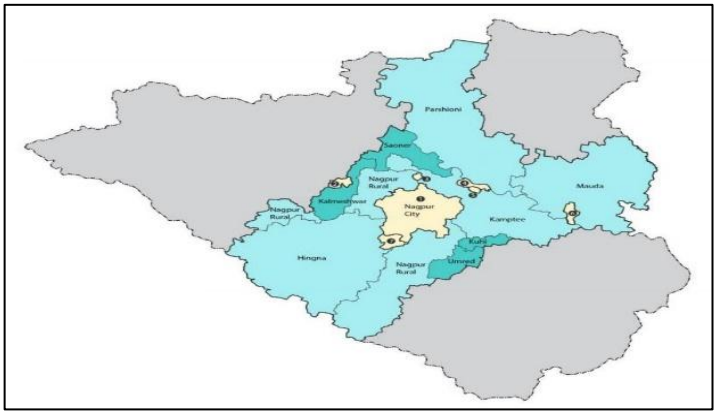
Maharashtra Metro Rail Corporation Limited

Comprehensive Mobility Plan for Nagpur Metropolitan Region



DRAFT CMP REPORT

MARCH 2025

RITES
THE INFRASTRUCTURE PEOPLE
(A Government of India Enterprise)

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Chapter – 1
INTRODUCTION

1. INTRODUCTION

1.1 BACKGROUND

Nagpur, a rapidly expanding urban center located in central India, stands as the third largest city within Maharashtra and serves as the state's secondary capital. It hosts the annual winter session of the Maharashtra State Vidhan Sabha and holds strategic significance as it sits precisely at the geographical center of India, marked by the Zero Mile Marker. Functioning as a pivotal commercial and political hub within the Vidarbha region of Maharashtra, Nagpur also boasts the distinction of being the second greenest city in India and is often referred to as the 'Tiger Capital of India' due to its proximity to several tiger reserves nationwide. Renowned for its production of high-quality oranges, Nagpur is aptly nicknamed the Orange City of India. With its advantageous location and burgeoning connectivity, the city is emerging as a key economic center. Additionally, Nagpur has been designated as a Smart City, achieving the top position among 100 smart cities in India in 2019 for its effective implementation of the central government's Smart City Mission.

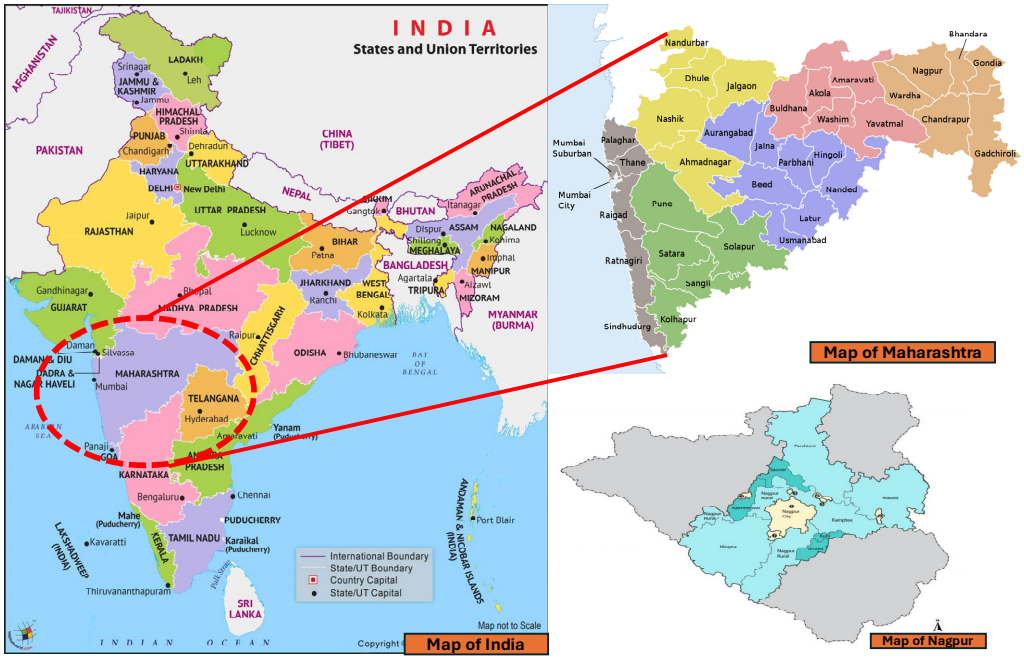
Nagpur boasts a plethora of technical institutes capable of meeting the growing demands of the IT-ITES industry in the area by producing an ample workforce. Recognized for its affordability, Nagpur has emerged as a sought-after location for Information Technology Enabled Services (ITES) and Business Process Outsourcing (BPO) entities. With the development of the Multi-modal International Cargo Hub & Airport (MIHAN), Nagpur is poised to evolve into a significant player in the national IT sector.

The city of Nagpur acts as the headquarter for the Nagpur district with a population of about 46 Lakh of which about 24 Lakh population accounts to Nagpur Municipal Corporation as per 2011 Census data.

The city lies at the very center of the country and is well connected to all other parts of the country by road and railway networks. It is about 770 km from Mumbai, 1080 km from Delhi and 500 km from Hyderabad. The North-South Corridor connecting Kashmir to Kanyakumari passes through Nagpur.

Figure 1.1 shows the location of Nagpur in Maharashtra.

FIGURE 1.1: NAGPUR IN INDIA AND MAHARASHTRA



The traffic problems are bound to grow in magnitude with the rapidly changing city unless advanced actions are taken now. Therefore, it is essential to have a comprehensive mobility plan in place to ensure planned development of transport infrastructure to meet the expected transport demand in the future years at an acceptable level of service.

As per Metro Rail Policy – 2017, Comprehensive Mobility Plan should be revised and prepared at least once every five years to address the constantly changing scenarios of mobility. With a view to expanding the effective and efficient urban transport system, the Maha Metro has decided to undertake a Comprehensive Mobility Plan study for Nagpur Metropolitan Region and appointed RITES as consultant to carry out the study.

1.2 SUSTAINABLE MOBILITY PRINCIPLES

Sustainable mobility means satisfying the needs of the current generation without compromising the ability to satisfy the needs of future generations. Sustainable mobility is therefore the mobility model that enables movement with minimal environmental and territorial impact. The current model of travel in Indian cities is unsustainable as it is fundamentally based on motorized transport and, specifically, the use of private vehicles.

A model of sustainable mobility would be one in whose means of transport consume the least energy and produce less pollution per kilometer travelled and passengers have greater recognition (travel on foot, by bicycle, collective transport and shared

car). To achieve this, there are following 8 principles that guide the sustainable transport and development:

- WALK | Develop neighborhoods that promote walking.
- CYCLE | Prioritize non-motorized transport networks.
- CONNECT | Create dense networks of streets and paths.
- TRANSIT | Locate development near high-quality public transport.
- MIX | Plan for mixed use
- DENSIFY | Optimize density and transit capacity.
- COMPACT | Create regions with short commutes.
- SHIFT | Increase mobility by regulating parking and road use.

Thus, a Sustainable Urban Mobility Plan for a city is a strategic plan designed to satisfy the mobility needs of people and businesses in cities and their surroundings for a better quality of life. It builds on existing planning practices and takes due consideration of integration, participation, and evaluation principles.

CMP Nagpur is a Sustainable Urban Mobility Plan for the city with a long-term vision for desirable accessibility and mobility pattern for people and goods in the urban agglomeration. It focuses on the mobility of people to address urban transport problems and promote better use of existing infrastructure (i.e., improvement of public transport, pedestrian and NMT facilities) which leads to the integration of land use and transport development and is essential for building smart cities.

1.3 NATIONAL URBAN TRANSPORT POLICY

The National Urban Transport Policy (NUTP) has been formulated by the Ministry of Urban Development in 2014 to transform the current urban transport system into a safe, convenient affordable, quick, comfortable, reliable and efficient transportation system across all urban areas in India. The objectives of the NUTP are:

- Incorporating urban transportation as an important parameter at the urban planning stage rather than being a consequential requirement.
- Bringing about a more equitable allocation of road space with people, rather than vehicles, as its main focus.
- PT should be citywide, safe, seamless, user friendly, reliable and should provide good ambience with well-behaved drivers and conductors.
- Walk and cycle should become safe modes of UT.
- Introducing Intelligent Transport Systems for traffic management

- Addressing concerns of road safety and trauma response
- Raising finances, through innovative mechanisms
- Establishing institutional mechanisms for enhanced coordination in the planning and management of transport systems.
- Building capacity (institutional and manpower) to plan for sustainable urban transport and establishing knowledge management system that would service the needs of all urban transport professionals, such as planners, researchers, teachers, students, etc.

1.4 VISION AND OBJECTIVES OF MOBILITY PLAN

"The CMP is a long-term vision for desirable accessibility and mobility pattern for people and goods *in Nagpur to provide, safe, secure, efficient, reliable and seamless connectivity that supports and enhances economic, social and environmental sustainability."*

The objectives of CMP are:

- Develop a long-term strategy for the desirable city mobility pattern that recognizes all modes of transport and avoids a piecemeal and reactive approach to existing problems and those expected to arise in future.
- Improve and promote public transport, non-motorized vehicles (NMVs) facilities for pedestrians as important transportation modes.
- Promote integrated land use and transport planning.
- Develop an urban transport strategy that is in line with the current National Urban Transport Policy (NUTP).
- Ensure that the most appropriate, sustainable and cost-effective investments are made in the transport sector.

1.5 REVIEW OF EARLIER REPORTS

The some of the major studies carried out in the past by various organizations relating to transport infrastructure development in Nagpur are as follows:

- Comprehensive Mobility Plan for Nagpur, 2018
- City Development Plan for Nagpur, 2041
- Detailed Project Report for Nagpur Metro Rail Project, 2013
- Detailed Project Report for Extension of Nagpur Metro Rail – Phase 2
- Smart City Proposal for Nagpur

- Parking Policy and Parking Master Plan Nagpur, 2016
- Operation and Implementation Plan for Feeder Bus Service, 2016

1.8.1 COMPREHENSIVE MOBILITY PLAN FOR NAGPUR, 2018

Comprehensive Mobility Plan has been prepared with a vision for transport in Nagpur to ensure that the city has a planned, best performing transport system to address the needs and concerns of the city. The objective of CMP is to develop specific actions in the form of short, medium and long term transportation improvement proposals that will achieve the transportation vision for the area.

Existing Traffic Characteristics:

- 2 wheelers are the highest at 42.6% followed by Auto rickshaws at 19.8% and Bus at 15.6%. Whereas cars have the lowest mode share at 5.7%.
- The total daily trips are estimated at 51,20,650 as derived from the household survey, of which the majority trips (43.3%) are for Work and Business whereas education accounts for 31.3% trips.
- About 90% of the trips are vehicular trips while 10% are walk trips. The per capita trip rate for motorized trip in the study area is 1.3.
- The average trip lengths are observed to be 7.6 km (including walk trips) and 8.2 km (excluding walk).
- 37% trips are made in 11-20 minutes and about 21% in 1-10 minutes.

Important CMP Strategy and Proposals are as follows.

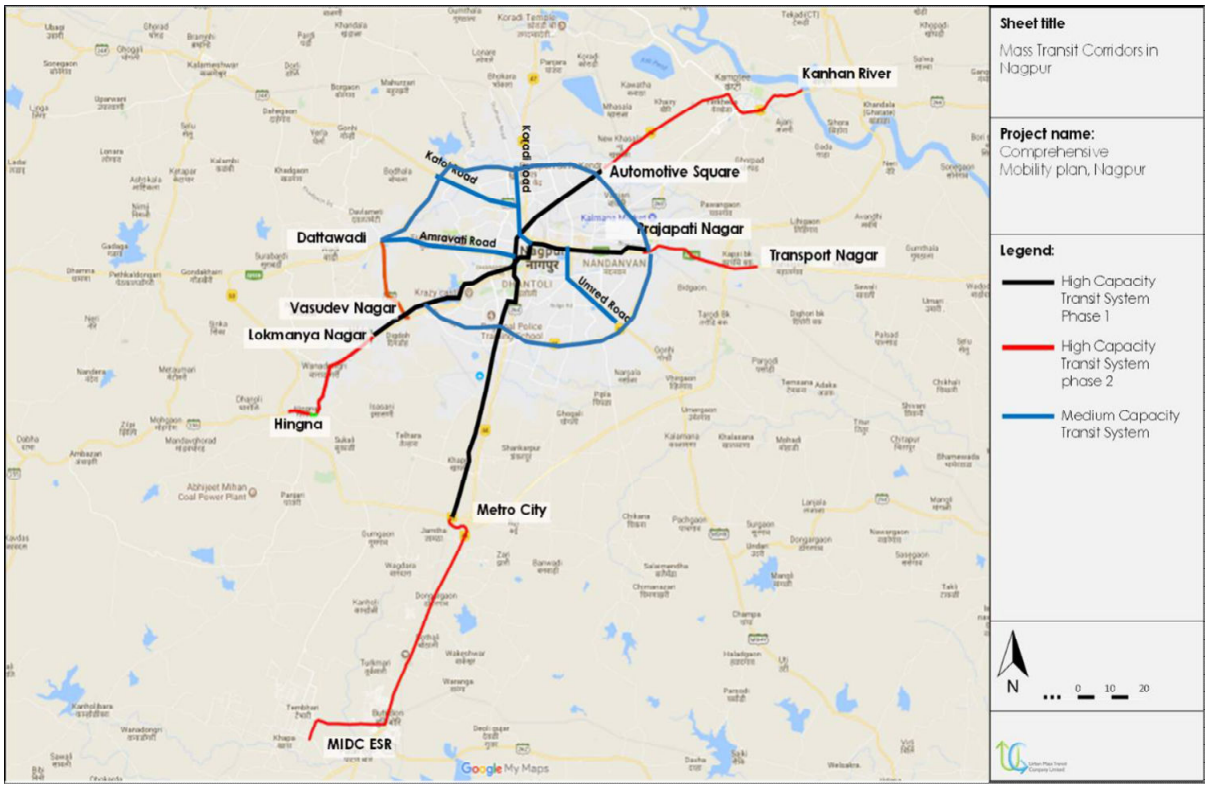
Based on the PPHPD (Passengers per Hour per Direction) values estimated from the transport model developed for CMP, corridors mentioned in **Table 1.1** and shown in **Figure 1.2** are proposed as High Capacity Mass Transit Corridors and Medium Capacity Transit corridors.

