DEVELOPING STRATEGIES FOR MAKING RIVER-SENSITIVE CITY: A CASE OF LUCKNOW

A Dissertation

Submitted in Partial Fulfillment of the

Requirements for the Degree of

MASTER OF URBAN AND REGIONAL PLANNING

In

Developing Strategies for Making River-Sensitive City

by

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JUNE, 2022

CERTIFICATE

It is certified that the work contained in Dissertation entitled **"DEVELOPING STRATEGIES FOR MAKING RIVER-SENSITIVE CITY: A CASE OF LUCKNOW"** been by **Supriyam Shrivastava, (Roll No.1200106020)** for the award of **Master of Urban and Regional Planning,** from Babu Banarasi Das University has been carried out under our supervision and that this work has not been submitted elsewhere for a degree.

The matter embodied in this dissertation has not been submitted by her for the award of any other degree of this or any other Institute.

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Date: June-2022
Place: Lucknow

ABSTRACT

Cities and rivers have an intrinsic relationship. Traditionally, the rivers have been at the centre of various cultural, religious, livelihood-related, and recreational avenues in cities. Throughout the history of civilizations, rivers have been at the centre of human settlements, owing to easy availability of water for subsistence, agriculture, navigation and other basic necessities required for existence. A number of the earliest and most prominent ancient cities were established along the banks of rivers, which include the Euphrates-Tigris rivers in Mesopotamia, Nile in Egypt, Ganga in India, and Huang-Ho in China. Even today, there are several examples of cities, where the rivers have played a vital role in defining their development. Examples of these include the Thames in London, Seine in Paris, Hudson in New York, Yarra in Melbourne, Ganga in Varanasi, Yamuna in Delhi, and many others. City & river act as interconnected units, all working together, to achieve a common vision for the development. Serious concerns of urban areas are related to water challenges. Negative impacts of rapid urbanization in cities on its rivers are water pollution, extending to biological and structural changes in the natural state of the water channels.

Key Words: Making river-sensitive master plans, Water Sensitive design and planning, Riverfront development, Impact of river channelization and riverfront development.

Aim:

To develop guideline for making river-sensitive city

Objective:

1. To study the existing scenario of the river within the city.
2. To study the appropriate case studies and develop an understanding.
3. To evaluate the existing methodologies for the river- sensitive developments.
4. To identify the gap between the environmental, social and cultural functions of a river within the city.
5. To develop a methodology for river-sensitive city development.

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Supriyam Shrivastava

CANDIDATE'S DECLARATION

I hereby declare that the work, which is represented by me in this dissertation, entitled "**Developing Strategies for Making River-Sensitive City: A case of Lucknow",** in partial fulfillment of the requirements for the award of the degree of **Master In Urban And Regional Planning** submitted to the **School of Architecture and Planning, Babu Banarasi Das University Lucknow,** is an authentic record of my own work carried out during the period from July 2021 to June 2022 under the supervision of **Ar. Aditya Dubey**, School of Architecture and Planning B.B.D. University Lucknow, Uttar Pradesh, India.

The matter embodied in this dissertation has not been submitted by me for the award of any other degree of this or any other institute.

Date: June, 2022

Place: Lucknow

This is to certify that the above statement made by the candidate is correct to the best of my knowledge.

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Place: Lucknow

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CHAPTER: 1 INTRODUCTION

1.1 Background

Throughout the history of civilizations, rivers have been at the centre of human settlements, owing to easy availability of water for subsistence, agriculture, navigation and other basic necessities required for existence. A number of the earliest and most prominent ancient cities were established along the banks of rivers, which include the Euphrates-Tigris rivers in Mesopotamia, Nile in Egypt, Ganga in India, and Huang-Ho in China. Even today, there are several examples of cities, where the rivers have played a vital role in defining their development contours. Examples of these include the Thames in London, Seine in Paris, Hudson in New York, Yarra in Melbourne, Ganga in Varanasi, Yamuna in Delhi, and many others.

There is an intrinsic relationship between rivers and cities, which is symbiotic in so many ways. On the one hand, rivers provide cities with a wide range of services resulting in both tangible and intangible benefits, and support the livelihoods of a large number of people. These benefits include assured water supply for residents, businesses, agriculture, and public places; fish and other riverine resources; flood control; recreational areas; and carbon sequestration, among others. Additionally, there are numerous social and religious benefits of rivers. On the other hand, rivers rely on the good practices in the city to help preserve their natural character and profile, and sustain their ability to continue to offer various ecosystem services. The rivers, for their part, have always fulfilled their role in this symbiotic relationship. However, cities, in general, have failed to match this commitment. This has led to a state where many rivers have been exploited indiscriminately, without any consideration for their carrying capacity.

Today many of our rivers are facing threats on multiple fronts. There are concerns regarding pollution in the rivers, drying up of river stretches, encroachment into floodplains, loss of river related biodiversity, and several others. Invariably, development activities in cities are the biggest cause for these issues and challenges. In the quest for economic development, somehow cities have bitten the hand that feeds them. For example, only 22 kilometres of the Yamuna River that flows through Delhi is responsible for 70% of the pollution in the entire river.

1.2 Role of Urban Rivers

Urban rivers have always been recognized for their role in serving as water resources, protection of nature, fisheries, and provision of recreational areas with considerable contributions to landscape. In addition to these roles, rivers also have certain other definite environmental, social, cultural and economic values.

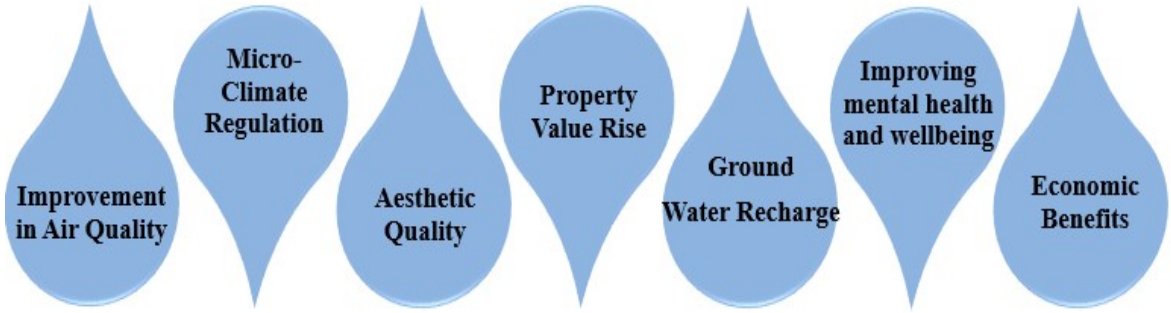


Figure 1 Role of Urban Rivers

1.3 Need of River-Sensitive City Plan

Any improvement in the river's condition cannot be achieved without first addressing the issues in urban areas.

Figure 2 Direct dumping of solid waste & Direct discharge of sewage

Figure 3 Unplanned dhobi Ghat & Pollution of Gomti River

Cities have been a major part of the problem and will need to be part of the solution as well.

1.4 Aim

To develop guideline for making river-sensitive city.

1.5 Objective

1. To study the existing scenario of the river within the city.
2. To study the appropriate case studies and develop an understanding.
3. To evaluate the existing methodologies for the river- sensitive developments.
4. To identify the gap between the environmental, social and cultural functions of a river within the city.
5. To develop a methodology for river-sensitive city development.

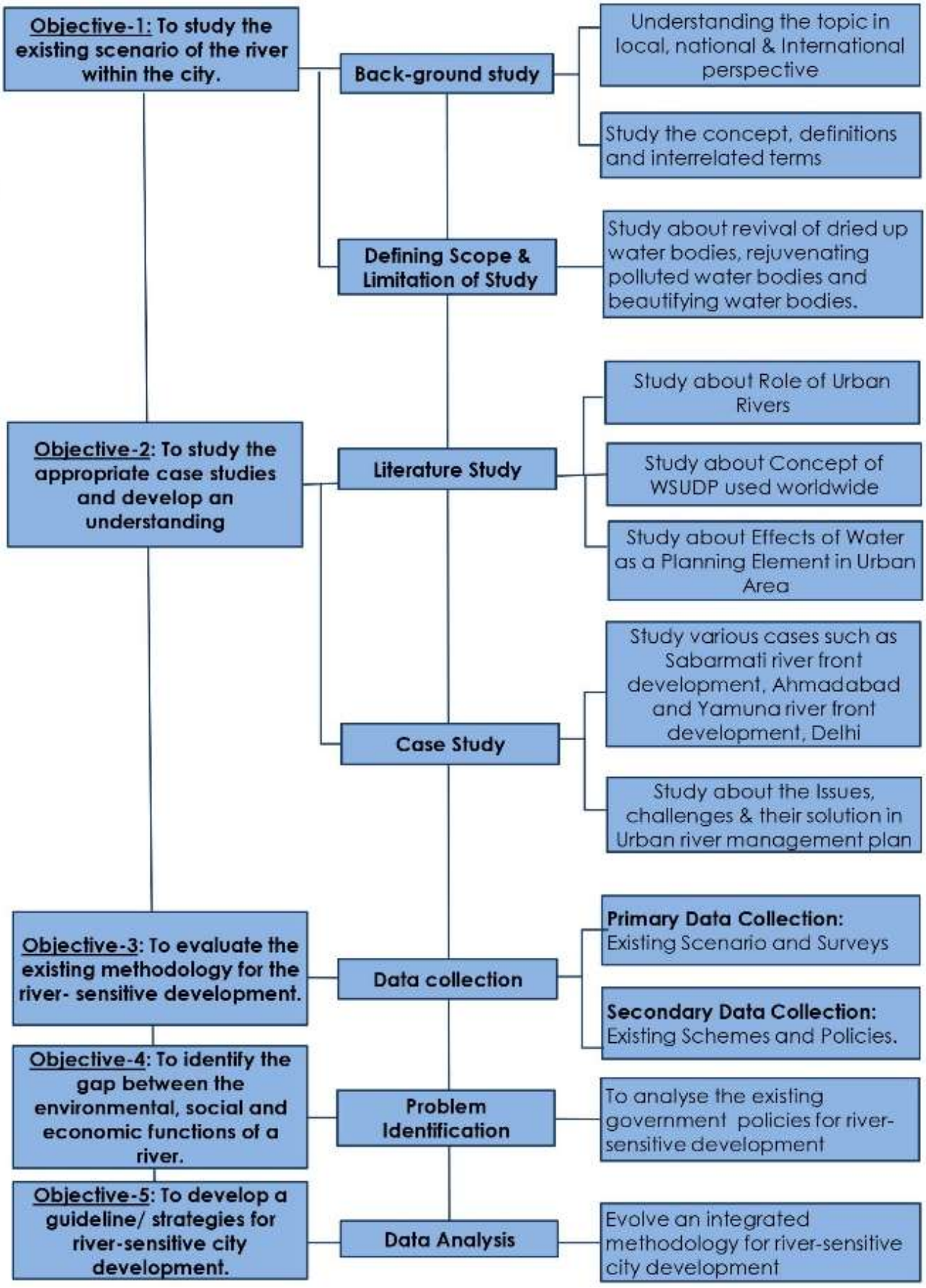
1.6 Scope

1. To inculcate river-sensitive behaviour among citizens and engage them in river management activities.
2. To find different techniques by which we can use river water as a main water resource.
3. To redevelop river as a centre of various cultural, religious, and recreational avenues in cities.

1.7 Limitations

1. To focus only on particular area for making pollution free river rather than its whole stretch.
2. To focus only into river concentric development rather than complete infrastructure of the city.
3. My finding will be restricted to the design and planning rather than its financial aspects.

1.8 Methodology



CHAPTER: 2 LITERATURE STUDY

Cities and rivers have an intrinsic relationship. Traditionally, the rivers have been at the centre of various cultural, religious, livelihood-related, and recreational avenues in cities. City & river act as interconnected units, all working together, to achieve a common vision for the development. Serious concerns of urban areas are related to water challenges. Negative impacts of rapid urbanization in cities on its rivers are water pollution, extending to biological and structural changes in the natural state of the water channels.

2.1 Concept of WSUDP used worldwide

Table 1 Concept of WSUDP used worldwide

Concept	Country
Water-sensitive urban design (WSUD)	Australia
Low-impact development (LID), best management practices (BMP)	USA
WSUD, sustainable drainage system (SUDS)	UK
Decentralized rainwater/storm-water management (DRWM)	Germany
Sound water cycle on national planning (SWCNP)	Japan

Source: Centre for Science and Environment, 2016

2.2 Key statistics related to urban rivers

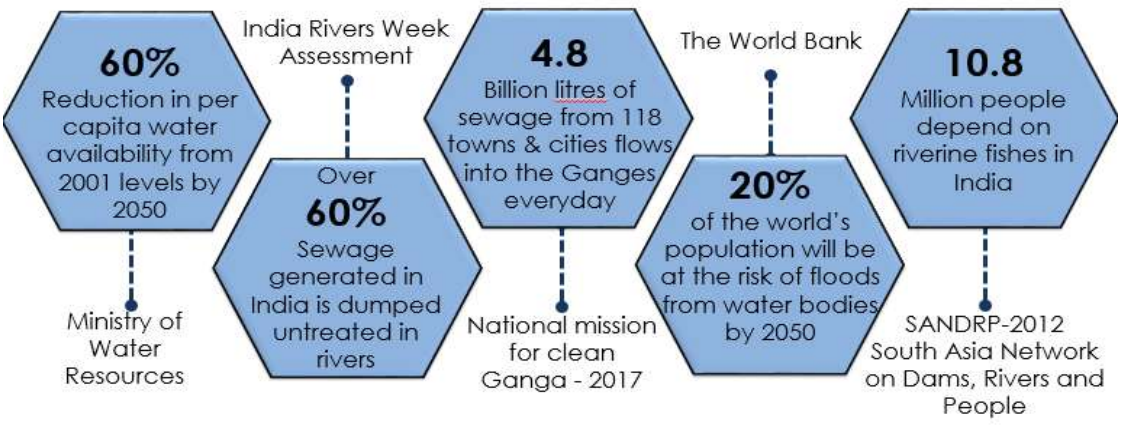


Figure 4 Key statistics related to urban rivers

2.3 Effects of Water as a Planning Element in Urban Area

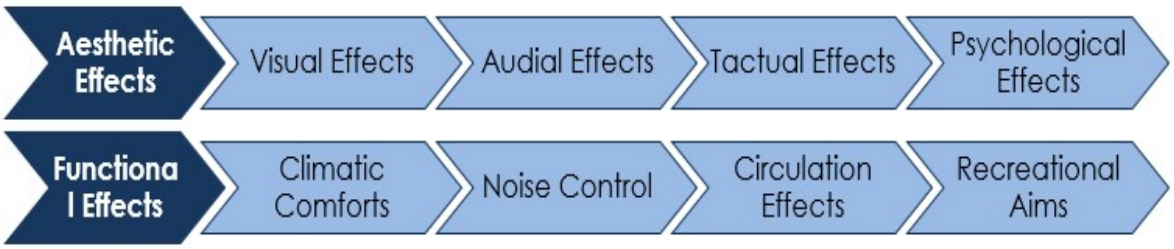


Figure 5 Effects of Water as a Planning Element in Urban Area

2.4 Policy documents related to conservation of water bodies

Table 2 Policy documents related to conservation of water bodies

Government department	**Objectives**
Ministry of Water Resources (2009)	To provide Guidelines for repair, renovation and restoration of water bodies with external assistance and domestic support.
Ministry of Environment and Forests (2008)	Aims at restoring the water quality and ecology of the lakes in different parts of the country.
Ministry of Water Resources (1996)	This document is a model bill for the regulation and control of the groundwater.
International Environmental Law Research Centre (1993)	The document describes the Act to regulate the exploitation of groundwater for the protection of public drinking water sources.
Water Resources Department (2005)	The document describes the details of the Maharashtra Water Resources Regulatory Authority Act.

Source: Compiled by author

2.5 Water Policies

Table 3 Water Policies

Ministry of Water Resources (2009,2008)	
National Water Mission - National Action Plan on Climate Change - Volume I and II	To conserve water through minimizing wastage and ensuring equitable distribution of water across and within states through integrated water resources development and management.
Ministry of Water Resources (2002)	
National Water Policy	It addresses the problem of scarcity of water and the need to conserve this resource through optimal, economical, sustainable and equitable means.
Department of Water Resources (Government of Goa) (2008)	
Policy on Rain Water Harvesting	To provide the details of the Rainwater Harvesting policy for the State of Goa and providing guidance to all the concerned departments

Source: India Water Portal

2.6 Development challenges for water management in cities

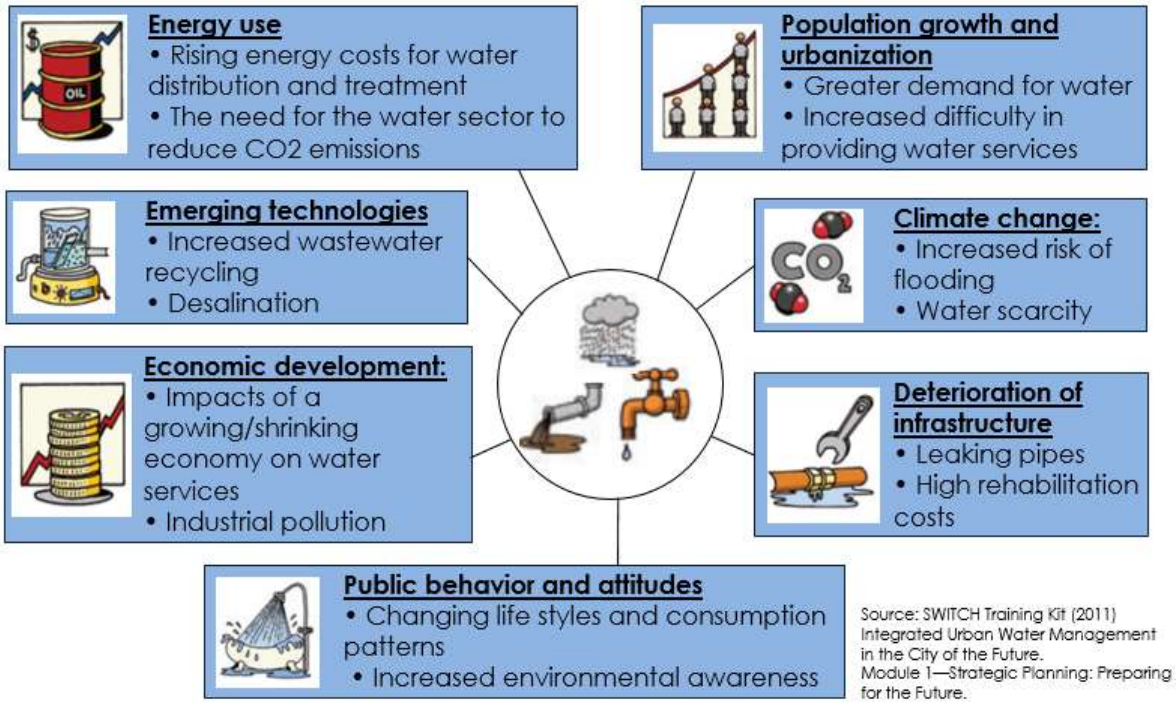


Figure 6 Development challenges for water management in cities

2.7 Issues, challenges & their solution

Table 4 Issues, challenges & their solution

Issues & Challenges	Solution
Restriction of river channels and natural drains	• To prevent encroachment on river banks and along city drains. • To remove obstructions from the drainage network of the city.
Pollution in rivers and drains	• To prevent discharge of untreated wastewater (domestic/ industrial/ agricultural) in the water channels. • To restrict disposal of solid waste (domestic/ industrial/ bio-medical/ hazardous/ social or religious) in the water channels.
Drying up of rivers and streams	• To ensure regulated extraction of water from surface and ground water sources. • To promote reuse and recycle of water for limiting potable water requirement. • To promote ground water recharge for augmenting water extraction.
Degrading waterbodies and wetlands	• To rejuvenate water bodies and wetlands. • To ensure sustainable and efficient management of water bodies and wetlands.
Depleting green cover	• To create a riparian zone with native species along the water channel for pollution and erosion control. • To maintain adequate forest/ tree cover across the city for ground water recharge
Weak citizen-river connect	• To design and develop a riverfront catering to the needs of the citizens in a sustainable manner. • To make the riverfront accessible to the public • To create a stronger economic value for the river

Inefficient river management and governance	• To establish a wholesome multi-disciplinary and inter-sectoral framework for river management in a city. • To scale up citizen involvement in river management activities. • To identify resources for project implementation, management and funding.

