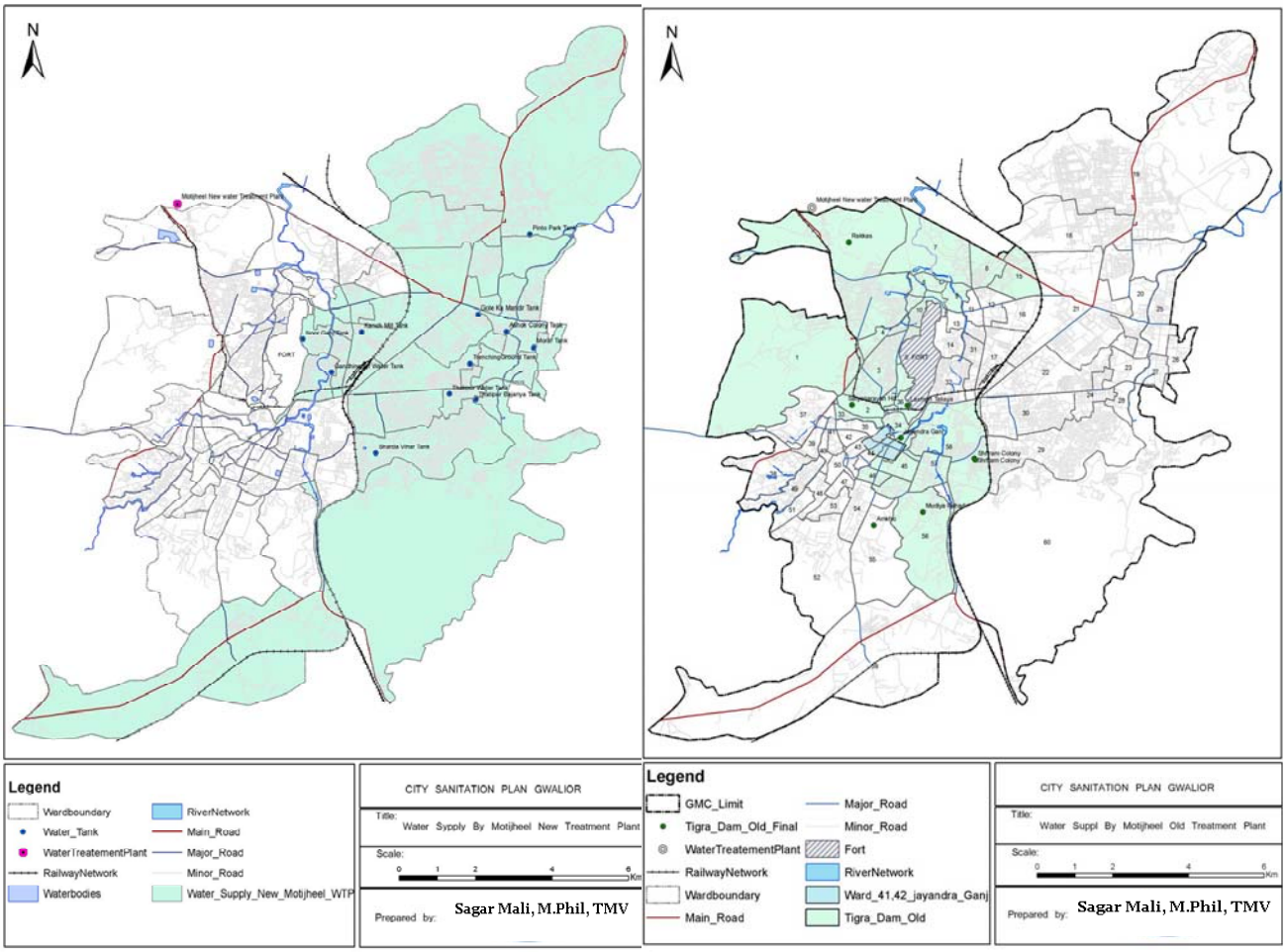


Fig: 4.6 Water Supply by Moti Jheel Old & New Treatment Plant



Source: Gwalior Municipal Corporation (GMC) and Primary Data Collection

I) Tighra Dam Treatment plant:

A new 10 MGD water treatment scheme at Tighra is being implemented, under project UDAY to augment the water supply system to cope with present as well as 2024 year water demand. The treatment plant would mostly supply water to Lashkar area and few areas of Gwalior zone.

Fig: 4.7 water Supply network of Tighra New Treatment Plant

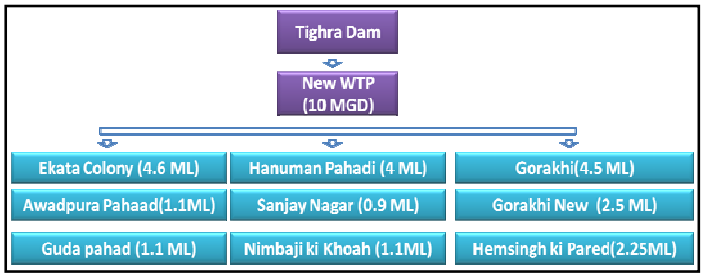
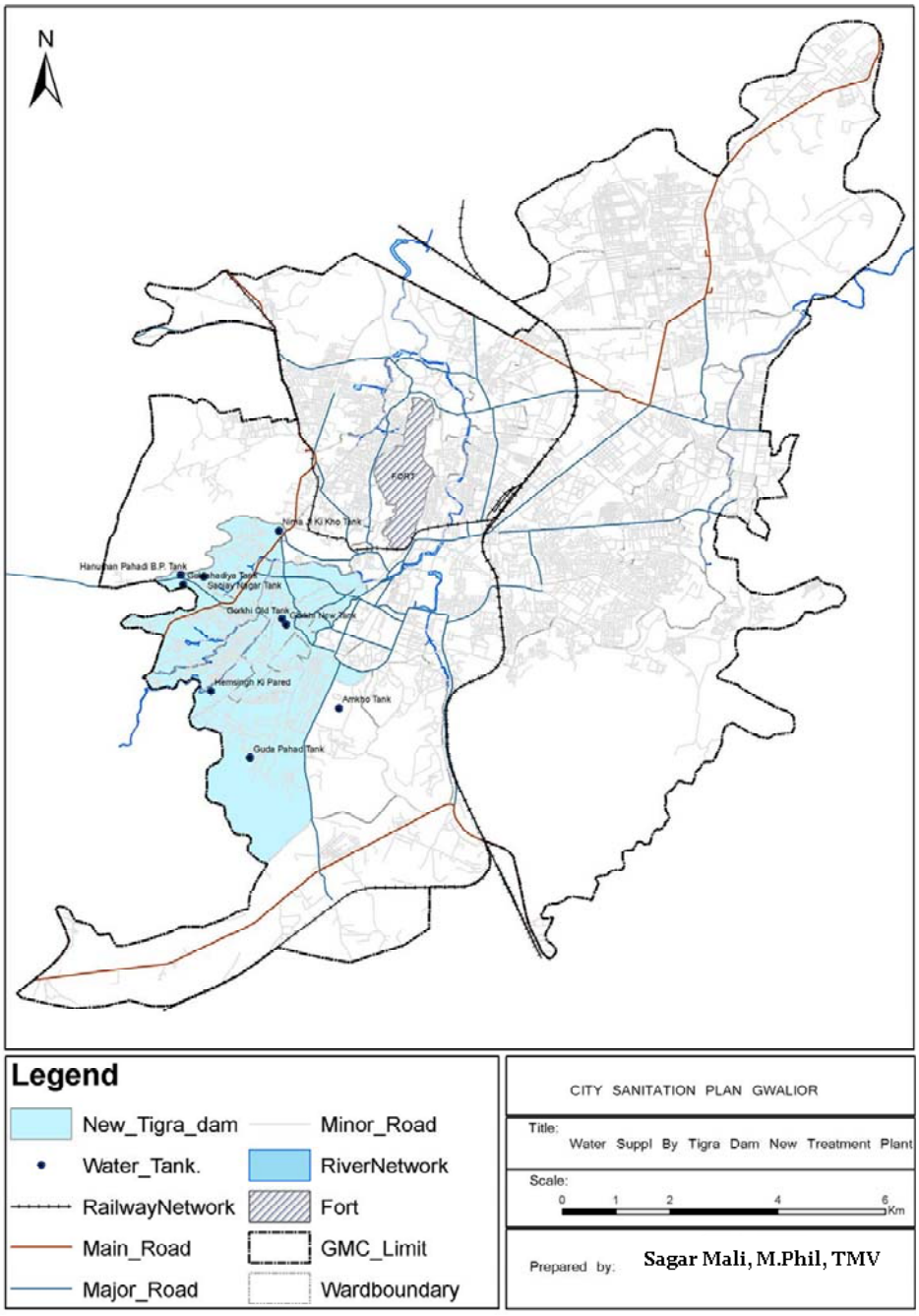


Fig: 4.8 Water Supplies by Tighra Dam Treatment Plant



4.4 Waste Water Management of Gwalior city:

4.4.1 Introduction:

Gwalior city have one of the oldest sewerage systems in M.P., which was laid in the year 1936. The underground sewer lines are mainly laid in the core city area while some areas in Lashkar and Morar lacks in it. Municipal sources reveal that the city is having 58 km of underground main sewer covering an area of about 132.8 sq. km. of the city (i.e. about 76% of the total Municipal area). The official sources also reveals that presently the city is having 550 km of sewerage system with different size of diameter, sice the system is quite old it and it has been developed in different phases, because of this reason at certain points the outlet of sewers are directly opening in open drains/ nallahs.

4.4.2 Terrain & Topography:

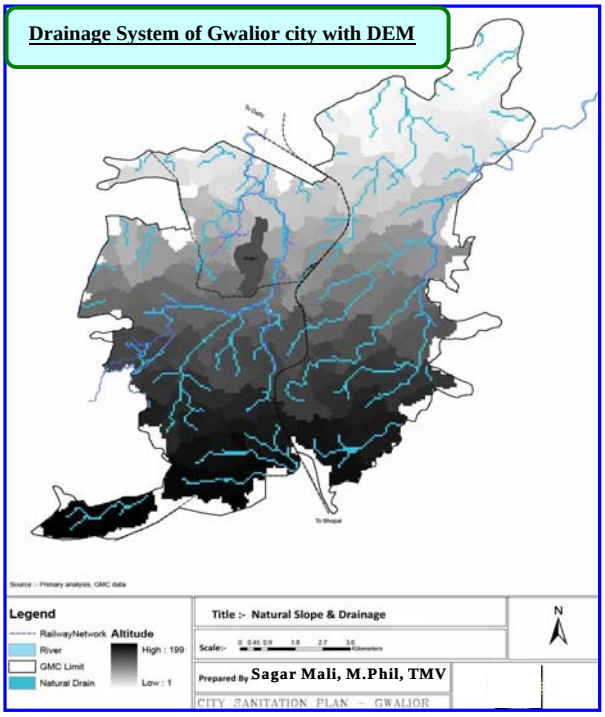
The city lies in a horse shoe shaped valley surrounded on three sides by low hills of Vidhyan ranges. From the point of view of Military strategy the city enjoyed natural protection in the past having hills on three sides. The topography of South of Lashkar provides three large tracks of cut up & uneven land all along the three rivers & their tributaries presenting a serious problem of land reclamation.

The terrain itself has developed the natural tributaries and streams which are eventually channelized into two min rivers viz. Swarnarekha River flowing in North south direction through the eastern part of the city and Morar River in the eastern region of the city.

4.4.3 Natural Drainage System:

The topography of city is such that the hillocks are situated on the southern & western side of the city. The important hills on the western side are Hanuman hill. Gupteshwar hill , Shankarpur hill etc. & on the southern side Mudiya Hill & Odhapur hill . A ridge line is also stages from Mudiya hills on the southern side and passes through the Railway Station & J.C.Mills area. The city is thus divided into two parts from drainage point of view, Viz. (1) Lashkar & Gwalior & (2) Morar . The general relief difference is about 40 meters between southern & northern portions (hill tops are not considered). The main drainage systems of these two areas are Swarnarekha River & Morar River.

Fig: 4.9 Natural Slope & Drainage Network



- SWARNAREKHA RIVER

The swarnarekha River is a sub tributary of river Chambal. The Swarn Rekha River emanates from 3.5 km up stream of Barai village. The river after passing through 7 Nos. old tanks and enters in the Gwalior city at Hanuman Bandh. The total distance from its origin to Hanuman Bandh is 20 km. After Hanuman Bandh, it flows from the heart of Gwalior town in a length of 13.65 km. ultimately it meets in to river Sank., on upstream of Pllowa Dam, which is a Tributary of River Chambal. The length of Swarnarekha River from its origin to confluence point is 70.65 km.

- MORAR RIVER

The Morar River emanates from a distance of about 15 km. upstream of Ramaua Dam in Gwalior district. The nearest village at this point is Deopura which can be located on Topo Sheet No. 54j/9. The river travels a distance of of 42 km. in Gwalior district and joins Vaishali River on the boundary of Gwalior district. Vaishali River ultimately joins Sindh River near village Bilao in Bhind district. On Morar River , Ramaua Dam is constructed and on the downstream of Ramaua Dam , two pickup weir . Morar Pickup weir and Bahadur pickup weir which utilized the discharge released from Ramaua Dam for irrigation through their canal system.

Fig: 4.10 Catchments Area of Swarnrekha & Morar River:

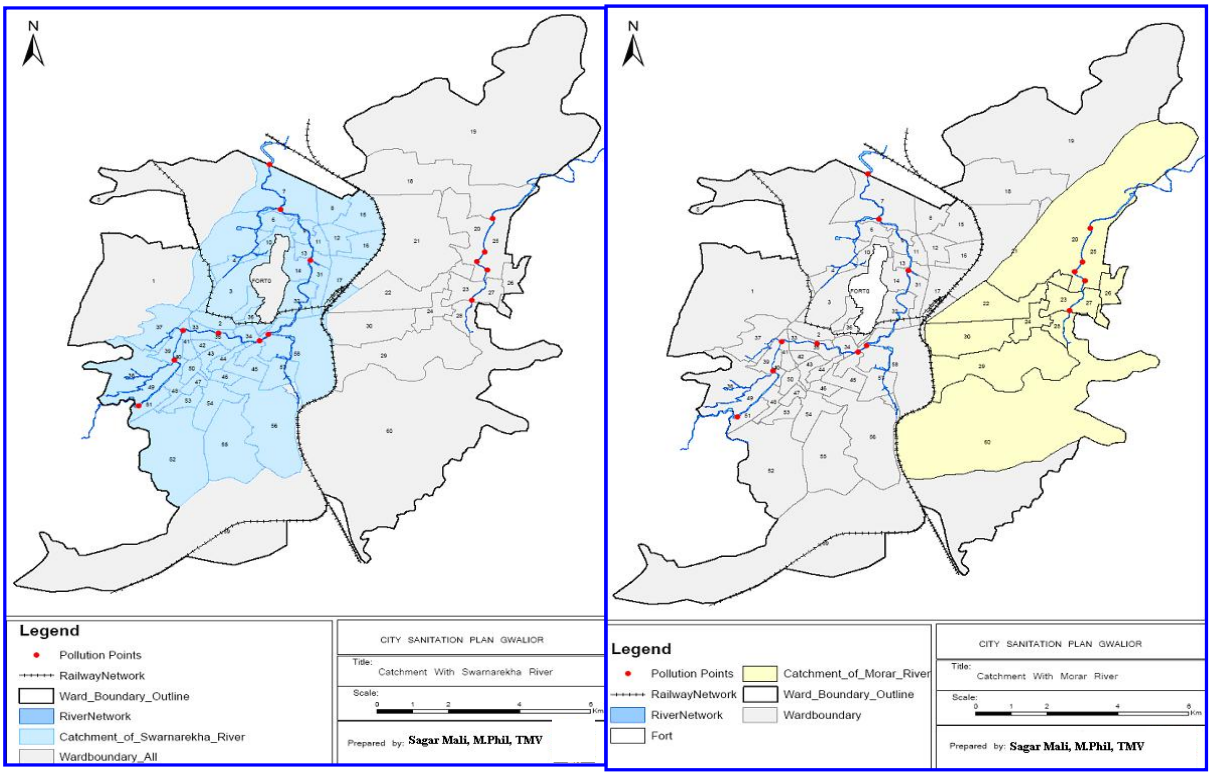


Table: 4.5 Indicator wise details of sewerage system and surface drains

Indicators	Details
Coverage of Properties with different type of toilet connections	75%
Coverage of Properties with sewer connections	30%
Adequacy of wastewater treatment capacity	98%
Coverage of Storm Water Drainage Network *(only primary drains)*	6.23%

Source: Gwalior Municipal Corporation (GMC), Service Level Benchmarking, 2009

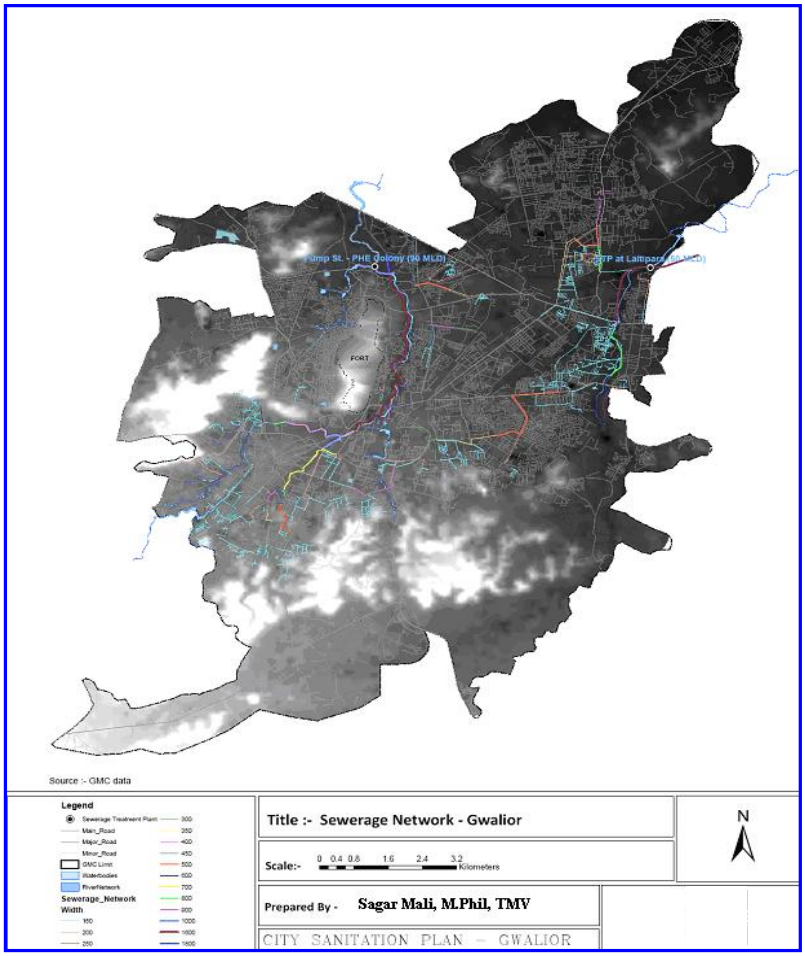
Presently, the secondary treatment facility for the sewerage generated in the city is partially present. It is observed that in most of the secondary sewers are letting their waste water directly into the nearby nallahs which ultimately merge either into the Swarnrekha River or Morar River. Although the city is having two STPs, namely a) Lal Tipara, Morar STP, and b) Gwalior Sewage Firm, but both of these STPs are yet to start functioning fully. The STP at Gwalior Sewage Firm near PHE colony is having the total capacity of about 90 MLD but

presently working as Pumping Station only. Recently the STP at Laltipara near Jaderua Bridge on Morar River has started working. The total capacity of this STP is about 50 MLD. The total waste water treatement capacity in the city is about 140 MLD and the waste water generated is about 142 MLD. Hence presently the adequacy of wastewater treatment capacity is about 98%.

Considering the existing sewerage networks, the city is mainly divided into two zones; a) Laskar-Gwalior Zone located on the western part of the city and b) Morar Zone located on the eastern part of the city.