TABLE 1.1 MASS TRANSIT CORRIDORS IN NAGPUR

SN	Mass Transit Corridors	Length (km)
High Capacity Mass Rapid Transit Corridors		
1	Automotive Square to Khapri Station	19.7
2	Pardi to Mount View (Hingna)	20.1
3	Automotive Square to Kanhan River	13.0
4	Prajapati Nagar to Transport Nagar	5.6
5	MIHAN to MIDC ESR	18.5
6	Lokmanya Nagar to Hingna	6.7
7	Vasudev Nagar to Dattawadi	4.5
Medium Capacity Transit System Corridors		
8	Katol Road	5.8

SN	Mass Transit Corridors	Length (km)
9	Koradi Road	2.6
10	Umred Road	5.5
11	Amaravati Road	8.2
12	Vasudev Nagar to Dattawadi on Inner Ring Road connecting Katol Rd. Amravati Rd. Hingana Rd, Wardha Rd., Umred Rd., Bhardara Rd & Kamptee	34.0

FIGURE 1.2 MASS TRANSIT CORRIDORS IN NAGPUR



Important Multi Modal Hub locations proposed in CMP are represented in **Table 1.2**. Apart from physical integration, fare integration and information integration is also proposed. Intelligent Transport System is also proposed for Nagpur city including AFCs, Validators, Electronic Ticket Machines, Security Access Modules etc.

TABLE 1.2 PROPOSED MULTI MODAL HUB

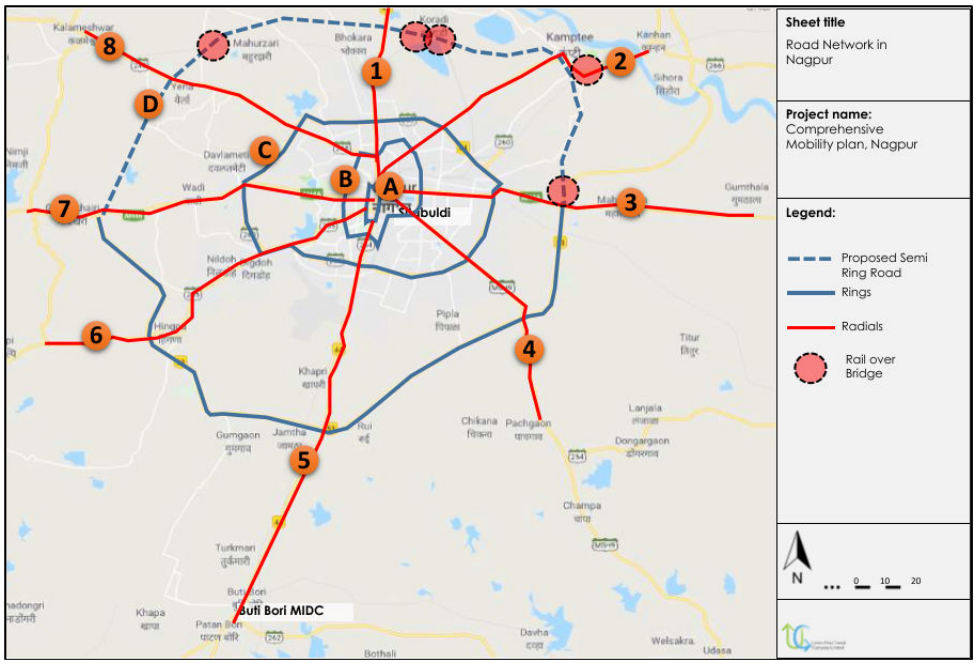
Type	Proposed Multi-Modal Hub	Number of Modes	Modes
Level 1: City Transport Modes Only	Mor Bhawan Bus Terminal	3	• High Capacity Mass Rapid Transit system • IPT Connectors • City Bus Service
	Sitabardi Bus Terminal	3	• High Capacity Mass Rapid Transit system

Type	Proposed Multi-Modal Hub	Number of Modes	Modes
			• City Bus Service • IPT Connectors
Level 2: Regional Transport Modes + City Transport Modes	Ganesh Peth Bus Terminal	2	• Regional Bus Service • City Bus Service • IPT Connectors
	Chatterpati Bus Terminal	2	• Regional Rail • City Bus Service
	Ravi Nagar Bus Stop	2	
	Nagpur Railway Station		• Regional Rail • High Capacity Mass Rapid Transit system • City Bus Service • IPT System
	Ajni Railway Station	3	• Regional Rail • City Bus Service • IPT System
	Kamptee Railway Station	3	• Regional Rail • High Capacity Mass Rapid Transit system • City Bus Service • IPT System
	Nagpur Airport	2	• High Capacity Mass Rapid Transit system • City Bus Service • IPT/Airport Connectors

Road Network Proposals

Ring radial road network pattern is proposed for Nagpur. Based on the road network envisaged some semi-ring and radial roads are also proposed to be completed/constructed to achieve the desired overall road network in the city.

FIGURE 1.3 PROPOSED ROAD NETWORK DEVELOPMENT



The review of various proposals in Comprehensive Mobility Plan for Nagpur 2018 with current status has been presented in **Table 1.3.**

TABLE 1.3 CMP 2018 REVIEW

SN	Proposal	Current Status
A) Mass Rapid Transit Corridors		
a)	**High Capacity MRTS Corridors**	
1.	Automotive Square to Khapri Station	MRTS Under Operation from Automotive Square to Khapri
2.	Pardi to Mount View (Hingna)	MRTS Under Operation from Prajapati Nagar to Lokmanya Nagar
3.	Automotive Square to Kanhan River	MRTS Under Implementation from Automotive Square to Kanhan
4.	Prajapati Nagar to Transport Nagar	MRTS Under Implementation from Prajapati Nagar to Transport Nagar
5.	MIHAN to MIDC ESR	MRTS Under Implementation from MIHAN to MIDC ESR Butibori
6.	Lokmanya Nagar to Hingna	MRTS Under Implementation from Lokmanya Nagar to Hingna
7.	Vasudev Nagar to Dattawadi	Not Taken Up
b)	**Medium Capacity MRTS Corridors**	
8.	Katol Road	Not Taken Up
9.	Koradi Road	Not Taken Up
10.	Umred Road	Not Taken Up

<table>
<tr><th>SN</th><th>Proposal</th><th>Current Status</th></tr>
<tr><td>11.</td><td>Amaravati Road</td><td>Not Taken Up</td></tr>
<tr><td colspan="3">B) City Bus System Improvement</td></tr>
<tr><td>1.</td><td>
<table>
<tr><th colspan="2">Bus Augmentation</th></tr>
<tr><th>Year</th><th>No of buses required (LoS-1)</th></tr>
<tr><td>2018</td><td>2058</td></tr>
<tr><td>2021</td><td>2068</td></tr>
<tr><td>2031</td><td>2601</td></tr>
<tr><td>2041</td><td>3021</td></tr>
</table>
</td><td>The Nagpur Municipal Corporation currently operates about 100 electric and 237 diesel buses. Around 130 electric buses are to be inducted in the fleet soon while another 500 electric buses are under procurement process. The NMC aims to replace its entire fleet with electric buses by 2027.</td></tr>
<tr><td>2.</td><td colspan="2">
<table>
<tr><th>SN</th><th>Proposed Terminal and Depot Locations</th><th>Present Status</th></tr>
<tr><td>1.</td><td>Dattawadi</td><td>Not Taken Up</td></tr>
<tr><td>2.</td><td>Babulkheda</td><td>Not Taken Up</td></tr>
<tr><td>3.</td><td>Hingna</td><td>Integrated deport and terminal facility operated by MSRTC</td></tr>
<tr><td>4.</td><td>Katol Naka</td><td>Not Taken Up</td></tr>
<tr><td>5.</td><td>Takli</td><td>Not Taken Up</td></tr>
<tr><td>6.</td><td>Octroi Checkpost</td><td>City Bus Depot operated by NMC at Wadi Naka</td></tr>
<tr><td>7.</td><td>Patwardhan</td><td>City Bus Depot operated by NMC</td></tr>
<tr><td>8.</td><td>Wathoda</td><td>City Bus Depot under construction by NMC</td></tr>
<tr><td>9.</td><td>Teka Naka</td><td>City Bus Depot operated by NMC</td></tr>
</table>
Apart from the above locations Maharashtra State Road Transport Corporation (MSRTC) has terminal and depots at Ganeshpeth, Mor Bhavan, Butibori & Kamptee locations for regional operations. The terminal at Mor Bhavan and depots at Khapri Naka, Hingna Naka & Koradi facilitate City Bus operations.
</td></tr>
<tr><td colspan="3">C) Multi Modal Transit Hubs</td></tr>
<tr><td colspan="3">
<table>
<tr><th>SN</th><th>Proposed Multi-Modal Hub Location</th><th>Modes</th><th>Present Status</th></tr>
<tr><td>1.</td><td>Mor Bhavan/ Sitabardi Bus Terminal</td><td>High Capacity Mass Rapid Transit system
IPT System
City Bus Service</td><td>Implemented</td></tr>
<tr><td>2.</td><td>Ganesh Peth Bus Terminal</td><td>Regional Bus Service
City Bus Service
IPT System</td><td>Not Taken Up</td></tr>
<tr><td>3.</td><td>Chhatrapati Bus Terminal</td><td>High Capacity Mass Rapid Transit system</td><td>Implemented</td></tr>
</table>
</td></tr>
</table>

SN	Proposal		Current Status
		City Bus Service	
		IPT System	
4.	Ravi Nagar Bus Stop	High Capacity Mass Rapid Transit system	Not Taken Up
		City Bus Service	
		IPT System	
5.	Nagpur Railway Station	Regional Rail	Implemented
		High Capacity Mass Rapid Transit system	
		City Bus Service	
		IPT System	
6.	Kamptee Railway Station	Regional Rail	Not Taken Up
		High Capacity Mass Rapid Transit system	
		City Bus Service	
		IPT System	
7.	Ajni Railway Station	Regional Rail	Implemented
		City Bus Service	
		IPT System	
8.	Nagpur Airport	High Capacity Mass Rapid Transit system	Implemented
		City Bus Service	
		IPT/Airport Connectors	
D) Intelligent Transport System (ITS)			
1.	Automatic Fare Collection (AFCS) system		Implemented
2.	Electronic Ticketing Machine (ETM)		Implemented
3.	Validators		Implemented - Integrated with ETM
4.	Security Access Modules (SAM)		Implemented
5.	Integrated Control Unit (ICU)		Implemented
6.	Proposed Backend Sub-System		Implemented
E) Road Network Proposals			
Major Rings			
1.	Chandrapur Nagpur road – Tekdi Road		Implemented
2.	W High Court Road – Mescobagh raod – Dr Ambedkar road – Ajni Road		
3.	Inner Ring road		

SN	Proposal	Current Status
4.	Outer New ring	
Major Radials		
1.	Koradi Road	Implemented
2.	Kamptee road	
3.	NH-6 (Donargarh – Nagpur Road)	
4.	Taj Bagh Road	
5.	Wardha Road	
6.	Hingna Road	
7.	Amravati Road	
8.	Katol Road	
Rail Over Bridge		
1.	Boregaon	Implemented – Alignment of ORR has been modified during implementation. As per modified alignment, Rail Over Bridges constructed at four locations namely Bharatwada, Koradi, Uppalwadi Rd and Ranala.
2.	Mahadula	
3.	Suadevi	
4.	Kamptee	
5.	Kapsee	
F) Construction of Footpaths		
664 kms of roads are proposed to have footpaths		Presently the city has footpaths along about 200 kms of the road network.
G) Construction of Cycle Track		
1.	Wardha Road	Not Taken Up
2.	Hingna Road	
3.	Amravati Road	
4.	Katol Road	
5.	Koradi Road	
6.	Kamptee Road	
7.	C. A Road	
8.	Umred Road	
9.	Inner Ring Road	
H) Public Bike Sharing Scheme		
All the mobility corridors recommended for dedicated cycle tracks on both side of the roads with docking stations at each transit station (MRTS station, major bus station and Interchanges etc)		Not operational
I) Pedestrian Zones		
1.	Sitabuldi	Not Taken Up
2.	Mahal	
3.	Itwari	
4.	Sadar	

SN	Proposal	Current Status
J) Freight Management		
1.	Inner ring road	Implemented
2.	Outer New ring	Implemented
3.	Improvement of existing Transport Nagar	Not Taken Up
4.	Movement Restrictions of heavy vehicles in the city from 09:00am – 07:00pm	Movement restricted for heavy vehicles in the city from 08:00 AM to 12:00 PM and 04:00 PM to 09:00 PM.
5.	Development of new goods/truck terminal near Kapsi in proximity to the Outer Ring Road	One truck terminal being operated privately at Kapsi industrial area.
6.	Identification of a Mobility Corridor for Goods Vehicles, movement to be restricted completely on all other roads	Not Taken Up
7.	Complete ban on all animal carts being used for goods movement	Not Taken Up
8.	Setting up of truck terminals at the following locations • Koradi • Kamptee • Kapsi • Gumgaon • Gondakhari	• One truck terminal/ parking being operated privately at Kapsi industrial area. • Other locations not taken up • Apart from this, one truck terminal/ parking is being operated by Nagpur Improvement Trust (NIT) near Automotive Square on Kamptee Road.
9.	Segregated high speed goods vehicle lane on Ring Road	Not Taken Up
10.	Promotion of Use of small and medium size vehicles with modern emission controls in the central city areas	Use of E-Carts is now common in Nagpur central city areas.
K) Parking Management		
Proposed Pay and Park Locations		**Present Status**
1. Gaurakshan Rahate colony		Not Taken Up
2. Indian Gymkhanna ground		
3. Panchsheel chowk to lokmat chowk (Area below the fly over)		Free Parking Available
4. Area in front of Yashvant stadium		
5. Kachipura chowk to Creams Hospital (south)		Pay and Park Implemented
L) Junction Improvement Proposals		
1.	Shankar Nagar Chowk	Implemented

SN	Proposal	Current Status
2.	Golibar Chowk	Fly over under construction
3.	Indora Chowk	Fly over under construction
4.	Chatrapati Chowk	Implemented
5.	Variety Chowk	Implemented
6.	Ashok Chowk	Fly over under construction
7.	RBI Chowk	Implemented
8.	Medical Chowk	Implemented
9.	Jaystambh chowk near railway station	Fly over constructed, junction geometrics need to be improved.