2.8 Design Principles of Urban river management plan

Following are the design principles on which the URMP framework has been developed:

2.8.1. Simple:

The URMP framework has been intentionally kept simple and concise. The objective is not to create an overwhelming set of guidelines but instead develop a template for effective and tangible actions to be taken. In addition, given that the URMP will have to be developed by Urban Local Bodies (ULBs) who are already tasked with several other responsibilities, simplicity of the plan would receive more buy-in.

2.8.2. Generic but yet city-specific:

The overall framework of the URMP has been designed to be generic to ensure that all river cities in the Ganga River Basin have a common vision and associated objectives for managing the river. However, since each city is unique in character, the framework also allows for city-specific considerations to be captured in the URMP. This aspect is elaborated in detail in the next section.

2.8.3. Synergistic:

The URMP is not meant to re-invent the wheel. Instead, it acknowledges the role and importance of other Plans that a city may have, and complements those. These include Master Plan, City Sanitation Plan, City Development Plan, among others. The URMP also seeks synergies with on-going urban missions, such as the Atal Mission for Rejuvenation and Urban Transformation (AMRUT), Smart City Mission, and Swachh Bharat (Urban), in the city with the intent to dovetail certain aspects of the URMP into these missions.

2.8.4. Sustainable:

Given that financial constraints are one of the main reasons why several ambitious plans fail, the framework ensures that there is a clear line of funding and finances for the various interventions to be undertaken within the URMP.

2.8.5. Measurable:

The URMP must have a provision for ‘reflection and course correction’. This essentially means the URMP will be a living document that is continuously upgraded from time to time

to respond to emerging needs. In order to do so, the framework has made provisions for the progress under the URMP to be measurable and quantifiable.

Figure 7 Design Principles of Urban river management plan

2.9 Inferences of Research papers

Table 5 Inferences of Research papers

Paper Name	Author Name	General name	Methodology Approach	Conclusion
The Gomti Riverfront in Lucknow, India: Revitalization of a Cultural Heritage Landscape	Swati nagpal & Amita sinha	Journal of Urban Design, November 2009	The paper outlines an urban conservation model and suggests design interventions that would revitalize the riverfront.	The design proposal for the riverfront reconciles the past and present by restoring the historic connection between heritage buildings and the river.

Impact of river channelization and riverfront development on fuvial habitat: evidence from Gomti River, India	Venkatesh Dutta, Urvashi Sharma , Kashifa Iqbal , Adeeba, Ravindra Kumar, Ajey Kumar	Environmental Sustainability July 2018	This study can provide valuable insights for future projects on riverfront development and restoration measures in India and elsewhere.	The design of riverfront projects should be based on sound ecological principles so that health of the river is measurably improved.
Riverfront Development	Shruti Kapoor	Conference Paper, November 2016	To formulate the framework for Riverfront development as a Socio-Interactive space.	The framework required for a successful riverfront should have Multiple activities in different zones along riverfront.

2.10 Parameters

2.10.1. Environmentally responsible:

The river will be able to support a habitat for biodiversity to thrive.

I. To ensure effective regulation of activities in the floodplain

Rationale: A floodplain is defined as the area inundated by a flood that occurs once in a fixed number of years, typically hundred years for major rivers. The Development Plan/Master Plan of cities ideally would have some or the other regulations for land use and permissible activities in the river flood plains (if not the entire flood plain, then at least part of it). However, in several cities these areas have been encroached upon by unauthorized colonies, or used for unauthorized activities such as agriculture, sand mining, etc. Ensuring that only permitted activities and structures are allowed in the floodplains is crucial for the river's health.

Scope of interventions: The range of interventions under this objective could include establishing zoning regulations, adopting river-sensitive planning norms, stricter law enforcement, awareness raising, capacity building of farmers, relocation strategies for unauthorized colonies, among others.

II. To keep the river free from pollution

Rationale: Pollution is the biggest concern for the rivers in the Ganga River Basin. Rivers are the ultimate recipients of untreated wastewater from towns and cities. The wastewater discharged by one city becomes source of water supply for another city downstream, thereby creating a cycle of health hazards.

Scope of interventions: Both structural and non-structural measures are required to achieve this objective. The structural measures include laying the required sewage infrastructure (i.e. sewer network, interceptor drains, sewage treatment plants, etc.), and ensuring that the infrastructure is in working condition. Where it is not possible to have complete sewerage coverage, decentralized solutions are also a good option. Non-structural measures include community workshops to encourage citizens to connect their households to the sewer network, awareness raising, incentivizing industries and large residential societies to install in-house treatment plants, etc.

III. To rejuvenate waterbodies and wetlands in the city

Rationale: In many cities, waterbodies and wetlands are intrinsically connected to rivers either through their drainage patterns or groundwater flow. Rejuvenating water bodies and wetlands can go a long way in reducing the burden on rivers. They improve groundwater recharge, which in turn helps augment the water supply of a city, and reduces the stress on rivers. Similarly, rejuvenated wetlands are natural "wastewater treatment plants" that can significantly mitigate the pollution load entering a river. The recreational benefits that these two interventions offer are an added incentive to the city.

Scope of interventions: Under this objective, the activities could focus on revival of dried up waterbodies, rejuvenating polluted waterbodies, beautifying waterbodies for commercial and recreational purposes, among others

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IV. To enhance the riparian buffer along river banks

Rationale: A riparian buffer is a longitudinal stretch of vegetation on either bank of a river, whose significance cannot be over-emphasized. It acts as a shock absorber for the river and its aquatic ecosystem from detrimental developmental activities. The buffer zone also protects the urban area from the impact of floods. Ideally, the riparian buffer should be a continuous stretch with a width of twelve to fifteen meters. Smaller cities may be able to achieve this faster. However, the present conditions should not dictate the ambition of the future, and cities must take up whatever is possible today, and aspire for the ideal condition in its longterm planning, syncing it with the Master Plan.

Scope of interventions: The only intervention required under this objective is to develop a rich continuous buffer of vegetation 38 along the river on either bank. The plantation strategy must account for the soil conditions, water depth, native plant species, and the nature of ground profile.

V. To adopt increased reuse of treated wastewater

Rationale: Reuse of wastewater is an excellent avenue to relieve the stress on rivers. This would result in lesser freshwater extracted from the river and more water available to maintain the environmental flow in the river. 75-80% of the freshwater supplied to a household returns as wastewater. This vast volume is nothing short of a new resource of water. Furthermore, in every city there is usually limited scope for direct reuse of treated wastewater. However, the remaining can easily be used to revive water bodies, and groundwater recharge, thereby augmenting the future supply of the city.

Scope of interventions: Potential avenues for the use of treated wastewater are for agriculture, horticulture, dual piping (wherever possible) where treated wastewater is used for flushing, road cleaning, bus/metro cleaning, reviving water bodies, groundwater recharge, among several others.

VI. To ensure adequate good quality return flow from the city in the river

Rationale: This is based on the premise of a city making its contribution to maintain the environmental flow of the river. In its simplest form, environmental flow is water required by a river to sustain its natural habitat. Usually a city has very little control over the environmental flow in the river, given that this is regulated by national or state authorities. However, this should not absolve the city of its responsibility to the river. There is no definitive guideline of how much a city should give back to the river as this depends on site-specific factors. Cities will have to take stock of the rivers within their stretches, and decide upon an optimal contribution after adjusting for in-house uses. It is expected that the amount of return flow should be in proportion to the amount of water the city takes from the river. If the city decides on reserving a portion of the treated wastewater for return flow, it must ensure that the effluent meets the effluent standards set by CPCB.

Scope of interventions: The interventions under this objective can include diverting a part of the storm water into rivers. Another possibility is to release treated wastewater in the local drains. Given that recycling and reuse of treated wastewater is also important for non-potable uses within the city, the releases in the river will have to be carefully balanced.

2.10.2. Economically beneficial (Business)

The river will provide opportunities for economic development.

VII. To develop eco-friendly riverfront projects

Rationale: Riverfronts add both aesthetic and economic value to the river. It serves as a medium to bring the river to the forefront. It is also a major avenue for recreation opportunities. In doing so, riverfronts become a wonderful instrument to connect citizens to the river, as well as become a source of revenue.

Scope of interventions: The city can choose the scale and scope of the riverfront development as per its need. They need not be large massive structures like promenades, condominiums, plazas, etc. Small scale projects such as parks, picnic spots, urban forests, ghats and herbal gardens can be equally effective in bringing back the people to the river.

VIII. To leverage on the economic potential of the river.

Rationale: Cities must begin to realize that a river has tremendous economic value through the ecosystem services it provides, and livelihoods it can support. Already cities across the globe have boosted their economies through river-centric activities. Rivers can help cities progress up the economic ladder, which every city aspires. Needless to say, the scale and extent of such activities must account for carrying capacity of the river.

Scope of interventions: There are several economic uses of the river such as navigation, agriculture, fishery, water sports, river cruises, riverside markets, floating markets, among others.

2.10.3. Socially inclusive (Life)

IX. To inculcate river-sensitive behaviour among citizens

Rationale: Citizen support is vital for long-term sustainability of urban river systems and the success of any initiative by urban local bodies. This support becomes far easier to solicit when citizens are aware of the issues at hand, and how they can help address those. Cities need to develop a dedicated strategy to spread awareness about the benefits of healthy rivers through innovative dissemination mechanisms. This will be stepping stone for the desired behavioural change.

Scope of interventions: The print and electronic media are the usual avenues for implementing this objective. However, other non-traditional means such as social media, children's camps, hoardings, app-based dissemination, games, celebrating a river day, etc. could also be considered.

X. To engage citizens in river management activities

Rationale: This is important to make a shift from 'citizens as spectators' to 'citizens as actors'. This also sends out the message that river management cannot be the government's mandate alone. Residents will need to step and share the onus of responsibility. Most progressive societies have some or the other form of this governance model. In the long run, it will help create a transformation in the mindset of people towards ecological assets of the city.

Scope of interventions: The modalities through which this objective can be achieved include setting up community groups for monitoring the river health; river clean-up activities, citizen groups to interface between the government and public; among others.

CHAPTER: 3 CASE STUDIES

3.1 Sabarmati River Front Development, Ahmadabad City, India.

3.1.1 Aim

This project has been conceptualized as an urban project to significantly improve the habitat, structure and conditions of the river and adjoining areas.

3.1.2 Objective

This project has been conceptualized as an urban project to significantly improve habitat, structure and conditions of the river and adjoining areas.

3.1.3 Design Strategies

- The project has provided more than ten kilometers of continuous pedestrian promenade on each bank and has also made public Ghats available for direct access to the water.
- 85% of riverfront land has been proposed for public infrastructure, recreational parks, plazas, sports facilities, and gardens.
- Introduction of civic and cultural institutions like museums, exhibition spaces, monuments, performance venues, has significantly enhanced the availability of civic amenities.
- SRFD has also focused to upgrade iconic informal markets, and to create vibrant new spaces for Residents and Tourists.

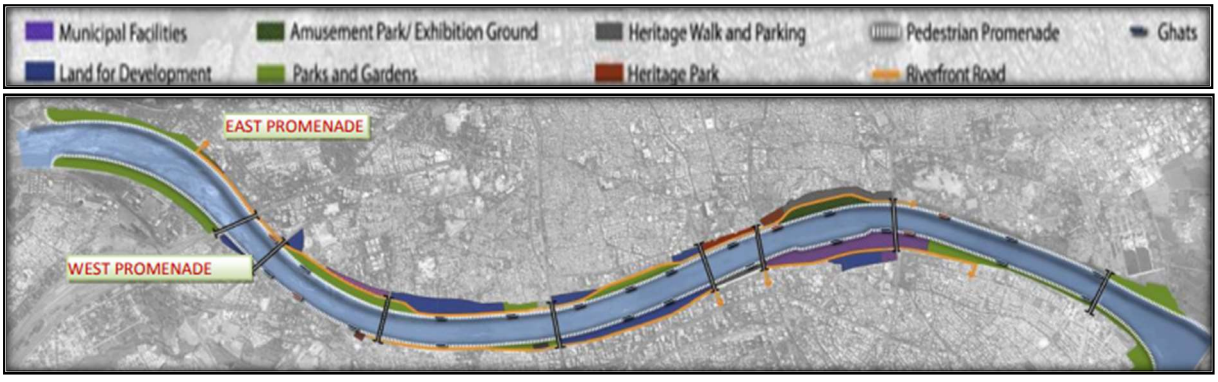


Figure 8 Map Shows the Proposed development along the River

3.1.4 Inclusive Development

I. Rehabilitation of the slums

- More than 10000 families residing in the riverbed/affected by the project.
- Relocated and rehabilitated on well-developed residential colonies.
- Eliminated the risk of flooding for these many poor communities and
- Improved Social and Economic well-being of them.

Figure 9 Rehabilitation of the slums

II. Rehabilitation of Gujari Bazaar

- The project has strengthened and upgraded the existing Gujari Bazaar (Unorganized Sunday market) on nearby well developed riverfront market.
- Capacity : 1641 vendors
- Parking: Two wheelers: 1942 & Car: 428
- Area: 63,000 Sq. Mt.
- Tree Plantation: 800 Nos.

Figure 10 Before & After condition of Gujari Bazaar

III. Rehabilitation of Dhobis (Washermen)

- Dhobis using river bed for this activity have been rehabilitated.
- Sate of art Laundry campus and unique of its kind in the country.
- Total seven blocks have been constructed
- Facility to use terrace to get the clothes dry
- Can use washing machines, dryers.
- Used water is discharged in to the existing STP just behind.
- Area : 9380 Sq mt,
- Capacity : 168 Dhobi
- Toilet Block, Admin Office, Electric sub-station, etc.

Figure 11 Before & After Condition of Dhobi Ghat

IV. Environmental Improvement

- Interceptor sewer system ensuring clean water in the river
- Retention of water in the river almost for the whole year
- Having 12.5 million cubic meter storage of the water, recharge of ground water aquifers of the city.
- Plantation of more than 20000 trees and Development of various gardens and parks, Biodiversity park etc. as Green Area.

Figure 12 Environmental Improvement

V. Public Gardens

- River Front Park at Subhash Subhash Bridge: East (1.2 Km long, 62,000 Smt Area)
- Garden at Usmanpura : West (0.6 Km long, 18,500 Smt Area)

Figure 13 Public Gardens

VI. Creating network of public spaces

- Bio diversity Park Near Vasna Barrage on West Bank : Area 15 Ha.
- Flower Garden Bh. V.S. Hospital (W), 4.6 Ha
- Khanpur (E) 2.0 Ha (Proposed)

VII. Recreational Activities

- Boating Facility at three different locations:
  - Vallabh Sadan,
  - Sardar Bridge and
  - Dadhichi Bridge

Figure 14 Boating Facility

VIII. Ferry Services at Riverfronts

- The ferry services can be proposed using 11.5 km long water body created in Ahmadabad city.
- This may connect either side of the city area on North - South link.
- The infrastructure created can accommodate at least six points on each side for station.
- These points are well connected with the nearby city/suburbs.
- The roots may be created in such a way that existing boating facilities should not get disturb.
- Ahmedabad is not used to Water transport, it may require to promote this through various efforts.

3.1.5 Analysis

- Riverfront development shouldn't be about just beauty and aesthetics but should address issues of environment and ecology.

- This project focus is to create leisure and recreation but basically it is helping to replace a dynamic living water system with a constant modern concrete canvas.
- The project will reduce the riverbed from a variable width of 600-300 m to a fixed width of 275m.
- Instead of concretizing the entire area, an option of both hard & soft land, some bricked up and some left as an open expanse, which at times would be flooded and occasionally dry and retained, would create an ever changing dynamic picture with the river as the focal point.

3.2 Yamuna River front Development

3.2.1 Aim

To conserve, protect & restore the Biodiversity of Yamuna River by Public Recreation spaces that the city needs in framework of Zonal Development.

3.2.2 Objective

To reestablish the river's eco system so that people start using river for recreation purpose and to protect the city activities from floods and havoc of river.

3.2.3 Design Strategies

- Active recreational facilities go hand in hand with passive recreation.
- Connecting all three zones (Protective biodiversity zone, Interactive biodiversity zone, Public recreational zone) with green linkage system, which act as wildlife movement corridor.
- Develop an active corridor for recreation and leisure by adopting the concept of mixed land uses including Commercial, Residential and Institutional uses. These would house open facilities like playgrounds, theme parks and would be treated as open recreational spaces that can be used by public residing in the city.
- Introducing major concept as walk by treating it as showcase for the river.

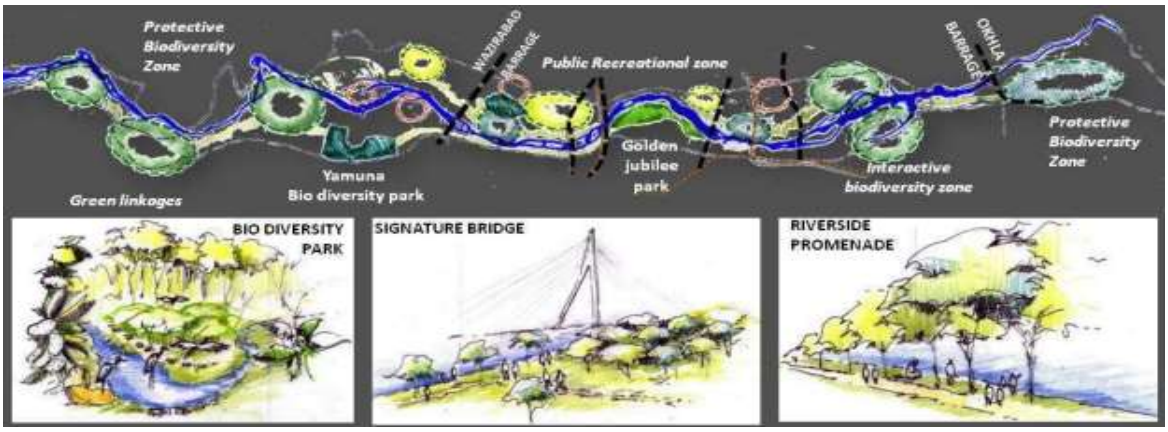


Figure 15 Conceptual Plan for Yamuna Riverfront Development

3.2.4 Analysis

- This kind of riverfront development basically changes the ecological and social space of the river altering it into an urban commercial space rather than a natural, cultural, social and ecological landscape.
- The floodplains have been developed to make pathways and real estate commercial projects.
- The need to conserve the 52-km stretch of the Yamuna in Delhi and Uttar Pradesh as 'conservation zone' and restoring the river's ecological functions is also stressed.
- The project involves developing infrastructural and recreational facilities like parks, Yoga centers, picnic spots, golf course, sports centers, polo grounds, etc. on Yamuna plains.
- The project does not lay emphasis on sustaining, cleaning, and rejuvenation of the river.

CHAPTER: 4 SITE ANALYSIS-REGIONAL SETTING

4.1 Site Introduction

I have selected a patch of Gomti River approx. 7.5 km from IIM road to Kudiya Ghat in Lucknow, Uttar Pradesh.

Figure 16 Location of selected Site

Table 6 Details of Site

Patch Length	**7.5 Km.**
Population	3,13,562 Nos
Total Area	3509 Ha
Density	90 P/Ha
Literacy Rate	76.12%
Sex Ratio	924

4.2 History

The Gomti River, an alluvial river of the Ganga Plain and one of the important tributaries of the Ganga, originates near Mainkot, from Gomat Taala lake also known as– 'Fulhar Jheel' in Madhotanda, about 30 km, 3 km east of the Pilibhit town in Uttar Pradesh at an elevation of 185 m. The river flows through an incised valley southwards through the districts of Sitapur, Lucknow, Barabanki, Sultanpur, and Jaunpur before meeting the Ganga river at

Kaithi, District-Ghazipur, bordering Varanasi (at an elevation of 61 m.) after traversing 940 km, in south south-east direction. Various Tributaries of River Gomati are Gachai, the Sai, the Jomkai, the Barna, the Chuha, the Saryu, the Giri, the Kalyani, and the Kathna.

The geographical extent of the Gomti sub-basin lies between 79° 59' to 83° 14' east longitudes and 25° 25' to 28° 40' north latitudes of the country. The Gomti sub-basin of the Ganga basin has a total catchment area of 29,865 sq.km. Majority of the surface area of the Gomti Basin is generally flat, sloping towards South and South East with altitude varying from 200 m to 62 m above mean sea level. For about 450 km from the origin, the difference in the elevation is about 100 m and for the remaining stretch of 500 km, there is an elevation difference of 25 m.