In Laskar- Gwalior zone the major surface drains which carries the sewage of the city are; Swarnrekha River and Jhinsi nallahs. And in Morar Zone the sewage is collected and conveyed through an underground sewer which ultimately merges into the Morar River. Each zone has their own outfall, trunk main and branch sewer lines. All sewer flow through gravity and carries the sewerage to the respective sewerage treatment plants.The following figure illustrate the existing sewerage system in the city:

Fig: 4.11 Existing sewerage system of Gwalior



4.4.4 Collection, Conveyance and Disposal system in the Sewerage Zones:

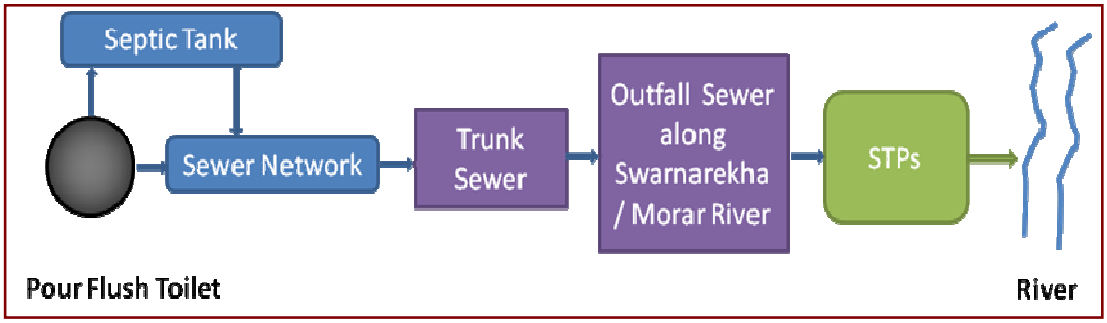
Under the present system, the waste water generated in the city is collected and conveyed to the STPs by means of sewer networks. The waste water generated at the household level toilet is either directly collected into the sewer or it goes through septic tank and the over flow from septic tank goes into the sewer network through open drains, which are intercepted at strategic locations in Laskar-Gwalior Zone only, whereas in case of Morar Zone interception of open drains is still in planning phase.

The sewer network comprise of laterals, branch and main sewers. This sewer system carries waste water to the trunk sewers. The trunk sewers ultimately discharge into outfall sewers which are connected to the STPs.

The treated water coming out of the STPs has been used for irrigation purposes. It is estimated that about 2000 Hectares of agricultural land can be irrigated by this treated effluent. But at present only Morar STP is under running condition and in the STP at Laskar-Gwalior zone only primary treatment is going on and in case of Morar zone the treated water is used for irrigation purpose where as in case of Laskar-Gwalior zone raw sewerage (after screening) is been used for irrigation purpose. GMC has also received funds for completion of components related to secondary and tertiary treatment of sewage at the STP at Laskar-Gwalior zone.

The following sketch shows a typical process of sewage collection, conveyance and disposal method.

Fig: 4.12 Schematic sketch of waste water collection, conveyance and disposal system



The cluster wise and ward wise classification in both the sewerage zones is mentioned in the following table:

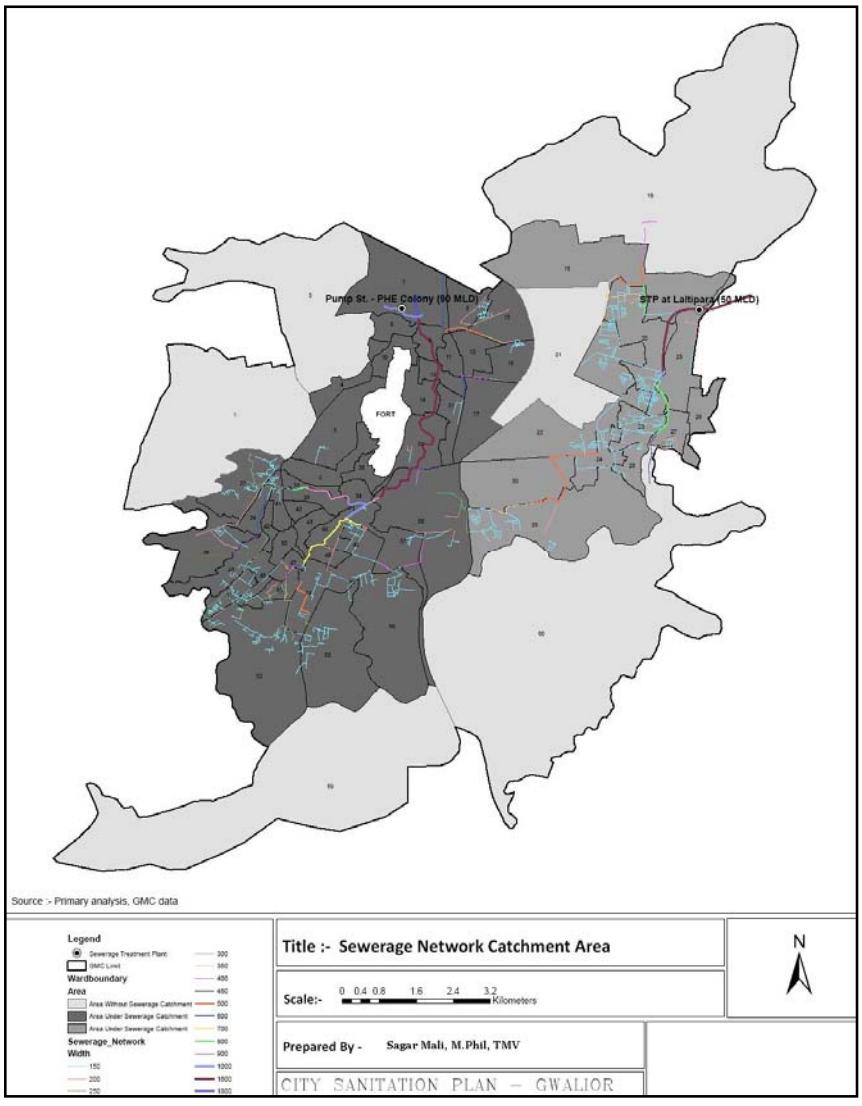
Table: 4.6 Overall wastewater conveyance system

Sewerage zone	Cluster number	Ward number	Wastewater Conveyance through
Lashkar – Gwalior zone	1, 7, 8, 9, 10, 11, 12	1 to 17, 31 to 59	Outfall sewer along Swarnarekha river
Morar zone	2, 3 , 4 , 5 , 6	18 to 30 and 60	Outfall sewer along Morar river

Almost about 60% of the total waste water generated in the city is conveyed by these two outfall sewers.

The following map shows the two sewer zones along with the catchment area it covers in the city.

Fig: 4.13 Sewerage zones in Gwalior



Zone wise salient features of the existing sewerage system are mentioned in the following table:

Table : 4.7 Salient features of existing sewerage system

Sr. no.	Particular	Lashkar-Gwalior zone	Morar zone
1	Sewerage zones in the city	a) Laskar – Gwalior Zone	b) Morar zone
2	Existing system first planned in the year	1936	1942-43
3	Existing length of sewer	640 km (2011)	
	Proposed sewer length (under UIDSSMT)	69 km	
4	Area covered under	70% of the city area	30% of the city area
5	Existing STP	90 – MLD not functional (only screening and pumping)	50 MLD - Functional
6	Design Capacity of STP	Up to 2039	Up to 2039

In the Lashkar-Gwalior Zone,the total length of the Swarnrekha River(Which acts as major sewage carrier) within GMC limit is about 13.65 km. It starts from Hanuman Bandh located at the southern part of the city and moves towards north direction and it terminates at Jalalpura Dam (pickup wear). PHED has laid a main trunk sewer along the Swarnrekha River with the diameter ranging from 350 mm to 1800 mm and captures all the nallahs/ open drains which are diverting towards the River. During normal days the system carries the waste water of about 45-65 MLD, whereas in rainy season it carries waste up to 150 MLD. This system carries the waste water of about 60% of the total city population and is executed in 1992.

Presently the system is not working with its full capacity because the main trunk sewer is having leakages at many points and thus causing silt deposition which creates hinderances in free flow of the waste water.

The second zone is Morar zone where Morar River is acting as the main carrier of the total waste water generated in this zone. Under GMC limits the River starts from Ramanna Dam and the last point is Jaderua Bridge. Apart from this PHED has laid a main trunk sewer of about 12 km for this zone with the diameter varies from 350 mm to 1400 mm, which terminates at an STP located at Laltipara near Jaderua Bridge with capacity of 50 MLD. It carries the waste water of the zone covering 40% of the population.

Most of the colonies like, Pinto Park, Deendayal nagar, Windser Hill in Morar zone is yet to connect with Trunk Sewer and hence presently there waste water is directly goes into the river and thus pollutes Morar river.

4.4.5 Waste Water Generation :

The wastewater (sewage) generation for future has been calculated at 80% of the water demand. The water demand for this purpose has been calculated at the rate of 135 lpcd. Additionally the institutional and fire demand and the unaccounted losses for water have also been considered for calculations the water demand as per the CPHEEO[5].

Presently the total amount of waste water generated into the city is 149.76 MLD. It includes the waste water generated from domestic, institutional and other activities performed in the city. In terms of waste water management system the city has been divided into two zones, i.e.

a) Lashkar – Gwalior Zone

b) Morar Zone

i) Generation of Waste water in Lashkar- Gwalior Zone:

The total amount of waste **water generated in the zone is 106.73 MLD** through 71% population of the city residing in the zone. But the total amount of waste water generated in the zone is not 100% conveyed by the existing sewerage system.

The data given in the following table reveals that only 64.23% of the HHs has individual toilets which are connected with the sewerage system and hence only 62.32 MLD of waste water is conveyed by the present sewerage system.

[5] For fire : 0.1xsqrt of P/1000 (CPHEEO norm); Unaccounted water losses upto 15% (CPHEEO norm)

Table: 4.8 Lashkar- Gwalior Zone generation of waste water

Lashkar - Gwalior zone				
Cluster number	**Cluster Name**	**Population in 2011**	**Water demand (MLD)[6]**	**Wastewater generation (MLD)**
1	**Upcoming educational hub – Kedarpur area**	14163	2.69	2.2
2 (50%)	**Mudia Pahad, Chandwadni Naka**	45863	8.71	7.0
5 (50%)	**Railway station**	40014	7.60	6.1
7	**Ranipura, Indira nagar, Charshar ka Naka**	214756	40.80	32.6
8	**Bhahodapur, Anandnagar area**	47024	8.93	7.1
9	**Satyanarayan Hill**	114697	21.79	17.4
10	**Maharaj Bada**	175869	33.41	26.7
11	**Guda-Gudi Ka Naka**	33963	6.45	5.2
12	**Ramaji ka pura**	15986	3.04	2.4
Total		**702335**	**133.42**	**106.7**

(Source: Primary Survey and Projections)

Table: 4.9 Cluster wise results of assessment of waste water management (Lashkar-Gwalior zone)

Cluster no.	Cluster name	Issues in existing wastewater management system
1	**Upcoming educational hub – Kedarpur area**	Under developed area having minimal coverage of sewerage system. The natural gradient is also a constraint in this area
2 (50%)	**Mudia Pahad, Chandwadni Naka**	Underdeveloped cluster mainly ward # 60. Hence limited area is having sewerage system, the area occupied by LIG/ migrants people having low level of sewerage infrastructure
5(50%)	**Railway station**	Needs augmentation of existing sewerage system
7	**Ranipura, Indira nagar, Charshar ka Naka**	One of the oldest settlements of the city. The sewerage system is also very old
8	**Bhahodapur, Anandnagar area**	Existing condition of the waste water management is satisfactory,
9	**Satyanarayan Hill**	Undulating terrain is a major constraint to construct sewerage system in many localities

[6] Water demand calculated considering water demand for institutional use, firefighting and unaccounted water losses during transmission and distribution.

10	**Maharaj Bada**	Densely occupied area covered with sewerage system, existing condition of the waste water management is satisfactory
11	**Guda-Gudi Ka Naka**	Undulating terrain is a major constraint to construct sewerage system in many localities, LIG class of people with poor sewerage facility
12	**Ramaji ka pura**	Sanitation facilities are not satisfactory, area mainly dominated by LIG class of people

ii) Generation of Waste water in Morar Zone:

This zone is located on the eastern part of the city and covers 29% population of the city. The major cluster covered under this zone and the waste water generated in each zone is mentioned in the following table:

Table: 4.10 Zone wise generation of wastewater

Morar zone				
Cluster number	**Cluster Name**	**Population in 2011**	**Water demand (MLD)[7]**	**Wastewater generation (MLD)**
2 (50%)	**Mudia Pahad, Chandwadni Naka**	45863	8.71	7.0
3	**City center area**	50924	9.67	7.7
4	**Bheemnagar, Kumharpura Rapat**	73354	13.93	11.1
5 (50%)	**Railway station**	40015	7.60	6.1
6	**Deendayal nagar, Pinto Park area**	72945	13.86	11.1
Total		**283101**	**53.78**	**43.0**

(Source: Primary Survey and Projections)

The total amount of **waste water generated in the zone is 43.02 MLD** through 29% population of the city residing in the zone. But the total amount of waste water generated in the zone is not 100% conveyed by the existing sewerage system.

The data given in the following table reveals that only 65.30% of the HHs has individual toilets which are connected with the sewerage system and hence **only 28.09 MLD of waste water is conveyed by the present sewerage system.**

[7] Water demand calculated considering water demand for institutional use, firefighting and unaccounted water losses during transmission and distribution.

4.4.6 Drainage System :

During the field survey it has been observed that most of the drains got chocked due to dumping of solid waste by the people, in some cases the drains got encroached due to illegal constructions, in few cases the natural slope is not maintained while constructing the *pacca* drains. These are some of the major issues which were observed during the field visits; and are the major cause of water logging in the city.

Dumping of solid waste and debris directly into the open drains is also a serious threat to the existence of natural drains. There is an urgent need to overcome/ ban on this activity by sensitizing the pubic as well as line agency on this issue through various awareness activities.

Efforts are also made to channelize most of the major drains inorder to reduce the silt deposition into the drains. Following are some of the pacca nallas/ drains, Vijay nagar drain, Tansen nagar drain, mahal drain (under construction).

The following table shows the cluster wise status of roads and drains running along them.

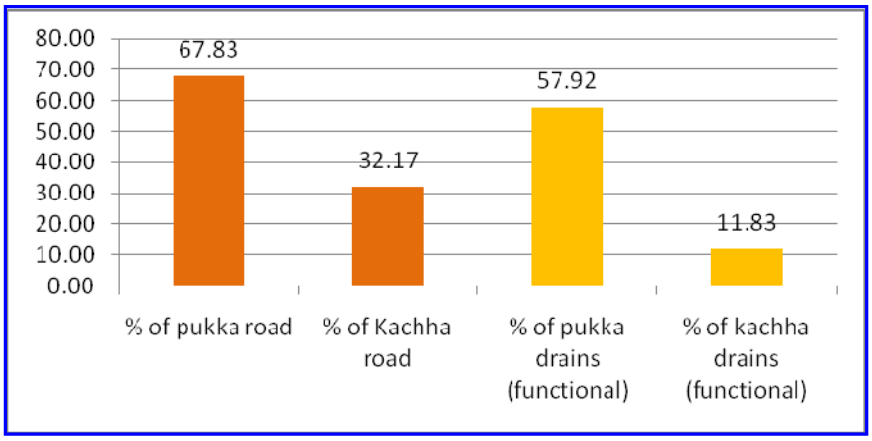
Table: 4.11 Cluster wise availability of roads and drains

		Road		Drains		
Cluster no.	**ward number**	**% of pukka road**	**% of Kachha road**	**% of pukka drains (functional)**	**% of kachha drains (functional)**	**% of non functional dains/ no drains**
1	59	34	66	30	20	50
2	51, 53, 54, 56,48, 60	70	30	65	10	25
3	24, 29, 30	75	25	70	10	20
4	23,26,27, 28	60	40	55	10	35
5	17,21,22,57,58	65	35	60	10	30
6	18,19,20,25	80	20	70	7	23
7	6,7,8,9,10,11,12,13,14,15,16,31,32	60	40	60	15	25
8	3,4,5	75	25	40	20	40
9	2,33,34,36,37,38,39	80	20	70	5	25
10	35,40,41,42,43,44,45,46,47,49,50	80	20	70	5	25
11	52,55	75	25	60	10	30
12	1	60	40	45	20	35
	Total	**67.83**	**32.17**	**57.92**	**11.83**	**30.25**

Source: Primary Survey

The data reveals that the city is having 67.83% of Pacca road out of which 57.92% is covered with pacca drains. Apart from this 32.17% of roads are of kachha type and 11.83% is covered with kachha drains. The data also reveals that cluster no. – 1, 8 and 12, are lacking sufficient coverage of proper drains to carry storm water from the city. The following graph replicates the city wide scenario about availability of drains and roads.

Fig: 4.14 Percentage of Road & Drains



At present about 30% of drains got chocked and not functioning with its full capacity. Dumping of solid waste into the drains is the main cause of chocking in the drains. The following pictures show a common scenario of drains in the city.

Photo: 4.1 Condition of open drains in the city

The main problem in the drain is choking due to dumping of household garbage into the open drains especially polythene or plastic bags. Due to this drain are not working with its full capacity and at many places this situation creates the condition of water logging.

4.5 Solid Waste Management:

4.5.1 Introduction:

One of the most prime challenges in the city is of managing the solid waste. There is considerable amount of solid waste generated through various commercial and residential establishments. However there is lack of adequate infrastructure, human resource and management to clean the city on regular basis.

Dumping of solid waste and garbage in open areas/open drains *(nallahs)* is a common practice observed in the city. As per Gwalior Municipal Corporation (GMC), presently 250 T/day of solid waste is generating in the city from various sources, and about 80% (i.e. 200 T/ day) of waste has been collected daily.

Door to door collection of solid waste is not practiced at present, but some initiatives have already done in the past. Presently the GMC is having two transfer stations for dumping the solid waste generated in the city. these transfer stations are located at, a) Gudda –Guddi ka Nakka (Laskar), and b) Suresh nagar (Thaitipur).

Apart from this GMC is also having a sanitary land fill site (SLF) which is develop at Chandoha khurd near Kedarpur village on Shivpuri road link, with a total area of 25.8 Ha. The total capacity of existing SLF is about 8 years.

Along with SLF site, GMC is having a solid waste composting plant near the land fill site. The total capacity of the plant is about 300 T/day. About 60% of the waste has been converted into compost and remaing waste has been seggreted into recyclable and inert materials. Oveall administration of the composting plant is done by the Gwalior Municipal Corporation.

Table: 4.12 Indicator wise details of Solid waste management

Indicator	Details
SWM generated per day	250 MT
collection	about 200 MT
collection efficiency	80%
Door to door collection	No
Total road length covered by street sweeping	400 km

Source: Gwalior Municipal Corporation (GMC), Service Level Benchmarking, 2009

4.5.2 Composition of Municipal Solid Waste:

The Municipal waste mainly consists of residential waste, Institutional waste and commercial waste. Municipal waste also includes waste resulting from municipal activities and services such as street waste, dead animals, market waste and abandoned vehicles.The Municipal solid waste consists of mainly organic waste, inorganic waste and inert substance which are generated mainly at household and commercial level.

4.5.3 Constituents of Solid Waste:

Total Solid Waste generated in the city is calculated as per the guidelines given by CPHEEO Manual. The table shown below gives general idea about the various constituents of solid waste. This information is based on the observation while on the visit to the city

Table: 4.13 Types of Solid Waste and their Contents

Types of waste	Contents
Organic Waste	Green leaves
	Household Kitchen waste
	Commercial wet waste
	Vegetable market waste
Recyclable Waste	Paper
	Cardboard
	Plastic /Rubber
	Metal, aluminum
	Glass
Inorganic Waste	Rotted metal
	Polythene
	Others

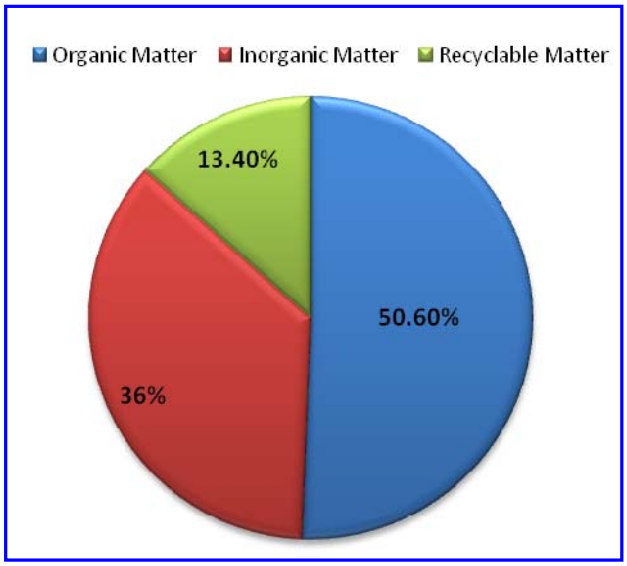
Source: Reconnaissance survey

4.5.4 Details of Physical characteristics of MSW in Gwalior:

The total solid waste generation in the city like Gwalior has been estimated by assuming per capita solid waste generation of 350 gm per day (as per CPHEEO Manual on Solid Waste). Based on these assumptions the present generation of solid waste in Gwalior is around 344.90 MT /day.