1.8.2 CITY DEVELOPMENT PLAN FOR NAGPUR, 2041

A City Development Plan - 2041 for Nagpur was prepared in 2015 for the area under Nagpur Municipal Corporation. The CDP is an attempt to identify an integrated solution to the challenges facing the city. It recognizes the economic growth strategy as well as the actions that would be required by various agencies to ensure the sustainable development of the city. The CDP is the ULBs strategy that presents the vision of a desired future for the city, and the mission statements on how the ULB, together with other stakeholders, intends to work towards achieving this long-term vision. The City Development Plan incorporates the assessment of city on majorly four levels: Socio Cultural and Economic Environment; Physical Environment; Infrastructure Services and Institutions; Urban Poverty and Heritage.

The total area considered under the revised development plan being prepared by NMC is 235 sq. km. Of this, 217.6 sq km is under NMC jurisdiction, and the remaining 7.3 sq km is located outside NMC limits. An area of 17.7 sq km is earmarked for sewerage and drainage disposal schemes. NMC has divided the entire area into 10 planning units for preparing the development plan. The area of the newly merged census town is 7.3 sq km will also be added to the NMC area for future development under revised development plan. In order to improve the land use and conform to the required norms as per URDPFI guidelines, the Town Planning department has prepared the revised development plan for Nagpur.

The State Government formed Nagpur Metropolitan Area (NMA) in 1999. The metropolitan region includes Nagpur city, Nagpur Gramin (rural), Hingna, Parshivni, Mauda, and Kamptee tehsils and parts of Savner, Kalmeshwar, Umred, and Kuhi tehsils. The total metropolitan area considered for carrying out planning and preparing the land use plan is 3,780 sq km, excluding the Nagpur city area under NMC jurisdiction. Preparation of the land use plan for NMR was carried out in two phases. In Phase – 1, the land use plan for an area of 1,520 sq km has been prepared by NIT.

1.8.3 DETAILED PROJECT REPORT FOR NAGPUR METRO RAIL PROJECT, 2013

Detailed Project Report for Phase 1 corridors was prepared by DMRC in year 2013. The salient features of the recommended metro rail system and engineering are summarized below:

- Standard Gauge (1435 mm)
- Maximum permissible speed 80 kmph, Scheduled speed for North-South & East-West Corridors are 32-34 kmph and 30 kmph respectively.
- 3 Car rake with 25 KV AC, Overhead Current Collection System
- Signalling System - Cab signaling and continuous automatic train control with Automatic Train Protection (ATP)
- Automatic Fare collection system with POM and Smart card etc.
- Depot- cum- workshop near Khapri Station (MADC Land) and near Lokmanya Nagar Station (SRP Land)

TABLE 1.4 SUMMARY OF DPR PHASE 1

Description	Length (km)	Max. PHPDT						Stations (Elevated, At Grade)
		2016	2021	2026	2031	2036	2041	
Line 1 (North-South Corridor): Automotive Square to MIHAN	19.66	10089	10936	11915	12934	14286	15729	18 (15, 3)
Line 2 (East-West Corridor): Prajapati Nagar to Lokmanya Nagar	18.56	7746	8460	9154	9906	10748	11882	20 (20, 0)

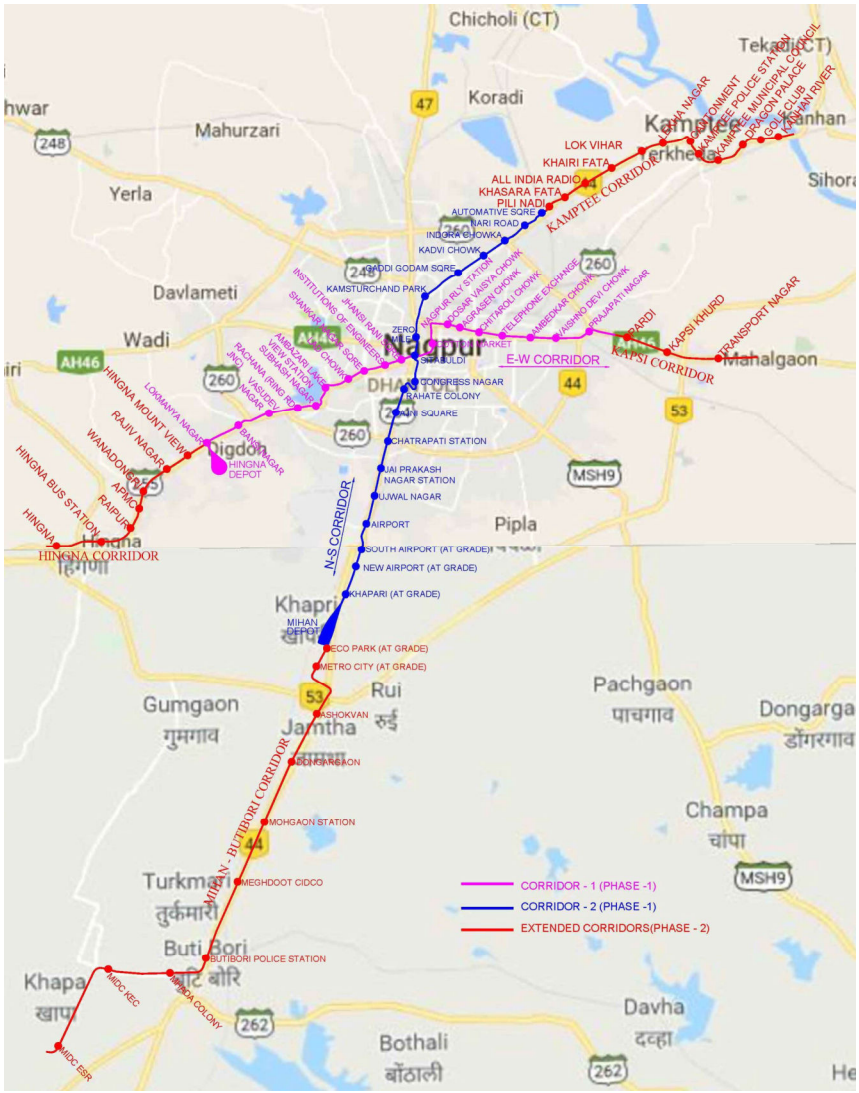
1.8.4 DETAILED PROJECT REPORT FOR EXTENSION OF NAGPUR METRO RAIL – PHASE 2

The Detailed Project Report for the extension of Nagpur Metro Rail in Phase 2 was prepared by Maha Metro in 2019. It was proposed to extend the following corridors in four directions. The total length of all four corridors is 43.7 km, with 32 stations. Out of 32 stations, 2 stations (ECO Park and Metro City) in Corridor 1A MIHAN to MIDC ESR are at grade, while rest of the stations are all elevated. The proposed corridors are presented in **Table 1.5** and route map has been shown in **Figure 1.4**.

TABLE 1.5 PROPOSED CORRIDORS IN PHASE-II

SN	Phase-II Corridor		Length (in km).	No. of Station
1	CORRIDOR-1A	MIHAN TO MIDC ESR	18.7	10
2	CORRIDOR-2A	AUTOMOTIVE SQUARE TO KANHAN RIVER	12.9	12
3	CORRIDOR-3A	LOKMANYA NAGAR TO HINGNA	6.7	7
4	CORRIDOR-4A	PRAJAPATI NAGAR TO TRANSPORT NAGAR	5.4	3
		TOTAL	**43.7**	**32**

FIGURE 1.4 PROPOSED METRO EXTENSION IN PHASE 2



The transport demand forecast has been assessed for the full system of Nagpur Metro i.e Phase 1 & 2. The maximum peak hour peak direction trips (PHPDT) for proposed metro corridors of Nagpur Metro Phase 1 & 2 are given in **Table 1.6.**

TABLE 1.6 MAXIMUM PHPDT ON PHASE 1 & 2 NAGPUR METRO CORRIDORS

Phase	Corridor Details	Maximum PHPDT		
		2024	2031	2041
1	Automotive Square to MIHAN	12952	13407	15743
	Prajapati Nagar to Lokmanya Nagar	10195	11411	16889
2	1A - MIHAN to MIDC ESR	3501	4387	5695
	2A - Automotive Square to Kanhan River	9012	9546	11445
	3A - Lokmanya Nagar to Hingna	3462	3887	5137
	4A - Prajapati Nagar to Transport Nagar	3511	3858	5213

1.8.5 SMART CITY PROPOSAL NAGPUR

The Smart City Report has been prepared by Nagpur Municipal Corporation envisaging all the aspects of infrastructure development. The Report has assessed the contemporary condition of the city and analyzed its comparative position with respect to the vision benchmarks. Transportation has been one of the prime aspects of development.

The major projects which will entail huge capex are in the field of improving the transportation facility in the area, tourism and heritage, waste water and sewage management, augmentation of water supply system, augmenting the electricity distribution and supply system, strengthening the social infrastructural backbone of the area, etc. The smart city proposal are summarized as below:

a. City Vision and Goals

Poly-Centric City: Converge the Nag Riverfront Development & Metro Rail projects to foster sub-center development in key locations such as Ambazari, Sitabuldi & Prajapati Nagar by 2025. Create Recreation & Economic facilities in the sub-centers through land-use restructuring to create a balance between economic & recreational facilities.

Safe & Walkable Streets: Develop inclusive, walkable & complete streets using contemporary street design & based on TenderSURE project; make streets accessible for children, women, senior citizens and the disabled. Create a safe city environment using technology & constant surveillance of crowded areas & busy streets.

Economic Vitality: Use land pooling mechanism to create real estate for logistics & warehousing in the eastern periphery of the city.

Transit Oriented Development: Encourage compact, mixed-use developments using the TOD policy for the Metro routes; redevelop at least one 50 acre area by 2025 on TOD principles. Shift Central Jail to the periphery of the city by 2025 to free up premium real estate space along the metro route; utilize PPP route to develop theme based facilities.

Connect Places and Move People:

- Create multiple & affordable modes of urban mobility using the 38 km metro network & a bus based PT system to capture 40% trip share by 2025.
- Develop pedestrian only market places like Sitabuldi and Itwari; one such pedestrian only market will be developed by 2020.
- Provide last mile connectivity through cycle tracks and public bike sharing systems; develop a demo zone of 100 Km of cycle tracks & 5 bicycle sharing kiosks by 2020; replicate and scale-up to entire city by 2030.
- Create walkable and cycle friendly promenades around water bodies such as

Gandhisagar, Futala and Ambazari lake-fronts.

Carbon Neutral and Sustainable Habitat: Replace conventional buses with 'green buses' to reduce carbon emissions.

b. Area-Based Proposal

Retrofitting in 951 acres of Pardi-Bharatwada-Punapur in the eastern periphery to make Nagpur a truly inclusive city by removing the dichotomous growth and enhance the city's profile by improving the quality of life in vulnerable areas to bring them at par with the rest of the city. By investing INR 876 Crore over five years, this will improve the quality of life of residents & resolve the regularization quandary & land-use conflicts.

This endeavor will result in

- An Eco-friendly, inclusive & low impact carbon neutral neighbourhood.
- A walkable, well-connected mixed-use area with public realm investments visible in its pedestrian boulevards, public spaces & buildings.
- A replicable example of leveraging the convergence of riverfront development and public transport (metro) projects to influence urban form & create vibrant sub-centers.

c. Pan-City Proposal

Unified Operations Command and Control (UOCCC) will be a unified platform for sub-systems of Intelligent Parking, Smart Traffic Signaling, Common Mobility Card, Emergency Response Service, Safety Surveillance & NMC's Utility Operations.

1.8.6 PARKING POLICY AND PARKING MASTER PLAN NAGPUR, 2016

The Parking Policy and Parking Master Plan was prepared by Nagpur Municipal Corporation in 2016. The study analyses the existing parking demand for various locations in the city and proposes various strategies based on the demand. The salient study findings are as below.

- In 2015, daily parking accumulation was highest at Eternity Mall Bus Parking (969 ECS during weekdays and 1628 during weekends), while Wardha Road had the lowest daily parking accumulation (129 ECS during weekdays and 109 ECS during weekends).
- Peak Hour Accumulation during weekdays was highest (313 ECS) at ST Bus Stand and lowest (14) at Tehsil Karyalay. During weekends, the highest accumulation (306 ECS) is observed at Gandhi Bagh Park and lowest (9 ECS) at Tehsil Karyalay.
- Total capacity in 2015 was 1427 ECS.
- The daily parking accumulation is projected to increase in 2025 to a total of 4830 ECS during weekdays and 6933 ECS during weekends, while the same

for peak hour is projected to increase to 1196 ECS during weekdays and 1160 ECS during weekends.

The existing and projected parking demand has been shown in the **Table 1.7** to **Table 1.8.**

TABLE 1.7 PROJECTED DAILY PARKING ACCUMULATION (WEEKDAY)

Location name	Type of parking	Capacity (ECS)	2015	2016	2020	2025	2030	2035
Mangalwari Bazar Rd	On-Street	160	574	608	765	1022	1369	1837
Tehsil Karyalay	On-Street	100	172	182	229	306	410	550
Gandhi Bagh Park	On-Street	320	244	258	324	432	579	777
Eternity Mall Bus Parking	On-Street	240	969	1026	1292	1727	2313	3104
Wardha Road	Off-Street	207	129	137	173	231	311	418
Sitaburdi Market	Off-Street	67	190	201	253	338	453	609
ST Bus Stand	Off-Street	333	433	459	578	774	1036	1391

TABLE 1.8 PROJECTED DAILY PARKING ACCUMULATION (WEEKEND)

Location name	Type of parking	Capacity (ECS)	2015	2016	2020	2025	2030	2035
Mangalwari Bazar Rd	On-Street	160	998	1057	1333	1784	2390	3207
Tehsil Karyalay	On-Street	100	352	373	469	627	840	1127
Gandhi Bagh Park	On-Street	320	395	418	527	705	945	1267
Eternity Mall Bus Parking	On-Street	240	1628	1725	2174	2907	3895	5224
Wardha Road	Off-Street	207	109	115	145	194	260	350
Sitaburdi Market	Off-Street	67	185	196	247	332	444	596
ST Bus Stand	Off-Street	333	216	229	288	384	514	689

Based on the demand, various policies and strategies for implementation have been recommended. The details are presented in **Table 1.9**.