The characteristic of the river is perennial. The river is characterized by sluggish flow throughout the year, except during the monsoon season, when heavy rainfall causes a manifold increase in the runoff. Sai River is its major tributary having a drainage area of 12,900 sq. km., approximately 43% of the total catchment area of Gomti basin. Sitapur, Lucknow, Sultanpur and Jaunpur are the four major urban settlements on the banks of the river. The Gomti Basin lies between East longitudes 79°57’ and 83°11’ and North latitudes of 25°23’ and 28°42’. It is bounded by Ramganga Basin in North-West, Ghaghara Basin in North and North-East, and Ganga Basin in South-West, South and South-East. There are three Sub-basins defined in Gomti Basin namely Lower Gomti, Sai and Upper Gomti. The basin covers 17 districts (2 fully and 15 partial) and 161 blocks (90 fully and 71 partial) of Uttar Pradesh.

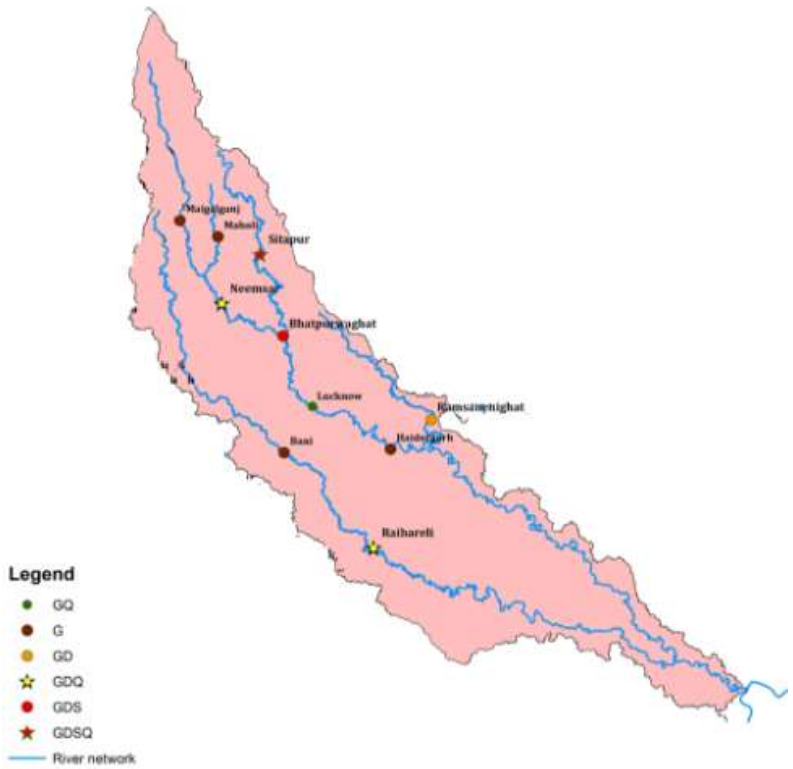


Figure 17 Gomti River Basin

4.3 Regional Connectivity

Table 7 Regional Connectivity

Name	Distance
Chadhary Charan Singh Airport	18.5 KM
Charbagh Railway Station	10 KM
Kaiserbagh Bus Stand	5 KM
Alambagh Bus Stand	12.8 KM

The Site is well connected to the major parts of Lucknow by bus and Railway rouite.

Figure 18 Proximity Radius Map

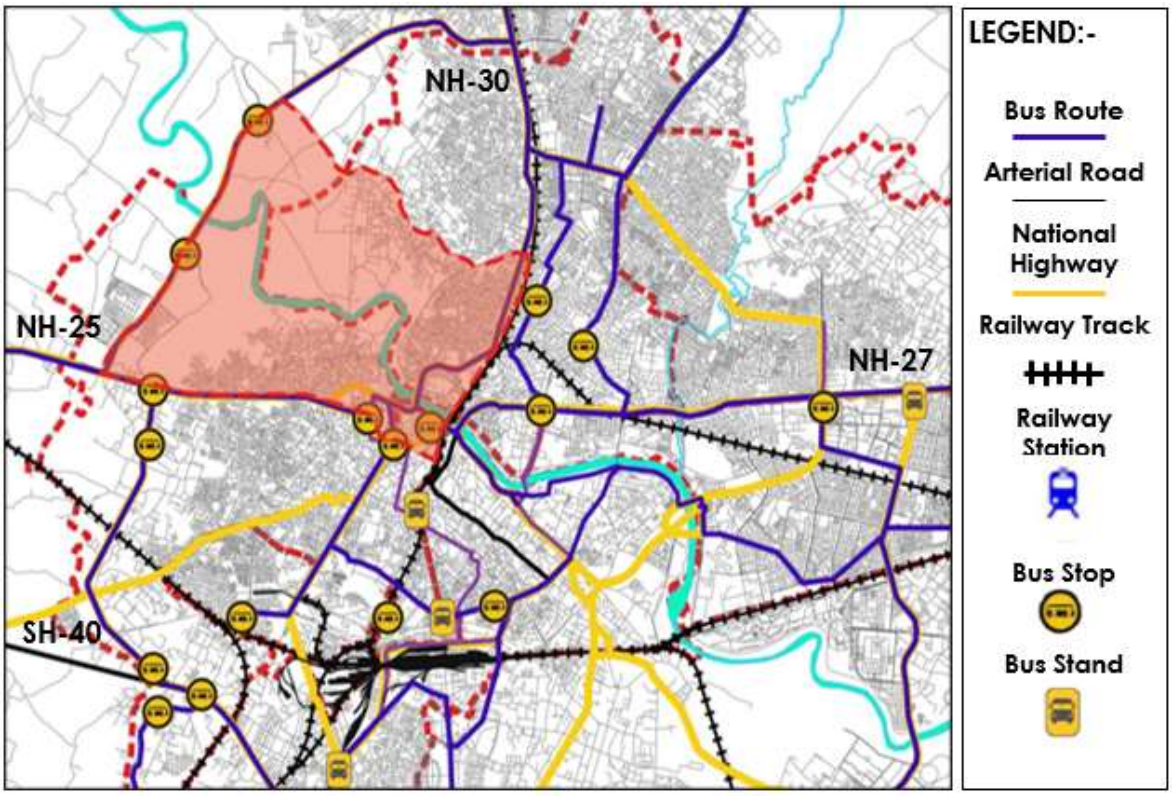


Figure 19 Selected Patch Map Showing the Regional Connectivity

4.4 Site Levels

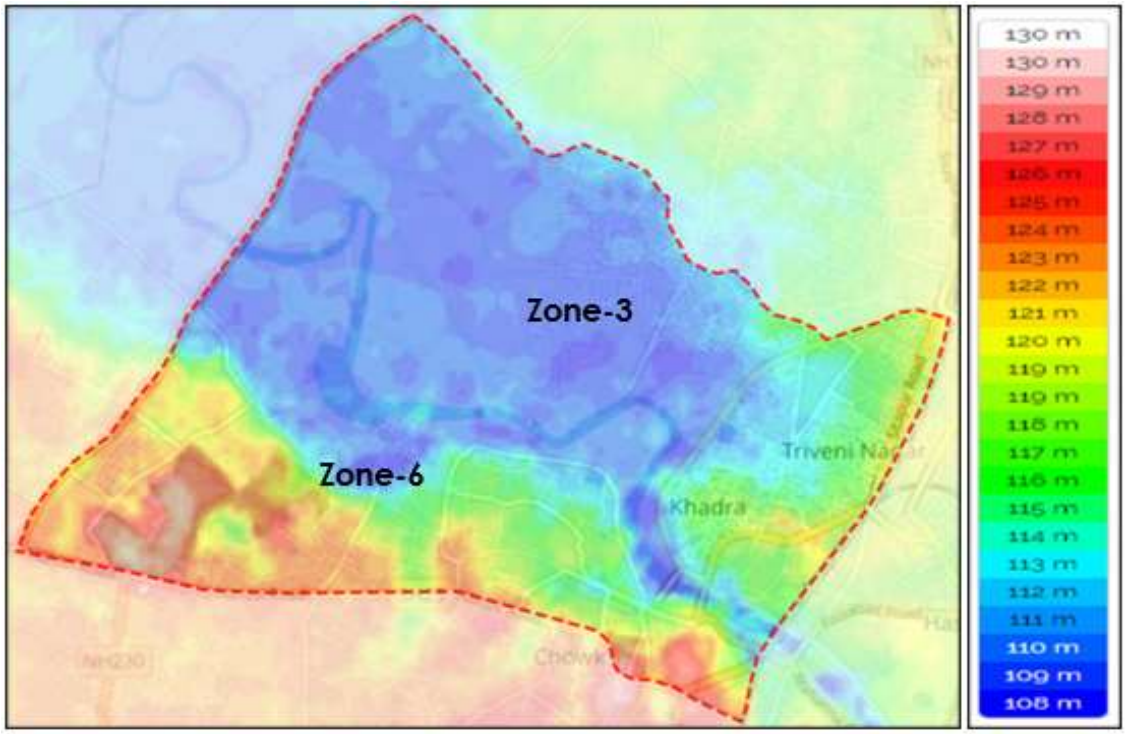


Figure 20 Map Show the Elevation of Site

Min. Elevation: 108 m Max. Elevation: 130 m Average Elevation: 121 m

The city stands at an elevation of approximately 123 metres (404 ft) above sea level. Lucknow district covers an area of 2,528 square kilometres (976 sq mi). Bounded on the east by Barabanki, on the west by Unnao, on the south by Raebareli and in the north by Sitapur and Hardoi, Lucknow sits on the northwestern shore of the Gomti River.

4.5 Landmarks

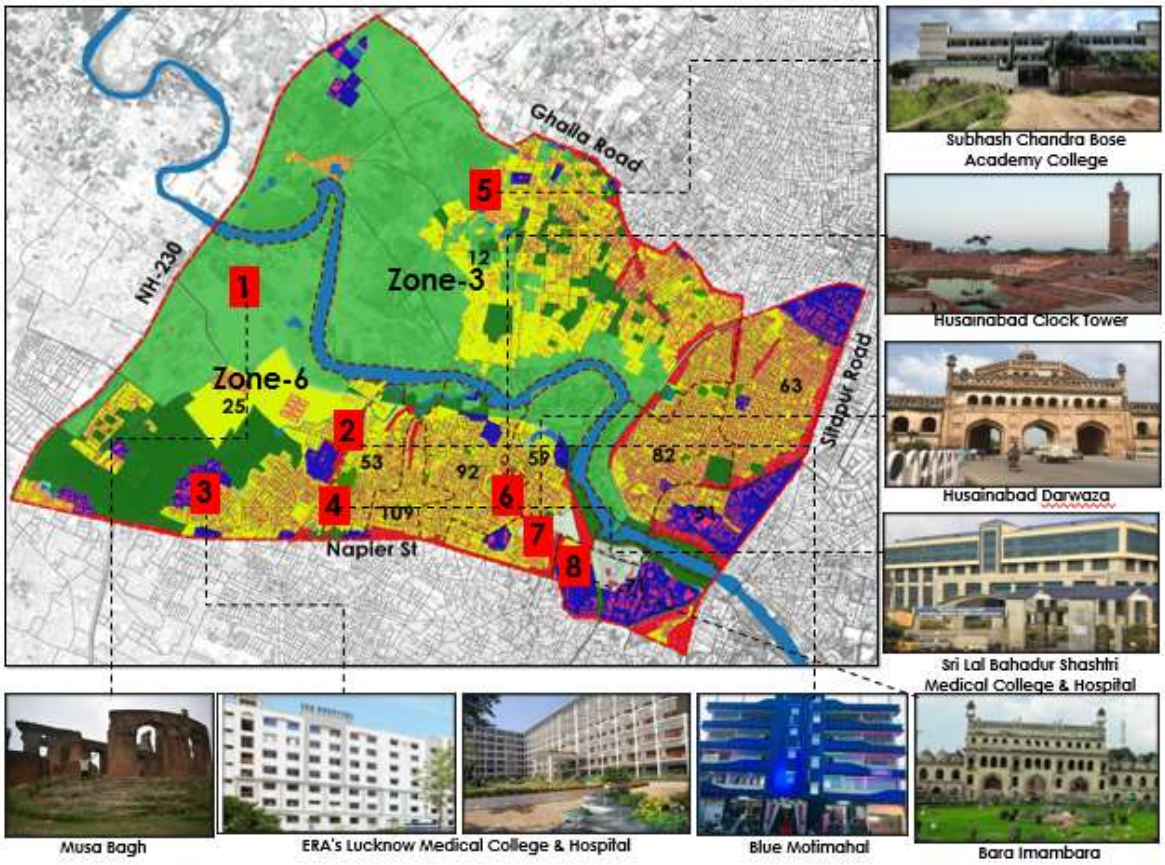


Figure 21 Selected Patch Map Showing the location of Landmarks

CHAPTER: 5 SITE ANALYSIS-DEMOGRAPHIC PROFILE, URBAN POOR AND SLUMS

5.1 Demographic Profile

The basic elements to be considered while planning for a peri-urban area are population growth, density of population, literacy, sex-ratio, socio-economic and occupational structure pattern, etc. The other aspects to be consider for peri-urban area planning are, land use pattern, circulation pattern and its access to the region, allocation of different facilities such as schools, hospitals, parks, play grounds and shopping complexes, etc. The Urban Agglomeration (U.A.) consists of Lucknow Municipal Corporation and Lucknow Cantonment. As per Census 2011, Lucknow city's total population is 28.17 lakh. The population in the last six decades has risen tremendously by almost six times (from 5 lakh to 28 lakh in 2011). The city's decadal population growth rate is 28.87% during 2001-2011, which is less than the country urban population growth rate (31.80%) but is higher than state urban population growth rate (28.75%).Lucknow city is expected to have population of 4.5 million in 2021. The male population increased from 1199273 in 2001 to 1460970 in 2011 (21.8%) and the female population rose from 1067660 to 1356135 (27.02%) in the respective year.

Lucknow has changed from small, isolated population centre in early 1990s to large, interconnected urban agglomeration today having diverse economic, physical, and environmental features. The temporal and spatial dimensions of the land use have changed significantly. The city has experienced a steady increase in population arising from natural growth, large-scale migration and addition of peri-urban areas.

As per the provisional census data for the year 2011, Lucknow City's total population is 28.17 lakh. There is a growth of almost six times in the city population in the last six decades, from 5 lakh in the year 1951 to 28 lakh in the year 2011. Lucknow city's decadal population growth rate of 28.87% for the last decade is less than the country urban population growth rate (31.80%) and is at a little higher side from state urban population growth rate i.e. 28.75%.

Table 8 Demographic Profile of Selected Site

Year	Population	Increase in Population	Growth Rate (%)	Area (HA)	Density (PPH)	URDPFI (125-175 PPH)
1981	1,56,607	-	25.85	3509 Ha	45	Below the standard
1991	1,97,091	40,484	22.38	3509 Ha	57	Below the standard
2001	2,41,201	44110	35.00	3509 Ha	69	Below the standard
2011	3,13,562	72361	30.78	3509 Ha	90	Below the standard
2021	3,65,880	52,318	23.20	3509 Ha	104	Below the standard
2031 (Projected)	**4,18,198**	**52,318**	**14.30**	3509 Ha	**119**	**Below the standard**
2041 (Projected)	**4,70,516**	**52,318**	**12.51**	3509 Ha	**134**	**Within the standard**

One of the basic demographic characteristics of the population is the sex composition. Sex ratio is defined as "the number of females per 1000 males". In any study of population, analysis of sex composition plays a vital role. The sex composition of population is affected by differentials in mortality conditions of males and females, sex selective migration and sex ratio at birth. As per provisional figures 2011, Census of India, the Sex ratio of LMC is 928 females per thousand males which is higher than the district (917) and state (908) however lower than the national level figures i.e. 940. Sex ratio in the city has shown improvement from the last year census from 893 females per 1000 males in 2001 to 928 females per 1000 males in the year 2011. The ward-wise sex ratio of Lucknow shows that the highest sex ratio of 1040 is found in ward number 103 while the lowest is found in ward number 67 with 796 females per 1000 males in 2011.

Total children (0-6 age group) in Lucknow city are 293,697 accounts to 10% of the total population. Out of the total age group 0-6 population, 52% accounts for male population while 48% accounts for female population. Child sex ratio of girls is 896 per 1000 boys which is less than the total sex ratio of the city.

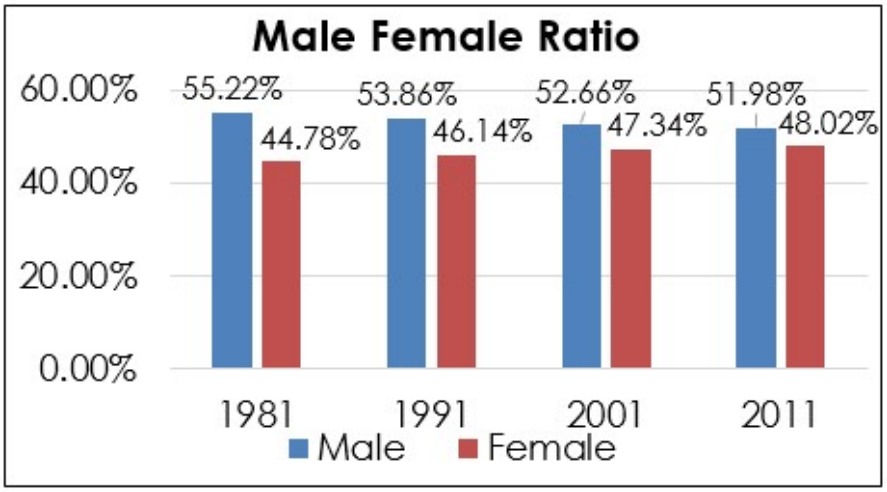


Figure 22 Sex Ratio of Site

Literacy rate reflects the socio- economic development of any region. Lucknow city has the highest literacy rate of 82.50% when compared to the district, state and urban India literacy rate. The high literacy rate can be attributed to Lucknow city being one of the leading centres of higher education in the state.

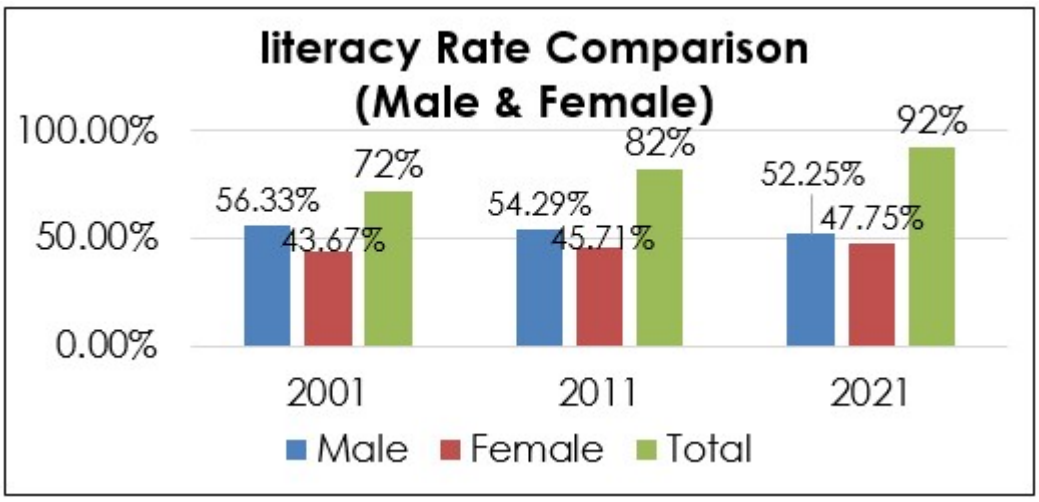


Figure 23 Literacy Rate Male Female Comparison

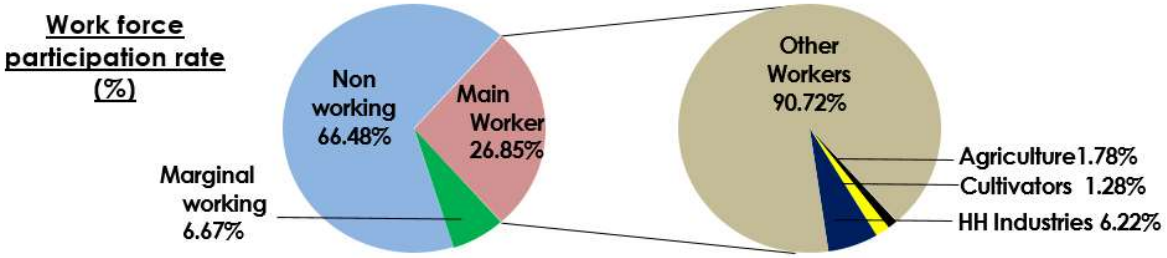


Figure 24 Work Force Participation Rate of Site

5.2 Density

The overall liveability of a place is dependent on the population density of that place, In case of Lucknow as per the provisional figures of Census 2011; the population density is 8049 persons/ Sq.km (approx. 80 pph). The average population density of Lucknow city is on the lower side of the permissible limits of the UDPFI guidelines for metropolitan cities; it is also the lowest when compared to other mega cities.