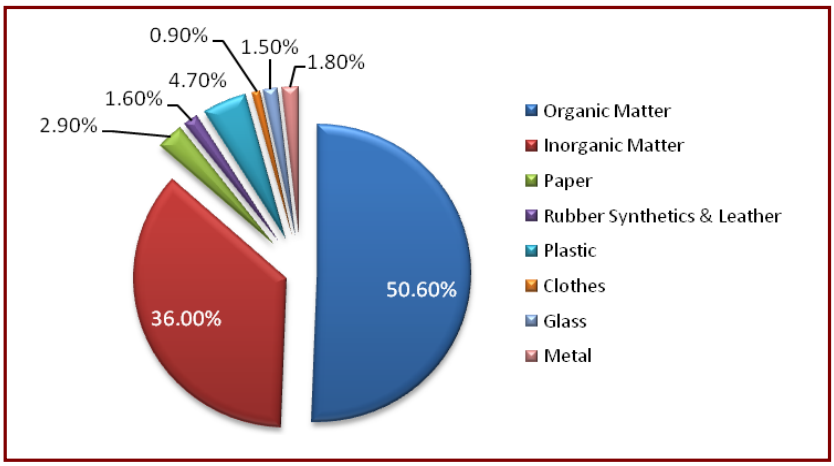
In case of Gwalior out of total Municipal waste generated, 50.6% of waste is of organic waste and the remaining waste is either inorganic or recyclable waste. The composition of waste broadly has been given in the following chart.

Fig: 4.15 Composition of Solid Waste in Gwalior



The total Municipal solid waste generated in the city Gwalior having maximum percentage of organic matter (50.60%), followed by inorganic (36%) and recyclable waste (13.40%).

Fig: 4.16 Physical Constituents of MSW, Gwalior



The following chart indicates the detailed breakup of MSW generated in the city. The bulk density is about 495 kg/m and the Gross Calorific Value is 875 Kcal/kg.

Table: 4.14 Parameters of SW in Percentage

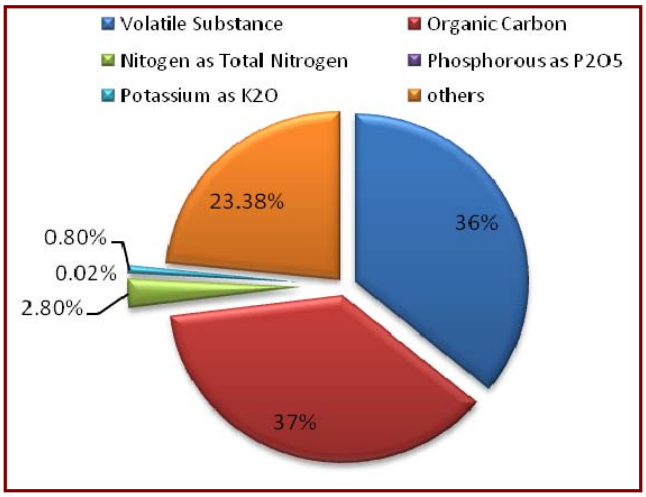
Parameter	Percentage
Organic Matter	50.60
Inorganic Matter	36.00
Paper	2.90
Rubber Synthetics & Leather	1.60
Plastic	4.70
Clothes	0.90
Glass	1.50
Metal	1.80

Source: CDP Gwalior

4.5.5 Details of chemical characteristics of MSW in Gwalior

The major chemical constituents in MSW are Organic Carbon, Nitrogen, Phosphorous, Potassium and Volatile substance. The following graph shows the major chemical composition of MSW generated in the city.

Fig: 4.17 Chemical Constituents of SW, Gwalior



Here, carbon to nitrogen (C/N) ratio is 13.21, which is a very important factor for determining the suitability of the solid waste for composting. Normally the range of C/N ratio in Indian Municipal Solid Waste is 21.13-30.94 and the average value of C/N ratio is 25.66.

The table below depicts the chemical composition of MSW generated in the city.

Table: 4.15 Chemical Parameters of SW, Gwalior

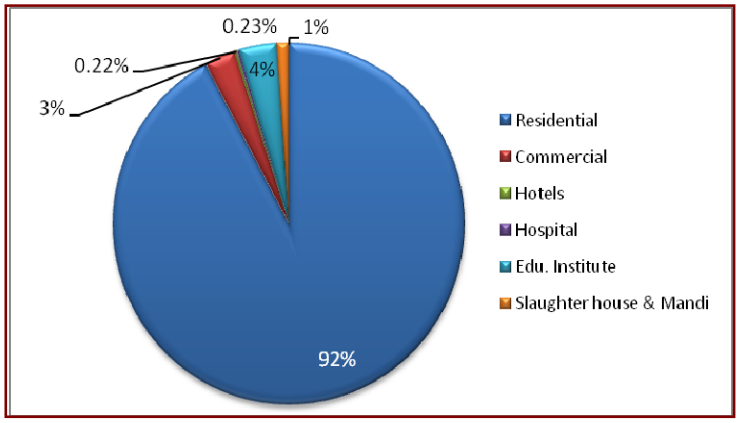
Parameter	Value*
Volatile Substance	36 %
Organic Carbon	37 %
Nitrogen as Total Nitrogen	2.8 %
Phosphorous as P2O5	0.02 %
Potassium as K2O	0.8 %
Others	23.38%
C/N Ratio	13.21

*All values are on dry weight basis

4.5.6 Total Municipal Solid Waste Generation in the City:

Depending upon the Land use, generation of Municipal Solid waste is calculated. The norms for different land uses are referred from CPHEEO manual. In Gwalior city, total waste generated per day is around 374.28 MT. The land-use wise distribution/ generation of Solid Waste is given in the chart below:

Fig: 4.18 Total waste generation in % by various Land uses



The following table shows the details of waste generated as per different land use:

Table: 4.16 Total waste generation by various Land uses

Land use	Total Waste Generation, (MT/Day)	Percentage
Residential	344.9	92.15
Commercial	10.66	2.85
Hotels	0.82	0.22
Hospital	0.85	0.23
Educational Institute	13.05	3.49
Slaughter house & Mandi	4	1.07
Total	**374.28**	

Fig: 4.19 Location of Slaughter House and Vegetable Markets

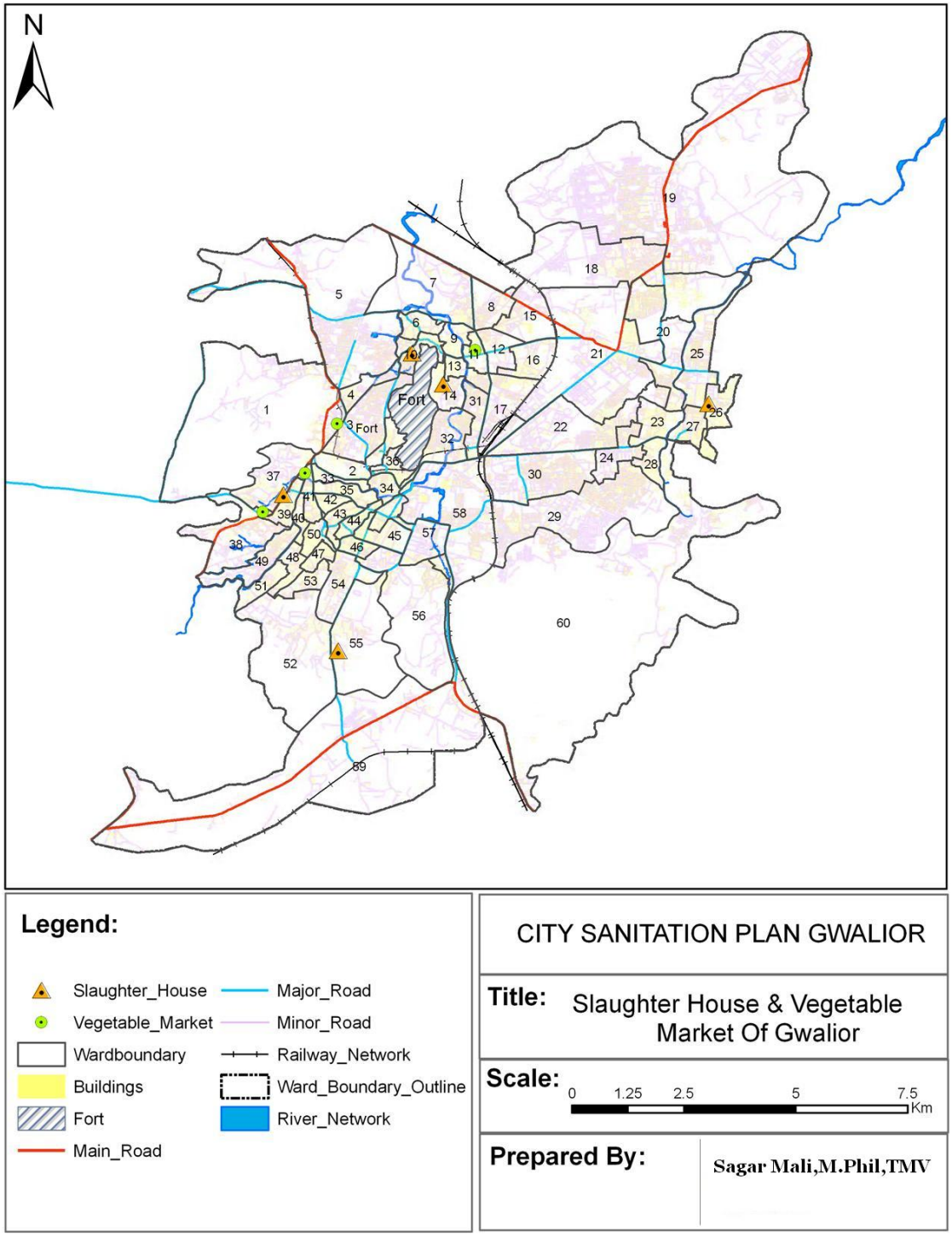


Table: 4.17 Cluster wise waste generation and its collection (2011)

No. of Cluster	Cluster Name	Cluster wise Population	Generation of waste in MT	Percentage
1	**Upcoming educational hub – Kedarpur area**	14163	4.18	**1.44**
2	**Mudia Pahad, Chandwadni Naka**	91727	27.04	**9.31**
3	**City center area**	50924	15.01	**5.17**
4	**Bheemnagar, Kumharpura Rapat**	73354	21.63	**7.44**
5	**Railway station**	80029	23.60	**8.12**
6	**Deendayal nagar, Pinto Park area**	72945	21.51	**7.40**
7	**Ranipura, Indira nagar, Charshar ka Naka**	214756	63.32	**21.79**
8	**Bhahodapur, Anandnagar area**	47024	13.86	**4.77**
9	**Satyanarayan Hill**	114697	33.82	**11.64**
10	**Maharaj Bada**	175869	51.85	**17.85**
11	**Guda-Gudi Ka Naka**	33963	10.01	**3.45**
12	**Ramaji ka pura**	15986	4.71	**1.62**
Total		**985436**	**290.54**	**100.00**

4.5.7 Solid Waste Management in Gwalior City:

In Gwalior, MSWM has been carried out by two different agencies i.e. GMC and AKC developers Ltd. GMC has been mainly involved in street sweeping, waste collection, transportation and dumping of waste at SLF located at Shivpuri Link road. Whereas, the private agency - AKC Developers Ltd., involves in segregating recyclable wastes which is followed by compost manufacturing with the bio-degradable materials. Other recyclable matters and compost are send to market.

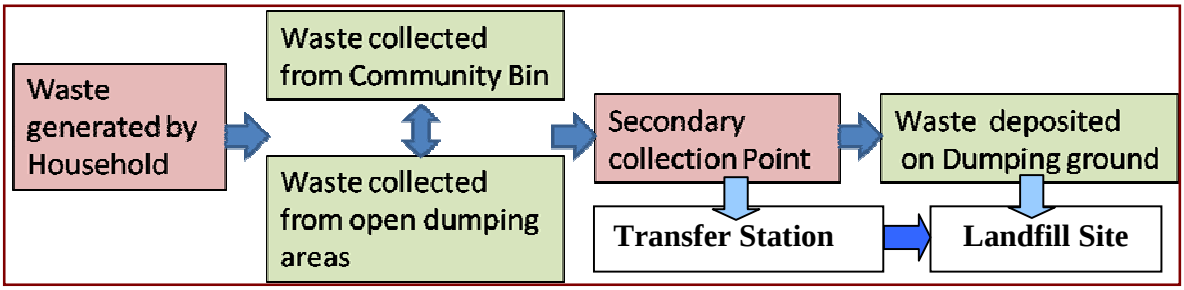
The following sections describe the existing system of MSWM in the city in three different stages, i.e. a) Collection, b) Transportation and c) Disposal.

i) Garbage Collection System:

At present there is no door to door garbage collection system in the city. There is no practise of segregation of waste at the source. There is no provision of sufficient number of waste bins at neighbourhood level which results into dumping of the waste into nearby small open sites or existing bins. The waste from these small open dumping sites is collected by the Municipal staff through Lorries/tri-cycles and dumped at community waste bins. The waste

collected at existing waste bins or at bigger open dumping site is lifted by tractor trolleys and dumped into secondary collection points i.e. Transfer stations. From Transfer Station the waste is collected in periodical manner and shifted to Sanitary Landfill Site.

Fig: 4.20 General Solid waste management practice in the city



Source: Primary data Collection

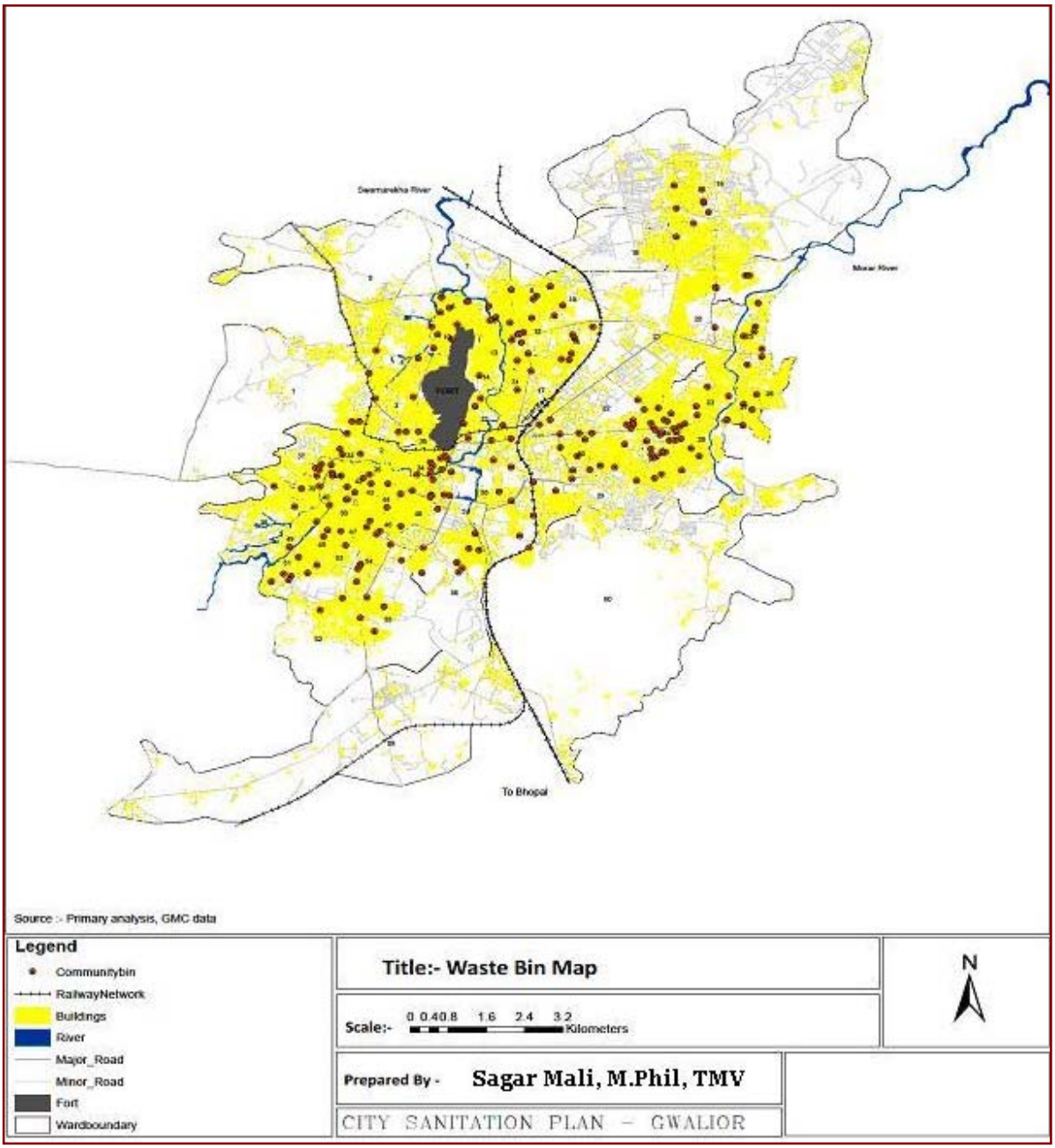
Table: 4.18 Cluster wise waste Bins and its collection (2011)

No. of Cluster	Cluster wise Population	Generation of waste in MT	Existing waste bins available	Collection of waste in MT
1	14163	7.40	0	4.07
2	91727	34.54	22	19.00
3	50924	20.26	33	11.14
4	73354	28.11	13	15.46
5	80029	30.45	34	16.75
6	72945	27.97	20	15.38
7	214756	77.60	42	42.68
8	47024	18.90	11	10.39
9	114697	42.58	17	23.42
10	175869	63.99	25	35.20
11	33963	14.33	9	7.88
12	15986	8.04	5	4.42
Total	**985436**	**374.18**	**231**	**205.80**

Source: Primary Survey

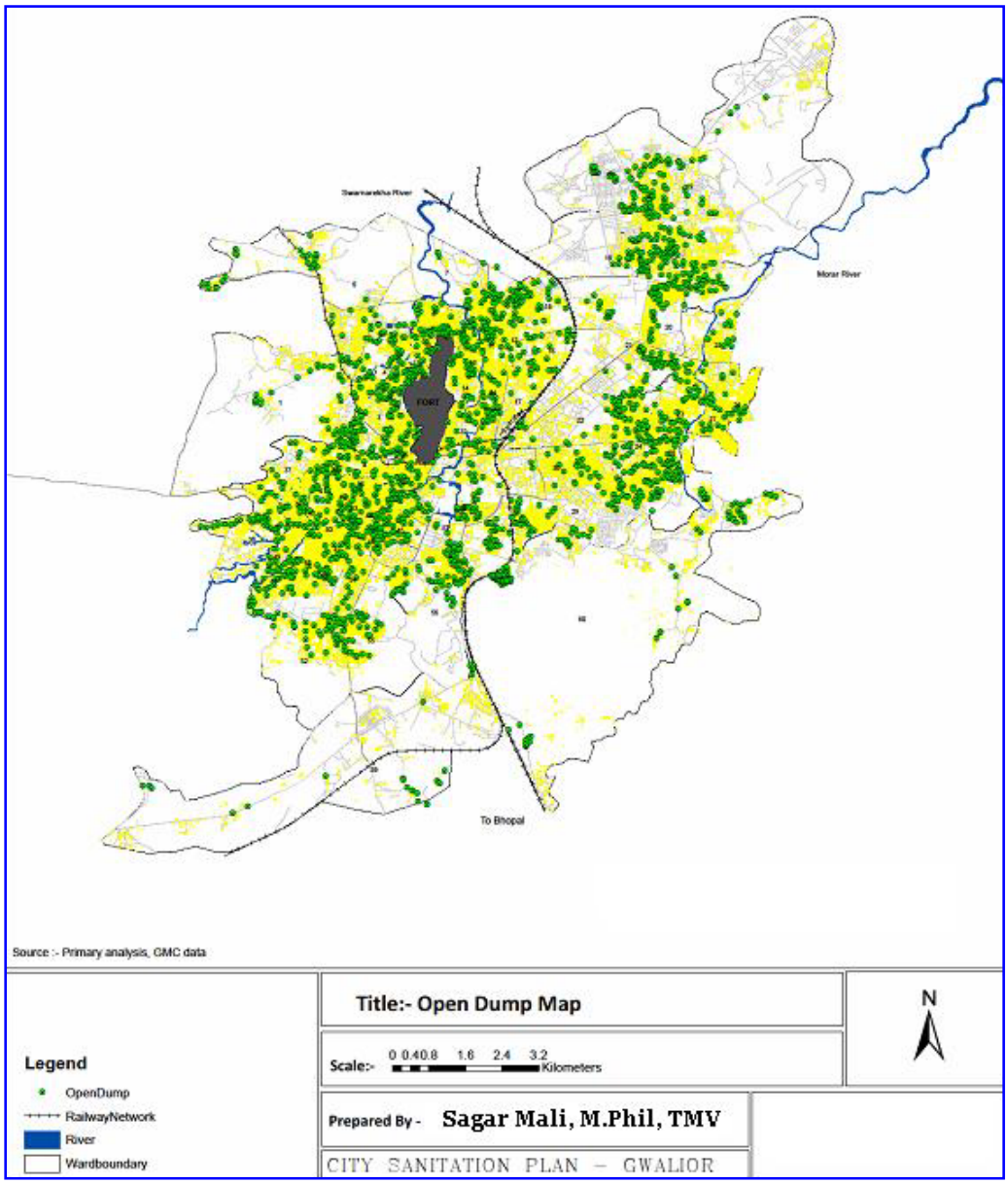
The maps below shows wards wise number of waste bins and open dumping areas:

Fig: 4.21 Distribution of Community bins in overall city



There are about 231 community waste-bins have been identified in the city during the survey.