TABLE 1.9 PARKING POLICY OBJECTIVES & STRATEGIES

SN	Policy Objectives	Strategies
1	Discouraging the use of private vehicles	• Promote the use of shared vehicles • Reclaim the public spaces • Public transit employee benefit program • Reduce the residential street width requirements • Introduce paid on-street parking • Eliminate parking minimums and establish maximums or parking caps • Decouple land use from off-street parking requirements

SN	Policy Objectives	Strategies
2	Relieving the congestion on roads	• Banning of excessive parking on roads • Increase the parking fee • Ensure that all the parking spaces are paid • Implement a zone based parking system • Restrict parking in transit-rich and dense areas • Enhance enforcement • Promote the use of public transport • Setting priorities for different parts of parking • Prioritize on street parking as the primary source for short term parking • Setting shared off-street parking as the primary source for long term parking
3	To ensure the safety of pedestrians	• Prevent the misuse of footpath for parking • Ensure that places for parking of vehicles are used for the purpose • Improve enforcement and control
4	To ensure safe and secure parking	• Create organized and regulated parking services • Licensing of parking lots • Permit only authorized vehicle parking holders to park in designated lots • Establish parking control center
5	Integrate parking with public transport and non-motorized transport	• Parking lot to be provided in major interchange hubs • Feeder service to be extended to all localities such that people are required to walk less than 250m to access the transport • Park and ride facilities for private vehicles only at major interchanges and for bicycles at all main stations • Implement way finding and signage improvements
6	Enabling appropriate pricing for various	• Sell parking as a luxury item • Price or tax off-street parking according to the market cost • Adopt appropriate technological solutions for fare collection • Create a demand management responsive • pricing structure for on-street parking • Implement an IT platform for registering, • paying and tracking • Use pricing to ensure an available space
7	Ensure the reduction in air pollution	• Implement emission based parking charges • Adopt building design guidelines • Change laws to enable controlled parking zones

1.8.7 OPERATION AND IMPLEMENTATION PLAN FOR FEEDER BUS SERVICE, 2016

An operation and implementation plan for feeder bus services for the Nagpur Metro was prepared by Maha Metro in 2016. In the study, A total of 38 routes have been

identified where 20 routes are falling along Prajapati Nagar – Lokmanya Nagar Corridor and 18 routes are falling along Automotive Square – Khapri Corridor. The average route length is of 5.53 Km and total route network length is of 210.17 Km. Out of the total 38 routes 27 are circular routes and 11 are point to point routes. A total of 31 metro stations are connected with the feeder service. Details of the routes with fleet size are presented in **Table 1.10**.

For the selection of type of vehicle, an alternate analysis was performed. Based on emissions and revenue earned, it is recommended that electric vehicles should be used for the services.

TABLE 1.10 ESTIMATED FLEET FOR VARIOUS ROUTES WITH FLEET SIZE

Route ID	Corridor	Route Type	Station Covered	Length (Km)	Vehicle Type	2018	
						Fleet Required (Peak Hr)	Fleet Required (Non-Peak Hr)
R-1	E - W	Circular	Prajapati Nagar	6.17	Mini Van	5	2
R-2	E - W	Point to Point	Prajapati Nagar	5.86	Mini Bus	3	2
R-3	E - W	Circular	Prajapati Nagar	4.37	Mini Van	3	1
R-4	E - W	Circular	Vaishnov Devi Chowk	7.11	Mini Van	3	2
R-5	E - W	Circular	Telephone Exchange, Dr Ambedkar Sq	5.1	Mini Van	4	1
R-6	E - W	Circular	Telephone Exchange	6.61	Mini Van	4	2
R-7	E - W	Circular	Telephone Exchange	3.77	Mini Van	2	1
R-8	E - W	Circular	Telephone Exchange	5.43	Mini Van	4	2
R-9	E - W	Circular	Agrasen Chowk, Dosar Vashya	3.18	Mini Van	8	3
R-10	E - W	Circular	Nagpur Railway Station	4.15	Mini Bus	6	3
R-11	E - W	Circular	Sitaburdi	4.12	Mini Bus	6	3
R-12	E - W	Circular	Institution of Engineers	4.35	Mini Van	12	7
R-13	E - W	Circular	Shankar Nagar, LAD Sq	4.49	Mini Bus	2	1
R-14	E - W	Circular	Shankar Nagar	3.54	Mini Bus	2	1
R-15	E - W	Circular	LAD Sq, Shankar Nagar	3	Mini Van	2	1
R-16	E – W	Point to Point	Ambazari Lake View Stn	4.1	Mini Bus	2	1
R-17	E - W	Circular	Subhash Nagar	5.58	Mini Van	2	1
R-18	E – W	Point to Point	Rachana	3.75	Mini Van	2	1
R-19	E – W	Point to	Bansi Nagar	6.85	Mini Van	6	4

Route ID	Corridor	Route Type	Station Covered	Length (Km)	Vehicle Type	2018	
						Fleet Required (Peak Hr)	Fleet Required (Non-Peak Hr)
		Point					
R-20	E – W	Point to Point	Lokmanya Nagar	5.22	Mini Bus	2	1
R-21	N – S	Point to Point	Automotive Sq	4.38	Mini Van	8	4
R-22	N - S	Circular	Automotive Sq	4	Mini Bus	2	1
R-23	N - S	Circular	Nari Rd	5.33	Mini Van	3	2
R-24	N - S	Circular	Nari Rd	3.41	Mini Van	2	2
R-25	N - S	Circular	Indora Chowk	5.15	Mini Bus	3	1
R-26	N - S	Circular	Indora Chowk	3.21	Mini Van	2	1
R-27	N - S	Circular	Kabdi Chowk	5.43	Mini Van	6	3
R-28	N - S	Circular	Gaddi Godam	4.71	Mini Van	2	1
R-29	N - S	Circular	Kasturchand Park	5.7	Mini Van	9	3
R-30	N - S	Circular	Zero Mile	6.62	Mini Van	8	8
R-31	N – S	Point to Point	Congress Nagar	9.32	Mini Van	32	22
R-32	N – S	Point to Point	New Airport	2	Mini Van	2	3
R-33	N – S	Point to Point	Chatrapati Sq	5.98	Mini Bus	4	2
R-34	N – S	Circular	Chatrapati Sq, Ajni Square, Jaya Prakash Nagar	6.34	Mini Van	8	2
R-35	N – S	Circular	Ujwal Nagar	5.67	Mini Van	6	4
R-36	N – S	Circular	Airport	2.18	Mini Van	2	3
R-37	N – S	Point to Point	Khapri	2.69	Mini Van	4	2
R-38	N – S	Point to Point	Khapri	31.3	Mini Bus	10	4
					Total Mini- Van	**151**	**88**
					Total Mini-Bus	**42**	**20**

1.6 STUDY APPROACH AND METHODOLOGY

1.9.1 APPROACH

Study approach will focus on delivering all the required objectives within the agreed scope and timeframe maintaining professional quality that will meet the Client's expectations and in confirmation to MoHUA Guidelines. We will be proactive to the needs of client and will provide professional staff having the technical ability and communication skill to successfully complete the project. We will maintain excellent communications with all project stakeholders including senior staff and key stakeholders. Our approach is collaborative and coherent to complete the project

within the time limit. The methodology has been developed after careful consideration of the project requirements outlined in the Terms of Reference (TOR) with an execution plan, direction and approach that is described in subsequent sections herein.

We will draw on our extensive experience in providing consultancy services for similar projects in different cities of India and overseas, and the general approach will be based on:

- Clear understanding of the project's wider objectives and the Terms of Reference (TOR)
- Clear understanding and appreciation of the local conditions based on site visits and previous experience in similar projects;
- An ability to rapidly mobilize suitable experts' team with proven success on other projects
- An appropriate work plan based on understanding of the important issues and likely time requirements
- Use of effective project management and coordination systems
- Development of a close association with client officials to ensure that matters are discussed openly and resolved quickly
- Establishing strong links and encouraging frequent and open communications with all concerned stakeholders, especially in relation to the finalization of the alignment, environmental and social assessments
- Preparing all reports in a format agreed with the Client and in line with Appraisal Guidelines for Metro Rail Project Proposals prepared by MoHUA in September 2017

1.9.2 STUDY METHODOLOGY

The study methodology includes details for carrying out activities/tasks and interaction with client and various agencies which are involved in the planning process at various stages of the project. It identifies a clear set of integrated actions to ultimately achieve efficient, safe, cost effective and environmentally sustainable mass transport system.

As per the Terms of Reference (ToR), principal areas of activity are primarily divided into six stages and further subdivided in to various sub tasks described as following:

- Stage I: Define objectives of Mobility Plan and delineate Planning Area and Horizon of Mobility Plan
- Stage II: Data Collection and Analysis of the existing Urban Transport Environment
- Stage III: Development of Business as Usual (BAU) Scenario
- Stage IV: Development of Sustainable Urban Transport Scenarios
- Stage V: Development of Urban Mobility Plan
- Stage VI: Implementation Plan

Stage I: Define objectives of Mobility Plan and delineate Planning Area and Horizon of Mobility CMP

The first task in preparing the CMP document consists of defining the objective, delineate the Planning Area and Horizon of Mobility Plan. This task includes the following tasks to cover the aspects of CMP:

- Define Objectives and Vision of the Mobility Plan
- Delineation of the Planning area and planning horizon
- Survey Plan
- Work Plan

1. Define Objectives and Vision of the Mobility Plan

The ultimate objective is to prepare the CMP and provide short, medium and long-term strategies as per the MoHUA guidelines guidelines 2017 and revised CMP toolkit 2014 for the desirable mobility pattern of the city's populace. The detailed objectives to promote integrated land use & transport planning including the development of urban transport strategies in line with the current National Urban Transport Policy (NUTP) have already been outlined in study objective section.

Vision statement for CMP has been formulated after careful examination of previous studies of similar nature including the Master Plan, City Development Plan etc. It is also in line with the objectives of National Urban Transport Policy (NUTP) and Appraisal Guidelines for Metro Rail Project Proposals prepared by MoHUA in September 2017.

2. Delineation of the Planning Area and Planning Horizon

The CMP addresses not only city transportation needs but also the needs for regional connectivity. Accordingly, as per the RFP document, the Study Area for this assignment is the Nagpur Metropolitan Area (NMA) (3567 Sq. km) as shown in **Figure 1.2.**

Planning horizon for CMP is 30 years i.e., till Year 2054. Improvements for Short, Medium and Long term will be proposed under the CMP for duration of 5 years, 10 years and upto 30 years respectively from the base year (2024).

The surveys will be carried out in line with CMP Toolkit (2014) as part of the CMP for study Area. The Plan will describe the locations, schedule, sampling approach, and staffing plan for each survey. The Inception Report will also include all survey forms that are used in the CMP Toolkit.

The detailed work plan has been prepared to achieve the objectives of CMP. Our study approach focuses on delivering all the required objectives within the agreed scope and timeframe maintaining professional quality. We will follow the collaborative and coherent approach to complete the project within the time limit.

SUBMISSION OF INCEPTION REPORT

All the activities/tasks listed above lead to the preparation of Inception Report. The submission will cover the following components:

i. Overall study background, study area, vision & objectives, scope of work, review of earlier studies
ii. Demographic and land use characteristics, existing transport network characteristics, city public transport and reconnaissance survey of study area
iii. Study methodology to be followed for preparation of CMP.
iv. Reconnaissance Survey to identify preliminary traffic and transportation issues in the study area.
v. Primary surveys to be carried out in the Study Area
vi. Work plan for the study to be followed and way forward.
vii. The Inception Report will be submitted and discussed with the client for approval.

Inception Report shall be submitted within 90 days *from date of start.*

Stage II: Data Collection and Analysis of the existing Urban Transport Environment

This task relates to database generation from primary and secondary sources to appreciate the existing urban transport and environment, issues, problems and constraints. The output of this stage will provide input for subsequent stages of the study:

3. Review of City profile, delineation of Traffic Analysis Zones and review of Land Use pattern and Population density

To study the present socio-economic profile & trends over a period of time of the City, the data will be collected from secondary sources on location, population and demographic data, land area, growth pattern and identification of notified areas, regional linkages, administrative boundaries, socio-economic data, Environmental issues, such as natural conservation areas, Urban Development and Urban Sprawl etc.

For the purpose of analysis and development of travel demand forecasting model, the Study Area will be subdivided into smaller areas known as Traffic Analysis Zones (TAZs). TAZs will be delineated taking into account various factors such as administrative boundaries, physical barriers like water bodies, railway lines, highways and homogeneous land uses. TAZs located inside the study area are called internal zones whereas TAZs outside the study area are termed as external zones. Analysis of trip interactions between internal-internal, internal-external, external-external and external-internal will be taken up on the basis of these zones.

A preliminary review of landuses in each TAZ will be carried out which will be linked with the data on population & employment collected as secondary data from various sources. CMP will rely on Master Plan, and City Development Plan as the prime data sources for reviewing existing and proposed land-use patterns. The area of TAZs and

the population figures will be used to derive the population density of each zone. The pattern of land use will be analyzed for percentage of land under each land use to arrive at ratio of residential land use and employment-generating land use, which has significant influence on travel distance and choice of walking, bicycle and public transport modes.

4. Review of the Existing Transport Systems

   A review of existing transport infrastructure and facilities will be done for each transport mode, including walking, bicycle, cycle rickshaw, shared auto-rickshaw, public transport, and any other prevailing modes. The review will include all types of facilities and amenities including pavement description, intersection treatments, lighting, parking space, parking cost and operation-related parameters.

   The available pertinent study reports, literature and database (from secondary sources & primary surveys) will be the basis for identifying problems and issues relating to traffic and transport problems in the City and its environs.