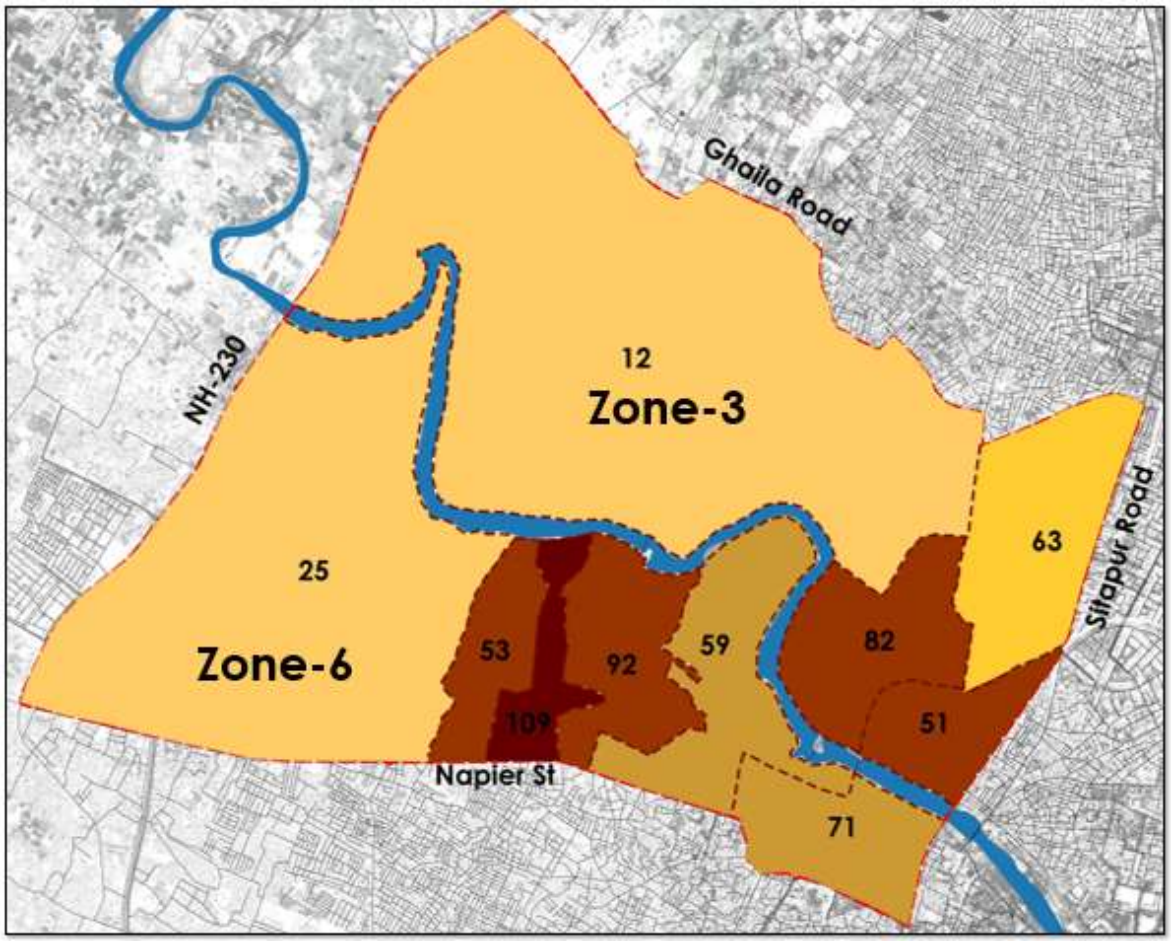
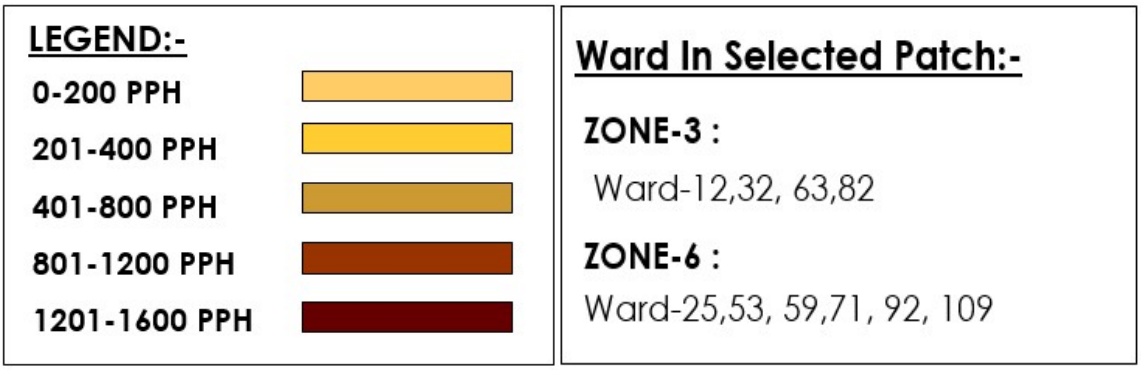


Figure 25 Map shows the Density of Site



5.3 Urban Poor and Slums in Study Area

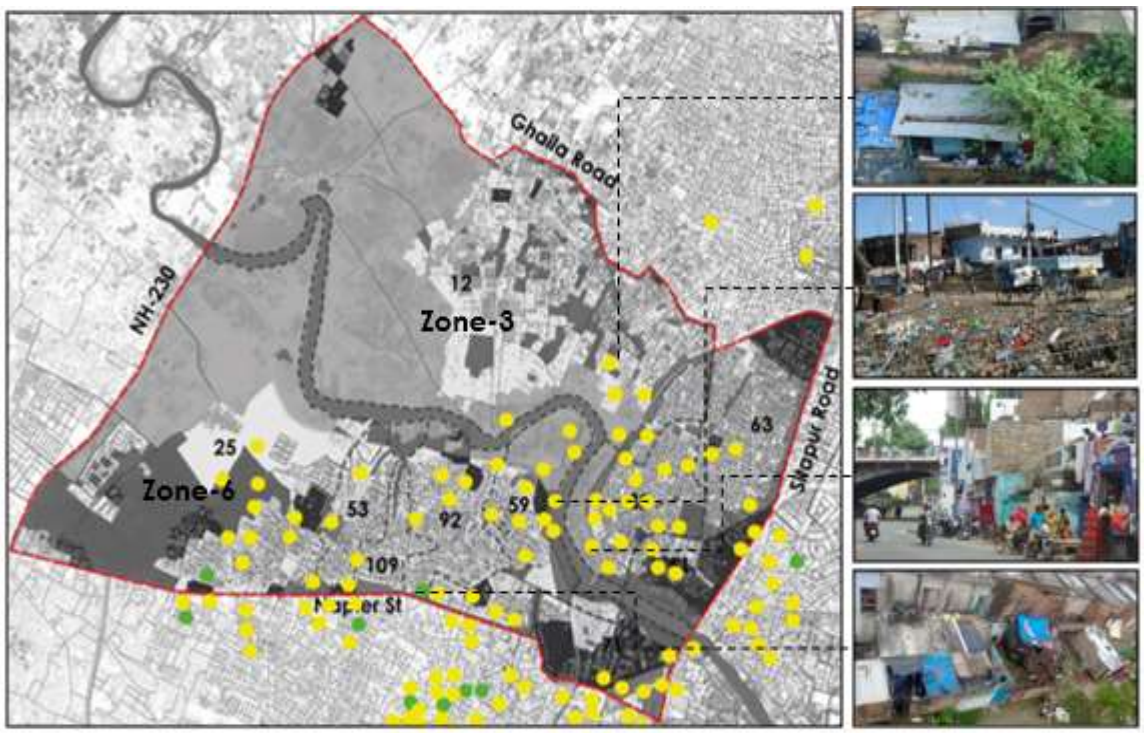


Figure 26 Map show the Location of Slums

Table 9 Share of Slum Population Ward wise

Zone	Slum Population	Share of Slum Population	No. of Slums
Zone-3	44600	25.33%	32
Zone-6	22459	16.34%	39

Sanitation data given in the table above clearly shows the poor sanitation conditions in slums. More than 25% of the people staying in slums defecate in open areas like open ground, along river side, along canal etc. 54% of the HHs have own latrine facility whereas 19% of the HHs use public toilet or shared toilet.

SWM in slum areas is being taken care by private concessionaire (deployed by LMC) however it has not been implemented in all the areas. 32% of the HHs disposes garbage on daily basis whereas in 38% of the HHs there is no garbage collection system. Rest 30% HHs disposes garbage on weekly or fortnightly basis.

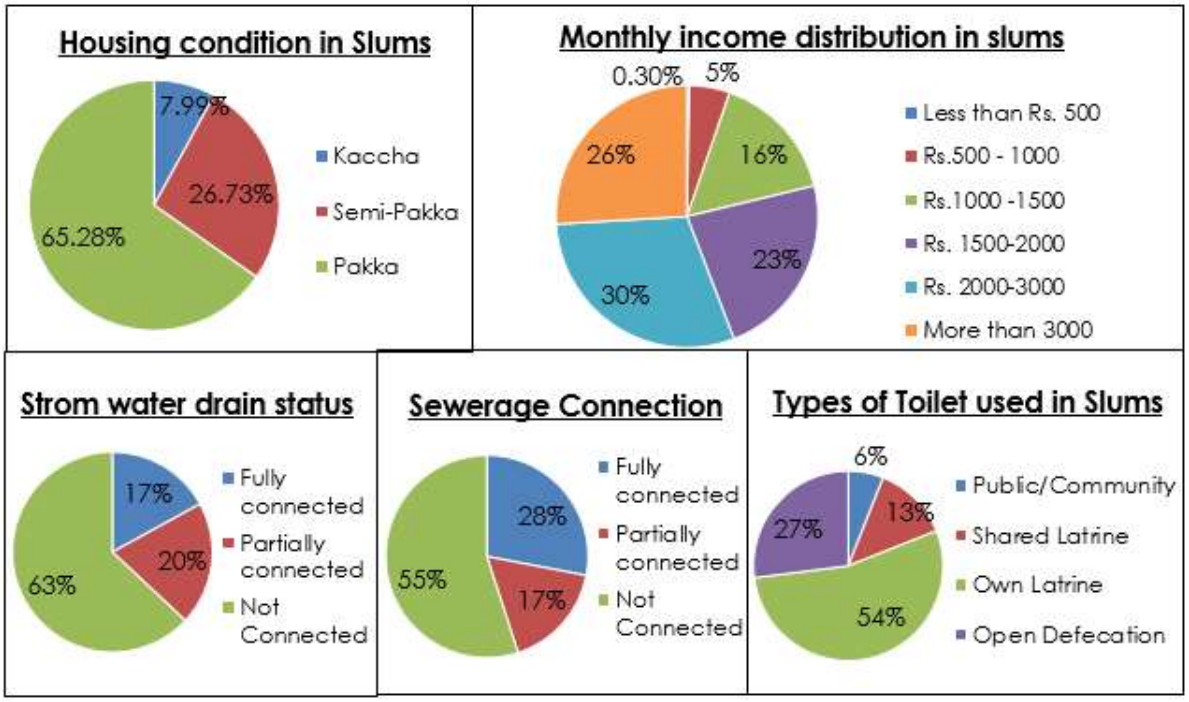


Figure 27 Condition of Slums

CHAPTER: 6 SITE ANALYSIS-SITE LANDUSE AS PER MASTER PLAN & EXISTING LANDUSE

6.1 Study area landuse as per Mater Plan of Lucknow

From a small Lakhanpur village, Lucknow has grown to a metropolis with 28 lakh of population spread over an area of 350 sq. km. In the year 1951, total area under LMC was only 48 sq. km and in the period of 40 years it has increased nine folds. Last expansion of LMC boundary was done in the year 1987 after including surrounding villages. Since then no amendments in the boundary has taken place.

Gomti River life line of Lucknow city divides the city into two parts Trans Gomti and Cis Gomti and the city has grown along both the sides in a circular manner with NH and SH network radiating out form the city in all the directions. The central business district (CBD) of Lucknow is located in the heart of the city and the urban sprawl of the city has resulted in the city growing outwards in all directions. The driving forces for the growth of the city were capital city, administration hub, educational hub and trade and commerce activities which have been continuous attraction for the people of rural and nearby urban areas. The CBD of Lucknow is the high density zone with major land use under residential and commercial activities. The old city is congested with its narrow roads and lack of open spaces. Majority of the middle and high income groups are inhabited on the peripheral newly developed areas. Due to growing population, the demand of new residential areas is also increasing resulting into development of new colonies such as Gomti Nagar, Rajajipuram and Indira Nagar. Also in the previous decade Lucknow has seen real estate boom in terms of various integrated townships in the outer skirts of the city. The urban sprawl has taken place in all directions but more significantly in the eastern and northern directions. Significant changes in land use are evident in the southern part of the city also.

As per Master Plan 2021 the developed municipal area in the year 1987 was 9,170 ha which was increased to 16,270 ha in the year 2005. The Lucknow Master Plan was prepared in the year 2004-05 for the year 2021 covering the total area of 413 sq. km. estimated area in the year 1987 was 9170 hectare which has increased by 77.4% in the year 2004-05. Trends in land uses have been interesting, especially the fact that residential use has grown dramatically in comparison to all other uses, although there has also been notable growth in commercial, industrial and public sector land use.

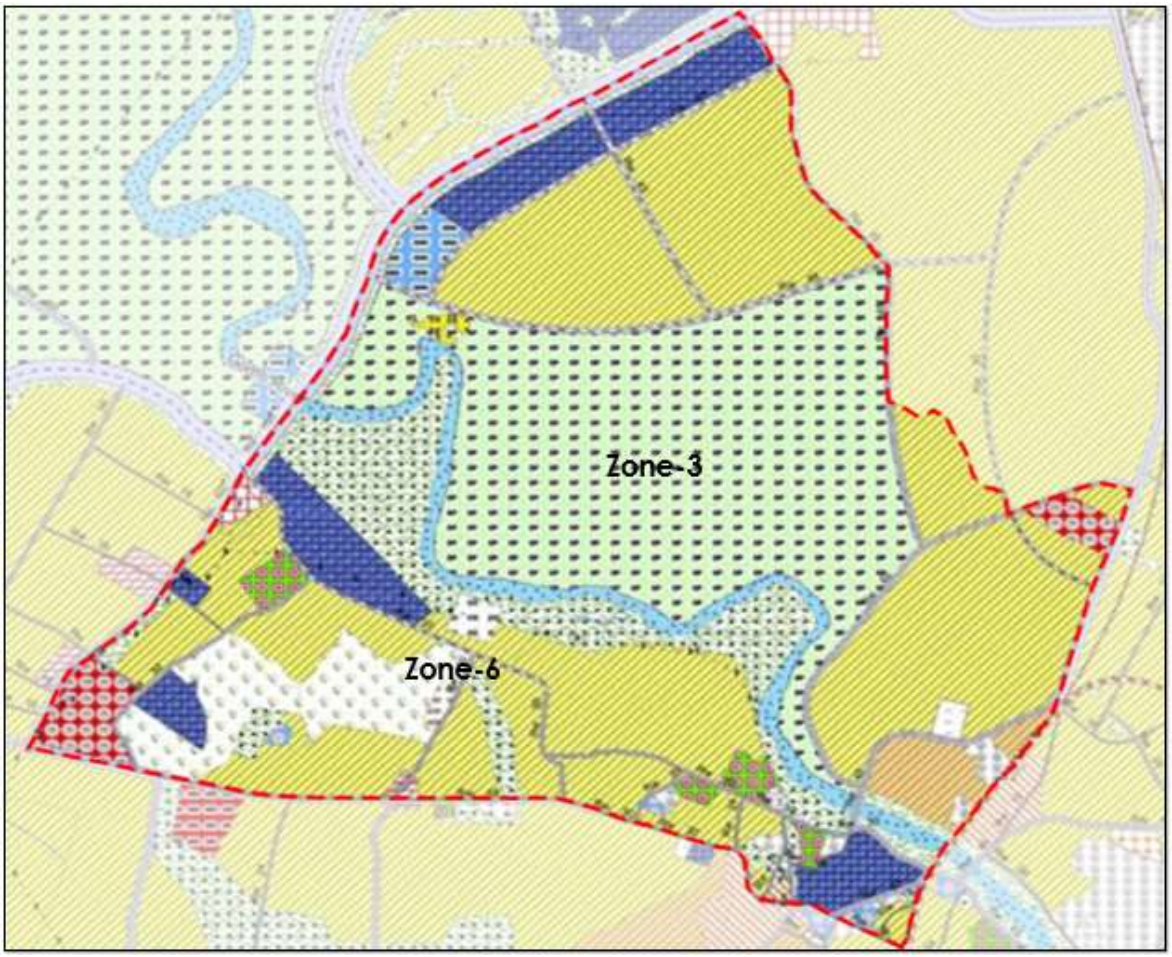


Figure 28 Map Shows the Landuse of site as per Master Plan of Lucknow

6.1.1 Residential Areas:

A per the land use data of the year 2004-05, 55% of the total land is under residential use. There has been drastic change in % of residential land use between the year 1987 and 2005. Key reasons for the increase in residential area have been growing population, development of new colonies by LDA, AVP and private developers.

6.1.2 Commercial Areas:

Only 2% of the land area comes under commercial land use which is not in conformity to the standards provided by UDPFI guidelines, which suggests approximate 5% of the city area should come under commercial use. Hazratganj, Aminabad, Chowk are the old markets located in old Lucknow area. Apart, Yayhiyaganj, Fatehganj, Sadatganj are the whole sale

market area in the city. In the newly developed areas Nishatganj, Kapoorthala, Gol Market, Indira nagar and Gomti Nagar are prominent. In the newly developed areas the growth pattern of commercial land use has been haphazard and irregular due to slow and unplanned development.

6.1.3 Institutional Areas:

3% of the land area comes under institutional use as per Lucknow Master Pan. Major institutional areas are located in Vidhan Sabha Marg and Kaiserbagh area. The areas with new development have provision for setting up of office buildings in commercial areas hence there has been expansion of institutional area in Lucknow.

6.1.4 Industrial Areas:

Lucknow city has been famous for small scale and house hold industries however there are few areas in the outer skirts of the city such as Amousi, Sarojni Nagar at Kanpur road where industrial development has taken place. Apart, Aishbagh and Deva Marg areas also attracted industrial units. 6% of the land use comes under industrial use.

6.1.5 Recreational Areas:

Only 3% of the land area comes under recreational uses. Key parks in Lucknow city are Begum Hazrat Mahal Park, Dayanidhan Park, Suraj Kund Park, Shaheed Samrak, Budha Park, Botanical Garden, Ambedkar Park, Hathi Park, Nimboo Park, Residency and Geological Garden. Major open areas in Lucknow are situated along Gomti River whereas the old city area lacks in open spaces and green areas.

6.1.6 Water Bodies:

Lucknow city is situated along the banks of River Gomti. Apart from the river, there are few water bodies in the form of pond and lake such as Moti Jheel, Chand Jheel, Kathouta Jheel, Ahal Jheel etc. Presently most of the water bodies have dried up and have become polluted due to non-maintenance.

6.1.7 Public Services:

10% of the city area falls under public services use such as university, colleges, medical facilities, training centers, research institutes etc. Lucknow city is progressing in providing the various kinds of medical and educational facilities not only to the city people but to the nearby villagers also.