Fig: 4.22 Distribution of open dumping areas in overall city



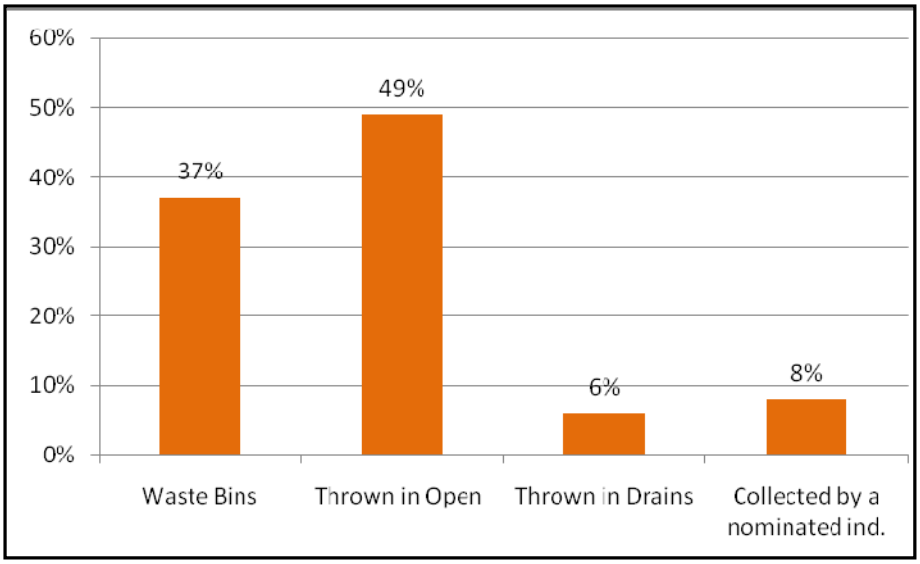
There are about 2198 open dumping areas have been identified in the city during the survey.

Total waste generated in the city is also studied across the clusters. The table below shows the cluster wise number of bins available and the waste collected. Presently the collection is about **55%** of the total waste generated in the city.

Table: 4.19 Cluster wise no of open areas used for garbage dumping

No. of Cluster	Cluster Name	Cluster wise Population	Number of open areas used for garbage dumping
1	**Upcoming educational hub – Kedarpur area**	14163	48
2	**Mudia Pahad, Chandwadni Naka**	91727	232
3	**City center area**	50924	177
4	**Bheemnagar, Kumharpura Rapat**	73354	83
5	**Railway station**	80029	245
6	**Deendayal nagar, Pinto Park area**	72945	337
7	**Ranipura, Indira nagar, Charshar ka Naka**	214756	331
8	**Bhahodapur, Anandnagar area**	47024	241
9	**Satyanarayan Hill**	114697	175
10	**Maharaj Bada**	175869	212
11	**Guda-Gudi Ka Naka**	33963	84
12	**Ramaji ka pura**	15986	32
Total		**985436**	**2197**

Fig: 4.23 HH throw garbage



Source: Primary Survey

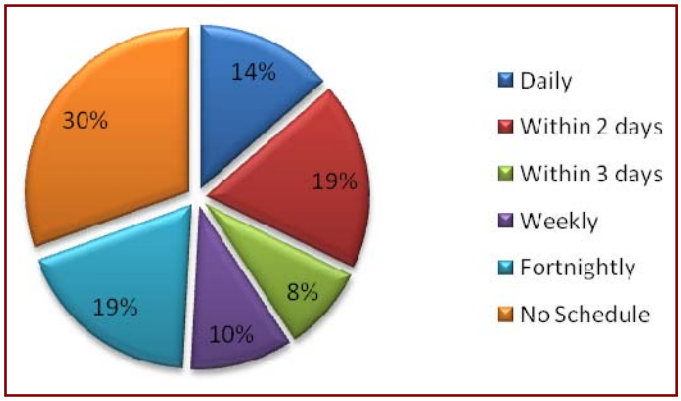
As shown in the graph, almost 49% of people throw waste in open areas, 37% people throw garbage in waste bins and about 6% HHs throws their waste along the open drains/ nallas or road side. There are about 8% households where waste is collected through a nominated person.

4.5.8 Frequency of waste collection:

GMC is responsible to collect the waste from various formal as well as informal waste collection points. It has been observed and reoprted during the field visits that the frequency of waste collection varies from daily basis to fortnightly basis. This seems to be dependent upon the collection points put in the form of waste collection bins.

The following graph represents the city wide scenario on frequency of solid waste collection from different community level waste bins or open dumping sites.

Fig: 4.24 Frequency of garbage lifting/cleaning from waste bins



Source: primary survey

As we can see in the chart, almost 70% garbage collection is done on a periodical basis. 30% HHs reveals that there is no schedule of garbage cleaning in their areas.

The data also reveals that 14% of waste is collected once in a day. Location of garbage dumping site is also important factor in the collection system. More the distance of Community bin, less is the tendency to through waste in bin. This results in more no. of creation of open dumps.

ii) Garbage Transportation System:

a) collection of waste from waste collection points and transfer the waste upto the designated Transfer Stations. In this case transportation of waste is done by light moving vehicles/ slow moving vehicles like, Tractor Trolleys, and

b) Collection of waste from Transfer stations to Sanitary Landfill site and here the municipal staff is using Heavy vehicles/ fast moving vehicles like, Compactors, Dumper and so on, which carries the waste from Transfer stations up to the Landfill site.

Presently there are two Transfer stations located in the city, 1) at Gudde Guddha Naka (in Lakshar) and 2) at Suresh Nagar (in Morar). From Gudde Gudda Transfer station there are 15-20 trips every alternate day to transfer the waste upto Landfill site and from Suresh Nagar Transfer station 10 -12 trips every alternate day for the same.

Table: 4.20 Difference between wastes generated and collected at daily basis

No. of Cluster	Cluster wise Population	Generation of waste (MT)	Collection of waste (MT)	Gap in Waste collection (MT)
1	14163	7.40	4.07	3.33
2	91727	34.54	19.00	15.55
3	50924	20.26	11.14	9.12
4	73354	28.11	15.46	12.65
5	80029	30.45	16.75	13.70
6	72945	27.97	15.38	12.59
7	214756	77.60	42.68	34.92
8	47024	18.90	10.39	8.50
9	114697	42.58	23.42	19.16
10	175869	63.99	35.20	28.80
11	33963	14.33	7.88	6.45
12	15986	8.04	4.42	3.62
Total	**985436**	**374.28**	**205.80**	**168.38**

There is a gap of about 45% in waste transportation per day. In order to mitigate this gap, either number of vehicles deployed for transportation needs to be increased or no. of trips per day has to be increased.

The following table shows the transportation capacity of GMC to carry the solid waste from different collection points and dump the same up to the dumping site.

Photo: 4.2 Vehicles used for Solid Waste Transport

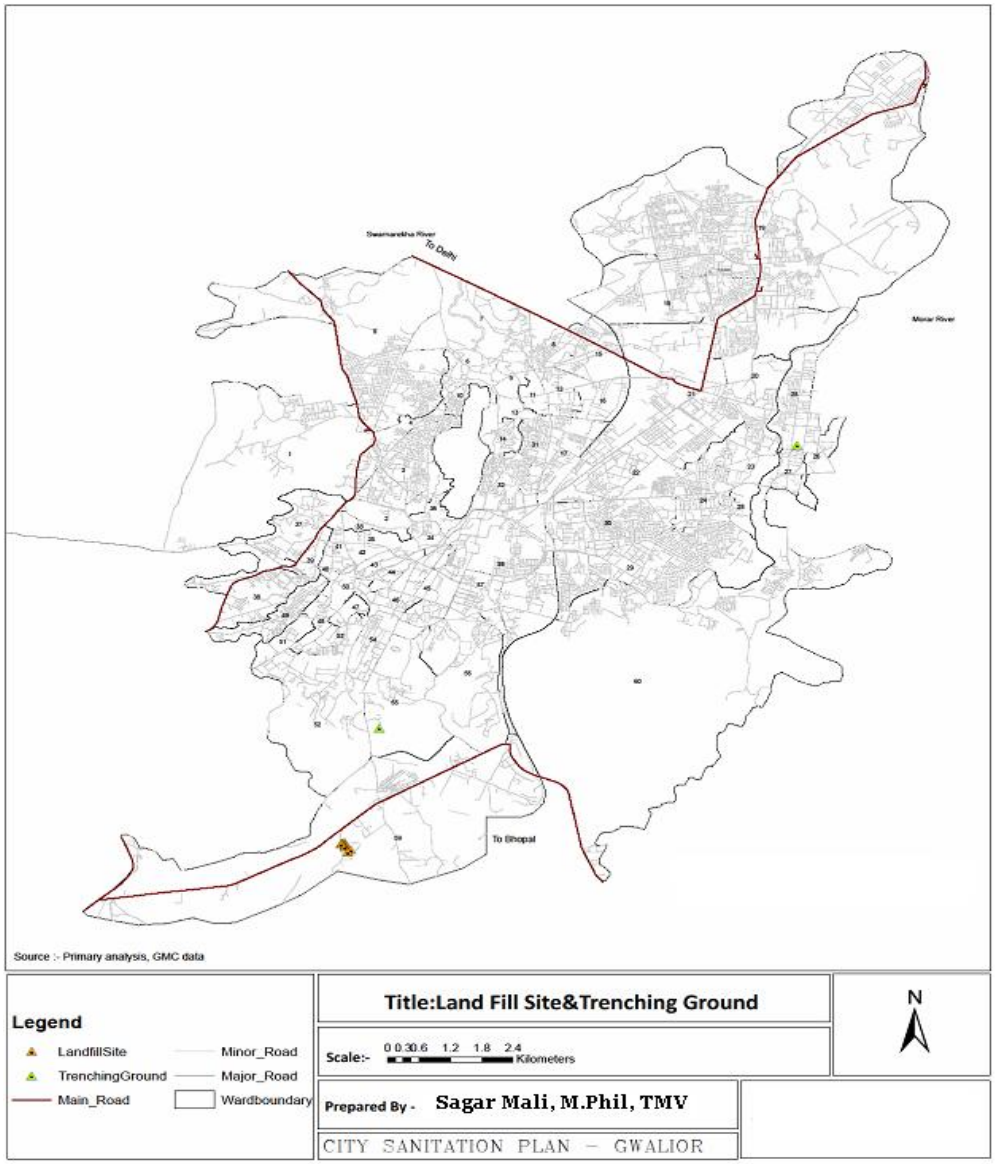
Table: 4.21Garbage Collected per day in MT

Type of Transportation Vehicle	Number	Workable vehicle	Trips/Day	Actual Trip	Capacity (cu m)	collection /day in MT
Loader*	4	1	-		-	
Eicher Container Carrier	14	10	8	5	2.5	43.75
Tractor Container Carrier	7	7	10	6	4.5	66.15
Tractor Trolley	21	21	3	3	2	44.1
Dumper Placer	3	3	8	8	5.5	46.2
Dumper	8	6	-	4	5	42.3
Compactor Machine	2	1			14	4.9
JCB*	4	4	-		-	
Others	2	2	-		-	
Total waste collected / day						**247.4**

GMC has the garbage carrying capacity of 247.4 MT/day, but presently only about 205 MT of waste is reaching at STF on daily basis. Hence, there is a possibility that a portion of waste has been dumped at non designated sites like, road side or other open areas in the periphery of the city.

The following map shows the locations of transfer station and SLF site in the city.

Fig: 4.25 Location of Transfer stations and SLF site in the city



iii) Garbage Disposal System:

GMC is having a fully functional Sanitary Landfill Site (SLF) for dumping of municipal solid waste generated in the city. Apart from this, it also has two transfer stations namely at a) Gudda –Guddi ka Nakka (Laskar), and b) Suresh nagar (Thaitipur).

The total area of SLF site is 25.8 HA and is located at '*Chandoha khurd* 'near *Kedarpur* village on *Shivpuri* road link. The approximate life of existing SLF is 8 years.

Table: 4.22 Salient features of Sanitary Landfill Site

Particulars	Details
Location	Chandoha Khurd Village
Area	25.80 ha
Distance from the city	12 km
Capital Cost	Rs. 11.77 Cr
Vermi Compost Unit	20.00 MT per day
Mechanical Compost Plant	110.00 MT per day
Weigh Bridge	30 MT/day
Capacity of Segregating Plant	300 MT/day

The capacity of SLF site is about 300 MT and the waste collected per day by GMC is about 205 MT. The present SLF site is having two types of composting plants,
a) Mechanical Compost Plant, and b) Vermi-compost Plant.

Presently, only Mechanical Compost Plant is under working condition and about 60% of the MSW is converted into compost and rest 40% has been dumped into the SLF site. Under normal conditions the compost is usually sold out to the farmers who can use it in their fields. But presently the plant is not running with its full capacity because of various local issues.

The SLF site is managed and developed by a private agency named as AKC Developers ltd., working under the supervision of GMC.

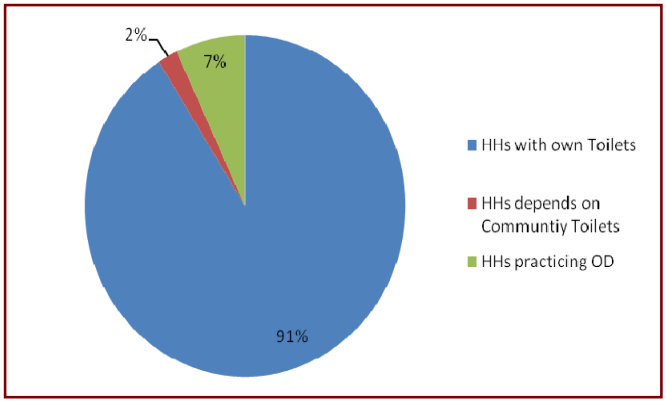
AKC developers Ltd., has been working with GMC on Public Private Partnership (PPP) basis. GMC has provided a land parcel to the private company for 35 years as on lease to develop an Integrated Municipal Solid Waste Processing Plant at - Survey No. 24, Village Kedarpur, Gwalior-Shivpuri Road, Gwalior. AKC developers Ltd., manufacture compost with the dumped biodegradable waste after segregating the recyclables.

4.6 Sanitation Scenario (Urinal & Toilets) :

4.6.1 Introduction:

Sanitation facility in the city of Gwalior is satisfactory with about 91% of total city population having access to sanitation facility mainly relying on individual toilets connected to underground sewer line, septic tank or soak pits. Out of remaining households which do not have individual toilets, about 2% households rely on community toilets and about 7% of households practice open defecation. The figure below demonstrates the overall status of sanitation facilities.

Fig: 4.26 Overall status of sanitation facility

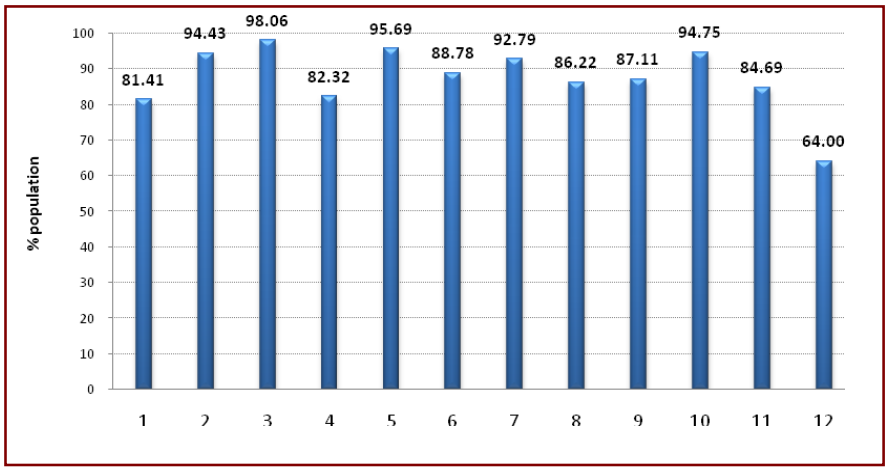


Source: Primary Survey Analysis, 2011

4.6.2 Existing Scenario of Household Sanitation:

The following graph represents the comparative scenario among various clusters about household level availability of toilet facility.

Fig: 4.27 Cluster wise availability of household sanitation facility



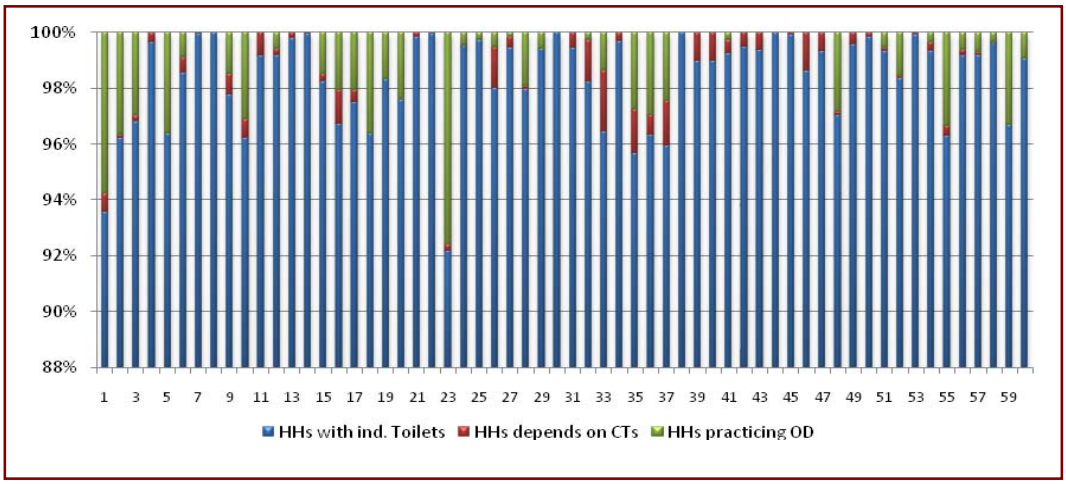
Source: Primary survey analysis, 2011

A detailed ward wise sanitation scenario is presented in the following Figure - 4, where ward wise coverage of households having access to individual household toilets, households using community toilets and households defecating in open is given.

Table: 4.23 Access to sanitation:

Type of waste water connection	Non Slum Properties	% of Properties	Slum Properties	% of Properties
Sewer	60000	37.27	7497	12.33
Septic tank (with or without soakpit)/ pit	68800	42.73	3068	5.05
Drains	0	0.00	27169	44.70
No access to toilet	32200	20.00	23053	37.92
TOTAL	**161000**	**100.00**	**60787**	**100.00**

Fig: 4.28 Ward wise status of access to sanitation



Source: Primary survey analysis, 2011

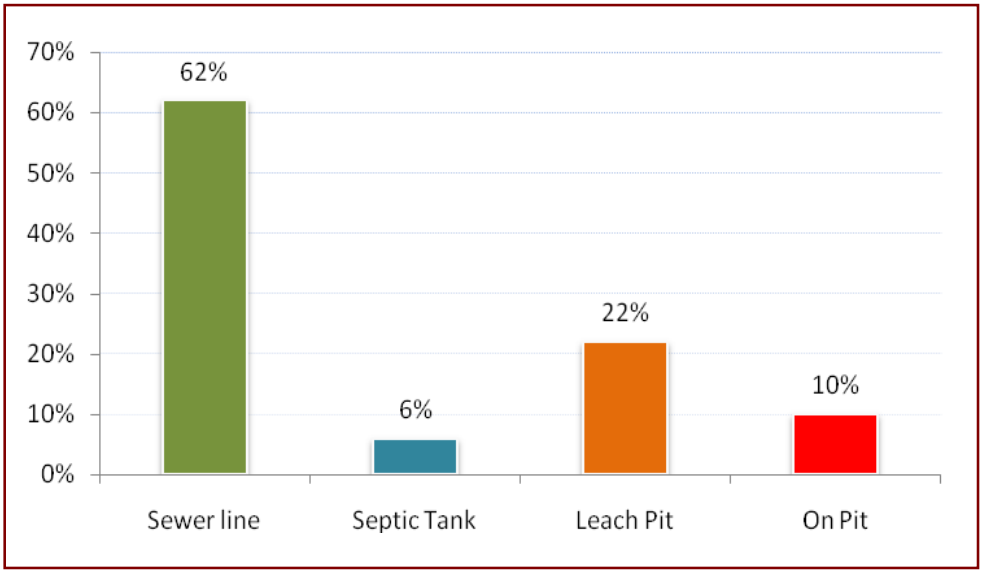
It is observed that the status of sanitation is not adequate in the wards like, ward no. – 1, 2, 23, 35, 36, 37, 55 and 59.