5. Data Collection Approach - Methodology and Sources

   All the relevant data, maps, documents and reports especially Master Plan, City Development Plan, etc. available with various stakeholders and other state/central government departments will be collected and compiled.

   The data regarding vehicle ownership, transport network, applicable transport policy and other available engineering parameters relevant to the assignment shall be collected. All other relevant information related to accidents, land use planning, mapping, right of way on key corridor shall be reviewed.

   Maha-Metro is expected to provide/facilitate to collect the required data for the study regarding the developments and current status to the RITES. The data to be collected from various secondary sources will include the following:

   - Ward/zone maps
   - Master/Outline Development/Physical Plans
   - Vehicle registration statistics and accident information
   - Landuse parameters such as population, employment etc.
   - Existing and proposed Transport Infrastructure details such as Road Network, Parking and Pedestrian facilities, NMT Lane, Freight Terminals etc.
   - Public Transport & Intermediate Public Transport details - Fleet, Routes, Schedule/Frequency, Fare etc.
   - Traffic safety and enforcement
   - Socio-economic characteristics
   - Goods Terminal Data - Origin & Destination, Commodity Type/Tonnage etc.
   - Gender and disable friendly facilities
   - Service Level Benchmarking
   - Planning norms, standards and relevant Acts
   - Institutional and financial situation

In addition to the secondary data collection from different agencies, various primary traffic & travel surveys will be carried out in the study area. The surveys are intended to update the available data and to appreciate the existing traffic flow, travel characteristics and patterns in different parts of the study area. The extents of surveys shall be decided based on the traffic intensity and travel patterns. The objectives of carrying out the primary traffic surveys are to provide the necessary information regarding:

- Present traffic flows on different links/nodes of the network
- Assessment of the level of service at different sections of the road network
- Identification of transport system management measures
- Data Input for Transport Demand Modeling

Following limited primary Traffic & Travel Surveys have been planned in order to update the CMP and to appreciate the existing traffic flows and estimate travel characteristics for the study:

- Road Inventory
- Speed and Delay Survey
- Classified Traffic Volume Counts
- Origin-Destination Survey at Cordons
- Pedestrian Survey
- Parking Survey
- Terminal Surveys
- Public Transport /IPT/Metro Station- Boarding and Alighting Survey and OD Survey
- NMT Opinion Survey
- Fuel Station Survey
- Household Interview Survey

6. Review of the Existing Travel Behavior

   Household Interview Surveys are the most reliable way of obtaining the information on existing travel behavior of the resident population in the study area. The survey is mainly intended to yield data on travel patterns and socio-economic characteristics of the households that influence trip making. Mode-wise details for each trip viz. purpose, journey time, frequency, fare, etc. together with data related to socio-economic aspects like age, education, income, and vehicle ownership will be collected. The travel details of the respondent shall include access mode to transit services, the egress mode from transit services, and “chaining” of sub-trips depending on individual/household circumstances.

7. Review of Energy and Environment

   In order to address the indicators of environmental impacts i.e. percentage of population exposed to air pollution, data on ambient air quality, will be collected. The other method proposed is to overlay transport network on a grid such that

emissions in a given cell will be estimated from Vehicle kilometer (VKM) in that cell. The VKM on the transport network links will be adopted from Travel Demand Model. Emission of PM, SO2, NOx for future years will be estimated using VKM forecasted by travel demand model using the Grid Overlay Method and respective emission factors. CO2 emission for future will be estimated using future Fuel Efficiency factors given in the tool kit.

8. Analyze Existing land-use transport situation

   The traffic situation shall be analysed based on secondary and primary data and issues shall be identified for the city. Data collected under above listed exercises will be collated under the specified service-level benchmarks (SLB) to understand the level of service provided to citizens of Nagpur. The SLB listed as under the CMP guidelines are as follows:

   - Public Transport Facilities
   - Pedestrian Infrastructure Facilities
   - Non-Motorized Transport (NMT) Facilities
   - Level of Usage of Intelligent Transport System (ITS) facilities
   - Travel speed (motorized and mass transit) along major corridors
   - Availability of Parking spaces
   - Road Safety
   - Pollution levels
   - Integrated Land Use Transport System
   - Financial Sustainability of Public Transport by bus

   Benchmark Analysis and Comparison with Indicators

   Transport indicators will be extracted from the data collected from primary and secondary surveys compare them with benchmarks under the SLBs listed above. The transport indicators will be broadly classified into following categories:

   - Indicators for mobility and accessibility
   - Infrastructure and land use
   - Safety and security
   - Environmental impacts
   - Economic (Response indicators).

   Stage III: Development of Business as Usual (BAU) Scenario

9. Framework for Scenarios

   Scenarios will be formulated to depict future growth and the needs and issues of mobility on the basis of data on traffic and travel characteristics collected through various secondary and primary surveys. The Business As Usual represents the future based on the continuation of past trends and will be used as a reference point for assessing the need for policy interventions. The BAU scenario will extrapolate

existing trends and will not assume any radical policy interventions for sustainable development and emission mitigation. However, infrastructure development and land use as depicted in the Master Plan will be considered under the BAU scenario. Future transport demand will be assessed under BAU, based on preferences of different socio-economic groups as revealed in the base year. In terms of passenger transport, the BAU scenario will predict increased car ownership and higher demand for motorization. The model for BAU will yield output on future transport indicators namely:

- Mobility and accessibility,
- Safety,
- Environment,
- Energy.

10. Socio-economic Projections

i. Demographic Projections

Demographic projection will include population projections for the city along with projection of rural and urban population. The population for each TAZ estimated will be used as the basis of demographic projections.

ii. Employment Projection

The jobs for each activity in a particular TAZ as collected, will be further projected for future years. The indicators for the BAU scenario will be analysed and compared to those estimated for the base year.

11. Land Use Transition

The land use type will be disaggregated into residential, commercial, retail, recreational, industrial, educational, religious, and other categories. Land use projections and allocations for the horizon years will be done in three steps. The first step includes the projection of socio demographics and the per capita space requirements for each activity in the city. The second step involves the allotment of activities based on connectivity and distances, as well as the availability of space. The third step includes the scope of the land use transition.

12. Transport Demand Analysis

The four-step model will be based on inputs of existing travel behaviour obtained from the household survey, and of transport infrastructure and service quality.

i. Transport Demand Model Framework

The four-step model approach for CMP will account for different purpose, gender and all modes of transport including NMT, intermediate public transport and public transport. VISUM software shall be used to develop the travel demand model for the Study Area. Details of the software are mentioned in **Table 1.11**.

TABLE 1.11 VISUM SOFTWARE SPECIFICATIONS

SN	Specification	Details
1.	Purpose	Traffic analysis, transportation planning, network modeling, and demand forecasting
2.	Key Features	Multi-modal transport modeling, Demand modeling, Network analysis, Scenario management
3.	Modeling Capabilities	Public transport, Private transport, Non-motorized transport
4.	Supported Data Formats	GIS data (e.g., shapefiles), CAD data, Excel, CSV, various traffic data formats
5.	Integration	Compatible with other PTV software like PTV Vissim, PTV Optima, and external data sources
6.	Visualization Tools	2D and 3D visualization, Thematic mapping, Interactive map-based interface
7.	Analysis Types	Static and dynamic traffic assignment, Cost-benefit analysis
8.	User Interface	Graphical user interface (GUI) with customizable toolbars and menus
9.	Support and Documentation	Extensive user manuals, online help, tutorials, and technical support

Adequate care will be taken in specifying the modeling parameters. Various stages of the modelling procedure have been explained in the following sections:

The base year travel demand model will replicate the road network and travel patterns of the city for testing of various short-term measures and to assess impacts of long term proposals to be formulated. The following table gives the input parameters and their data sources used for developing the base year model.

FIGURE 1.5 FOUR-STEP MODEL FRAMEWORK

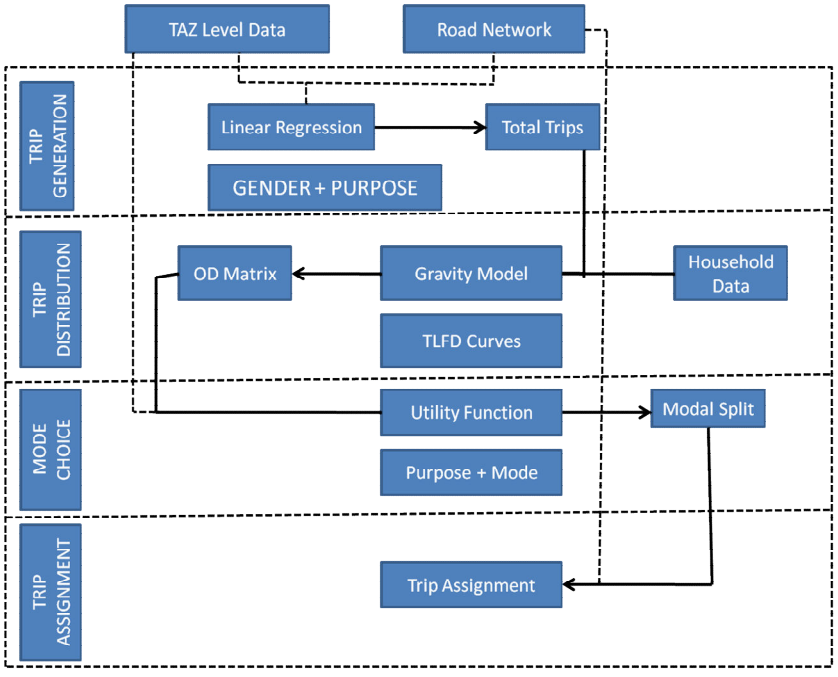


TABLE 1.12 MODEL INPUTS AND DATA SOURCE

SN	Model Input	Data Source
1	Traffic Analysis Zone Map	Ward Maps
2	Road Network	Data derived from Primary Surveys of Road Network Inventory and Speed and Delay
3	Trip Production Patterns	Household Interview Data and Land Use Data from Master Plan
4	Trip Attraction Patterns	Household Interview Data and Land Use Data from Master Plan
5	Trip Distribution	Household Interview data to calibrate the Gravity Model
6	Base Year Mode Shares	Household Interview Data
7	Trip Assignment	Network Calibration by Traffic Volume Counts

a. Trip Generation

Trip generation involves estimating the total number of trips produced and attracted to each TAZ. Trip production is dependent on socio-economic characteristics of households within the TAZ while trip attraction depends on the land-use type of the TAZ explained as follows:

Trip Production

Household interview data will be used to estimate the trip production for various types of households using the following steps:

- Purpose-wise trips (eg., Work, Business, Education, Others) produced in each household derived as a function of the socio-economic attributes of the household.
- Total number of households in each TAZ derived from the census data and number of trips produced will be estimated.
- The socio-economic characteristics of each TAZ will be derived from the household Interview data.

Trip Attraction

The number of trips attracted to each TAZ will be estimated in this step. The attractiveness of a zone is a function of the type of land-use of that zone as such, residential land uses produce trips while commercial, institutional and industrial areas typically attract trips. Land use data at the city level will be derived from the Master plan of the city.

Purpose-wise trips attracted to each zone from the household interviews will be correlated with land use types in each TAZ, using multiple linear regression technique. The attractions of each zone will then up scaled proportionally to the total attractions based on the total trips produced for each purpose.

Trip Distribution

Trip distribution is used to derive the Origin-Destination (OD) matrix from the Production Attraction (PA) table prepared in trip generation. Gravity Method will be adopted for trip distribution wherein trips between zone i and zone j (Tij) will be distributed in proportion to the number of trips produced in i, number of trips attracted in j and in the inverse proportion of the impedance between these zones i.e. travel time, travel cost, relative safety etc.

$$Tij = Pi\ [Ai\ Fij / \Sigma Aj\ Fij]$$

Where,

Tij = trips produced at I and attracted at j,
Pi = total trip production at i,
Aj = total trip production at j,
Fij = (friction factor) or computed using the TLFD curves
i = origin zone,
j = destination zone

Trip length distribution will be analyzed both purpose wise and mode wise, and the parameter found to be defining trip length distributions in greater clarity will be selected for trip distribution. If the type of mode will be found to be affecting the trip length more than purpose, mode share split will be carried out before the trip distribution. The following is the step wise procedure:

- The purpose wise peak hour trips are added up to get the total trips produced and attracted to each TAZ.
- The TAZ wise mode-share values will be derived from the household interview data and will be applied to the production attraction table to get the mode-wise production attraction for all zones.
- Current users: The mode share of public transport and cycles in each TAZ will be derived from the household interview data and will be used to derive the peak hour production attraction table for current public transport and cycling trips.
- Potential users: All the trips in the city form the potential public transport and cycle users in the city and it is important to model these trips in parallel to estimate their potential shift to public transport and cycles respectively.
- One of the features of the four-stage demand modeling process is that only the inter-zonal trips are considered for assignment. Hence, the proportion of intra-zonal trips in each TAZ will be calculated from the household interview data and these trips will be excluded from the demand modeling process.
- The production attraction table containing inter-zonal public transport trips will be used as the input for trip distribution.

For public transport trips, the generalized cost will be considered as impedance - worked out based on time taken for access, waiting, line haul, transfer, line haul and egress, and disutility of each of these in monetary terms.

b. Mode Choice

Mode choice models will be developed for all modes of transport including public transport and para-transit modes. The size of TAZ will be kept accordingly to cater to walk, bicycle trips and account for impact of access/egress trips on public transport.

- Mode Choice Equations

  A logit model function will be run to achieve the mode choice equations. Stated mode choice will be taken as the dependent variable, whereas the socio-demographics of the individual, built form indicators (at the trip's origin and end) and travel cost will be taken as the independent variables in the equation.

- Mode Choice for Walk and Bicycle

  One of the major differences in modeling NMT modes as compared to motorized modes is the impact of speed on mode choice. Speed of NMT (walk and bicycle) is generally constant and there is negligible impact of congestion. While other parameters like distance to be travelled, infrastructure quality, safety and security concerns have wider impact over mode choice of walk and bicycle. Along with the mode-related parameters individual socio-economic information needs to be accounted for modeling mode choice for NMT modes of transport.