6.2 Study area Existing Landuse Area

Table 10 Existing Landuse of Study area

ZONE	AREA (SqKm)
Residential	13.42 Sq.Km
Commercial	1.30 Sq.Km
Public/ Semi-public	2.47 Sq.Km
Forest/ Open Space/ Services	4.08 Sq.Km
Agriculture	7.84 Sq.Km
Heritage	0.37 Sq.Km
River/Water Bodies	2.91 Sq.Km
Circulation	2.70 Sq.Km
Total Area	**35.09 Sq.Km**

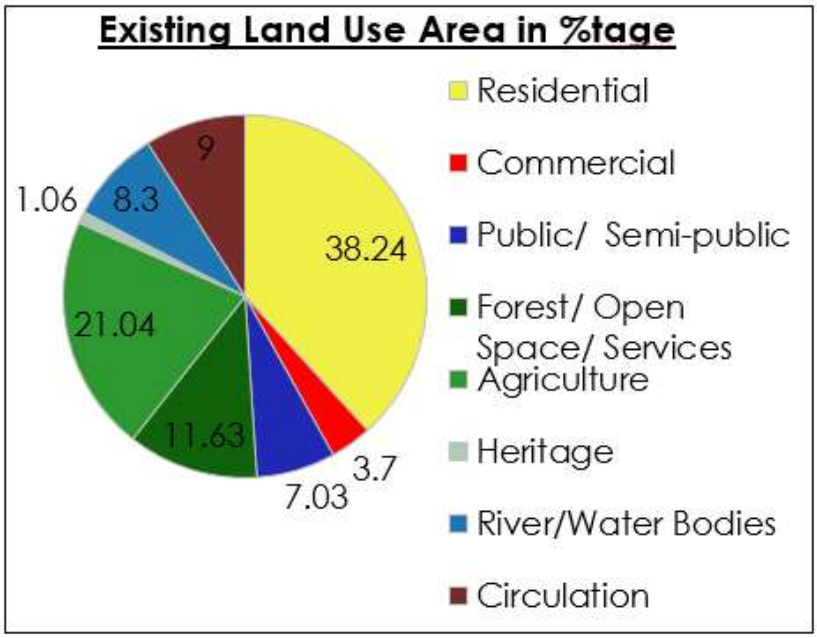


Figure 29 Existing Landuse area of site in %tage

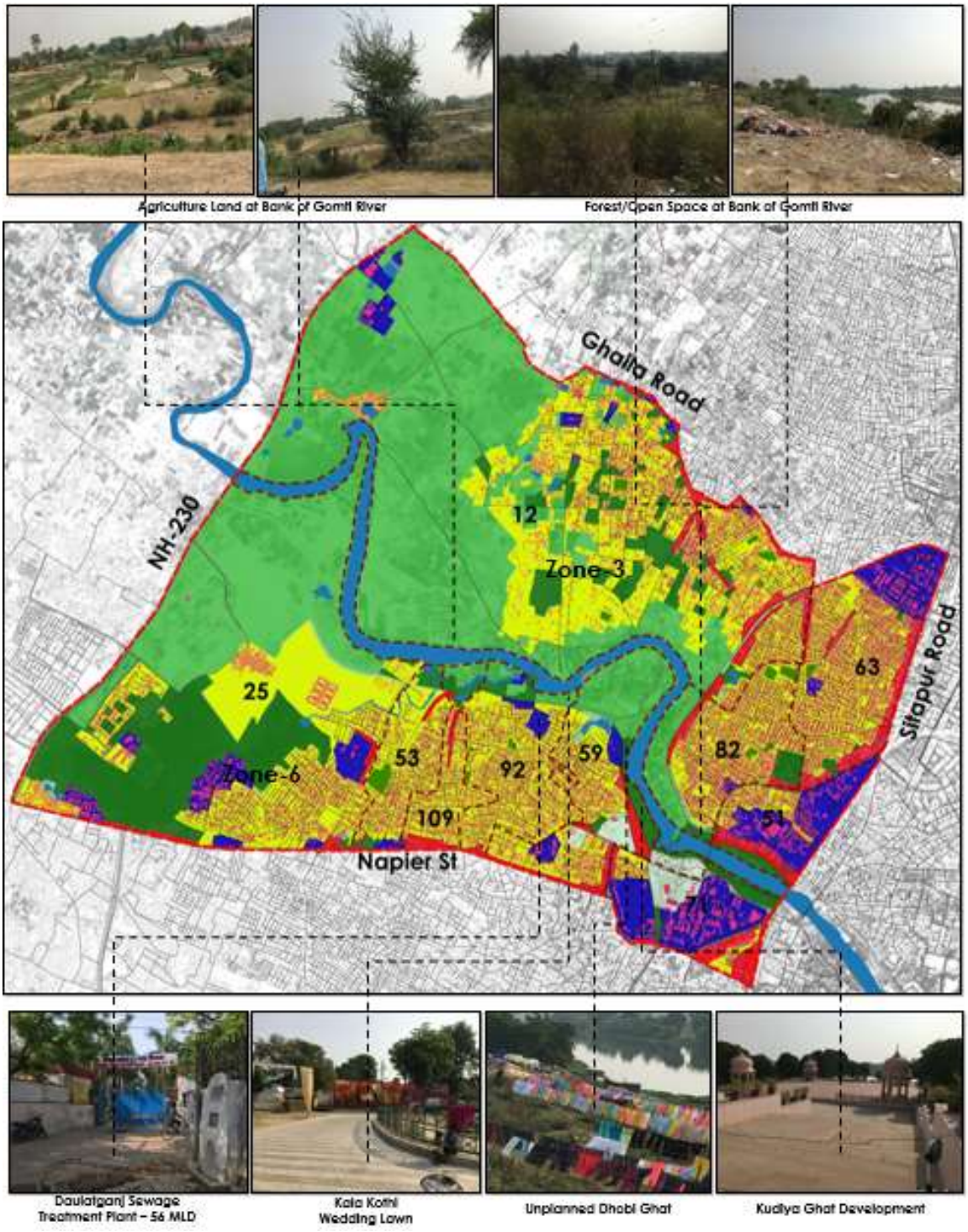


Figure 30 Map Shows the Existing Landuse of Site

6.2.1 Key Issues

I. Land use deviation from master plan:

There has been lot of variations in the proposed land use and actual development taking place in the city.

II. Haphazard development:

New development taking place in the periphery of the town is in very haphazard pattern with many unauthorized constructions are coming up. These type of development lack in the infrastructure and services availability and will be termed as unauthorized colonies.

III. Decreasing green cover:

As per land use figures shown in the earlier section, there has been reduction in green cover in the city from 4% to 3% between the years 1987 and 2005

CHAPTER: 7 PHYSICAL INFRASTRUCTRE-WATER SUPPLY, SEWERAGE AND SANITATION

7.1 History of water supply system in Lucknow

After the formation of Municipal Board in the year 1884, piped water supply was introduced in 1892. Earlier the system was proposed for the population of 2 lakhs only. The major source of water supply is River Gomti and the first raw water pumping station was constructed at Gaughat on the right side of the river and the treatment plant was established at Aishbagh (the oldest treatment plant in Lucknow). After the treatment at Aishbagh water works plant, the filtered water pumped to the City for distribution through a network of cast iron mains. Subsequently in the first half of the 20th Century the old steam engine device pumps were replaced with electricity driven system.

7.2 Water consumption per day per person in Study Area

Table 11 Water consumption per day per person in Study Area

Year	Population	Water Demand		Total Water Demand	
		Standard (LPCD)	Actual (LPCD)	Standard (MLD)	Actual(MLD)
1981	1,56,607	135	150	21.14	23.49
1991	1,97,091	135	150	26.61	29.56
2001	2,41,201	135	150	32.56	36.18
2011	3,13,562	135	150	42.33	47.03
2021	3,65,880	135	150	49.39	54.88
2031 (Projected)	**4,18,198**	**135**	**150**	56.46	62.73
2041 (Projected)	**4,70,516**	**135**	**150**	63.52	70.58

7.3 Water Districts of Lucknow City

A major reorganization of the water supply system was taken up around 1957 where the whole town was divided into 11 zones including cantonment. During the 80s and 90s decade the city has grown tremendously in terms of municipal limits and population resulting in mismanagement of water works and acute shortage of water supply in various areas of the city. For proper and equitable distribution of the water supply, Lucknow city was divided into five water districts in the Master Plan for Water Supply for Lucknow City in the year 1976. The districts were further sub divide into 32 zones. Water service districts are (A) City Service District, (B) North Service District, (C) East Service District (D) South Service District and (E) Cantonment.

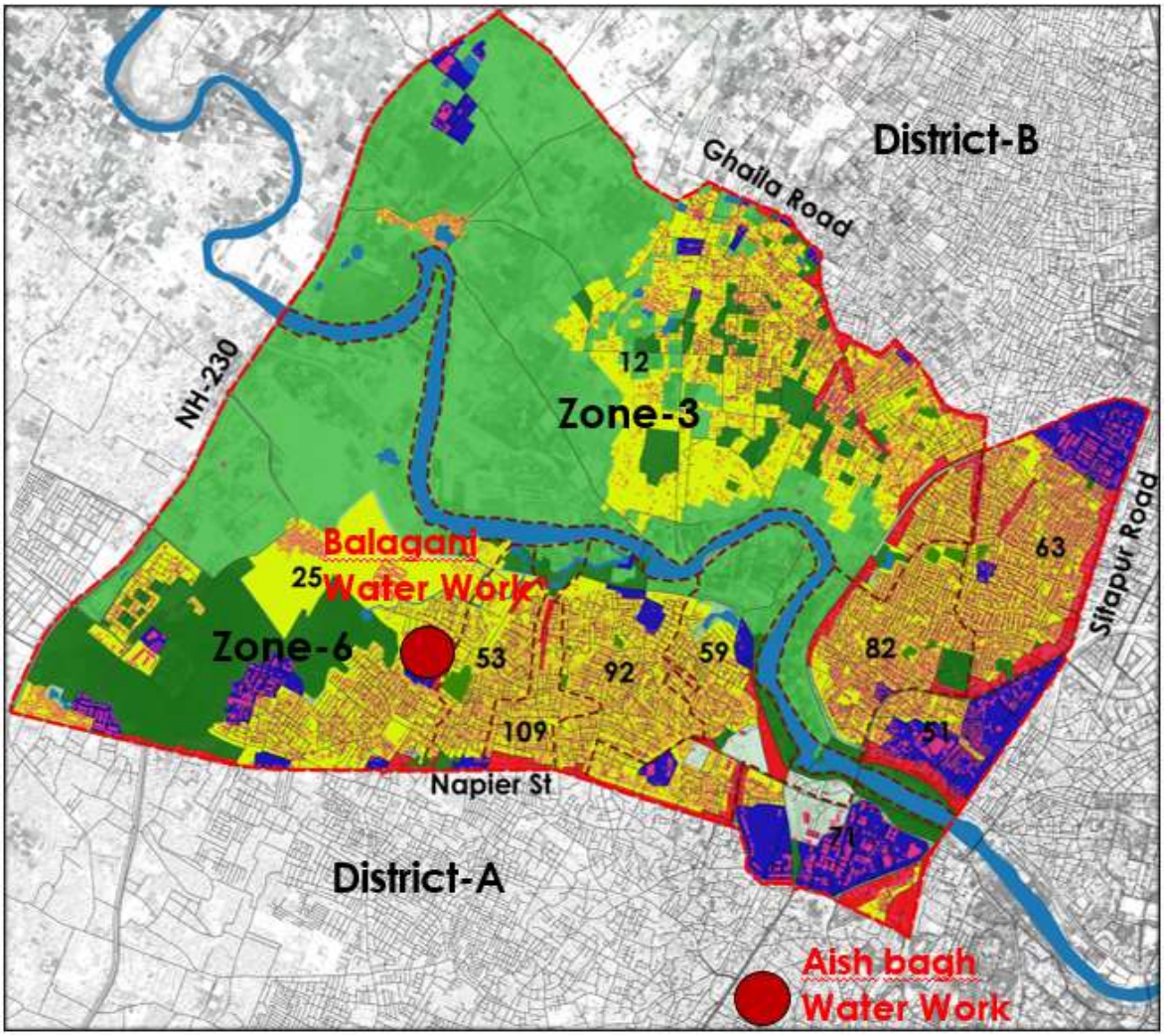


Figure 31 Map Shows the Location of Water Work

Table 12 District wise Water Source

Dist.	Zone	Population	Source
A	1,2,6	1185872	Surface: Aishbagh & Balaganj
B	3,4,7	773035	Tubewell & surface in some areas
C	4,7	289638	Surface: Gomti Nagar WW
D	5,8	568641	Ground Water
E	Cant		Ground Water

7.3.1 Treatment

The water extracted from the surface is treated in the Water Treatment Plants (WTPs). At treatment plant, the raw water is made potable up to the standards of safe drinking water by pre-chlorination, primary treatment and filtration. Quality control is assured through laboratory testing at the WTPs. Surface water treatment in Lucknow is done in three water works namely Aishbagh, Balaganj and Gomti Nagar. Ground water extracted from tube wells is treated through chlorination process by putting the bleaching powder in the tank near tube well. A brief description of the water works is given further.

I. Aish Bagh Water Works:
This is the oldest and first water work established in the year 1892 in Lucknow located at Aishbagh, District A. Water is lifted from Gaughat on the right side of the river. This WTP serves major area of District A with actual treatment capacity of 265 MLD. Five pumping stations located in various parts of the district are fed by this WTP. There are three sedimentation tanks with total capacity of 375 ML in this water works.

II. Balaganj Water Works:
The second WTP was commissioned in the year 1994 with actual treatment capacity of 200 MLD. It serves water demand in some of the areas of District A. Water is lifted from Gaughat on the right side of River Gomti. Five pumping stations located in various parts of the district are fed by this WTP. There are two sedimentation tanks with total capacity of 96 ML in this water works.

III. Gomti Water Works:
The third water work is located in Gomti Nagar which serves the water demand in District C. This is a newly constructed WTP on Sharda Sahayak Feeder Canal. Total capacity of the plant is 80 MLD. Prior to construction of Gomti Water Works, ground water was the major source of water supply in District C, however, after its implementation the use of ground

water has decreased in recent times. Instead of sedimentation tanks two clariflocculator are established here with total capacity of 40 ML each.

7.4 Water Supply System of Lucknow City & Study Area

7.4.1 Storage

After the treatment of water at WTPs, water is stored in main reservoirs located at the treatment plants. From the main reservoirs water is transported to zonal clear water reservoirs/zonal reservoirs and finally to overhead tanks located in various parts of the city. Presently there are 103 over head tanks with total capacity of 102 million litres. Apart, there are 24 clear water reservoirs/underground water reservoirs with total capacity of 67 million litres. More than 60% of the water is stored in OHTs which is on higher side as per normative standard of 33% of total water supply and rest 40% of the water is supplied via reservoirs directly. OHTs receive water from both reservoirs and tube wells.

Figure 32 Water Supply System

7.5 Coverage of water supply and existing situation

7.5.1 Coverage & Existing Situation

As per the projected population data for the year 2014 total water demand for Lucknow city is 610 MLD with 150 lpcd and 15% UFW. Actual water production in the city is 613 MLD which is equal to the actual demand hence in the existing situation there is no gap with respect to water supply. Approximately 60% of the city population is using surface water whereas rest of the 40% population use ground water source. Out of 110 wards 41 wards are served by ground water supply and rest 69 wards are served with both surface as well as ground water.

7.5.2 Per capita water supply and frequency of water supply

Before the implementation of the JNNURM schemes per capita water supply in Lucknow was 114 lpcd which increased to on an average 150 lpcd (as per current water production) excluding 30% of UFW which is on higher side than the normative standard of 135 lpcd. However, actual per capita water distribution is inequitable among various wards which ranges between 100 and 200 lpcd. Due to various Transmission & Distribution (T&D) issues, leakages, theft etc. actual per capita supply reduces in many of the parts. On an average city receives 2 to 3 hours (divided into morning and evening hours) of water supply in whole of

the day. There are various areas in Lucknow which receives only ½ an hour of water supply in whole day.

7.5.3 Water connection and Non-Revenue water

As per the information received from Jal Kal Department (LMC), Lucknow; total number of water connections in city are 3,15,473. Out of which 3,05,309 are HH connections, almost 62% of the total HHs in the city. At present there is no metering system in Lucknow city which results into unaccounted use of water and heavy wastage at consumer end.

7.6 Share of WW in LMC Area

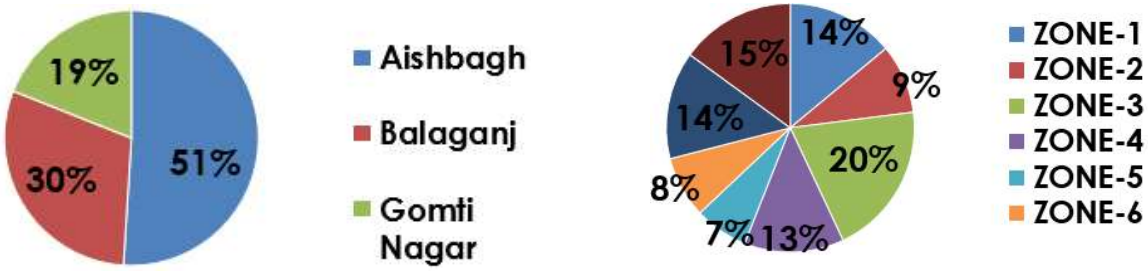


Figure 33 Share of WW in LMC Area

7.6.1 Organisation involve for water supply system in Lucknow

There are two major organisations responsible for water supply establishment and maintenance in Lucknow namely Jal Nigam and Jal Kal (LMC) (earlier known as Jal Sansthan). Jal Nigam is the responsible body for all the implementation and execution works related to water works in city area. After the execution of the water related works, Jal Nigam handover the works to Jal Kal for distribution, operation and maintenance purposes. Apart from these two organisations LDA, UPAVP and Private developers are responsible for executing works related to water pipelines in the townships and colonies/areas developed by them.

7.7 Sewerage and Sanitation

Sanitation has become a yardstick of socio–cultural development of a city. As a result of rapidly expanding populations, haphazard development, urban Sprawl, and inadequate or poorly designed and malfunctioning sewage treatment facilities, in urban areas untreated sewage is often discharged into rivers. This practice has serious repercussions to human health, river aquatic system, ecosystem and the already fragile economies. Consequently, there is an urgent need to increase wastewater treatment in the urban areas, which is presently far below the required levels. Improved sanitation results in improvement of health, reduction in child mortality/morbidity, improved water quality, environment and economic growth of a city.

7.7.1 History of sewerage system in Lucknow

The sewerage system in Lucknow town was first provided in 1918 and has been augmented from time to time. In 1948-49 a Comprehensive Drainage Scheme for Lucknow was prepared to cater to a population of 7 lakhs, of which 6 lakhs were expected to reside in the Cis-Gomti side and 1 lakh in the Trans-Gomti side. The plan included construction of branch and trunk sewers, pumping stations, rising mains and a sewage farm for disposal of sewage on land for farming. The works under this scheme were completed in 1955. In 1960-61, during a heavy flood in the River Gomti, considerable damage occurred to the sewerage system. In 1960s and 1970s as part of the Flood Protection Scheme, the construction of a pumping station behind the flood protection embankment rectified the damage caused to the sewerage system. In 1987-88 another Sewerage Master Plan was prepared. However, there have been no major works since the 1948 Master Plan, although a detailed Urban Environmental Services Master Plan Lucknow (1996-2021) was prepared in the 1990s to deal with improving the sewerage and sanitation situation in the City.

7.7.2 Sewerage Zones and Existing Situation

The overall sewerage system consists of 4 separate Sewerage Districts further divided into zones, each with its own pumping station or trunk sewer. Zones are further divided into several sewer sub-catchment areas. Sewer sub-catchment boundaries have been determined primarily on the basis of topographical features, existing sewer network and site investigations.

Table 13 Sewage Generation Detail

No.	Components	Remarks
1	Total Sewage generation	490 MLD
2	Sewer Network Coverage	45%
3	Number of Sewage Treatment Plants with capacity	2 STP (capacity of 401 MLD)
4	Gap in existing treatment capacity	89 MLD of total generation
6	Coverage of toilets	87%
7	Percentage of recycle and reuse water	0%
8	Number of Pay and Use toilets	207

7.7.3 Sewerage district I:

This District is situated on the east side of Lucknow City and has one sewage treatment plant (STP) located at Daulatganj, Gaughat area with capacity of 56 MLD (42 MLD under GoAP + 14 MLD under JNNURM) based on biological process called “Fluidised Aerobic Bio-reactor (FAB) Treatment Process”. Total population of the district is 2.81 lacs with waste water generation of 49 MLD. The district is self-sufficient in terms of treatment capacity.

7.7.4 Sewerage district II:

This district is on the south side from Sharda Canal sub divided into Zone I, Zone II and Zone III. Some areas have existing sewer networks developed by the Lucknow Development Authority (LDA) however rest of the area is not covered with sewer pipe lines. Area covered with sewer lines discharge sewage into existing 345 MLD STP located at Bharwara constructed under GoAP Phase II. Area not covered with sewer lines conveyed their sewage into open drains. Total population of this district is 3.67 lakhs and generating 64 MLD of waste water. A large part of this is occupied by low density peri-urban settlement and urbanization rate is increasing here. Some pockets of this area has sewer lines, however, they are not laid as per the norm and standards resulting in improper disposal of sewage.. Septic tanks and soak pits are also being used by many of the HHs. There is a proposal of 63 MLD STP at Bijnaur to serve this district in the future.

7.7.5 Sewerage district III:

This district is on the left bank of the Gomti River which is called Trans-side. The Kukrail Nala is the largest nala on the Trans Gomti side which divide the sewerage district into two parts. Right portion is known as Part I and left portion as Part II. Both the parts are independent to facilitate the sewerage system. Total population of District III is 10.35 lakhs with waste water generation of 180 MLD which is being treated at Bahrwara STP with total capacity of 345 MLD.