4.6.3 Types of Household Toilets:

It is reported that 62% of the toilets are connected to networked sewerage system, 22% are connected with leach pit (on site disposal), and about 6 % are connected with septic tank (on site disposal) while 10% households are having on pit latrines (on site disposal). In case of septic tanks the effluents are directly disposed into the open channels/drains, which is not a healthy practice as the effluent may carry pathogenic micro organism.

The following graph represents the overall profile of the type of disposal facilities available for disposal of human excreta at household level

Fig: 4.29 Type of Technology used for Individual Household Toilets



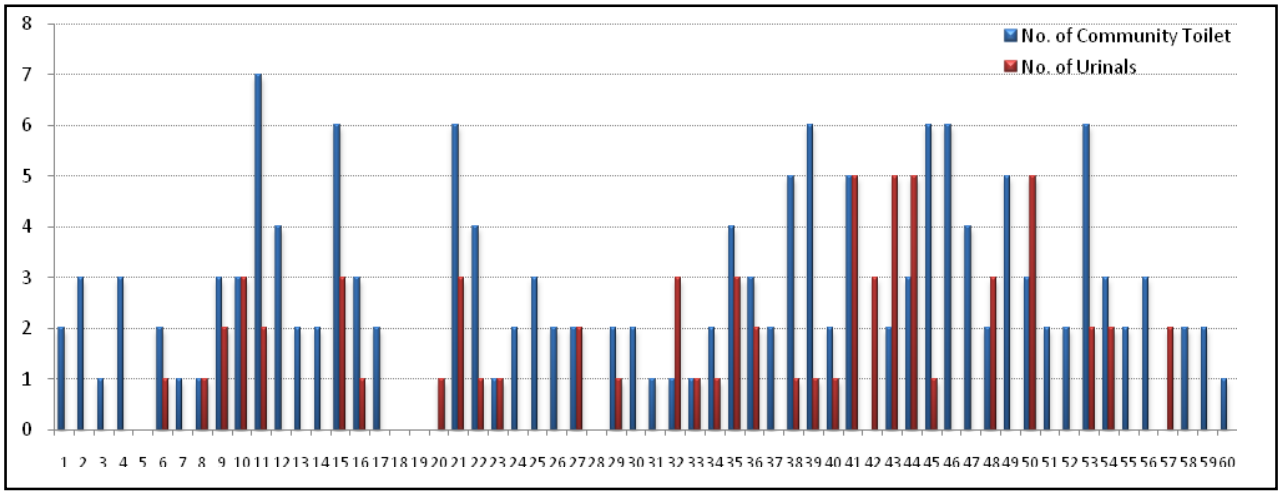
This is widely observed in Morar zone in cluster no. 2, 3, 4, 5 and 6 where most of households in the colonies have their outlet directly into the open channels/drains.

4.6.4 Public Urinals & Community Toilets:

As per present scenario, the data from Gwalior Municipal Corporation reveals that there are about 260 public sanitation utilities have been developed at various locations within the city. Out of which 162 are public toilets and 98 are public urinals. As per service level benchmarking data the total number of seats available in community toilets is about 826 (415 seats for Gents and 411 seats for ladies).

The following table illustrates the wardwise location of existing community/ Public toilets and Urinals in the city as identified in primary survey:

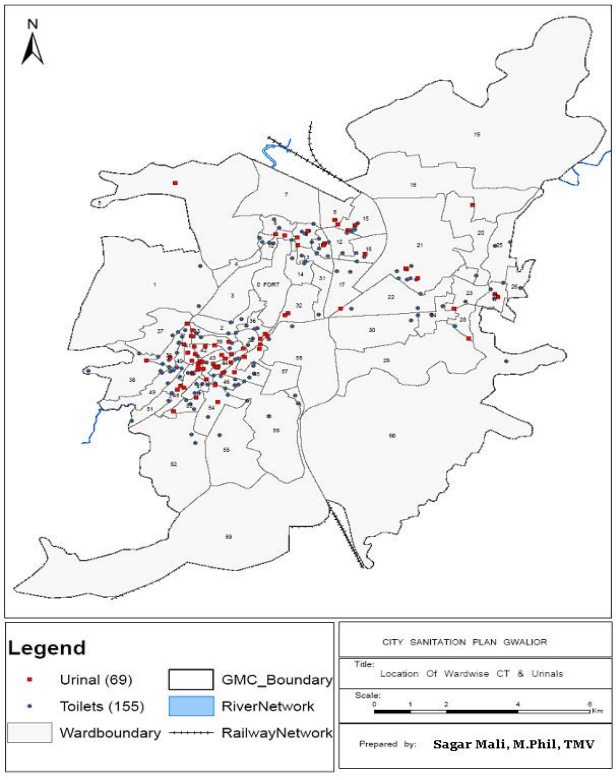
Fig: 4.30 Ward wise availability of Community Toilets and Urinals



The data reveals that certains wards are not having any facility of community toilets and urinals like, ward no. 5, 18, 19 and 28.

At present most of these toilets are in poor condition and lacks basic facilities of water supply and proper disposal of waste water from the toilet is also an issue. And hence about 80% of Community Toilets are in dilapidated / poorly maintained condition. The following pictures illustrate the existing condition of public toilets in the city.

Figure: 4.28 Ward wise location of Community toilets and Urinals in the city.



Chapter-V

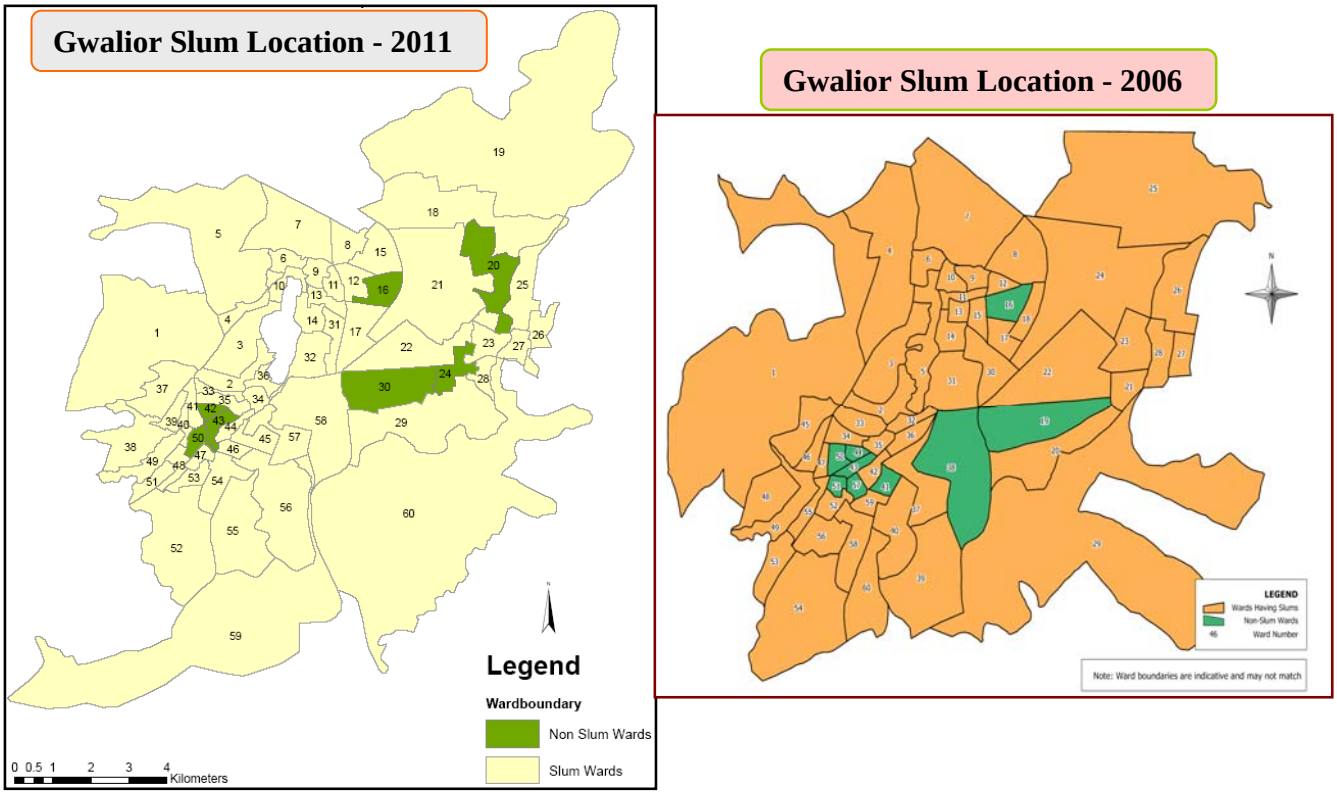
Sanitation Study in Slum Areas

5.1 Introduction:

Presently, the city is having 229 slum pockets out of which 217 slums are within Gwalior Municipal Corporation (GMC) limit and rest of the slums are located in Morar cantonment area which is outside GMC limit. As per GMC data, the slums in Gwalior are spread across 53 municipal wards and the remaining 7 wards are not having any slums, it includes ward nos. : 16, 20, 24, 30, 42, 43 and 50 as shown in map below

Map Locations of slum pockets in Gwalior in 2011 & 2006

Fig: 5.1 Locations of slum Pockets in 2011 & 2006



Comparing the present scenario with the situation of 2006, the following Map represents the sprawl of slums in the city. In 2006 also the slums was spread in 53 wards, but that where old wards. The remaining nine wards, where slums are not reported; includes – Ward no.: 16, 19, 38, 41, 43, 44, 50, 51 and 57.

5.2 Gwalior City Slum Scenario:

In the year 2011, about 83,855 households are staying in various slum pockets located within GMC limit; where as in 2006 about 60,787[8] households were stayed in the slums and out of which about 32% (i.e. 19636) of the households are reported to be BPL. The total slum population accounts for about one third of the city population. It is also observed that the household size in the poor pockets of the city got decreased from 6.76 to 5.92 in the past 5 years.

The percentage of urban poor population in Gwalior city corresponds to the population in slum areas. It indicates that almost all the population below poverty line is concentrated in to these slum pockets.

In order to carry out the assessment of the infrastructure facilities in the slum areas, an extensive survey[9] was conducted by GMC in the year of 2005-06. Later on the survey has been done in 2011 under the process of preparation of CSP for the project city, inorder to assess the improved level of infrastructure facilities/ municipal services in the slums. The survey covered 217 PPs in Gwalior to collect information on quality and status of available infrastructure and basic services impacting quality of life in PPs, qualitative survey was undertaken by using participatory tools. The data analysis provided information on slums with accessibility to water and sanitation. Qualitative data was collected through transect walks, field observations and FGDs with different stakeholders like, slum dwellers, ward Councillors (*Parshads*).

5.3 Sanitation Status in Slum Pocket:

The study mainly highlighted the access to the sanitation facility and their status in the slum areas elaborated as given below.

5.3.1 Water Supply:

Water availability and mode of water supply is an important issue in slums of Gwalior. The data reveals that presently in slums about 63% (52,829 households) of the households are

[8] Slum Population in year 2006 as per PPSA report

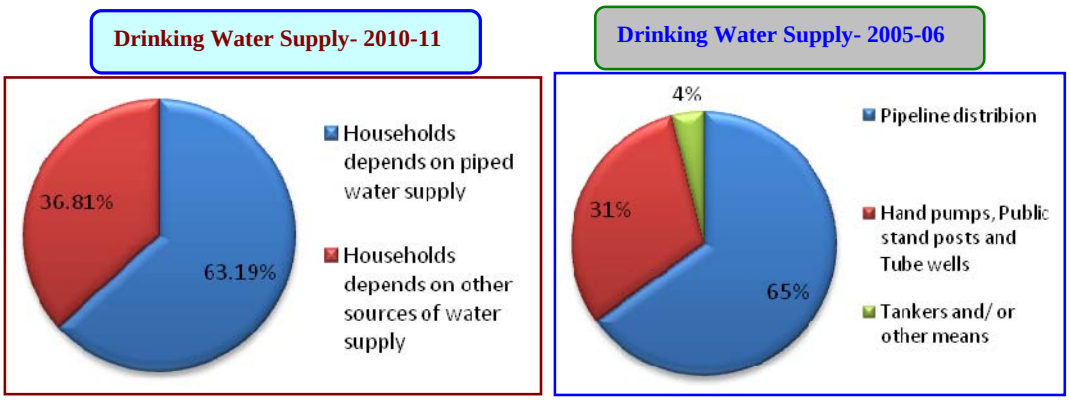
[9] UN-Habitat in partnership with WaterAid and GMC had launched this initiative in Gwalior in late 2005 to demonstrate community led approaches for pro-poor governance, an integrated approach to environmental sanitation, improving access to water and sanitation, local level cost effective and sustainable solutions and development of community managed water and sanitation facilities through setting up of sustainable systems and community based operations and maintenance.

In the first stage of implementation of SESI, a detailed slum enumeration exercise called Poverty Pocket Situational Analysis (PPSA) was carried out during November-December 2005 to identify the poor, their condition and needs to prioritize interventions in slums; and address their requirement through pro-poor delivery approach.

getting piped water supply either through individual tap connections or through Public Stand Posts and rest of the households depends on other sources of water supply.

Whereas in 2005-06 almost 65% (39,512 households) of the total slum households were having pipeline distribution supply and rests were relying on other sources such as hand pumps, bore wells, tube wells, and tankers.

Fig:5.2 Status – Drinking water facility in Year 2011 & 2006



During field survey it was observed that now the water pressure is also got increased in many poor pockets which is mainly because of the implementation of different water augmentation schemes under project UDAY and UTTHAN.

In the year 2005-06 the water supply was having very low pressure mainly at the tail end users and as a result people have to depend on alternative sources of water. But now the scenario got changed and people are getting improved water supply with high water pressure at the tail end localities. In the localities like, Abadpura (which is a tail end locality) the people are getting two times a day water supply with improved water pressure. This has resulted in saving of time and energy of the local people.

5.3.2 Sanitation Facility:

In Gwalior most of the slums are very old (few of them are in existence even more than 100 years). And gradually the development of basic infrastructure takes place in these pockets under various development activities initiated by Local government.

Table: 5.1Type of Sanitation facilities in Slums (2011 and 2005-06)

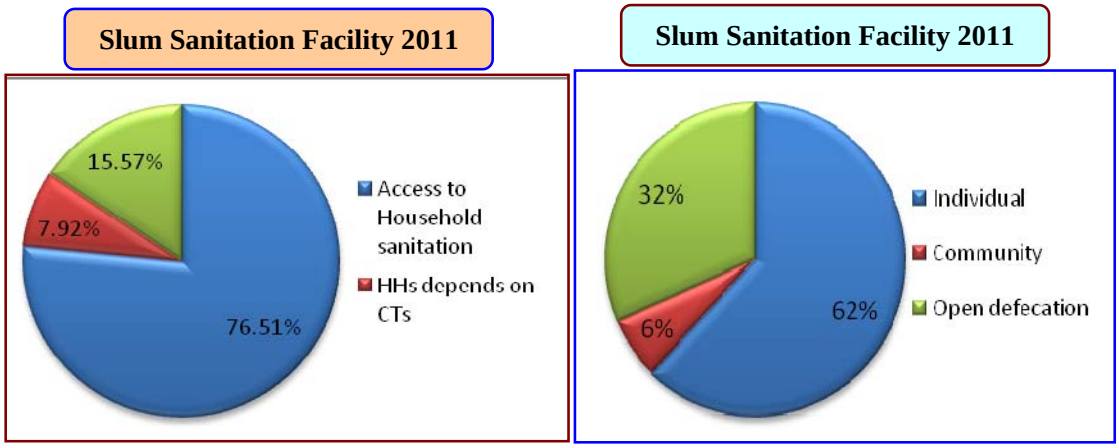
Sanitation facility in slums	2005-06	2011
Access to Household sanitation	62%	76.51%
HHs depends on CTs	6%	7.92%
HHs practicing OD	32%	15.57%

Source: Primary Survey.

In 2011 looking into the Sanitation facilities 76.51% of the households are having individual toilets, only 7.92% of the households using community toilets and the rest 15.57% households are forced to opt open defecation due to non availability of sanitation facilities with them. Open defecation is mainly observed along the banks of the Swarnrekha river, and concentrated in certain stretches like Railway Tracks.

As compared to the present scenario with the scenario in 2005-06 only 62% of slum population were having individual toilets, 6% depends on Community toilets and about 32% was practicing open defecation.

Fig: 5.3 Access to sanitation facility in slums in 2011 & 2005-06

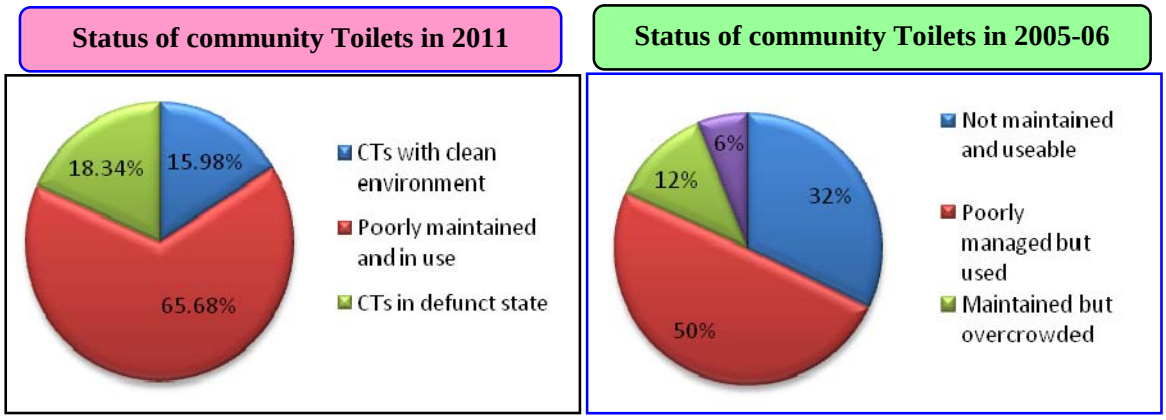


The data analysis reveals that the overall sanitation facilities got improved in 2011 as compared to 2005-06. Extent of open defecation is also reduced to almost half

5.3.3 Community Toilets:

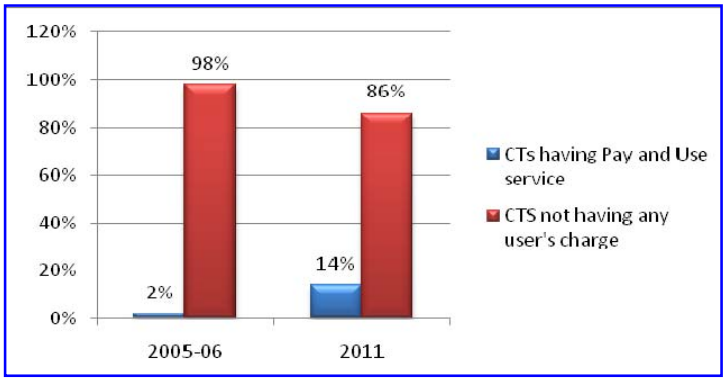
Status of community toilets is also not much impressive in the slums main reason being lack of O&M and negligence on behalf of GMC. At present only 15.98% CTs are having good environment and hygienic conditions, 65.68% of CTs are in the state of poor maintenance but still in use because the nearby people are not having any other alternative sanitation facility. About 18% of the CTs are in the defunct condition and not in use, some of them are encroached by the local people. Similarly in 2005-06, the condition of CTs was not so good, amongst 115 community toilets; about 32% toilets are in state of neglect and are not in use.

Fig: 5.4 Status of Community toilets in slums in 2011 & 2005-06



Efforts have been taken by GMC with the help of many NGOs like Water Aid and UN Habitat for developing slum level sanitation infrastructure, however, issue of managing these facilities is prominent. Presently, only 14% of the community toilets are running on pay and use concept while in 2005-06 only 2% of the total 115 existing toilets are run on user paying services which indicates ignorance of GMC towards institutionalizing the practice of pay and use toilets.