- Mode Choice for Public Transport

  Utility of public transport has minimum three inter-related segments i.e. access trip, haul trip and egress trip. Studies have shown that access/egress trip has a significant impact over public transport as a mode choice. Accordingly, the utility function for public transport will be formulated involving waiting time and discomfort of changing modes other than mode related parameters for access/egress trip and haul trip.

c. Trip Assignment

This step will be performed to determine number of trips made by different modes on each of the existing transport network link during peak and off-peak hour period. Trip assignment for NMT will account to land use and density parameters in the vicinity of the infrastructure/facility. Trip assignment for bicycle will include parameters related to traffic volume and speed.

The person trip OD matrices for current and potential users will be converted to vehicle trips based on the average occupancy observed in each mode from the occupancy survey carried out in the city. The mode wise OD matrices from Outer Cordon survey will be added to the OD from trip distribution and mode choice steps to develop the overall OD matrix of the city.

The mode-wise calibrated OD matrices derived from the above step will be assigned on to the road network using Capacity Restraint method. Since most links are assumed to have enough capacity for cyclists and since cyclists are sensitive to safety and security issues more than the speed, All or Nothing (AON) method will be adopted for cyclists. AON method will be used by considering the travel distance between ODs of the cyclists as the determining factor for route choice.

d. Model Validation

The link flows observed from trip assignment will be compared with the actual traffic flows observed from traffic volume counts conducted at various locations across the city. In case the observed and derived values do not match, the OD matrix will be re-calibrated till a tolerable variation is achieved. Using this procedure, the Transport Model is calibrated to match the actual volume counts observed on ground.

13. Technology Transitions

An understanding of vehicles, fuels and CO2 emissions from electricity use in transportation system is essential to considerate the implications of travel demand on CO2 emissions and air quality.

14. Model Framework

The framework for sustainable urban mobility will utilize the four strategic levers: Urban form, Non-Motorized Transport (NMT), Public Transport and Technology. The framework will study the impacts of alternative strategies using key indicators for mobility, safety, and local environment, as well as more aggregate indicators like CO2 and energy use.

Stage IV: Development of Sustainable Urban Transport Scenarios

15. Framework for Scenarios

The sustainable Urban Transport scenario visualises social, economic, environment and technological changes including Green House Gas Emission indicators, use of efficient fuels and vehicles and use of NMT & PT. This framework contained in the CMP tool kit is confirmed.

The main drivers will be socio-economic projections, land use, infrastructure and policy change. The socio-economic projections in the BAU scenario will be used, however for changes in land use, infrastructures and policies need some improvement. Model framework for Sustainable Urban Transport Scenarios, will be same as used for the Business As Usual scenario.

16. Strategies for Sustainable Urban Transport Scenario

CMP will identify investment priorities to help achieve the sustainable city goals. The sustainable scenarios will also assume an increase in motorized transport to some extent, which is inevitable given the low level of vehicle use on a per capita basis. Therefore, emphasis will also be placed on improving technology in terms of

efficiency and emissions. Key strategies can be typically classified into four categories namely:

- Change in urban structure,
- Improving non-motorized transport,
- Improving public transport, and
- Technological changes

These strategies are essential for developing Smart Cities and will deliver full benefits if they are implemented collectively; however, for analysis it will be useful to present them one by one to see the individual effect.

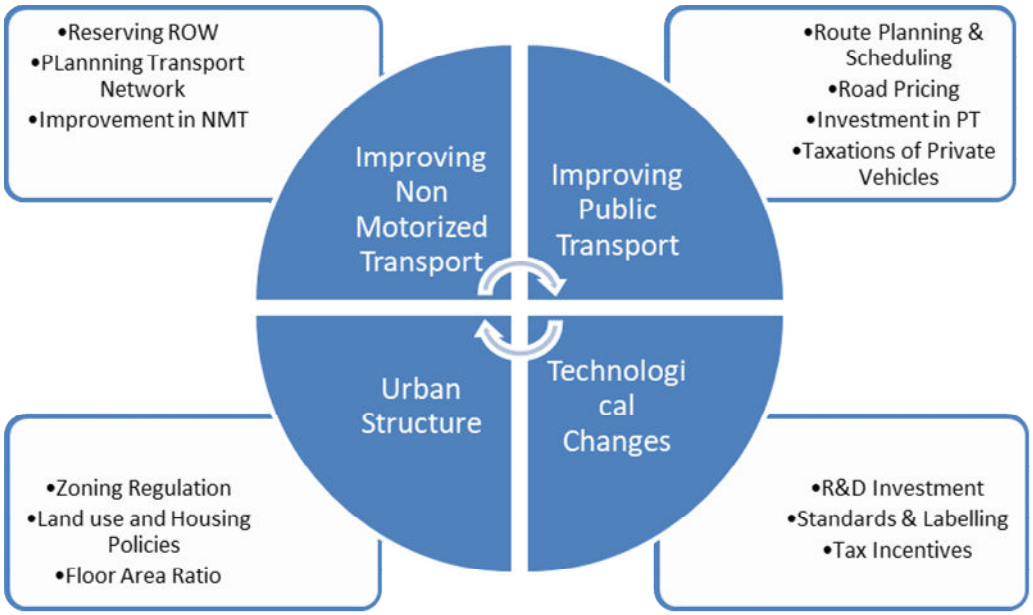
I: Urban Structure

Urban sprawl and uncontrolled growth of cities result in increased trip lengths, which is not a desirable scenario. The focus of the CMP will be to develop compact city with high density and multi-nuclei development. It will help shorten trip lengths and improve access to public transport.

ii: Non-Motorized Transport Infrastructure

The scenario considers improvements in NMT user experience by enhancing footpaths and bicycle lanes. It also addresses improvement in safety and accessibility for pedestrians and bicycles at intersections. Reducing barriers and impediments on roads to improve bicycle safety is another aspect considered under the scenario. Reduced conflicts between NMT users and buses on roads will also result in a increase in bus speed.

FIGURE 1.6 FOUR BROAD STRATEGIES AND ACCOMPANYING POLICIES FOR SUSTAINABLE SCENARIOS



iii: Public Transport

An assessment will be made about the quality of service of the present public transport services in the study area. If it is found that the city lacks a reliable bus service, a scenario of improved bus service with compatible pedestrian and bicycle

infrastructure for public transport will be considered. This scenario assumes that bus infrastructure and operations are improved so that reliable bus service is available at least along all arterial roads. Stress will be given to the provision of access and egress support infrastructures for walking and bicycle. The above-mentioned changes will be used to check the stated preference mode choice of respondents in the household survey. This will help compute the increased demand for public transport in the scenario where limitations of infrastructures (which exists in the BAU scenario) for public and non-motorized transport are removed.

iv: Improving Public Transport, NMT and Urban Structure

This scenario looks at how the implementation of NMT, public transport and urban structure strategies combine and complement each other.

v: Technology

Technology changes will encompass changes in vehicles design, fuels use, energy use and reduction in CO2 emissions related to electrically driven vehicle based on central / state policies.

vi: Regulatory and Financial Measures (Incentives and Disincentives)

Regulatory and financial measures are undertaken to promote shifting of people from private transport modes to sustainable urban transport. These measures will internalize the cost of externalities imposed by private vehicles in the form of parking policies, congestion pricing and carbon-taxes by central / state decisions. These will be incorporated in the model in form of increased generalized cost of travel by private modes.

CMP will identify investment priorities to help achieve the sustainable city goals. The sustainable scenarios will also assume an increase in motorized transport to some extent, which is inevitable given the low level of vehicle use on a per capita basis. Therefore, emphasis will also be placed on improving technology in terms of efficiency and emissions. Key strategies can be typically classified into four categories namely:

Based on above strategies, the likely sustainable urban transport scenarios which shall be developed for the Study are as under –

- BAU+LU (Business as Usual + Landuse) - In this scenario an alternative pattern of city growth in terms of land use parameters is envisaged.
- BAU+LU+PT (Business as Usual + Landuse + Public Transport) - In this scenario a PT system is introduced to reduce the private vehicle trips and carbon footprints
- BAU+LU+PT+NMT (Business as Usual + Land use + Public Transport + Non-Motorised Transport) - In addition to above, a safer walking and cycling infrastructure is recommended to be provided in this scenario
- BAU+LU+PT+NMT+Technology (Business as Usual + Land use + Public Transport + Non-Motorised Transport + Technology) - This scenario shall explain the likely impact of improving future vehicle and fuel technologies in the transport system. In addition, some regulatory measures could also be introduced.

17. Transport Demand Analysis of Alternative Strategies for Sustainable Urban Transport

The aim of above scenarios will be to improve transport infrastructure and increase the cost of using personal motorized vehicles. The method used to estimate travel demand for different modes under alternative scenarios is given below:

A four-step modeling is repeated, taking into account changes in parameters associated with different modes such as cost, travel time, availability, comfort and safety. These changes result in changed impedance to different modes and consequently, changes in people's transport choices. Likely changes to be accounted in the four-step model in alternate scenarios are described in **Figure 1.7** & **Table 1.13**.

FIGURE 1.7 SUSTAINABLE URBAN TRANSPORT SCENARIO

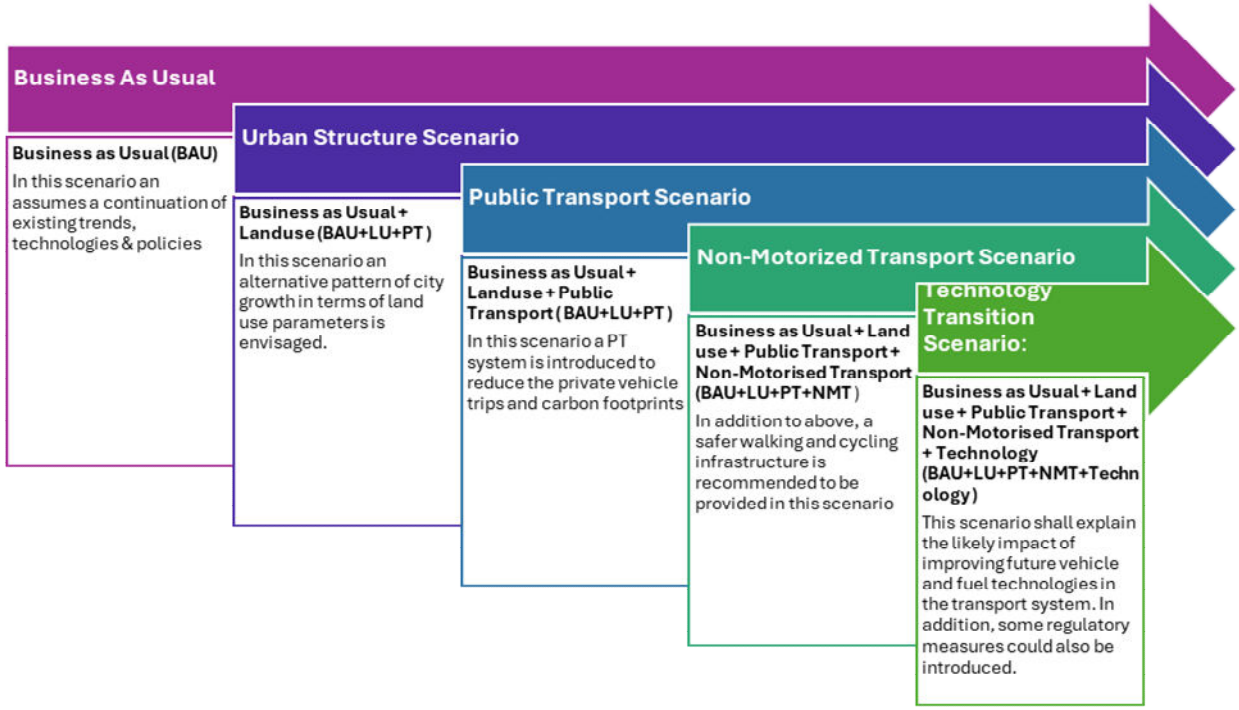


TABLE 1.13 DIFFERENCES IN FOUR STEP MODEL FOR ALTERNATIVE SCENARIOS

	Change Due to	Urban Structure	NMT Infrastructure	Public Transport	Technology	Regulatory & Financial Measures
Trip Production	Age-sex distribution and population growth	Population distribution in city				
Trip distribution	Change in land use parameters and change in impedance for	Distribution of activities (Residential, commercial		Change in impedance (Travel time, travel		

	Change Due to	Urban Structure	NMT Infrastructure	Public Transport	Technology	Regulatory & Financial Measures
	different modes	and industrial)		cost, accessibility and reliability)		
Mode choice	Change in impedance and trip length		Change in impedance (Bicycle Compatibility Index and similar for pedestrians)		Change in travel cost	Change in travel cost by different Traffic modes
Trip assignment	Change in impedance					

18. Technology Transitions under a Low Carbon Scenario

    One of the strategies for sustainable Urban Transport scenario is technology changes encompasses changes in vehicle design, fuel use, energy use and reduction in CO2 emission related to electricity.

    Decrease in CO2 emissions from fossil fuel vehicles and increase in Grid emissions – both resulting from increased use of electric vehicles will be estimated. Decrease in emissions due to use of improved fuel and vehicle efficiency is already reflected in emission factors of Annexure 6 of CMP toolkit.

19. CO_2 Emissions and Air Quality

    The model framework for sustainable urban transport scenarios will be same as the BAU scenario for estimating CO2 emissions and air quality.

1.9.3 SUBMISSION AND APPROVAL OF MRTS ROUTE IDENTIFICATION AND RIDERSHIP REPORT

All the activities listed above till task 19 will lead to the identification of MRTS routes and ridership including the station location. The Report will include Review of City profile, delineation of Traffic Analysis Zones and review of Land Use pattern and Population density, Review of the Existing Transport Systems, Data Collection Approach - Methodology and Sources, Study of Existing Travel Behaviour, Review of Energy and Environment and Analysis & Indicators, Travel Demand Modelling, Major travel corridors & ridership for MRTS.

Report on Identified MRTS Routes & Ridership shall be submitted within 150 days from date of start.