7.7.6 Sewerage district III Part I:

The localities in this part of District III include Daliganj, Aliganj, Nirala Nagar, Nishant Ganj, Khurram Nagar, Vikas Nagar, Jankipuram etc. almost 70% of the population of District III reside here. The localities developed by LDA and UPAVP have sewerage system but the disposal of this sewage is done through open drains. Some of the newly development areas are without sewerage system.

7.7.7 Sewerage district III Part II:

This part is located in left bank side of the Kukrail Nala. Colonies developed by LDA and UPAVP have got sewerage lines. All the sewage collected from these areas is discharged into Kukrail Nala / Gomti River.

At present the area has no sewage treatment plant; however, under the GoAP (Gomti Action Plan), one STP at Kakraha has been sanctioned by NRCD.

7.7.8 Sewerage district IV:

This district is on the right bank side of Gomti River called Cis-Side and includes the old city core with an old sewerage network subdivided into five zones (zone 1, 2, 3a, 3b, 5 & 5). The main interceptor sewer named as Cis Gomti Trunk Sewer runs parallel to the river along the west to east axis leading to Cis Gomti Pumping Station (CG Pumping Station) near Nishatganj Bridge from where it is diverted to Bharwara STP. It receives city sewage through lateral collector sewers. At present the system is defunct and the sewage farm also has become nonexistent. At present this district has no sewage treatment plant. Under GoAP,

the sewage from this district is proposed to be conveyed to the sanctioned sewage treatment plant at Mastemau with total capacity of 270 MLD.

7.8 Sewerage network

Sewerage system in Lucknow was laid down since the year 1918 and recently sewer lines have been laid down under JnNURM. At present total length of the sewer pipeline is 1174 km in district I and III. Some of the parts of district II and IV are also covered with sewer lines. Only 45% of the city area is equipped with sewage network.

Table 14 Detail of Sewerage District & STP

Sewerage District	Existing STP	Proposed STP
District 1 (Malihabad)	Daulatganj STP – 56 MLD	
District 2 (Lucknow)		Proposed Bijnaur STP –3 MLD (till2025) 126 MLD (till 2045)
District 3 (Bakshi ka talab & Mohanlalganj)	Bharwara STP-345 MLD	
District 4 (Lucknow & Mohanlalganj)		Proposed Mastemau STP – 270 MLD
Total	**401**	**333 (till 2045)**

7.9 Lucknow Sewerage Distribution

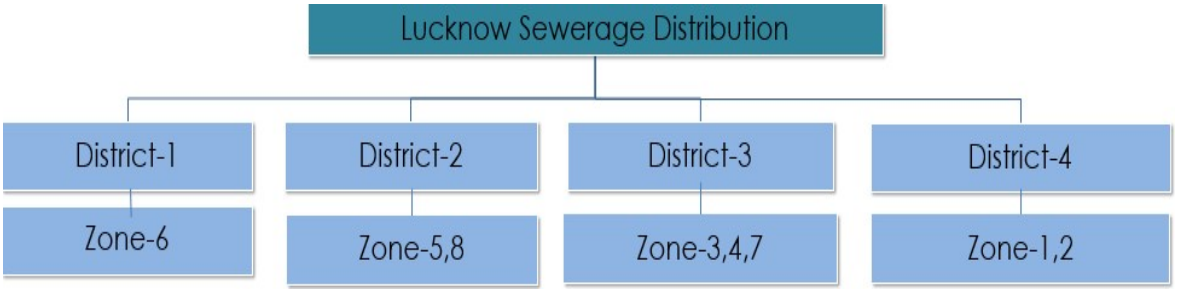


Figure 34 Lucknow Sewerage Distribution

7.10 Location of Formal & Informal Drains within Study Area

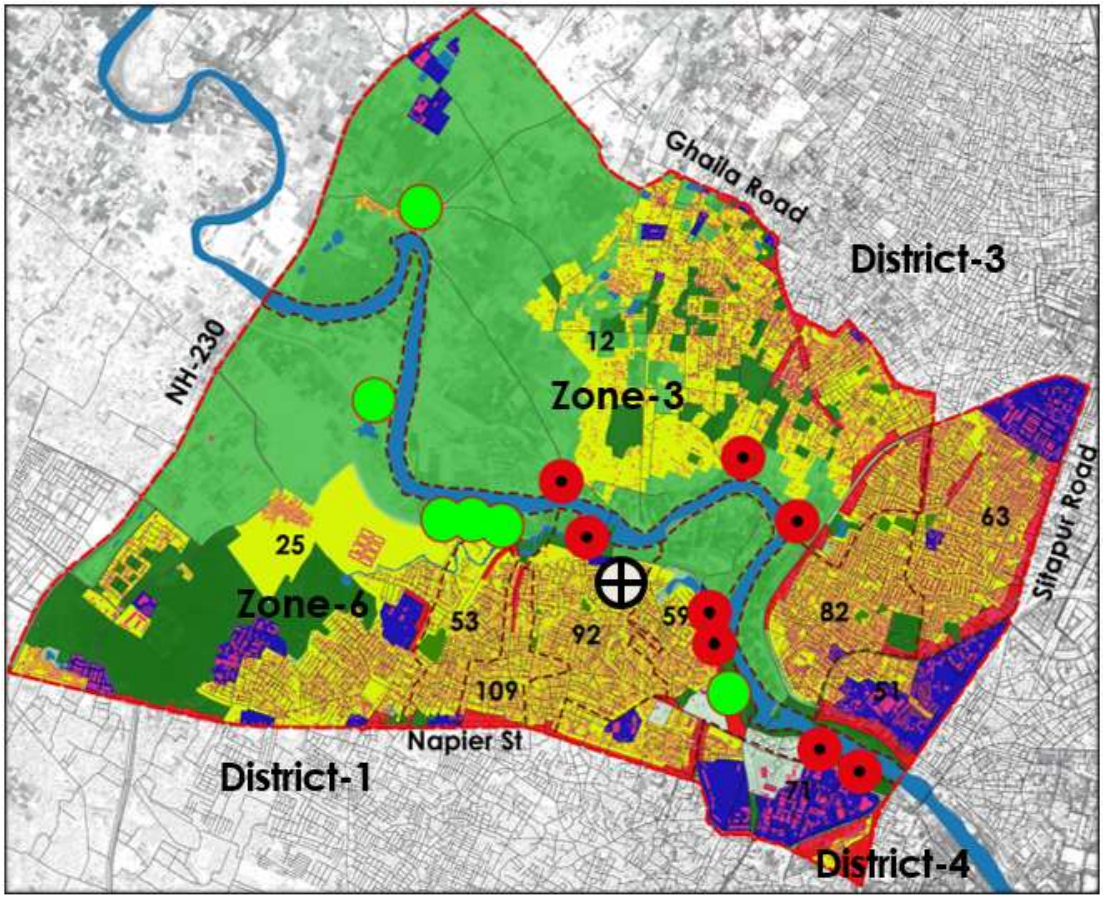


Figure 35 Location of Formal & Informal Drains within Study Area

No. of Formal Drains within Site- 6 No.
No. of Informal Drains within Site- 8 No.

Formal Drain | Daulatganj STP – 56 MLD | Informal Drain | Informal Drain

7.11 Existing Length of Sewerage Pipeline

Table 15 Existing Length of Sewerage Pipeline

District	Pipeline Length (km)	Coverage
District-1	339	24%
District-2	411	58%
District-3 (P-1)	485	62%
District-3 (P-2)	350	
District-4	809	100%
Total	**2394**	

CHAPTER: 8 PHYSICAL INFRASTRUCTRE-SOLID WASTE MANAGEMENT & ELECTRICITY

8.1 Solid Waste Management in study area

At present total municipal waste generation in Lucknow city is approximately **974.53 TPD** with an average per capita per day generation rate of **280 gm**.

Table 16 Waste Generation in Study Area

Year	Population	Waste Generation Per Capita(Kg/p/day)	Waste Generation (TPD)
1981	1,56,607	0.28	43.85
1991	1,97,091	0.28	55.19
2001	2,41,201	0.28	67.54
2011	3,13,562	0.28	87.80
2021	3,65,880	0.28	102.45
2031 (Projected)	**4,18,198**	0.28	117.10
2041 (Projected)	**4,70,516**	0.28	131.74

8.2 Solid Waste Management Process

Figure 36 Solid Waste Management Process

8.3 Solid Waste Collection Coverage

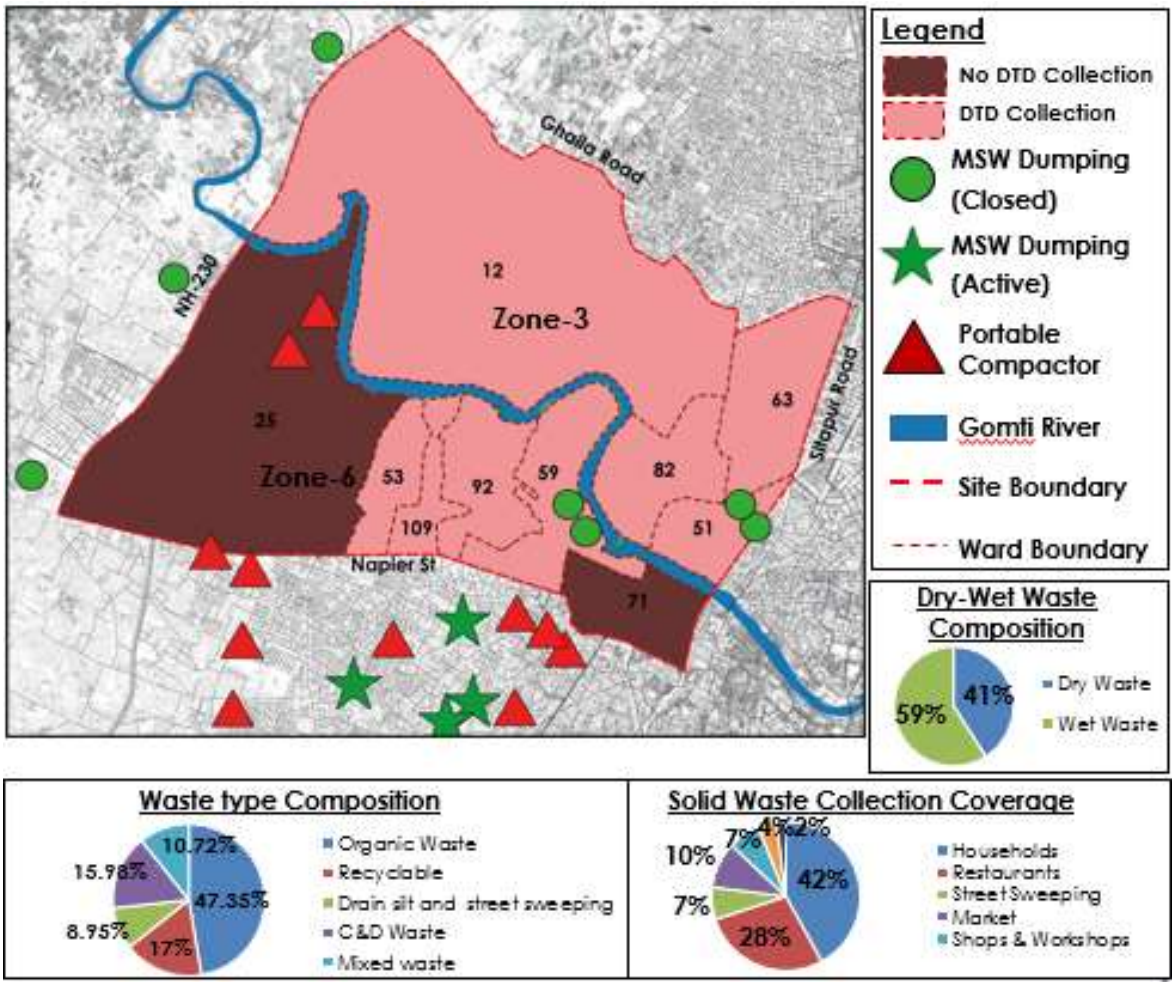


Figure 37 Solid Waste Collection Coverage

8.4 Electricity

Lucknow Electricity Supply Administration (LESA) is mainly responsible for Distribution of Electricity to the end-user of Lucknow Zone & Revenue Collection.

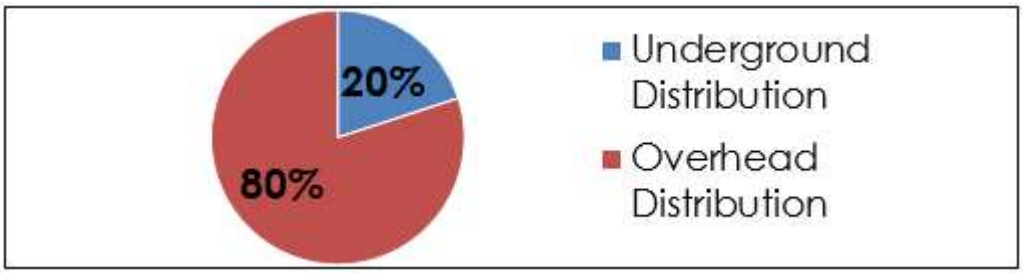


Figure 38 Electricity Distribution type

8.4.1 Location of Sub-Station

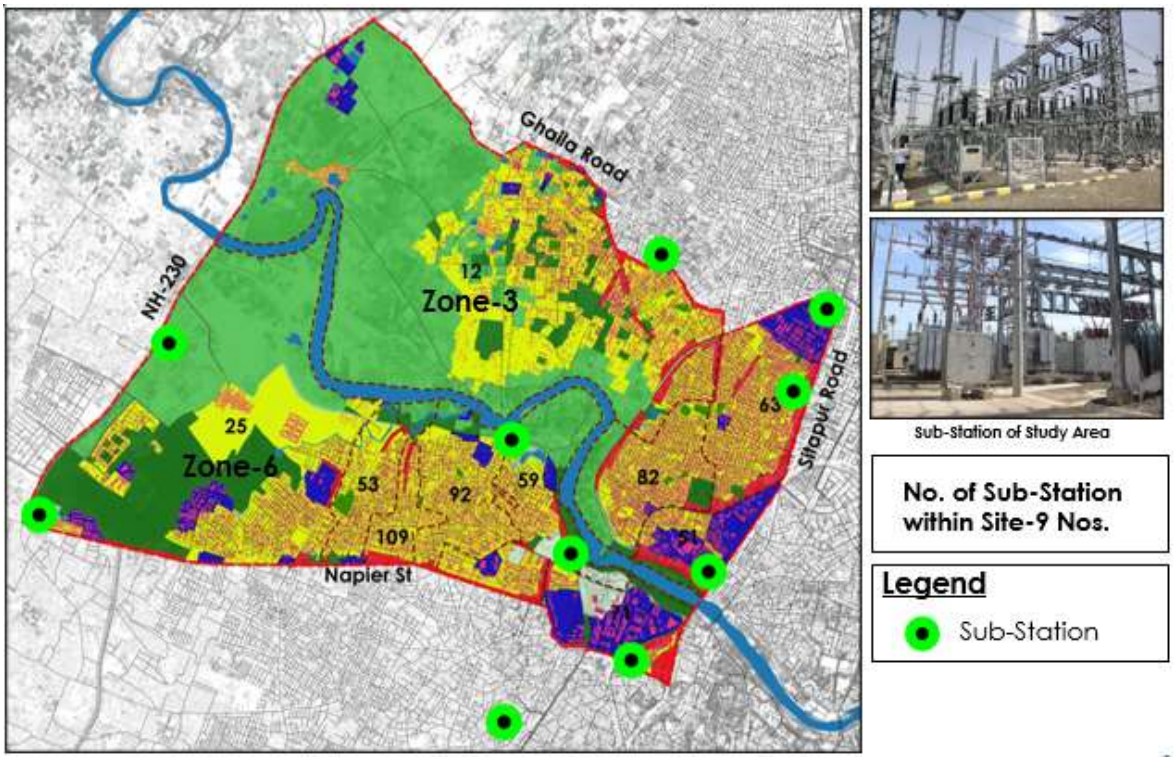


Figure 39 Map Shows the Location of Sub-Station

8.4.2 Power Demand and Supply

The LMC area generates 900 unit per capita household, lower than the National Average of 1000 units.

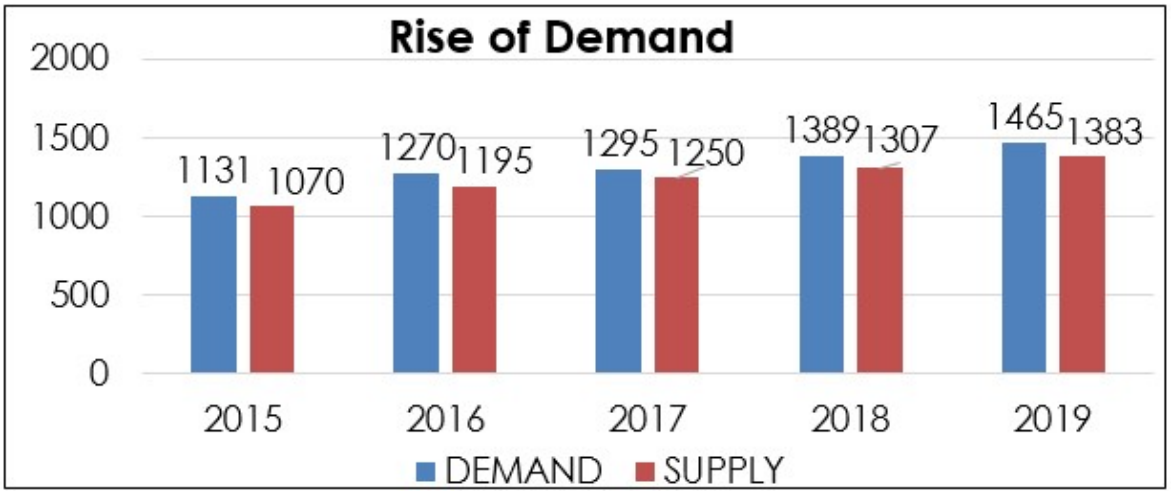


Figure 40 Power Demand and Supply

8.4.3 Solar and Renewable Energy Source

The State Government will endeavor to achieve 8% of total Electricity consumption from solar energy.

Installation of 10700 MW capacity of solar power is targeted till 2022 of which 4300 Megawatt capacity will be achieved through installation of rooftop Solar Power Plant. Presently, in Lucknow city solar energy contribution to grid is 6% of total power generation (25MW).