Fig: 5.5 status of pay and use community toilets in slums

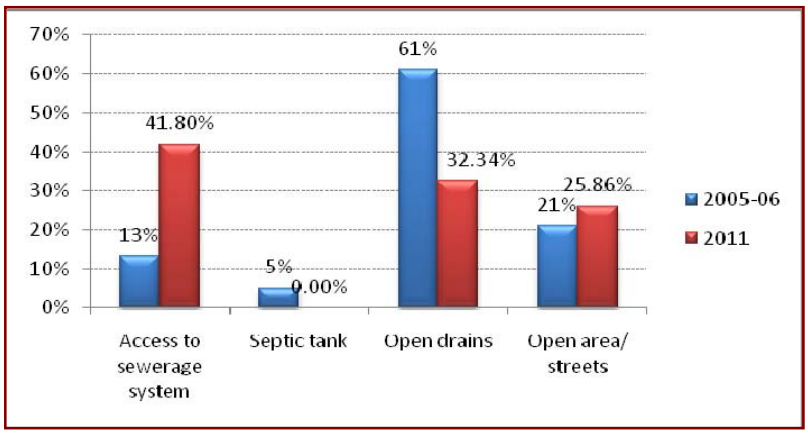


5.3.4 Waste Water Management:

As per present data on waste water management in Slums, the situation got improved as compared to the scenario in 2005-06. Presently, 41.80% of households are having sewer connectivity for disposal of waste water from their houses, 32.34% of the HHs have direct disposal of waste water into the open drains and 25.86% of HHs have direct disposal of waste water into the streets or nearby open plots. While in 2005-06 the waste water management scenario is not satisfactory, with only 13% of the slum population relying on sewerage system, the existing open channels along the roads are the only means of conveying surface water as well as waste water generated at household level (61% of the HHs).

The current practice of using open drains for wastewater conveyance adversely affects water quality as most of the water supply. Pipelines are running through or along these drains. Also, the waste water let into open plots result into stagnation as a consequences creating water logging conditions. Most of the sources of water like hand pumps; stand posts and bore wells as well as tube wells are prone to contamination due to likely seepage of such waste water near sources.

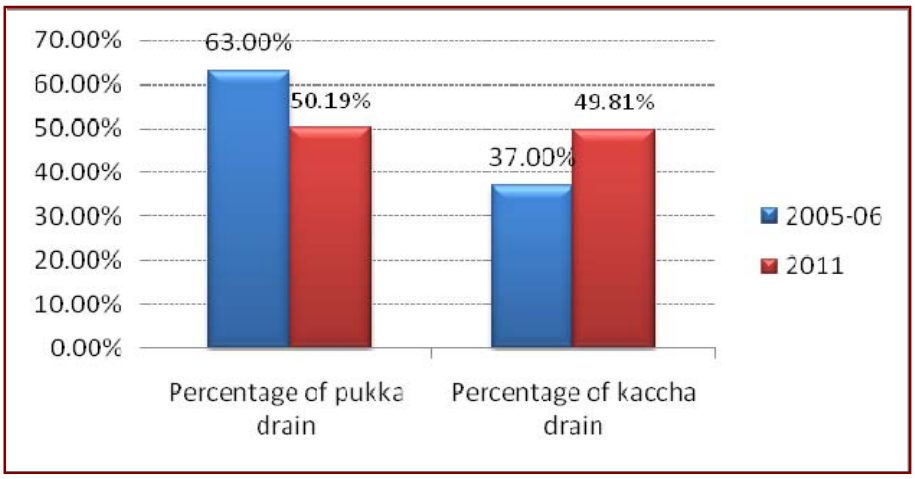
Fig: 5.6 waste water management in slum areas in 2005-06 and 2011



5.3.5 Storm Water Management:

The comparative analysis of data on availability of drains reveals that at present the percentage of Kaccha as well as pukka drains are almost equal. While in 2005-06 the percentage of pukka drains was high as compared to kaccha drains. This shows that there is a need to give more stress on development of proper drains in the slums.

Fig: 5.7 Storm water management in slum areas (2005-06 and 2011)



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These kaccha drains are mainly facing problem of siltation and thus the water carrying capacity got reduces which ultimately causes water logging in the slum area. It was also observed during the survey that drains are lack in consideration of design criteria and topography.

5.3.6 Overall Social Infrastructure facilities in Slum area:

Like sanitation amenities, facilities of health and education, recreation and sports are unsatisfactory. Most of the slum pockets with high density residential areas lack in open spaces those can be used for playgrounds or other recreational purposes.

In the absence of adequate physical and social infrastructural facilities, the quality of life in slum pockets is not satisfactory. Those who have aanganwadis, baalwadis and primary schools grossly lack in toilet facilities.

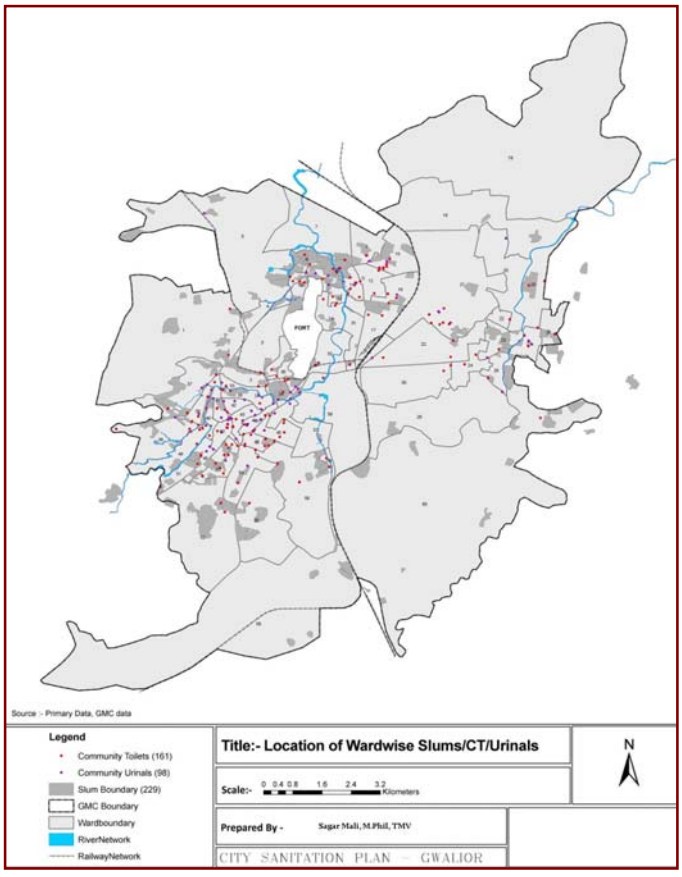
The data presented so far for the slum level infrastructure was based on the outcome of the survey conducted for assessment of existing poverty pockets in 2005-06 and 2011. However, considering various efforts taken up by GMC with the help of funding organizations like UN Habitat, ADB, Water Aid, in order to upgrade the sanitation infrastructure in slums numerous projects and schemes were floated and implemented. Considering the shift carried over in the infrastructure in slums in terms of coverage and improved status through these schemes, the need was felt to authenticate the available data for slum level infrastructure facilities and their impact on quality of life.

Following section elaborates the outcome of the survey conducted in the existing slums or poverty pockets and helps to quantify the change in infrastructure through comparative analysis of the prior data of 2006 and the present.

Table 5.2 Overall status of infrastructure in slums in 2005-06 & 2011

Sr. no.	Indicators	Year 2005-06	Year 2011
1	**Total population in Slum**	**410973**	**496135**
2	**No. of households in Slum**	**60787**	**83855**
3	**Household size**	6.76	5.92
4	**Sanitation facility**		
	Access to Household sanitation	62%	76.51%
	HHs depends on CTs	6%	7.92%
	HHs practicing OD	32%	15.57%
5	Access to piped water supply	65%	63%
6	Wastewater management		
	a. access to sewerage system	13%	41.80%
	b. Septic tank	5%	nil
	c. Open drains	61%	32.34%
	d. Open area/ streets	21%	25.86%

Fig: 5.8 Cluster wise Location of Slum in 2011



Chapter-VI

City Sanitation Planning

6.1 Introduction:

City Sanitation Planning (CSP) of the Gwalior city is important part of this research. Now all present status of different sectors has been studied and now is the need to provide a proposed planning for make effective development in various sectors of sanitation. Now we will study the sector wise suggested options for sanitation planning and implementation.

6.2 Population Projection:

Population projections form the basis of finding the future demand for infrastructure of different facilities. To select the appropriate method, population for 2001 was projected using various methods like Arithmetic Increase method, Geometric mean method and Exponential growth method. Out of these, for the year 2001, incremental method gave population figure closely resembling to that of census 2001 population. Hence in this report Incremental increase method for population projections is used for analytical purpose.

For Cluster wise projection the percentage of population in each cluster has been used to project the population for 2011, 2021 and 2031. The cluster wise population projection by Incremental method is shown below.

Table: 6.1 Population Projections by Different Methods

Year	Arithmetic Increase method	Incremental Increase method	Geometrical Progression method	Exponential Growth method
1951	241577	**241577**	241577	241577
1961	300587	**300587**	300587	300587
1971	384772	**384772**	384772	384772
1981	559776	**559776**	559776	559776
1991	690765	**690765**	690765	690765
2001	827026	**827026**	827026	827026
2011	944116	**985436**	1050366	1131293
2021	1061206	**1185166**	1334020	1468579
2031	1178295	**1426217**	1694276	1906426

Sources: Census of India and Analysis

All the technical design and proposals have been developed by considering these projected populations of the city. Based on the final projected population of the city for 2031, the cluster wise population projection has been done.

Table: 6.2 Cluster wise Population projection

Cluster no.	Cluster Name	Population		
		2011	2021	2031
1	Upcoming educational hub – Kedarpur area	14163	17033	20498
2	Mudia Pahad, Chandwadni Naka	91727	110319	132756
3	City center area	50924	61246	73702
4	Bheemnagar, Kumharpura Rapat	73354	88221	106164
5	Railway station	80029	96249	115825
6	Deendayal nagar, Pinto Park area	72945	87730	105573
7	Ranipura, Indira nagar, Charshar ka Naka	214756	258284	310816
8	Bhahodapur, Anandnagar area	47024	56555	68058
9	Satyanarayan Hill	114697	137944	166000
10	Maharaj Bada	175869	211515	254535
11	Guda-Gudi Ka Naka	33963	40846	49154
12	Ramaji ka pura	15986	19226	23136
	Total	**985436**	**1185166**	**1426217**

Sources: Census of India and Analysis

Using these projections now the future generation of Wastewater and Solid Waste has been projected.

The wastewater (sewage) generation for future has been calculated at 80 % of the water demand. The water demand for this purpose has been calculated at the rate of 70 lpcd. Additionally the institutional and fire demand and the unaccounted losses for water have also been considered for calculations the water demand as per the CPHEEO[10]. Here the grey water and black water have been calculated separately. For black water the per capita generation has been assumed at 40 lpcd. The grey water has been estimated as a difference of total sewage and black water.

[10] For fire : 0.1xsqrt of P/1000 (CPHEEO norm); Unaccounted water losses up to 15% (CPHEEO norm)

6.3 Proposed Planning of Water supply Network:

Before making plan of water supply system need to take in to consideration the present water supply network of the city and then make plan for the areas where water supply line is not exist.

Below map shows the present water supply network of the city. Here some zones have adequate water supply network and some zones have not water supply lines. In below map have 5 major circles where not water supply line exist.

First circle lies in Lashkar West zone where population density is medium to high. This area is not adequate water supply network and there area is along with Swarnrekha river. This circle area need to proper water supply line.

Second circle is in Lashkar East Zone where Population density is low. This is newly developing area and not water supply network is existing becoz of this area is high elevated. In summer season this region is suffered from lack of water and provide the water from tanker. Looking the future residential development and density of population in this area is needed to develop water supply network.

Third circle is in Lashkar East and Morar Zone which is also newly developing area with low population density due to high land area. Here is not water supply network available because of high elevation and in summer this area need to water supply from tanker. Now this area need proper water supply lines.

Forth and fifth circle is in Morar Zone where population density is low and not adequate water supply network. This zone needed water supply line.

Sixth zone is in Gwalior Zone which is old part of the city where water supply line is not sufficient. This region is developing very rapidly and looking the demand of population need to develop water supply network.

Fig: 6.1 Water Supply Planning Zone in Gwalior

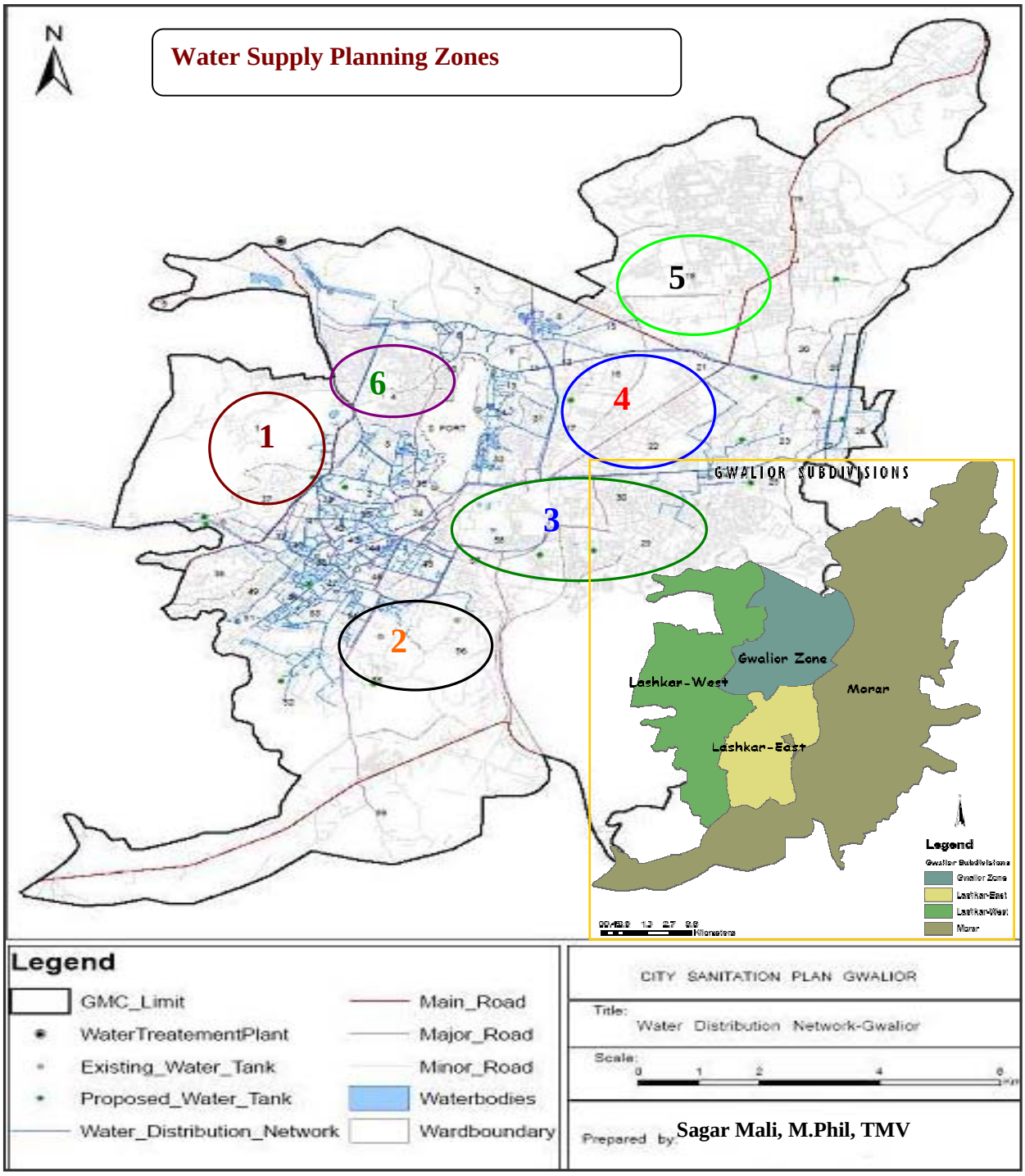


Table: 6.3 Cluster wise Water Supply Status

Cluster Name	Water Supply	Hand Pumps/ Tube Wells	Condition
Patan Dev	27%	73%	At majority of the places the pipeline of water supply is laid over the drains. There are chances of contamination of the water supply due to this.
Bhopal Road Ki Basti	6%	94%	
Tajpur	41%	59%	
Sanchi Road	62%	38%	
Purani Basti	52%	48%	
Yashwant Nagar	59%	41%	
Housing Colony	100%	0%	
Arjun Nagar Rahul Nagar	53%	47%	

Source: Secondary data

6.3.1 Water supply Demand:

The present water demand has been calculated using the Central Public Health and Environmental Engineering Manual on water supply. The current demand is given in table below:

Table: 6.4 Present Water Demand in Gwalior

Population	**985436 (2011)**
Domestic Demand @70lpcd	133.03 MLD
Institutional @20%	26.61 MLD
Fire Demand	3.14 MLD
Uncounted for Losses @ 15%	24.42 MLD
Total Demand	187.20 MLD
Supply	178.00 MLD
Demand Supply Gap	**9.20 MLD**

Source: Based on Analysis

6.3.2 Water Demand & Supply Gap:

The table below shows the key issues and gaps in Gwalior City. The water supply is only **109** lpcd as against 70 lpcd. The water supply lines at some places are laid on the drains. The hygienic conditions near bore well are also not maintained properly and may cause contamination to the water supply.

6.4 Proposed Planning of Waste Water Management:

6.4.1 Proposed Planning for Waste Water Management:

The wastewater (sewage) generation for future has been calculated at 80% of the water demand. The water demand for this purpose has been calculated at the rate of 135 lpcd. Additionally the institutional and fire demand and the unaccounted losses for water have also been considered for calculations the water demand as per the CPHEEO[11].Presently the total amount of waste water generated into the city is 149.76 MLD. It includes the waste water generated from domestic, institutional and other activities performed in city.

Table: 6.5 Actual quantity of waste waster trapped into the sewer

Lashkar zone						
Cluster number	**Cluster Name**	**Total HHs**	**Wastewater generation**	**HHs with sewer connectivity**	**Waste water trapped into sewer**	**Waste water not trapped into sewer**
1	**Upcoming educational hub – Kedarpur area**	2529	2.15	721	0.61	1.54
2 (50%)	**Mudia Pahad, Chandwadni Naka**	8190	6.97	5027	4.28	2.69
5 (50%)	**Railway station**	7146	6.08	5128	4.36	1.72
7	**Ranipura, Indira nagar, Charshar ka Naka**	38349	32.64	23130	19.68	12.95
8	**Bhahodapur, Anandnagar area**	8397	7.15	4344	3.70	3.45
9	**Satyanarayan Hill**	20482	17.43	12132	10.32	7.11
10	**Maharaj Bada**	31405	26.73	19044	16.21	10.52
11	**Guda-Gudi Ka Naka**	6065	5.16	3082	2.62	2.54
12	**Ramaji ka pura**	2855	2.43	621	0.53	1.90
Total		**125418**	**106.73**	**73229**	**62.32**	**44.41**

Hence there is a need to **curb the remaining 44.41 MLD of waste water generated in the zone.**

[11] For fire : 0.1xsqrt of P/1000 (CPHEEO norm); Unaccounted water losses upto 15% (CPHEEO norm)

Table: 6.6 Various mechanism of waste water disposal at Household level (Laskar-Gwalior Zone)

Lashkar-Gwalior zone										
Cluster number	Cluster Name	HHs having individual Toilets	HHs connected with sewer	%	HHs with septic tank	%	HHs with Leach pit	%	HHs connected in open drains	%
1	Upcoming educational hub – Kedarpur area	2059	721	35	0	0	927	45	412	20
2 (50%)	Mudia Pahad, Chandwadni Naka	7734	5027	65	387	5	1392	18	928	12
5 (50%)	Railway station	6838	5128	75	410	6	821	12	479	7
7	Ranipura, Indira nagar, Charshar ka Naka	35585	23130	65	2847	8	6049	17	3559	10
8	Bhahodapur, Anandnagar area	7240	4344	60	434	6	1448	20	1014	14
9	Satyanarayan Hill	17841	12132	68	1427	8	2676	15	1606	9
10	Maharaj Bada	29757	19044	64	2976	10	5951	20	1785	6
11	Guda-Gudi Ka Naka	5136	3082	60	257	5	1541	30	257	5
12	Ramaji ka pura	1827	621	34	0	0	877	48	329	18
Total		**114017**	**73229**	**64.23**	**8738**	**7.66**	**21682**	**19.02**	**10367**	**9.09**

Wastewater generated in Lashkar – Gwalior zone is conveyed through the outfall sewer running along the Swarnarekha River which ultimately connected to the STP located at PHE Colony, with the capacity of 90 MLD. The total length of the Swarnarekha Outfall sewer (Which acts as major sewage carrier and conveyor) within GMC limit is about 13.65 km. It starts from Hanuman Bandh located at the southern part of the city and moves towards north direction and it terminates at Jalalpura Dam (pickup wear).