Stage V: Development of Urban Mobility Plan

Based on the analysis of existing urban transport, BAU scenario, preferred land use

and transport scenario vision and strategy for development, urban mobility plan for the city will be prepared. The mobility plan will provide alternatives to enhance mobility for all users and all modes of travel. If possible, the urban mobility plan will suggest changes in the existing urban structure and form that encourages an increased use of public transport, walking and NMT.

The mobility plan will be the city's long-term blueprint for improving accessibility and mobility. The aim of the mobility plan will be to develop an adequate, safe, environmentally friendly, affordable, equitable, comfortable, efficient integrated transport system within the framework of a progressive and competitive market economy. It will attempt to create a well-connected network of complete road hierarchy, suggest measures to shift from unsustainable mobility to sustainable modes and integrate freight planning with urban transport.

The CMP will aim to plan for the people rather than vehicles by providing sustainable mobility and accessibility for all citizens to jobs, education, social services and recreation at an affordable cost and within reasonable time. The plan will be defined along the following lines:

20. Integrated Land Use and Urban Mobility Plan

National Urban Transport Policy (NUTP) has emphasized the integrated land use and transport planning. Urban structure determines the travel demand and transport system influence the urban structure. Location of various land use and activity nodes have influence on travel pattern.

At the same time, the transport nodes or hubs impact the allocation of landuse both at the city and local level. As such, integrating urban development with transport will be the key consideration towards compact and sustainable development of cities. Thus, elements for land use transport integration would be as follows:

- Enabling urban structure
- Completing the hierarchy of roads
- Aligning public transit with high density areas, mixed land use to capture the land value
- Integrating multimodal transit interchange and planning integration at vertical and horizontal level

Integrating land use with the urban mobility plan would entail a two-way interaction between the two plans. High density residential areas intertwined with high density employment areas, along with increased travel costs and an efficient public transport system will incite people to use NMT for short trips and public transport for long ones. The land use will be allocated in a manner that encourages short and fewer trips, thereby enabling improved accessibility to activities. This will also help people shift from private travel modes such as cars to NMT (including cycling and

walking).

Additionally, to encourage NMT, neighborhood design measures such as pedestrian footpaths and cycling tracks will be proposed. To summarize, the land use plan will locate activities in a manner that encourages low-carbon mobility and the urban mobility plan, in turn, should facilitate access to activities.

21. Formulation of Public Transport Improvement Plan

Public Transport Improvement Plans will be divided into a number of sections, including service improvements for buses and para-transit, appropriate MRT options and infrastructure development plans and intermodal integration plans.

Improving the public transport will involve infrastructural improvements like reserving lanes and tracks and improvement in level of service to not only maintain the existing modal share of public transport but also create a shift from other modes to public transport. A progression towards public transport technology will be suggested from the low-carbon point of view. System planning will consider not only where terminal, routes and stops are placed (i.e. routes and stops), but also consider the aspect of accessibility for pedestrians, cyclists, differently-abled, elderly people, and private vehicle users availing park and ride facilities.

22. Preparation of Future Road network Development Plan & NMT Facility improvement Plan

- **Road network development Plan**

CMP will list out road projects which need to be developed, strengthened, upgraded and interconnected including hierarchical road network, arterial road construction / widening projects, secondary road construction / widening projects, intersection improvement projects, flyover projects, railway over bridge or underpass projects. The hierarchical road network will be based on travel demand. The road network development plan will include inter-city connectivity and also consider the connectivity within study area. In addition to assigning hierarchy to the road network derived from its land use, urban roads will be assigned functions as streets. As the availability of additional road capacity often induces new travel, the induced demand will be considered for project cost and benefit.

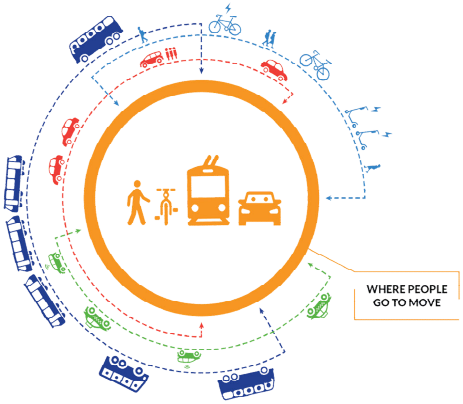
- **NMT Facilities**

Considering that the high number of trips in Indian cities are NMT, CMP will prioritize road space for NMT. As per the MoHUA guidelines, despite the latent

demand for motorized vehicle use, proposals to improve motorized vehicle mobility by increasing road space under the pretext of easing congestion will be discouraged as much as possible. New construction/ widening projects, flyover projects and underpass projects will also be discouraged.

As a large proportion of urban travel involves using NMT modes, specific streets and the street types will be identified which are preferred by individuals when walking or using a bicycle. Due consideration will be given to forming a network of NMT. An attempt will be made to ensure that all roads where individual are likely to walk should include at least 2 meters of clear, walkable footpath, all potential walking or bicycling locations should have NMT infrastructure, including comfortable footpaths, cycle tracks, streetlights, cycle stand, formal pedestrian crossing and NMT-designed signals at all junctions. Access to activities and transport services will also be taken into account. The design of these facilities will be inclusive and will provide travel opportunities to all sections of the society. NMT improvement plans and traffic management measures will be worked out for CBD, commercial centers, and other major activity centers. These detailed plans will define NMT policy for the whole region. Traffic management for major activity centers and city level infrastructure planning for pedestrians and cyclists will also be taken up.

23. Preparation of Mobility Management Measures



Traffic management plans will cover parking management plans, traffic control measures, intermodal facilities, demand management measures, traffic safety plan and ITS. Mobility management measures will be suggested in the CMP to enable enhanced use of public transit and NMT modes. Additional measures will be added to increase the cost of using personal motorized travel, including the taxation of cars and fuel, land use planning that encourages shorter travel distances and traffic management by reallocating space on the roads.

24. Preparation of Regulatory and Institutional Measures

Effective development of urban land use and transport systems often requires regulatory and institutional changes. Such requirements shall be suggested in the CMP. These measures can be developed region-wide/ city wide or be project specific. The regulatory and institutional plan may include the following:

Regulatory measures in relation to:

- Bus service improvement (concession, privatization, and lease contract);
- Traffic safety improvement (traffic regulation, mandatory road user education, enforcement systems);
- Introduction of Transport Demand Management (TDM) measures;

- Vehicle emissions (focus on non-fuel based vehicles and compressed natural gas/CNG vehicles);
- Public-Private Partnerships (PPPs).
- Institutional measures in relation to:
  - Coordination mechanism to integrate public transport operation and to integrate fares;
  - Establishment of Unified Metropolitan Transport Authorities (UMTA); if not in place earlier
  - Establishment of SPVs for the implementation of proposed projects; and other changes necessary to promote PPPs.

2. Development of Fiscal Measures

Fiscal measures shall also be considered to achieve a balanced modal split, and to secure the budget necessary to implement urban transport projects. As fiscal measures usually correspond to institutional and regulatory measures, the following aspects will be examined:

- Fare policy for public transportation, and parking.
- Subsidy policy for public transport operators.
- Taxation on private vehicles and public transport vehicles; and
- Potential for road congestion charging.

25. Mobility Improvement Measures and NUTP Objectives

The land use and transport measures proposed in the CMP will improve the mobility in the study area and cover the critical issues addressed in the NUTP. A table will be prepared summarizing the relationship between the NUTP objectives and the measures proposed in the study, together with a classification of the measures according to their implementation timeframe (immediate, short, medium and long term) as per the provision of NUTP.

Stage VI: Implementation Plan

26. Preparation of Implementation Programs

CMP will provide broad guideline prioritizing various projects for the measures identified into the following categories:

- Short term (2-5 years)
- Medium term (5-10 years)
- Long term (more than 10 years)

27. Identification and Prioritization of Projects

All the projects will be presented to the city stakeholders and the implementing agencies to identify the priority of the projects. The project list will merely be a description of priority projects whereas detailed project reports (DPR) with cost

estimates and financing will have to be prepared by the city authorities separately and approved by the urban local body and state government before seeking funding from the MoHUA or any other agency.

28. Funding of Projects

    The various project-funding options would be assessed, identifying the projects amenable to PPP and those that can be implemented based on the government sources of funding from the city, State Government and Central Government schemes. Alternative and innovative sources of funding will be identified to reduce the investment by various Government agencies.

29. Monitoring of CMP Implementation

    CMP is the basis for approving projects, plans and various regulatory measures within the city related to transport and it is therefore important to monitor and measure the impact of interventions. Agencies responsible for implementation of the projects and monitoring the progress of implementation of urban transport projects will be identified.

SUBMISSION OF DRAFT CMP REPORT

All the activities listed above, will lead to the preparation of Draft CMP Report. The Report will include all the recommendations as per MoHUA Toolkit. The Report will include all the medium and long-term measures along with immediate/ short term measures.

The Draft CMP shall be submitted within 225 days from date of start.

30. Stakeholders Consultation

    Stakeholders' consultation will be done after the submission of Draft CMP.

SUBMISSION OF FINAL CMP REPORT

The comments/ suggestions received in Stakeholder consultation will be incorporated and Final Report will be submitted within 15 days after comment and suggestion on Draft CMP report received from the client/stakeholder meeting.

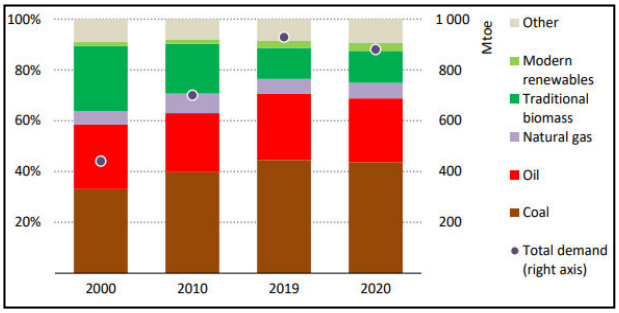
1.7 REVIEW OF ENERGY AND ENVIRONMENT

Primary Energy Demand

India's energy demand has tripled over the last three decades: the share of traditional biomass has fallen, leaving coal and oil dominant can be seen from **Figure 1.12**. As per Statistical review of world energy-2021," India's primary energy consumption fell by 5.9% in 2020, the first fall in consumption this century due to the corona virus pandemic. The combined share of energy consumption from oil, gas and coal fell from 90.6 to 89.7% and for renewable increased from 3.9 to 4.5%." With increased access to modern energy, the share of biomass particularly, non-commercial biomass is

expected to decline fast in the coming decades and will get replaced by other sources of modern and commercial energy. Coal will continue to remain predominant among all other commercial sources of energy in India until the foreseeable future because of its cost advantage relative to other energy sources.

FIGURE 1.8: TOTAL PRIMARY ENERGY DEMAND IN INDIA



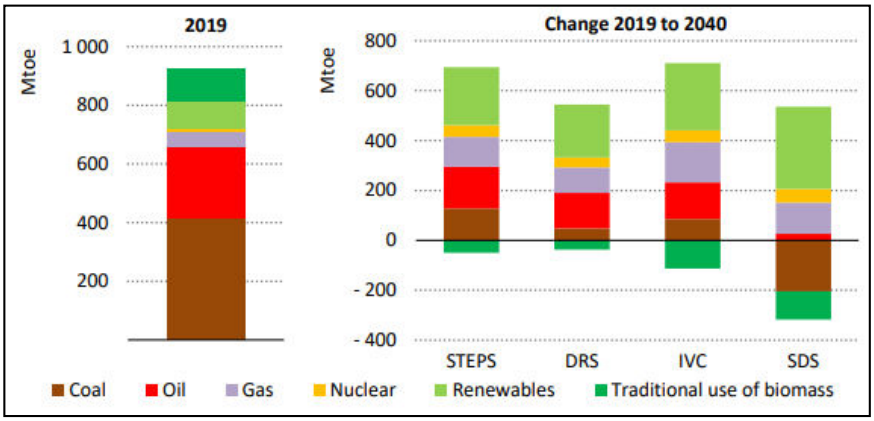
Source: India Energy Outlook 2021

Oil demand has more than doubled since 2000 as a result of growing vehicle ownership and road transport. LPG has also contributed to the growth of oil demand; transport energy demand grew 3.5 times as per India Energy outlook 2021.

Transport and industry sector account for a major share of total final energy demand, boosted by urbanization. The movement of freight across different cities of India to support domestic manufacturing will drive energy demand in the transport sector.

In terms of energy consumption, transportation is currently the fastest expanding end use industry, and urbanization will encourage even more expansion. Increasing demand for transportation in many Indian cities has resulted in traffic congestion and poor air quality. This has sparked a slew of regulatory efforts aimed at improving fuel efficiency and quality, as well as mass transit and transportation electrification. However, current policy policies are insufficient to avoid a huge, anticipated growth in oil consumption for road transport. Total primary energy demand in India by fuel and scenario from year 2019 to 2040 is given in **Figure 1.9.**

FIGURE 1.9: TOTAL PRIMARY ENERGY DEMAND IN INDIA BY FUEL AND SCENARIO



Source: India Energy Outlook 2021

Air Quality in Nagpur

The Central Pollution Control Board (CPCB) monitors Ambient Air Quality at various places in Nagpur. The Ambient Air Quality data is available from 2019 to 2023 is summarized in **Table 1.19**.

TABLE 1.14: AIR QUALITY DATA FOR NAGPUR

SN	Year	Air Quality Index
1	2019	100.6
2	2020	73.2
3	2021	77.9
4	2022	107.2
5	2023	130.1

Source: Central Pollution Control Board

The table shows the trend of the Air Quality Index (AQI) over five years from 2019 to 2023. In 2019, the AQI was recorded at 100.6, indicating moderate air quality. In 2020, there was a significant improvement, with the AQI dropping to 73.2, which could be attributed to reduced industrial activity and transportation due to pandemic lockdowns. However, the AQI increased slightly to 77.9 in 2021 as activities resumed. This upward trend continued into 2022, with the AQI rising to 107.2, suggesting a decline in air quality. By 2023, the AQI reached 130.1, the highest in the period, reflecting a concerning increase in air pollution levels over the years.

1.8 MAJOR ATTRACTION CENTERS

Deeksha Bhoomi

Deekshabhoomi is a Buddhist religious place located in Nagpur. It holds significant reverence as a sacred destination, attracting millions of pilgrims annually, particularly on Dhamma Chakra Pravartan Din or the Samrat Ashoka Vijaya Dashmi, observed on October 14th. The largest stupa globally stands in honor of his memory at Deekshabhoomi.