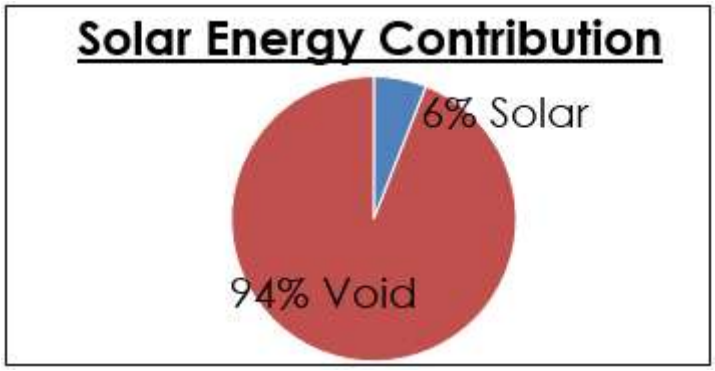


Figure 41 Solar Energy Contribution

CHAPTER: 9 SOCIAL INFRASTRUCTRE

9.1 Educational infrastructure in study area

Table 17 Educational infrastructure in study area

Category (School)	Student Strength	Pop. Served/ unit	Area Req.	Existing				Demand (2011)	Demand (2041)	Gap
				Nos	Govt.	Aided	Unaided			
Pre Primary, Nursery		2500	0.08 Ha	134	16	58	60	125	188	11
Primary School (I-V)	500	5000	0.40 Ha	144	21	0	122	63	73	122
Sr. Secondary (VI-XII)	1000	7500	1.8 Ha	128	8	7	113	42	49	113
Integrated School (Without Hostel)	1500	90000-1 Lakh	3.50 Ha	20	4	3	13	3	4	13
School for Physically Challenged	400	45000	0.70 Ha	1	1	0	0	7	8	0
School for Mentally Challenged		10 lack	0.20 Ha	1	1	0	0	0	0	0

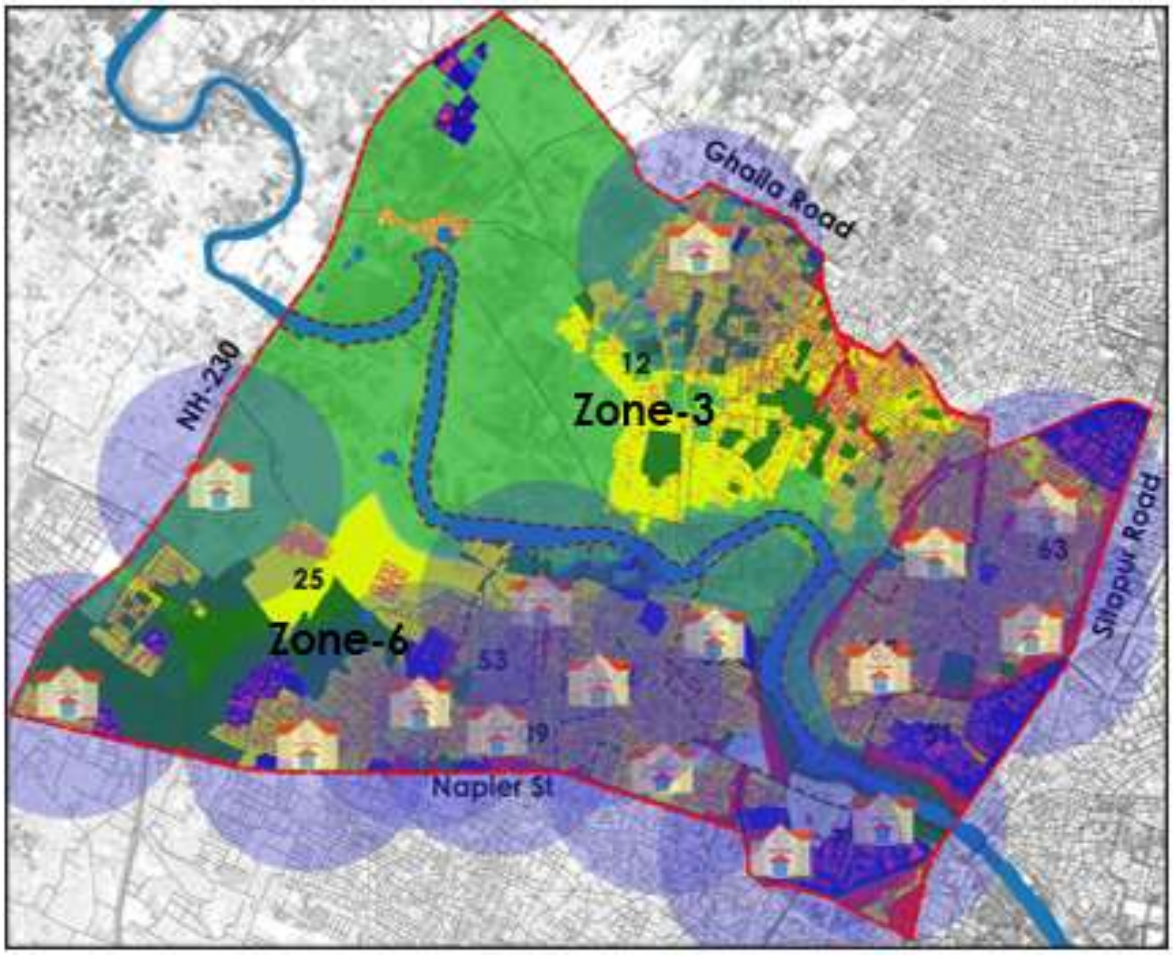
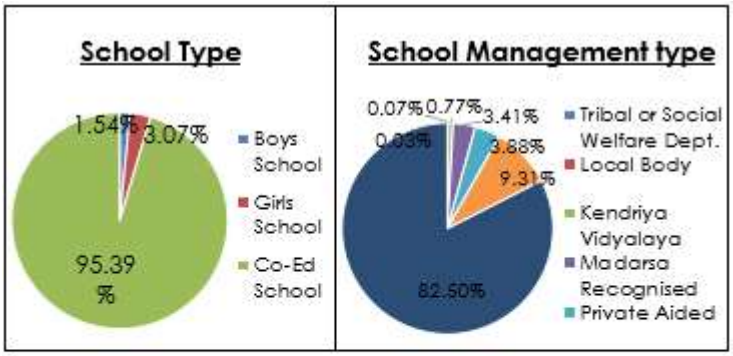


Figure 42 Map Shows the Location of Primary School and Their Catchment Area



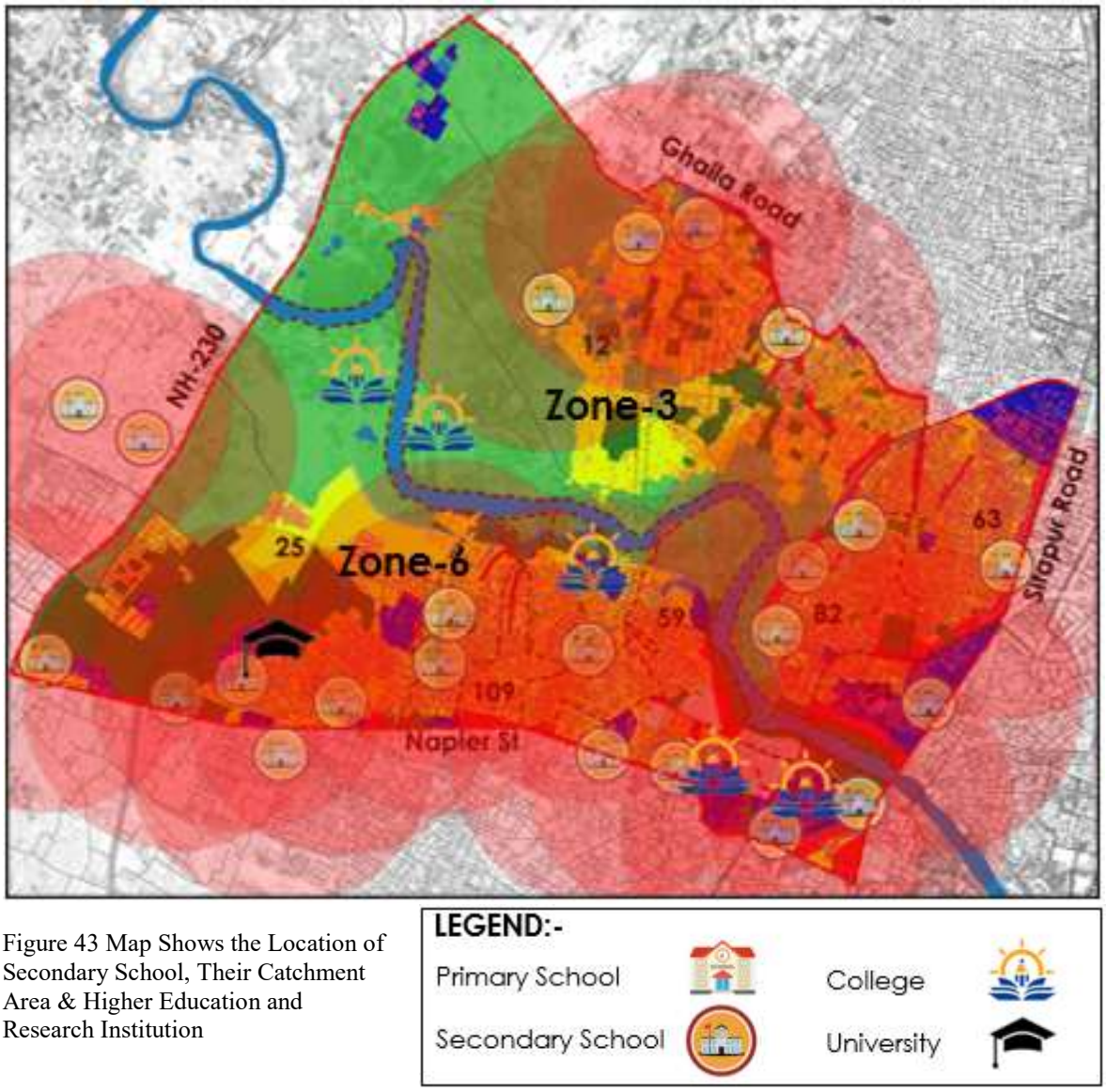


Figure 43 Map Shows the Location of Secondary School, Their Catchment Area & Higher Education and Research Institution

- Catchment area for Primary School-1Km.
- Catchment area for Senior Secondary School 3Km.
- Catchment area for Primary School is covers the entire Zone-6 but not in Zone-3.
- The Catchment of the Senior Secondary Schools is such that it majorly covers the entire Study area along with the Local Planning Area.
- Medical & management College are serving the population as per requirement. Universities & Engineering college are more than the requirement numbers for existing population. Overall, Govt. College are less in number as a result private college are coming up to serve the demand of population.

9.2 Health Care Facilities in Study Area

Table 18 Health Care Facilities in Study Area

Category	Existing Scenario-2021			As Per URDPFI	Future Projection	
	Govt.	Demand	Gap 2021	Pop./ Unit	Demand	Gap 2041
Sub Centre (Polyclinics & Dispensary)	2	3	1	100000	5	3
Community Health Center	3	11	8	30000	16	13
Primary Health Ctr.	5	3	+2	120000	4	+1
Sub-District Hospital	0	1	-1	300000	2	-2
District Hospital	1	1	0	500000	1	0
Dispensary Hospital for Pets & Animals	2	1	+1	500000	1	+1

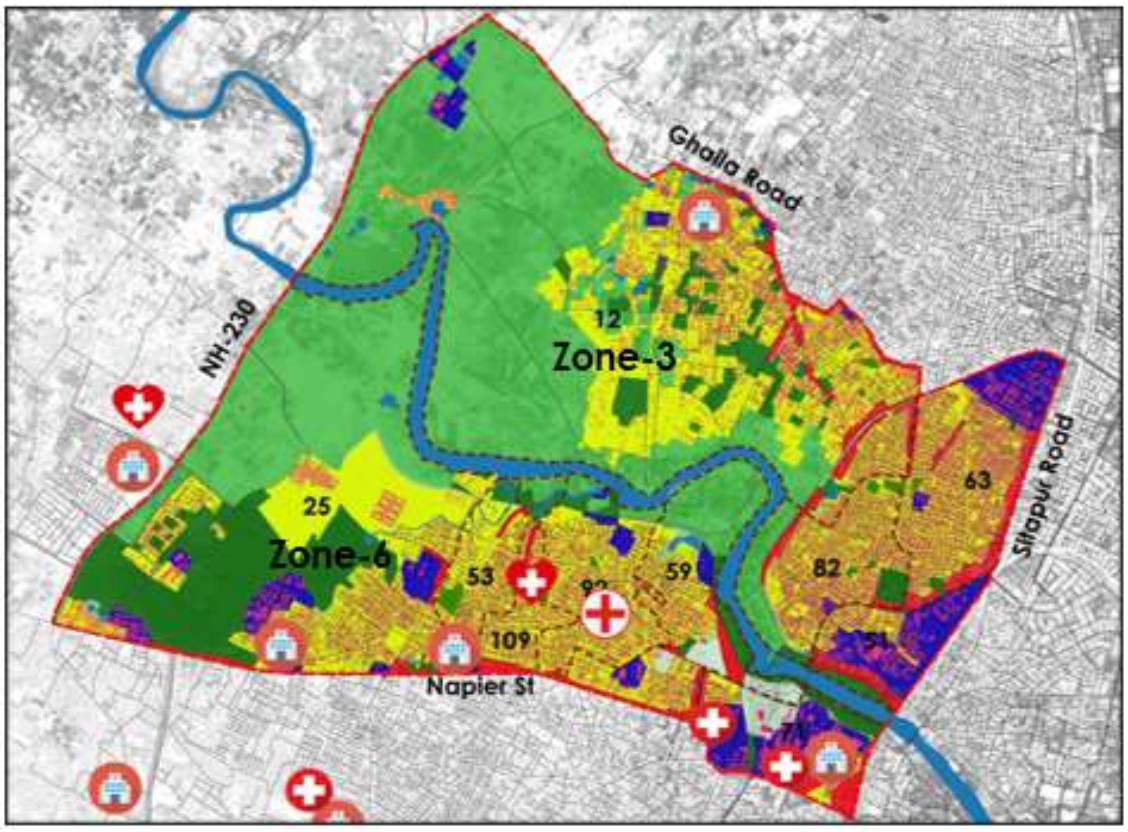


Figure 44 Map shows Locations of Healthcare Facilities in Study Area

9.2.1 Access to Health Care Facilities

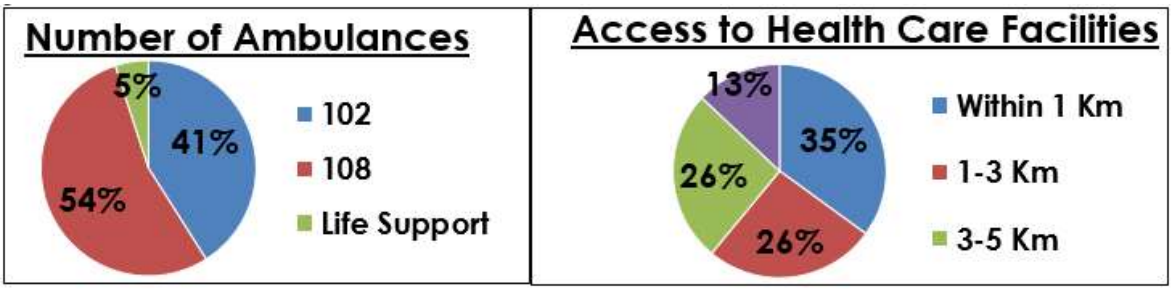


Figure 45 Access to Health Care Facilities

35% Population of the Study Area have more than 5 km distance from the health care facilities so there is more need for life support ambulances.

CHAPTER: 10 PROBLEM /PROPOSAL

Table 19 Existing Problems & Proposal

ASPECT	EXISTING	PROBLEM	PROPOSAL
Landuse	Mostly are mixed-use, agricultural and forest areas.		
Accessibility	Site is well connected to major areas/roads of the town,	There are many congestion points around our site.	
PHYSICAL INFRASTRUCTURE			
Water Supply	•Required water supply- 150l/per/d •Total water supply required-723.29 MLD •Water work (Aishbagh, Balagang & Gomti Nagar)-(200+180+75)=475 MLD •Water supply from Gomti river to zone-3 & Zone-6 are 8% and 20% respectively.	• 0% coverage of metered connection. • Low efficiency in collection of water supply charges. • Lack of awareness regarding water conservation among the citizens. • Excessive use of ground water. • New development entirely dependent on ground water • Quality of water pipe line is very	The river Gomti continues to be the main source of water supply to the city though a number of tube-wells have been bored to exploit ground water.

		low resulting into frequent breakages and leakages.	
Drainage	• There are 6 nos of Formal Drains within our Site and 8 nos of Informal Drains. • Rural areas are lacking in the facility of drainage with respect to Urban areas.	• The untreated water from informal drains is being regularly discharge to river. • No separate tax or charges for Drainage system • Dumping of garbage in storm water drains	There should be channelize the informal drains to the treatment plant so that the pollution of river can be controlled. • Drain must be run from all the street, with proper width and depth.
Sewerage and sanitation	Total Sewage generation in Lucknow City-450 MLD Sewer Network Coverage-45%	• Lack of sewerage network in newly added areas • Lack of sewerage system in slums • Lack of recycling and reuse facilities of wastewater • Open defecation in many slum areas.	• Reuse of treated wastewater and use for non-potable purpose. • Construction of Additional Sewage Treatment Plants
Solid Waste Management	• Door to door solid waste collection facilities not available in ward-25 & ward-71.	• Waste is still being dumped in open places leading to environmental degradation. • Unhygienic conditions at	• Door to door collection system should be implemented in left over wards.

		dhalaos are creating unhealthy conditions in the nearby residential areas.	
SOCIAL INFRASTRUCTURE			
Rehabilitation of Slums	• There are many slum pockets within our site and nearby river also. • Zone-6 consist of maximum no. of slums as compared to the whole city.	• There are lack of basic infrastructure and service facilities in these slum areas. • More than 25% of the people staying in slums defecate in open areas like open ground, along river side. 54% of the HHs have own latrine facility whereas 19% of the HHs use public toilet or shared toilet.	• Relocation of slum is to be provided in a particular zone within our study area. • Low cost housing under Pradhan Mantri Awas Yojana has to be provided for resettlement.
Redevelopment of Dhobi Ghat	• There are around 4 dhobi ghats being used for washing activities in bank of the river.	• The river water is being polluted continuously by the washing of cloths directly into the river.	• Well designed Dhobi Ghat with water supply & drainage should be constructed.
Place for Weekly Market	• There is no market place nearby the river.	• The local population has to travel some distance for the daily needs.	•Pucca Platforms should be constructed along with pathways for vendors in a particular location.

Place for Event area	• There is no event area nearby the river.	• There is no particular place for the calibration of national festival etc.	• There should be a particular demarcated place for events/ festivals.
Place for Urban Forestry	• There is very less Plantation nearby the river.	• Due to lack of plantation nearby river, the water level of the river is regularly decreasing.	• There should be development of dense afforestation / natural forest near the bank of the river, so that the ground water can be revitalized.
Development of Promenade & Parks	• No space for Public Walkway and Parks.	• Public movement nearby the river is very less due to lack of facilities/ green spaces.	• Public Walkway should be provided with some unique plantation & sitting areas, so that the morning /evening walk & gatherings can be enhanced.

10.1 Rehabilitation of Slums

Table 20 Share of Slum Population Ward wise

Zone	Slum Population	Share of Slum Population	No. of Slums
Zone-3	**44600**	**25.33%**	**32**
Zone-6	**22459**	**16.34%**	**39**

Sanitation data given in the table above clearly shows the poor sanitation conditions in slums. More than 25% of the people staying in slums defecate in open areas like open ground, along river side, along canal etc. 54% of the HHs have own latrine facility whereas 19% of the HHs use public toilet or shared toilet.

4656 Low cost housing under Pradhan Mantri Awas Yojana with all basic infrastructure has to be provided for resettlement.