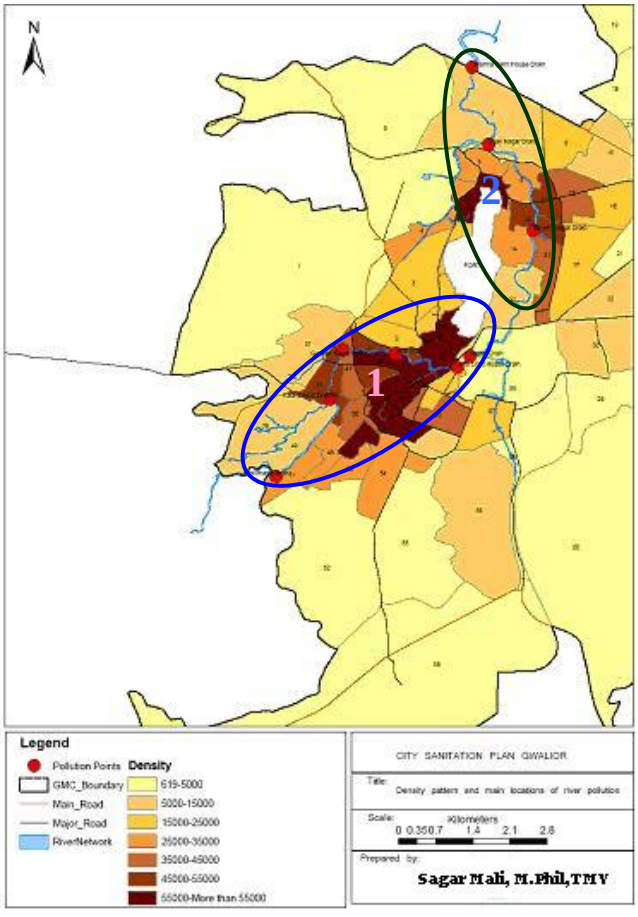
6.4.2 Population Density & Pollution in Gwalior-Lashkar Zone:

As the Map shown below reveals that most of the densely occupied localities of the city like, Maharaj Bada, Jinshi area, Padav and Old Gwalior (Cluster no. – 7, 9 and 10) are located around the Swarnarekha River and acts as a major contributor of waste water in the zone. This has generating maximum load on the existing sewerage system.

But due to absence of proper O&M, the existing sewerage system is not working efficiently. Secondly the present system is very age old and hence it got chocked and ruptured at many points. Due to this the nearby drains carry the waste water from the households and diverting towards the Swarnarekha River which adds pollution into it. The major drains in the zone are, Taraganj Nalla, Laxmiganj Nalla, and Nalla near Dolly Bua Ka Pul, Jinshi Nalla, Lalitpur Colony Nalla, Medical College / Ranipura Nalla, Tansen Nagar Nalla and Gansmandi Nalla.

The following map shows the ward-wise density and the location of major drains connecting to Swarnarekha River.

Fig: 6.2 Density pattern and main locations of river pollution



Source: Gwalior Municipal Corporation (GMC) and Primary Data Collection

Within the GMC limit area the river is passing through different residential and commercial areas like, Maharaj Bada, Jinshi area, Pool Baugh, Tansen nagar and Old Gwalior (Hazira). The area like, Maharaj Bada is the densely populated area and having mix landuse, similarly Old Gwalior (Hazira) is also a densely populated area. The nearby drains in these areas carry waste water from the residential as well as commercial areas and merge into the Swarnarekha River. These area shown in the map with circle No:1 have more sewer pollution due to high density and river proximity as well as the sewerage system of this area is very old and have damaged. This area needed good sewerage network system for minimize the river pollution of this area.

The area around Maharaj Bada and Swarnarekha River is having many Dairies which also add pollution through the drains running along the roads which ultimately merge into the nearby natural drains. The major drains which carries the waste water from the nearby areas and merge into the Swarnarekha River are, Kala Saiyad Drain, Ganesh nagar drain, Jinshi drain, Lighthouse drain, Mahal drain, Tansen nagar, and vijay nagar drain. This area indicates with circle No: 2 have high population density and high river pollution. This area needed proper well sewerage network for properly canalize the waste water of the city.

Photo: 6.1 Major drains which are adding pollution in the main river.

6.4.3 Population Density & Pollution in Morar Zone:

This zone is located on the eastern part of the city and covers 29% population of the city. The major cluster covered under this zone and the waste water generated in each zone is mentioned in the following table:

Table: 6.7 Actual quantity of waste waster trapped into the sewer

Morar zone						
Cluster number	Cluster Name	Total HHs	Wastewater generation	HHs with sewer connectivity	Waste water trapped into sewer	Waste water not trapped into sewer
2 (50%)	Mudia Pahad, Chandwadni Naka	8190	6.97	5027	4.28	2.69
3	City center area	9094	7.74	7401	6.30	1.44
4	Bheemnagar, Kumharpura Rapat	13099	11.15	7009	5.96	5.18
5 (50%)	Railway station	7146	6.08	5128	4.36	1.72
6	Deendayal nagar, Pinto Park area	13026	11.09	8442	7.18	3.90
Total		50555	43.02	33007	28.09	14.93

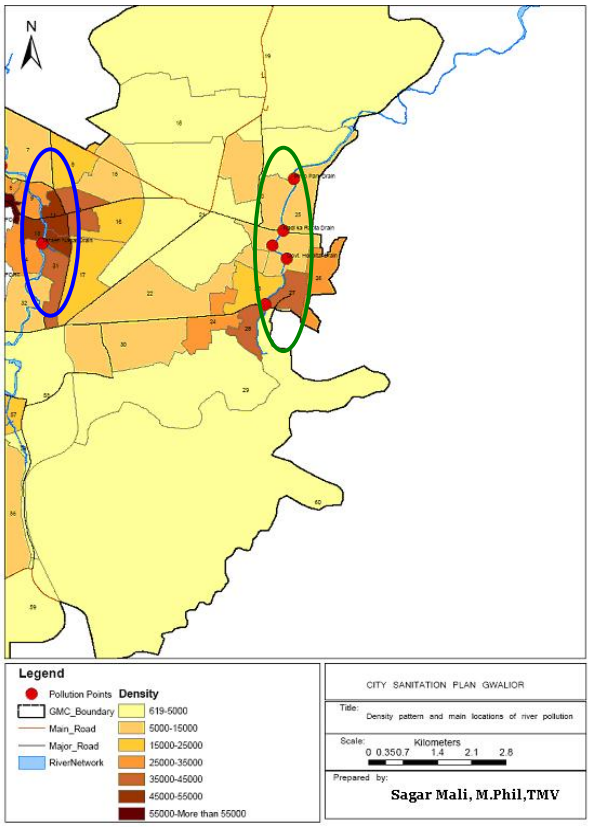
(Source: Secondary Survey)

Table: 6.8 Various mechanism of waste water disposal at Household level in Morar Zone

Morar zone										
Cluster number	Cluster Name	HHs having individual Toilets	HHs connected with sewer	%	HHs with septic tank	%	HHs with Leach pit	%	HHs connected in open drains	%
2 (50%)	Mudia Pahad, Chandwadni Naka	7734	5027	65	387	5	1392	18	928	12
3	City center area	8917	7401	83	1070	12	446	5	0	0
4	Bheemnagar, Kumharpura Rapat	10783	7009	65	539	5	1941	18	1294	12
5 (50%)	Railway station	6838	5128	75	410	6	821	12	479	7
6	Deendayal nagar, Pinto Park area	11564	8442	73	231	2	1735	15	1156	10
Total		45836	33007	72.01	2637	5.75	6334	13.82	3857	8.42

(Source: Secondary Survey)

Fig: 6.3 Density pattern and main locations of Morar river pollution



As the Map shown above indicates that the Morar River passes from the densely occupied wards like, ward no. – 28, 23, 27, 26, 25, 20. In few areas households are not connected with the sewer lines and hence the waste water from the residential as well as commercial areas directly goes into the drains which finally terminate into the Morar River. This area need the proper sewerage network system.

6.4.4 Demand Supply Gap in Morar Zone:

The below table reveals that the present system is sufficient to carry the waste water generated in the zone. And it is sufficient for future population also.

Table: 6.9 Demand – supply gap (Wastewater management) in Morar zone

No	Description	Unit in MLD
1	Capacity of the existing outfall sewer	100 MLD
2	Existing waste water generation	43 MLD

Table: 6.10 Cluster wise results of assessment of waste water management in Morar Sewerage zone

Cluster no.	Cluster name	Issues in existing wastewater management system
2	Mudia Pahad, Chandwadni Naka	Underdeveloped cluster mainly ward # 60. Hence limited area is having sewerage system, the area occupied by LIG/ migrants people having low level of sewerage infrastructure
3	City center area	Satisfactory condition of waste water management system
4	Bheemnagar, Kumharpura Rapat	Needs augmentation of existing sewerage system
5	Railway station	Needs augmentation of existing sewerage system
6	Deendayal nagar, Pinto Park area	Needs augmentation of existing sewerage system

6.4.5 Proposed Waste water Management Planning:

A) Proposed implementation period and future projections

It is proposed that the city sanitation plan is implemented during the year 2012 to 2015 and vision exercise is prepared for a period of next 20 years. Accordingly the following phasing has been defined for the city of Gwalior.

As given in the following Table, the CSP has to be implemented in three phases

- **Immediate phase which is starts at 2012 and ends by 2015**
- **Medium term which starts at 2012 and ends by 2023 and**
- **Long term which starts at 2012 and ends by 2033**

Glimpses of various activities that are planned during different phases are listed in the Table as given below.

Table: 6.11 Various activities planned during Phase 1

Immediate/ short term (CSP Implementation Period) : 0 TO 3 YEARS (2012 to 2015)
Responding to immediate demands which can be provided within a period of three years
1. Eradicating the practice of open defecation (including open urination) by means of construction of new individual toilets, community and public toilets including an effective disposal system
2. Responding to special needs and requirements of the poorest families, women, children and other special interest groups such as adolescent girls, physically disabled people
3. Reviving all existing community and public toilets and urinals
4. Establish a system for operation and maintenance of community and public toilets in the city so as to ensure cleanliness
5. Strengthening existing black water disposal mechanism by repairing existing faulty pits, septic tanks and sewer lines
6. Connecting all possible localities and households including slums to the existing sewer network
7. Responding to demand and gaps in all aspects of municipal solid waste management by consolidating garbage collection, storage, transportation, processing and land filling
8. Livelihood promotion activities by involving rag pickers, CBOs, NGOs and other stakeholders in activities such as door to door collection, segregation, recycling and reuse of garbage
9. Modernization of existing garbage transfer stations, slaughter house and vegetable markets
10. Developing fish market under the scheme promoted by fisheries board
11. Improving the working condition of the *sanitary workers* by building their capacities and providing training to them, by providing safety health kits and by providing adequate sanitation facilities at work place
12. Hiring additional staff including sanitary workers as per the norms
13. Tapping and chanalizing all waste water into sewer
14. Improving effectiveness and efficiency of existing STPs and operationalizing the 90 MLD STP at PHE colony
15. Initiating septage management system in the city and establishing septage treatment unit
16. Initiating IEC and awareness campaign
17. Strengthening storm water management by repair of existing drains and construction new drains in water logged areas
18. Preparing detailed project reports for medium and long term interventions (such as expansion of sewer network, and initiating work, etc)
19. Improving sanitation related income and expenditure by bringing financial efficiency, restructuring users fee, levying addition sanitation/SWM surcharge if necessary
20. Establishing SAMS (Sanitation Amenities Management System) and Monitoring system
21. Capacity building and training of all staff engaged in sanitation and SWM activities
22. Bringing interdepartmental coordination and convergence of schemes and programmes for ensuring mobilization of resources

Table: 6.12 Various activities planned during Phase 2

Medium term – 0 TO 10 years (2012 to 2023)
1. Strengthening existing toilets for safe excreta disposal
2. Preparing DPRs for additional SLF cells and initiating construction so that the SLF is ready by 2023
3. Initiating work related to consolidating storm water management system including ground water recharging, constructing and reviving drains at city level
4. Expanding sewerage network in possible localities
5. Expanding treatment facilities in term of a new STP of 75MLD
6. Developing "revolving sanitation fund" at city level so as to take care of upcoming toilet requirements for the poor
7. Improving financial condition of the city
8. Effective service redressal mechanism
9. Trained manpower at all level
10. Initiate River front development and environmental improvement activities along the Swarnrekha and Morar River

Table: 6.13 Various activities planned during Phase 3

Long term – 0 TO 20 years (2012 to 2033)
1. Scientific closure of Sanitary landfill site
2. 100% recovery of taxes and charges related to water, sanitation and SWM
3. Achieving service level benchmarks related to sanitation and SWM as specified by MOUD
4. Ensuring sustainable infrastructure promotion and management
5. Reviving environmental condition in and around the River Swarnarekha and Morar.

Since the number of toilets to be build and toilets that require renovation would increases even during the CSP implementation period – their likely increase in number during the phase 1 is calculated and presented in Table below.

Table: 6.14 Toilets requirement during the CSP implementation period

Sr. No.	Details of Types of toilet facilities and disposals type	Household toilet facilities required (2011)	Household toilet facilities required during CSP implementation period (2012-20015)*
A	**Provision of new toilets**		
1	Pour Flush with Septic Tank	871	884
2	Pour Flush connected to sewer	8482	8609
3	Pour Flush connected to simplifies sewer along with decentralized treatment system	419	425
4	Group Pour Flush toilets with common Septic tank	275	279
5	Group Pour Flush toilets connected to sewer	267	271
6	Pour Flush connected to simplifies sewer having connectivity with conventional sewer	1662	1687
	Total (A)	**11975**	**12155**
B	**Strengthening of existing septic tanks**		
1	Existing Septic Tank with soak away pit	1653	1677
2	Existing Septic Tank with disposal of waste water into sewer	7051	7157
3	Existing Septic Tank with small bore sewer followed by common septic tank	705	715
4	Existing Septic Tank with small bore sewer connecting to sewer line	1967	1996
	Total (B)	**11375**	**11546**
C	**Strengthening of existing pit latrines**		
1	Upgrading pit latrine to pour flush septic tanks	4401	4467
2	Upgrading pit latrine by connecting to sewer	38099	38670
	Total (C)	**42500**	**43138**

In order to comprehensively consolidate the sanitation situation in the city during the CSP implementation period, it is important that excreta disposal mechanism is consolidated including upgrading existing system and new toilets construction.

Fig: 6.4 Proposed Planning of storm water Management

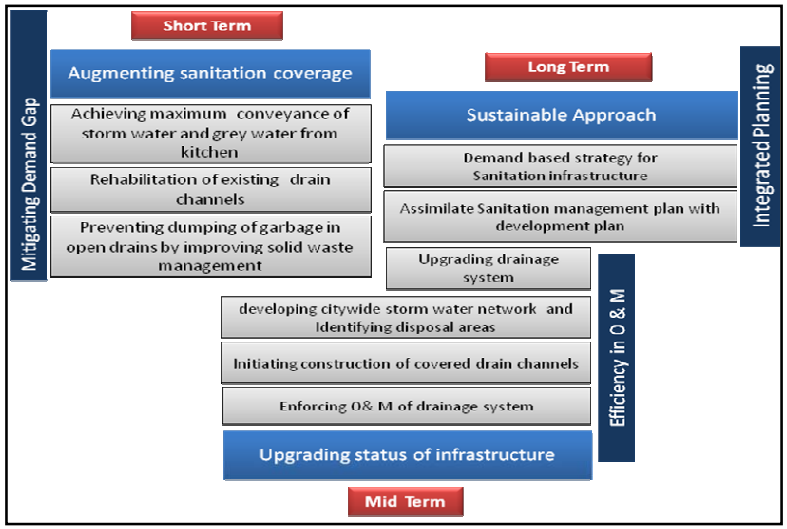
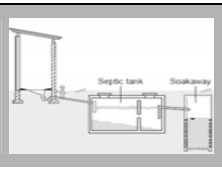
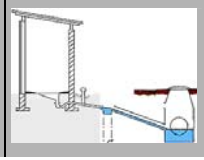
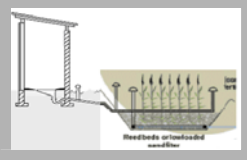
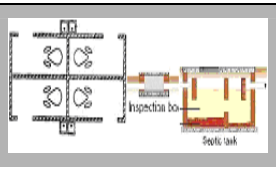
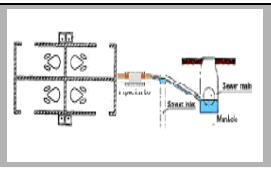
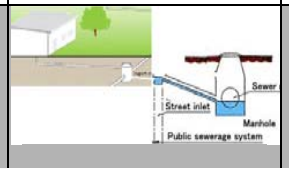


Table: 6.15 Annual implementation Plan during CSP implementation Period – Construction of individual level facility

Type of Household sanitation facility ▶	Pour Flush with Septic Tank	Pour Flush connected to sewer	Pour Flush connected to simplifies sewer along with decentralized treatment system	Group Pour Flush toilets with common Septic tank	Group Pour Flush toilets connected to sewer	Pour Flush connected to simplifies sewer having connectivity with conventional sewer	
Sketch of the proposed facility ▶							
New Constructions							
Year ▼							
2012-13	**295**	**2870**	**142**	**93**	**90**	**562**	**4052**
2013-14	**295**	**2870**	**142**	**93**	**90**	**562**	**4052**
2014-15	**295**	**2870**	**142**	**93**	**90**	**562**	**4052**

6.5 Solid waste Management Planning:

Solid waste Management is important part of sanitation planning. Solid waste generated from various areas of the city so the proper management of solid waste is important.

Total solid waste generation is calculated for different land uses viz. Residential, Commercial, Institutional and slaughter house. The CPHEEO manual guides waste generation for each land use, which is followed while calculating the total solid waste generation.

Table: 6.16 Details of Waste generation with various Land use

Source of waste Generation	Unit	Waste generation rate	Population (2011)/ Number	Category wise waste generated	Muni. waste generated in ton (MT) in 2011
1. Residential area	Kg/cap/day	0.25	985436	246.36	**246.36**
2. Commercial area					
a. Market (no of shops)	Kg/cap/day	0.1 to to 0.2	53309	26.65	**28.71**
b. Hotels/ Restaurants	Kg/cap/day	0.1 to to 0.2	4103	2.05	
3. Hospitals - district hospitals & private clinics (no. of beds)	Kg per bed	1.5	453	0.6795	**0.68**
4. **Educational Institutes**					
a. Schools					
i. Primary (309)	Kg/cap/day	0.05-0.2	29203	1.46	**2.90**
ii. Secondary (20)	Kg/cap/day	0.05-0.2	13291	0.66	
iii. Higher Secondary (130)	Kg/cap/day	0.05-0.2	10504	0.53	
b. College (10)	Kg/cap/day	0.05-0.2	5000	0.25	
5. Offices	Kg/cap/day	0.1	25720	5.14	**5.14**
6. **Vegetable Market** (Mandi)	ton per day	0.5-1	4	4.25	**4.25**
7. **Slaughters house**	ton per day	0.5-1	5	2.50	**2.50**
Grand Total					**290.54**

Source: Analysis and Secondary Data

Table: 6.17 Cluster wise number of Community Bins

No. of Cluster	Cluster Name	Cluster wise Population	Existing waste bins available
1	**Upcoming educational hub – Kedarpur area**	14163	0
2	**Mudia Pahad, Chandwadni Naka**	91727	22
3	**City center area**	50924	33
4	**Bheemnagar, Kumharpura Rapat**	73354	13
5	**Railway station**	80029	34
6	**Deendayal nagar, Pinto Park area**	72945	20
7	**Ranipura, Indira nagar, Charshar ka Naka**	214756	42
8	**Bhahodapur, Anandnagar area**	47024	11
9	**Satyanarayan Hill**	114697	17
10	**Maharaj Bada**	175869	25
11	**Guda-Gudi Ka Naka**	33963	9
12	**Ramaji ka pura**	15986	5
Total		**985436**	**231**

Table: 6.18 Cluster wise number of open areas used for garbage dumping

No. of Cluster	Cluster Name	Cluster wise Population	Number of open areas used for garbage dumping
1	**Upcoming educational hub – Kedarpur area**	14163	48
2	**Mudia Pahad, Chandwadni Naka**	91727	232
3	**City center area**	50924	177
4	**Bheemnagar, Kumharpura Rapat**	73354	83
5	**Railway station**	80029	245
6	**Deendayal nagar, Pinto Park area**	72945	337
7	**Ranipura, Indira nagar, Charshar ka Naka**	214756	331
8	**Bhahodapur, Anandnagar area**	47024	241
9	**Satyanarayan Hill**	114697	175
10	**Maharaj Bada**	175869	212
11	**Guda-Gudi Ka Naka**	33963	84
12	**Ramaji ka pura**	15986	32
Total		**985436**	**2197**

6.5.1 Issue of Municipal Solid waste Management:

Table: 6.19 Existing Practice in Solid Waste Management

Sr. No.	Stages of Waste Management	Existing Condition
1	**Collection**	• No institutionally organized collection from door to door. **About 75% of the waste is collected**, i.e. Municipal Solid Waste generated about 290.54 MT/Day & Collection is about 219.27 MT/Day. • **No Segregation of the waste is done at either any level, especially at the household level which is key to address the issue of rework and investment in redoing the same work of segregation**.
2	**Transport**	• **Lack of waste collection on daily basis** - According to field survey daily collection of waste has been carried out in about 55% of the wards, roughly 70 percent collection with a gap in collection efficiency of about 25 percent. • **Inadequacy in the management of existing infrastructure in terms of transportation vehicles** – Though the infrastructure is available for collection and transportation it is significantly underutilized. The issue is of management of the existing infrastructure.
3	**Processing and Disposal**	• **Scientific method for process and disposing the waste at Sanitary landfill site located at Chandoha Khurd village of capacity 300 MT/Day**. The segregation of the garbage is mechanical where the recyclables material such as metals, plastics etc. are removed and the bio-degradable waste is further processed for converting into compost. • Presently the plants include two types of composting facilities; a) Mechanical composting & b) Vermi composting. • Mechanical compost converts 110 TPD of Garbage into 50 TPD Compost & Vermi compost facility has capacity to convert 20 TPD compost. Vermi composting unit has just started.