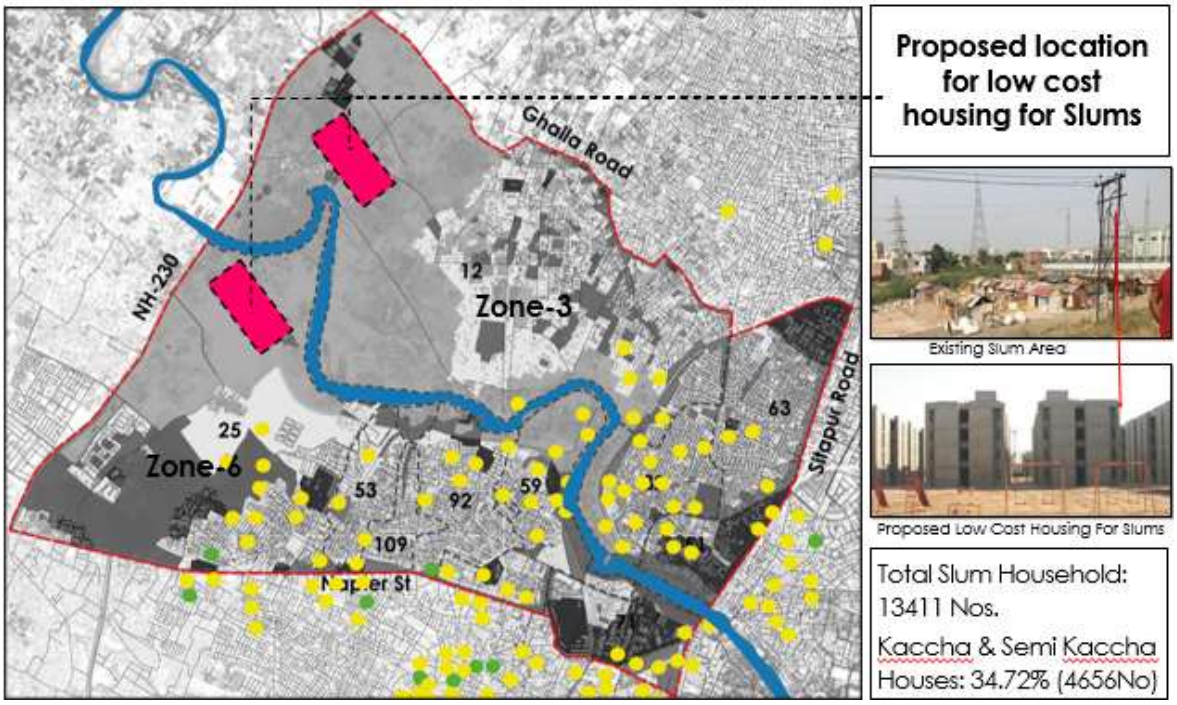


Figure 46 Map Shows the Proposed Location for low cost housing for slums

LEGEND:-	Proposal-1
Slums (< 50 House Holds) ●	4656 Low cost housing under Pradhan Mantri Awas Yojana with all basic infrastructure has to be provided for resettlement.
Slums (> 50 House Holds) ●	

10.2 Redevelopment of Dhobi Ghat

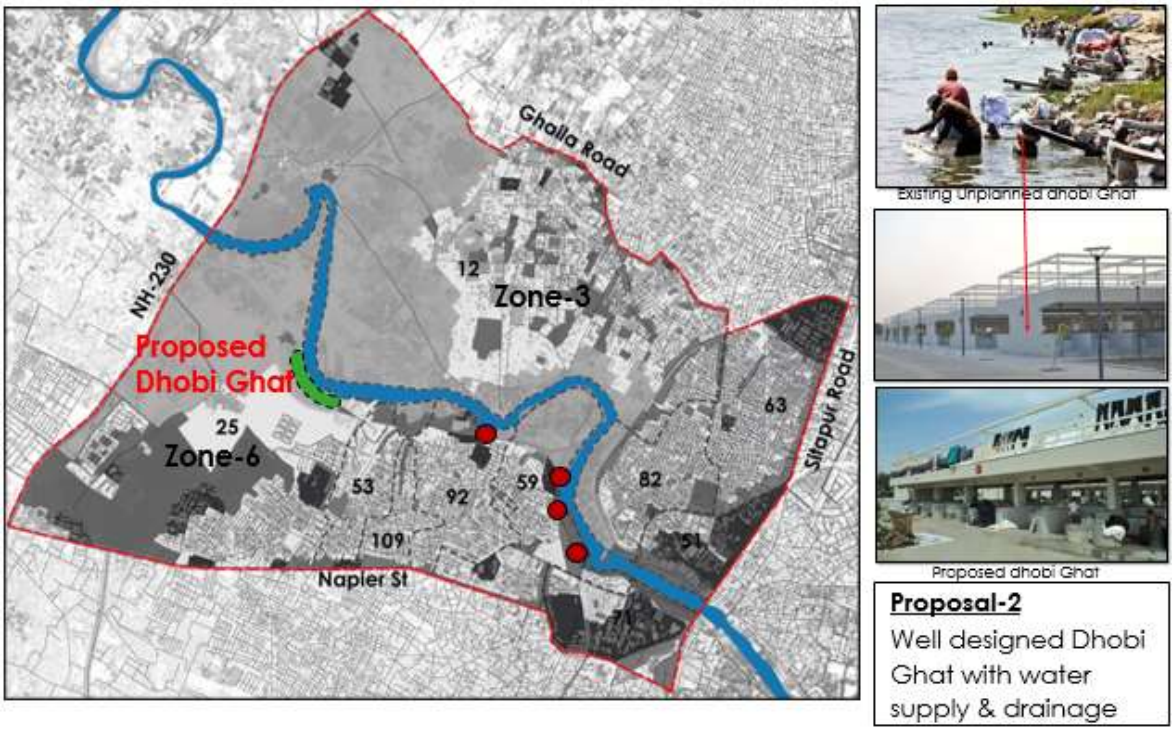


Figure 47 Map Shows the Proposed location for Dhobi ghat

10.3 Place for Weekly Market

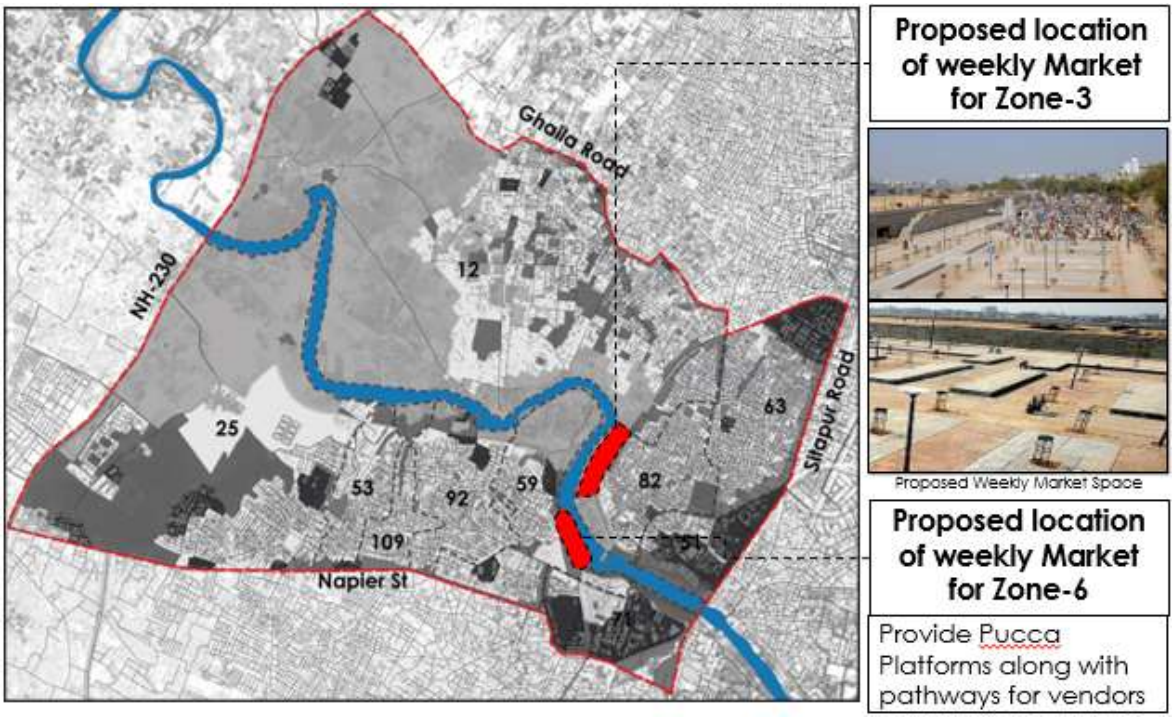


Figure 48 Map Shows the Proposed Location for Weekly Market

10.4 Proposal for Water Work

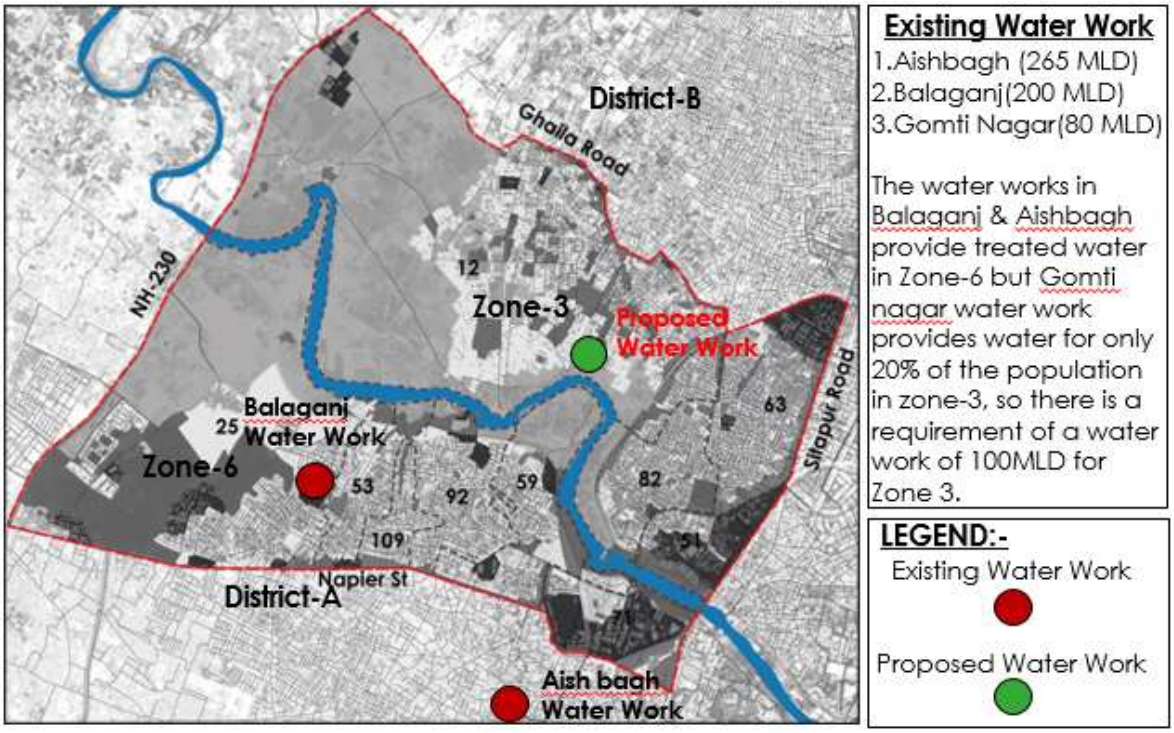


Figure 49 Map Shows the Location for Proposed Water Work

10.5 Development of Recreational Areas

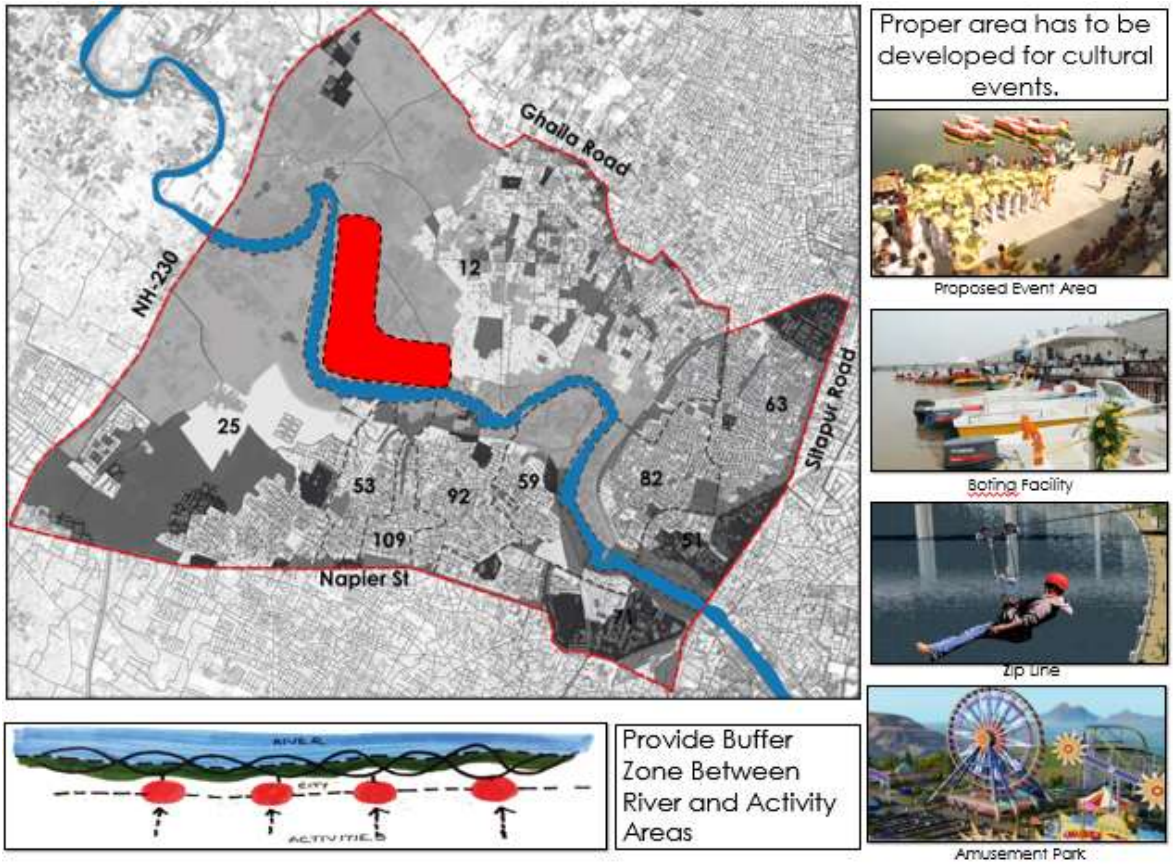


Figure 50 Map Shows Location for Recreational Areas

10.6 Proposal for Sustainable Drainage

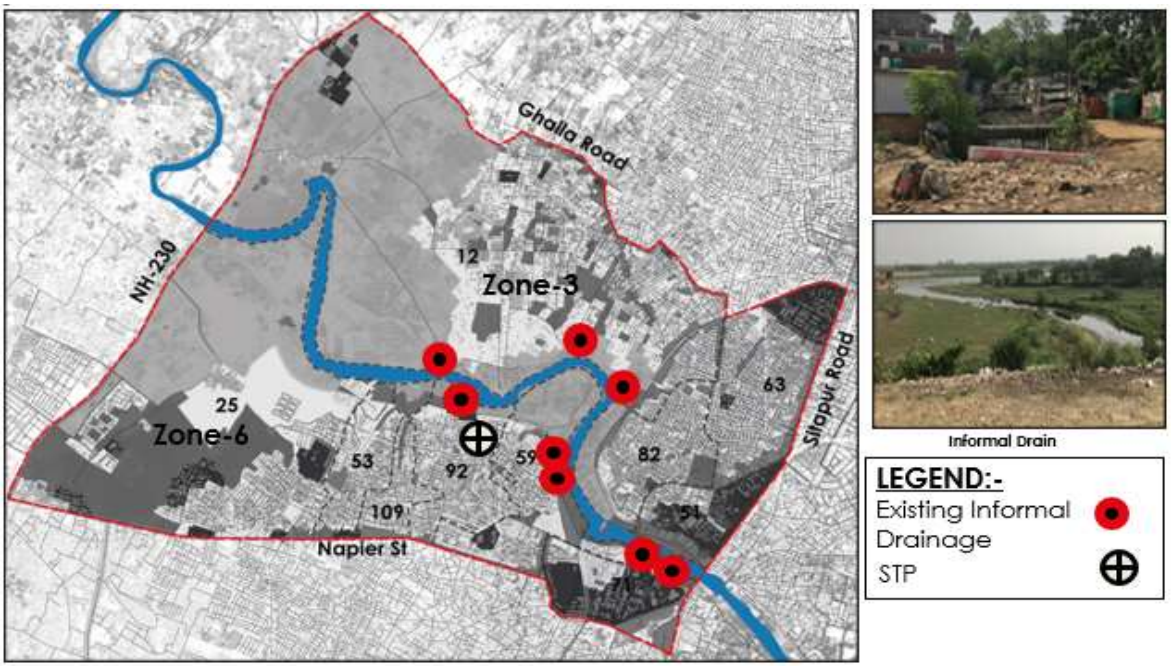


Figure 51 Map Shows Location of Informal Drainage

There are 8 nos of Informal drains, which are being directly disposed / mixed with Gomti river. They should be channelized into Daulatganj STP, so that the drainage water can be treated and leave it to the river or can be reused in Dhobi Ghat, etc.

10.7 Methodology to prepare Sustainable Drainage Systems Plan

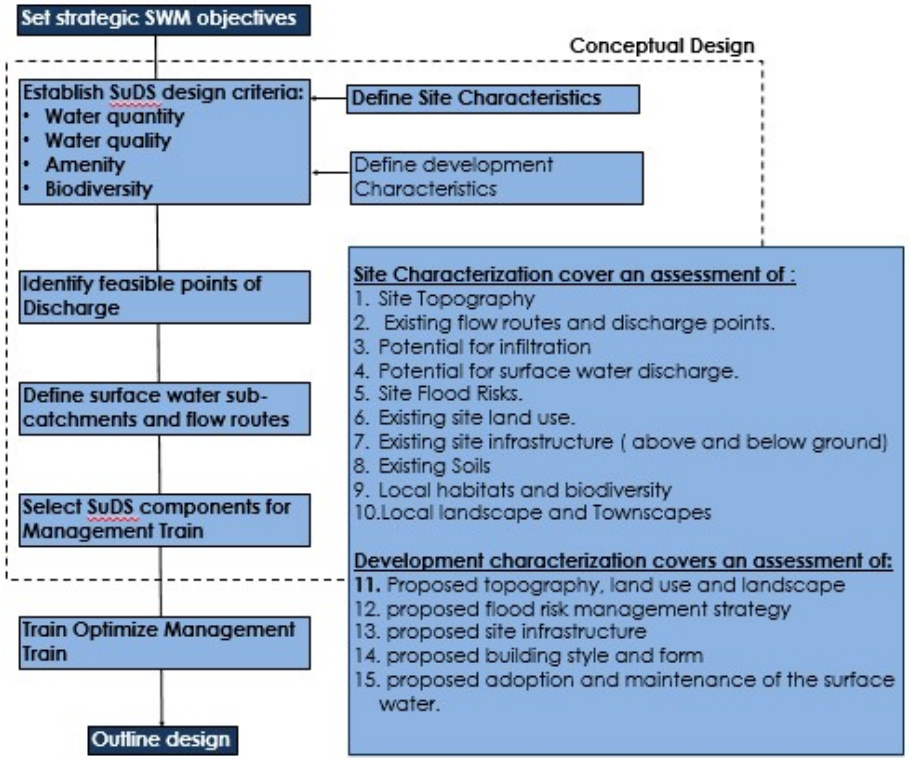


Figure 52 Sustainable Drainage Systems Plan

10.8 Component of Sustainable Drainage Systems

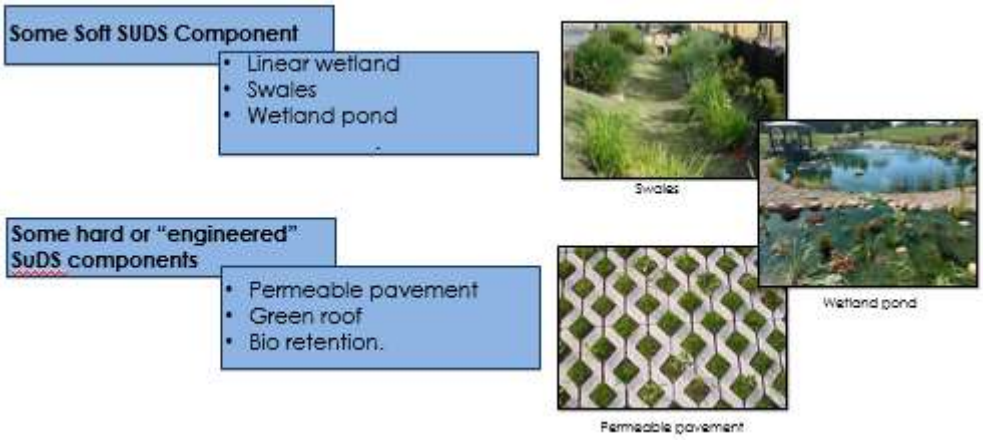


Figure 53 Component of Sustainable Drainage Systems

CHAPTER: 11 CONCLUSION

Long negligence by the inhabitants and perpetual human interventions along the river edge has caused immense environmental degradation as well as fuelled the growth of social disorders. Since the shift of the capital, economy of the place has suffered and a design solution which could help in bringing back the prosperity is much in need. Presently the river edge has unutilized spaces, encroachments, waste dumping and illegal constructions along with spaces which have become the core of illegal activities. Creating interactive spaces for public realm can solve all these current issues. By analysing the user's activity pattern and socioeconomic structure of the site and its context, it has been determined that a marketplace is an appropriate public space to attract people towards the site. It will also help in bringing back the economic stability to the locals. For designing the marketplace, a design vocabulary is developed. The market is designed in 2 different levels segregating the typologies of the shops. The first building is designed in arcade structure having an accessible ramp at the roof. The roof is designed to get vicinity of the river from every level of the place. Surrounded by thick greenery and having the river at one side, the walk on the roof is interactive and pleasurable. All vegetable shops, grocery shops, lifestyle and medical shops, stationery shops, food stalls, bistros etc. are composed in the arcade building. The void space is mainly designed for informal stalls and hawkers maintaining the vegetation of the place. This building is split into 2 levels. The 2nd level contains some public spaces with high arches as openings and some office blocks of the market union. The roads are designed with adequate pavement space for walking and cycling. Ghats are redesigned for better user experience and will attract tourists to the river. Activity spaces are designed along the riverside for the public realm. RCC has been used for the edge retention structure. For constructing public spaces and marketplace, brick masonry has been selected. Designed arches are kept in a certain ratio that it resembles the contextual heritage value. Trees are kept untouched along the river edge. This riverfront rejuvenation will induce a sense of belonging toward the site and the river in the mind of its users which will further help in proper utilization and maintenance of the site, basically ensuring proper waste management and least environmental degradation along with providing interactive spaces for different types of users.

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