6.5.2 Future Projection of Solid waste Generation:

The rate of generation of solid waste has been assumed at 250 grams/capita/day (as per CPHEEO guidelines). The increase in per capita waste generation has been assumed at 1.33% per capita/year[3].

Table: 6.20 Municipal Solid Waste (MSW) Generation

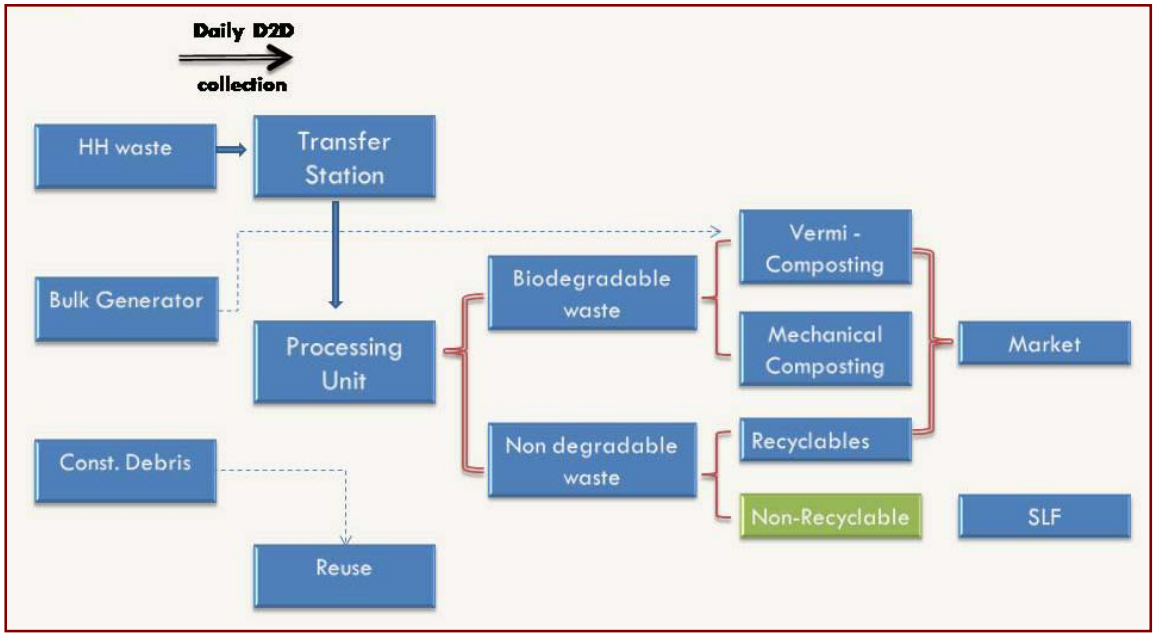
Cluster number	Cluster Name	Per Capita12 (gm/capita/day)			Solid Waste Generation (TPD)		
		2011	2021	2031	2011	2021	2031
1	Upcoming educational hub – Kedarpur area	295	337	384	4.18	5.73	7.88
2	Mudia Pahad, Chandwadni Naka	295	337	384	27.06	37.14	51.01
3	City centre area	295	337	384	15.02	20.62	28.32
4	Bheemnagar, Kumharpura Rapat	295	337	384	21.64	29.70	40.79
5	Railway station	295	337	384	23.61	32.40	44.50
6	Deendayal nagar, Pinto Park area	295	337	384	21.52	29.54	40.56
7	Ranipura, Indira nagar, Charshar ka Naka	295	337	384	63.35	86.96	119.42
8	Bhahodapur, Anandnagar area	295	337	384	13.87	19.04	26.15
9	Satyanarayan Hill	295	337	384	33.84	46.44	63.78
10	Maharaj Bada	295	337	384	51.88	71.21	97.80
11	Guda-Gudi Ka Naka	295	337	384	10.02	13.75	18.89
12	Ramaji ka pura	295	337	384	4.72	6.47	8.89
Total					290.54	399.01	547.98

[12] Annual increase in Rate of Generation is taken as 1.33%
Reference: Pappu, A., Saxena, M., Asokar, S.R., 2007. Solid Waste Generation in India and their Recycling Potential in Building Materials. Journal of Building and Environment 42 (6), 2311–2324.

6.5.3 Suggested Option for Solid Waste Management:

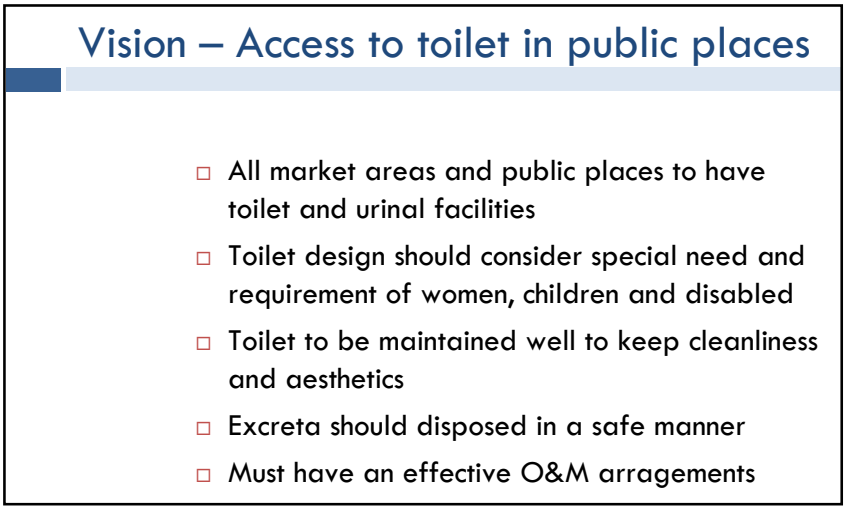
The option suggests door to door collection of solid waste through rag pickers with the help of hand carts and/or motorized vehicles. It will be taken to transfer station and then taken to the processing unit for further segregation and treatment. At the processing unit, the waste will be segregated into two parts, a) Bio degradable and b) Non biodegradable. The biodegradable material needs to be converted into composts and the Non biodegradable material has been again segregated into two parts, a) Recyclable and b) Non Recyclables. The recyclable material has been sold out into the market where as the non recyclable material has to be disposed into the SLF site. Whereas in case of debris it is utilized in low lying area as a filling material or it is utilized to convert into the material like brick.

Fig: 6.5 Schematic representation of SWM Option



6.6 Sanitation Planning of Urinal & Toilets:

Community toilet and public toilets play a pivotal role in meeting sanitation gaps in the city. As evident from the situational analysis section of this report, condition of most of the existing community and public toilets in the city is bad and require urgent upgradation in order to ensure that they play the expected role in meeting the sanitation gap. Vision statement in context to effectively upgrading and using the Public toilet and community toilets is as given below:



6.6.1 Strategies and Recommendations:

It is recommended that all the 111 number of existing complexes need to be up graded with a total investment of Rs.333 Lakhs. This will change the entire scenario of the city's community and public toilets and also arrest the practice of open defecation and open urination in public places.

Table: 6.21 System of Waste Disposal in Institutions

Particular	No. of Unit[13]	Unit cost (Rs. in lacs)	Total cost (Rs. in lacs)
Renovation of existing Community toilets	**111**	**3**	**333**

In addition to up gradation of all non functional and dysfunctional public toilets and community toilets about 15 locations have been identified where new toilets are required. Location of theses toilets is given in the following Table.

As given in the Table an investment of Rs. 225 lakhs is expected for constructing new toilets.

[13] Each unit will be of 15 seaters including Toilet, bathroom and Urinals

Table: 6.22 System of Waste Disposal in Institutions

Sr. no.	Proposed Location	No. of Unit[14]	Unit cost (Rs. in lacs)	Total cost (Rs. in lacs)
1	near bus stand	2	15	30
2	railway station	3	15	45
3	near Gole ka Mandir	1	15	15
4	Bada nr printing press	2	15	30
5	Laxmiganj mandi	1	15	15
6	city center	1	15	15
7	Killa Gate (Tempoo Stand)	1	15	15
8	Hazira chowk	1	15	15
9	Morar Tempo stand	1	15	15
10	Morar Sabji Mandi	1	15	15
11	near Medical college	1	15	15
Total		15		225

Fig: 6.6 Few ideal model toilets are depicted, which are location specific

[14] Each unit will be of 15 seaters including Toilet, bathroom and Urinals

6.6.2 Overall cost for Sanitation Facilities:

As given in the Table below and described in the preceding section, the total investment during the CSP implementation period of first three years is about Rs. 4964 Lakhs.

Table: 6.23 component wise break up cost

Sr. no.	Household sanitation intervention	Total cost
A	**Provision of New HH Toilets**	1342.12
B	**Strengthening of existing septic tanks**	366.96
C	**Strengthening of existing pit latrines**	2268.12
E	**Public / Community Toilets**	558.00
D	**Septage Management**	429.00
	Grand Total (in lakh)	**4964.20**

Chapter-VII

Conclusion

7.1 Introduction:

City Sanitation plan of the Gwalior city plays a vital role in the sanitation and proper healthy development of the city, this is the planning not only for today but also it a vision of next 20 years in sanitation sector. Before making sanitation plan of the I have did a sanitation study of the city in four major sector of the sanitation i.e Water supply, Waste Waster system with Natural drain, artificial drain and sewerage network, Solid waste management of the city and sanitation scenario with household toilets, public urinals and community toilets etc. and after study of these sector know the sanitation situation of the city and then make some proposed sanitation planning of the city for present and for next 20 years of vision. After study these research some sector wise conclusions comes up which is needed to be mention. Some sanitation sector wise conclusions is below:

7.2 Water Supply Network System:

- Low water pressure in the present water supply system mainly at the tail end users;
- Inefficient operation and maintenance of pipelines and public stand posts;
- Low efficiency of cost recovery mechanism;
- Inadequate Municipal water supply distribution system in newly developed areas/ colonies;
- High number of illegal connections in slum areas.
- Poor O&M of water supply facilities in the slum areas. In peak summers water is supplied by Municipal/ Private Tankers.
- New pipelines have been laid in nearly 33% of the city area which covers almost 90-95% of city area.
- Majority of places in the cluster of Pathan dev, Bhopal road ki bast, Tajpur, Sanchi road, purani Basti, Yashwant Nagar, Housing colony, Arjun nagar and Rahul nagar area the pipelines laid on the drains which create the many water born disease like Gastro etc. in these area.
- Rehabilitate existing system, reduce leaks, improve supply pressures, provide new service connections, and replace water meters and valves and fire hydrants Reduce

unaccounted for water to 30% by 31st December 1998 clean existing sewers and drains and carrying out urgent repairs.

7.3 Waste Water Management:

➢ Conclusion of Waste Water Management in Gwalior-Lashkar Zone:

- Most of the secondary sewers are letting their wastewater directly into nearby nalla, due to no connection to the existing main sewers.
- It is observed that, in some lanes/road sewer does not exist.
- Most of the households have not connected there wastewater to the sewers.
- Some of the manholes are damaged and over flowing.
- It is observed that some of the trunk mains have been damaged.
- High density city area like, Maharaj Bada, Jinshi area, Padav and Old Gwalior (Cluster no. – 7, 9 and 10) are located around the Swarnarekha River and acts as a major contributor of waste water in the zone. This has generating maximum load on the existing sewerage system
- Due to absence of proper O&M, the existing sewerage system is not working efficiently. Secondly the present system is very age old and hence it got chocked and ruptured at many points. Due to this the nearby drains carry the waste water from the households and diverting towards the Swarnarekha River which adds pollution into it. The major drains in the zone are, Taraganj Nalla, Laxmiganj Nalla, and Nalla near Dolly Bua Ka Pul, Jinshi Nalla, Lalitpur Colony Nalla, Medical College / Ranipura Nalla, Tansen Nagar Nalla and Gansmandi Nalla. etc.
- About 88 local drains (11 large, 20 medium and 57 small drains) flowing through the city area join the river Swarnarekha River. The discharge of wastewater (sewage) in these drains as overflow from septic tanks or leakages from broken sewerage lines and dumping of solid waste in their catchments cause organic pollution in the water quality of river.

➢ Conclusion of Waste Water Management in Morar Zone:

- Age old sewer lines got ruptured at different places causing siltation which restricts the free flow of sewage;
- Lack of proper maintenance of existing sewerage system especially main sewer lines;

- At certain points the sewer lines are not functioning properly because of siltation in main sewer lines. The major areas/ localities having such type of problems are, Farras Khana, Golpahadia, Harnampura, Ranipura, Goshpura # 2, Laxmanpura, Hemsingh ki Pared, Bheemnagar and Kumharpura (in Morar)
- It is observed that portions of the main sewerlines have been damaged at places;
- Rupture/ leakages in the outfall sewerlines causing water pollution in the channel constructed on the Swarnarekha Nalla;
- Small scale industries like, Dairies in the adjoining areas of the river add pollution in it through open drains.
- Open defecation and dilapidated condition of septic tanks (lack of septage management) adds to the pollutants specially the bacteriological contaminate.
- Most of the secondary sewers are letting their wastewater directly into nearby open drains/ nallahs, due to no connection to the existing main sewers;
- The Morar river while flowing through the city areas receives the discharge of wastewater (sewage) in no. of drains, as overflow from septic tanks or leakages from broken sewerage lines and dumping of solid waste in their catchment cause organic pollution which directly have adverse impact on the water quality of river;
- Discharge of hospitals and Private Nursing home into the open drains is also observed;
- Solid waste dumping in the open area/ open drains adds pollution in the river;
- Dilapidated condition of main holes adds siltation in the sewer lines.

7.4 Solid Waste Management:

- Insufficient vehicles available for garbage transportation
- Unscientific ways of waste transportation creating unhygienic condition polluting the environment
- Irregular lifting of waste in peripheral areas/ poor pockets
- The vehicles being used to transportation purpose are not maintained properly.

7.5 Household & Public Sanitation System:

➢ Household Sanitation:

- About 91% of city of population has access to household sanitation;
- While condition of toilets is satisfactory, there are issues related to the discharge and conveyance of black water which is not proper;
- Though about 68 percent (62 percent connected to sewer line and 6 percent with septic tanks) are supposed to have proper discharge and conveyance mechanism, the septic tank effluent is observed to be discharged into open drains or places;
- Connectivity and coverage achieved through underground sewerage system is inadequate despite of a good sewerage network. About 38% of the total households depend upon septic tanks, on pit toilets and leach pit, which lack in proper disposal of black water, operational and maintenance issues;
- Household where the toilets are connected to the septic tank and leach pit, the removal of sludge is not done on a regular basis;
- Effluent coming out of septic tanks, which can contain large pathogenic microorganism load, is often disposed off into open drains. This can cause different health problems Leach pit latrines lose their effectiveness and efficiency due to densely located pits as they provide little or no scope for absorbing liquid part of the black water;
- Twin leach pits have more advantage over single leach pits but space constraints hinder its application in most cases;
- On pit latrines are difficult to clean and people are hesitant to use these type of toilets because of fear of getting it filled.

➢ Public Toilets & Urinals:

- The city has large number of toilet complexes, which demands for an effective mechanism for their operation and maintenance and their effective functioning;
- The existing status of community and public toilets is not satisfactory with most of the toilets being in state of neglect. About 85% toilets are not found to be clean;
- Most of the community toilets lack proper operation and maintenance mechanism;
- Out of 148 toilets in use, 111 toilets though are not in usable conditions but are still being used by the community due to lack of other alternative;

- It is observed that some of the community toilets are encroached and are taken over by local people. There are about 30 community toilets which are either encroached, dysfunctional (broken) or under construction;
- Lack of adequate water supply has affected the hygiene and maintenance of the toilets and at the same time availability of electricity is also an issue;
- Facilities for women are worst in many areas;
- Toilet blocks located in public areas like commercial places, markets and vegetable Markets (Mandi), bus stand, railway station, etc. grossly lack in maintenance due to absence of water supply and lack of maintenance mechanism;
- Poor condition of community toilets and public toilets in the city is resulting in the use of open spaces and plots along the roads for open defecation;
- There seems to be a lack of ownership resulting into misuse and abuse of these facilities especially in the clusters dominated by slums and low income groups;
- Toilet complexes operated and maintained by Sulabh and community seem to be in a much better condition in terms of their operation and maintenance, cleanliness and usability;
- Availability of urinals for women in public places is very low due to which women have to suffer a lot;
- Cleanliness is an issue in case of urinals: about 84% of the urinals are not maintained properly and create foul smell;
- Inadequate numbers of urinals in the city, presently only 75 numbers of urinals are functioning in the city due to which people urinate in open places or along the compound walls, especially in commercial and public places.

7.6 Limitations:

- Due to large scale of City Extent and large number of house hold population I can't get the house hold toilet data from primary survey
- GPS survey did using Etrex GPS Receiver which have location accuracy in between 3 to 6 meter. Can't make less then 3 meter
- Due to high scope of study and less time limit I not make much analysis in City sanitation planning
- Due to large extent of city I not make maps of existing Artificial drainage network

7.7 Scope of the study:

City Sanitation plan of the city plays important role in systematic and effective planning of the city. Government of India has know the importance of city sanitation planning for development of the city and due to that reason central government encouraging to state government for making a successful planning of the major cities in the India. National government and World organizations has funding to state government in different schemes for making city sanitation planning of the cities.

GIS, GPS and Remote sensing plays vital role in systematic study and futuristic planning of the city. While making Sanitation plan of any city need to study the Geography of the area first and according to Physical and social setting of the city need to make planning and implementation of any schemes of sanitation planning. Geography of the area is important affected factor like Topography, Physical setting, Land use and Land cover, drainage network, Social and Economical status of the people and their distribution over a area is mainly affected in sanitation study and planning of the city.

References:

In Referances the study of previous works on city sanitation planning which used in present study. Here are some projects and books which worked on city sanitation planning and used these guidelines in my present research thesis.

1. Mohammad Hadi Sohbati (May 2011), Pune University Pune: "City Sanitation Planning of Ashta City Using Geoinformatics techniques". He successfully complete his M.Sc. project on Sanitation plan of the Ashta city of MP. His Project was useful in this research work

2. CEMDS, Austria (2010): City Sanitation Planning of Khajurao & Raisen City of M.P. CEMDS organization is Austrian based company one of the leading pioneer in the City sanitation Sector. CEMDS has completed his City sanitation work in Khajurao & Raisen city of MP. Reports of this organization effective & Planning is GIS based.

3. Bharatpur (Rajastan) city planning report (2010): Bharatpur city in Rajastan state has been make a city sanitation plan. Here I have used this report for my research guideline. In Bharatpur city sanitation planning have not used GIS techniques but have well planned of some important sectors of sanitation. This project report is important in my research work.

4. A report of Pune Municipal Corporation (2009): "Master Plan for Integrating Decentralized Basic Need Services (DEBANS) in Urban Sanitation Planning". This project report is also helpful in present studies which has studied slum areas and make a city sanitation plan consideration with slum pockets in the Pune city.

5. "Sanitation Planning Guide for Small Communities", a project report of State of Alaska, Department of Community and Economic Development (June 1999). This is a international project report on small community level sanitation planning. Here have used various techniques for sanitation planning.

Photo Plates

Photo: 7.1 Waste water Outlet in Swarnrekha River

Photo: 7.2 Discussion with GMC officers, Civilians and Ward Members

Photo: 7.3 Existing Status of some Toilets along with Modern Bio-toilet

Photo: 7.4 Water Supply Network in Slum Area

Photo: 7.5 Solid waste Thrown on open area & in Drains

Photo: 7.6 GPS Survey of Gwalior City