Butibori MIDC

At around 30 km from Nagpur, towards Hyderabad, an industrial estate has been established at Butibori within the area of 2,500 hectares (ha). Currently, 1,757 ha have been developed and approximately 722 units are operational. If the MIHAN project is completed in the near future, it would support the growth of export-related industries within the MIDC premises. This would further boost the economy of Nagpur city and would create huge employment opportunities within the region.

Hingna MIDC

Hingna MIDC estate was developed in 1962 and is located 7 km from Nagpur city. Several engineering industries, electrical-based industries, food-based industries, etc.,

are located in this Industrial area. The Maharashtra State Electricity Board (MSEB) has established two sub-stations in the estate area. To facilitate the industrialists and workers, amenities like a post office, banks, a police station, petrol pumps, canteens, and bus services are available in this area. In Hingna MIDC, about 1,266 units are operational.

Medium, Small, and Micro Enterprises/Industries (MSME)

Nagpur district has a number of small- and medium-scale industries. Most of the small-scale industries in the region are engaged in engineering and agro-based production. Majority of them are fabrication workshops; re-rolling mills; foundries; and manufacturing of steel furniture, auto parts, and machinery and machine parts. These small-scale industries provide employment opportunities and contribute towards the economic development of the region. As per the MSME Report on Nagpur, around 3.5 lakh people are engaged in the MSMEs. Approximately 41% of these workers are employed in the public sector enterprises, while 59% are employed in the private sector.

MIHAN

MIHAN is a state government initiative to support the economic development in and around Nagpur region. MIHAN is a composite project consisting of international airport and an SEZ. The project will be developed over an area of 4354 ha and will be developed by Maharashtra Airport Development Company Ltd. (MADC).

MIHAN comprises an international passenger and a cargo hub airport, a road terminal, a rail terminal, a health city, international schools, an SEZ, and various facilities. The MIHAN project is under implementation and is estimated to cost around Rs. 2,580 crores (as per 2002 rates). Multiple companies have started their operations at MIHAN. About 50 companies have acquired land and about 1000 people are already working in MIHAN. The MIHAN SEZ is proposed to attract various industries like IT, gems and jeweler, pharmaceuticals, processed food, health, garments, electronic goods, and other types of industries.

Tertiary markets

Along with formal economic activities there are markets (both formal and informal), which are part of Nagpur's economic profile and provide employment to many people. There are various types of markets like retail and wholesale and further it can be classified based on the goods that are sold in these markets. Some markets are held on daily basis, and some markets are held on specific days only. These markets are regularized by NMC and is maintained by the Market department with a dedicated team. Various NMC authorized markets held in the city are Gokulpeth Bazar, Somewaripeth Bazar (Budhwari Bazar), Netaji Market, Supermarket Sitabuldi, Mahatma Phuley Bazar, Mahal Bazar, Itwari Bazar etc. Major attraction centres in Nagpur are shown in **Figure 1.14**.

FIGURE 1.10: MAJOR ATTRACTION CENTERS

	
Sitabuldi	Deeksha Bhoomi
	
MIHAN	Hingna MIDC
	
Butibori MIDC	Mahatma Phuley Bazar
	
Narrow Gauge Rail Museum	Ambazari Lake

1.9 COMPOSITION OF REPORT

This 'Draft CMP Report' has five chapters covering the following topics:

1. **Chapter 1** describes the mobility principles, national urban transport policy, study area, vision & objectives of mobility plan, review of available resources, approach and methodology of the study.

2. **Chapter 2** reviews the city profile, primary traffic & travel surveys data and its analysis, review of energy and environment.

3. **Chapter 3** gives the development of Business as Usual (BAU) Scenarios and Sustainable Urban Transport Scenarios as part of travel demand assessment.

4. **Chapter 4** envisages the urban mobility plan, proposals of road network development, terminals, NMT, public transport, freight, regulatory & institutional measures, environment & social impact assessment and recommends comprehensive mobility plan along with impact of the proposed measures on service level benchmarks.

5. **Chapter 5** gives the implementation plan of the recommended projects, phasing, broad cost estimates and economic and financial.

Chapter – 2
REVIEW OF CITY PROFILE

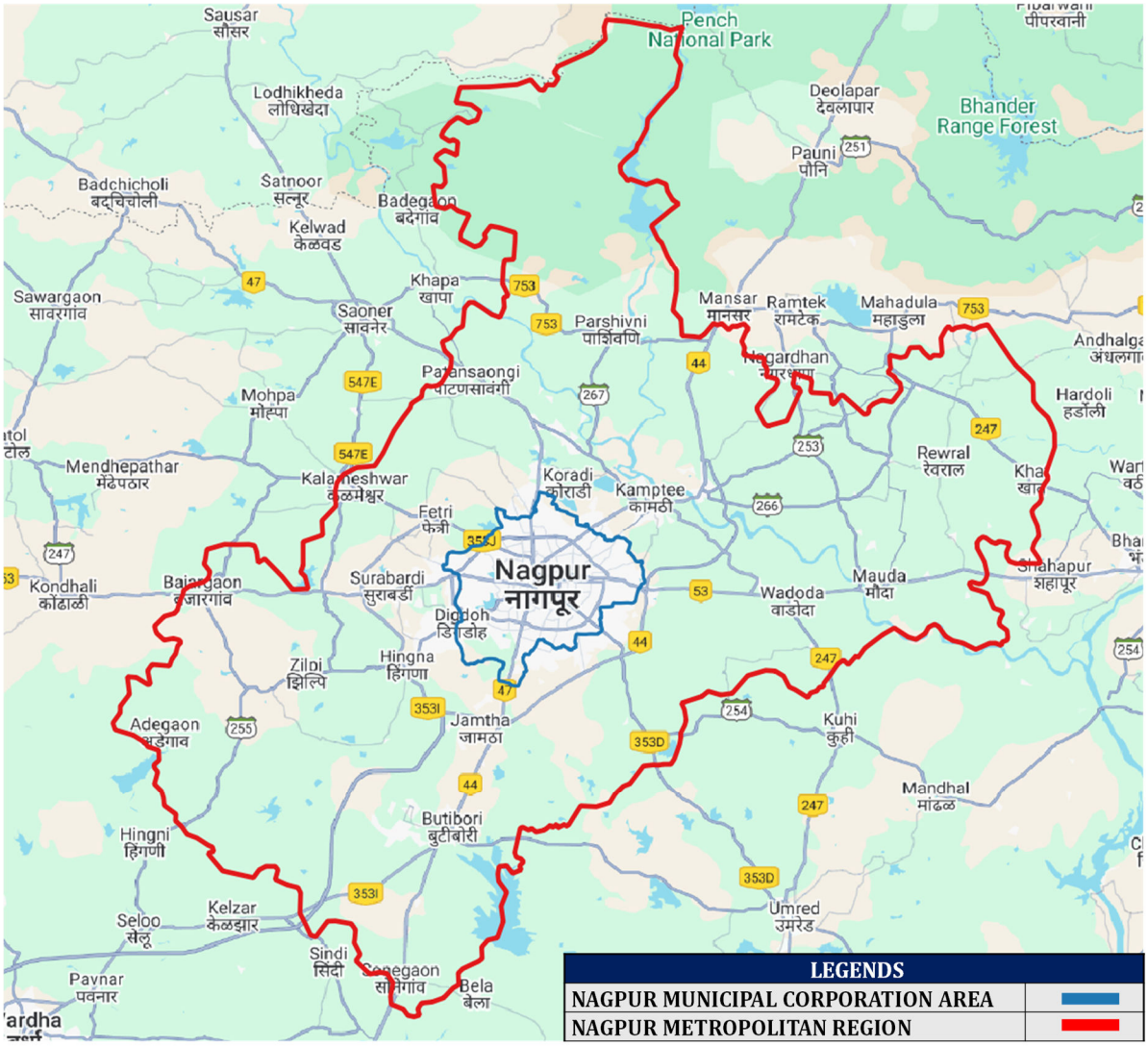
2. REVIEW OF CITY PROFILE

2.1. REVIEW OF CITY PROFILE & EXISTING TRANSPORT SYSTEM

REVIEW OF CITY PROFILE

The Study Area for this assignment is the Nagpur Metropolitan Region (NMR) including the area under the Nagpur Municipal Corporation (NMC). The NMR, includes 721 villages of 9 Tahsils, is spread across 3567 km^2. While the NMC is spread across 216 km^2. Collectively, the study area is spread across 3783 km^2.

FIGURE 2.1: STUDY AREA



i. Population and Demography

According to the 2011 Census, the study area had a total population of 35,61,661 as detailed in **Table 2.1**. The population within Nagpur Municipal Corporation (NMC) was 24,05,663 while the population outside the MC but within the study area was 11,55,998. Based on past

trends and City Development Plan 2041, the population for the study area comes out to be 43.7 lakh by the base year 2024.

TABLE 2.1 : STUDY AREA POPULATION (in Lakh)

Years	2011	2024
Nagpur Municipal Corporation (NMC)	24.1	29.5
Rest of Study Area (Outside City)	11.5	14.2
Total	**35.6**	**43.7**

Source: Census 2011 & City Development Plan 2041

ii. Work Force Participation

The capacity of any city to provide employment opportunities and absorb its working populace in various sectors of the economy is an important indicator of economic viability and self-sustaining characteristics. It is observed that out of the total work force, majority (71.4%) are male in Nagpur district. The work force composition by activities for year 2011 is presented in **Table 2.2**.

TABLE 2.2 COMPOSITION OF WORKFORCE IN NAGPUR DISTRICTS

SN	Category of Workers	Total Workers (In Lakh)	Male (%)	Female (%)
1	Cultivators	2.1	66.9	33.1
2	Agricultural Laborer	4.2	50.5	49.5
3	Workers in Household Industry	0.5	65.7	34.3
4	Other Workers	11.9	79.9	20.1
Total		**18.7**	**71.4**	**28.6**

Source: Census 2011

REVIEW OF EXISTING TRANSPORT SYSTEM

i) Road Network / Transport

Nagpur is very well connected with the surrounding region. The 700 km long Samruddhi Mahamarg connects Nagpur with Mumbai. NH 44, connecting Srinagar to Kanyakumari and NH 53, connecting Surat to Paradip both pass through Nagpur, making the city as a major junction point in the highway network of India.

ii) Rail Network

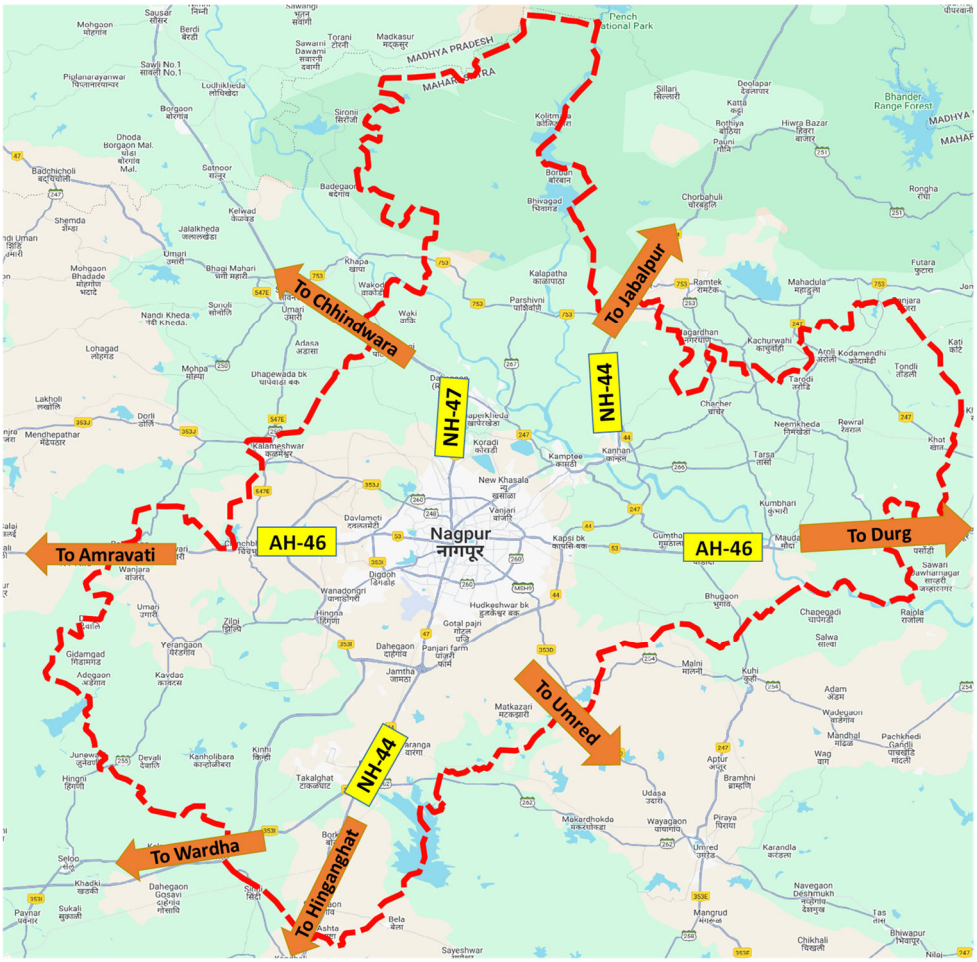
The city is served majorly by 3 railway stations, namely, Nagpur Railway Station, Ajni Railway Station and Itwari Railway Station which provide connectivity to major cities.

iii) Air Transport

Dr. Baba Sahab Ambedkar Airport serves the domestic as well as international air traffic. The airport handles around 2 million passengers per year and caters to four domestic

airlines and two international airlines connecting Nagpur to Sharjah, Doha and 12 domestic destinations.

FIGURE 2.2 REGIONAL CONNECTIVITY OF NAGPUR



iv) Existing Public Transport System

Public transport plays a crucial role in commuter transportation in any city. It offers economies of scale with minimized road congestion and low per capita road usage. Cheaper and affordable public transport systems world over have been proved to promote mobility – move people more efficiently and safely with increased opportunities for education, employment, social development etc.

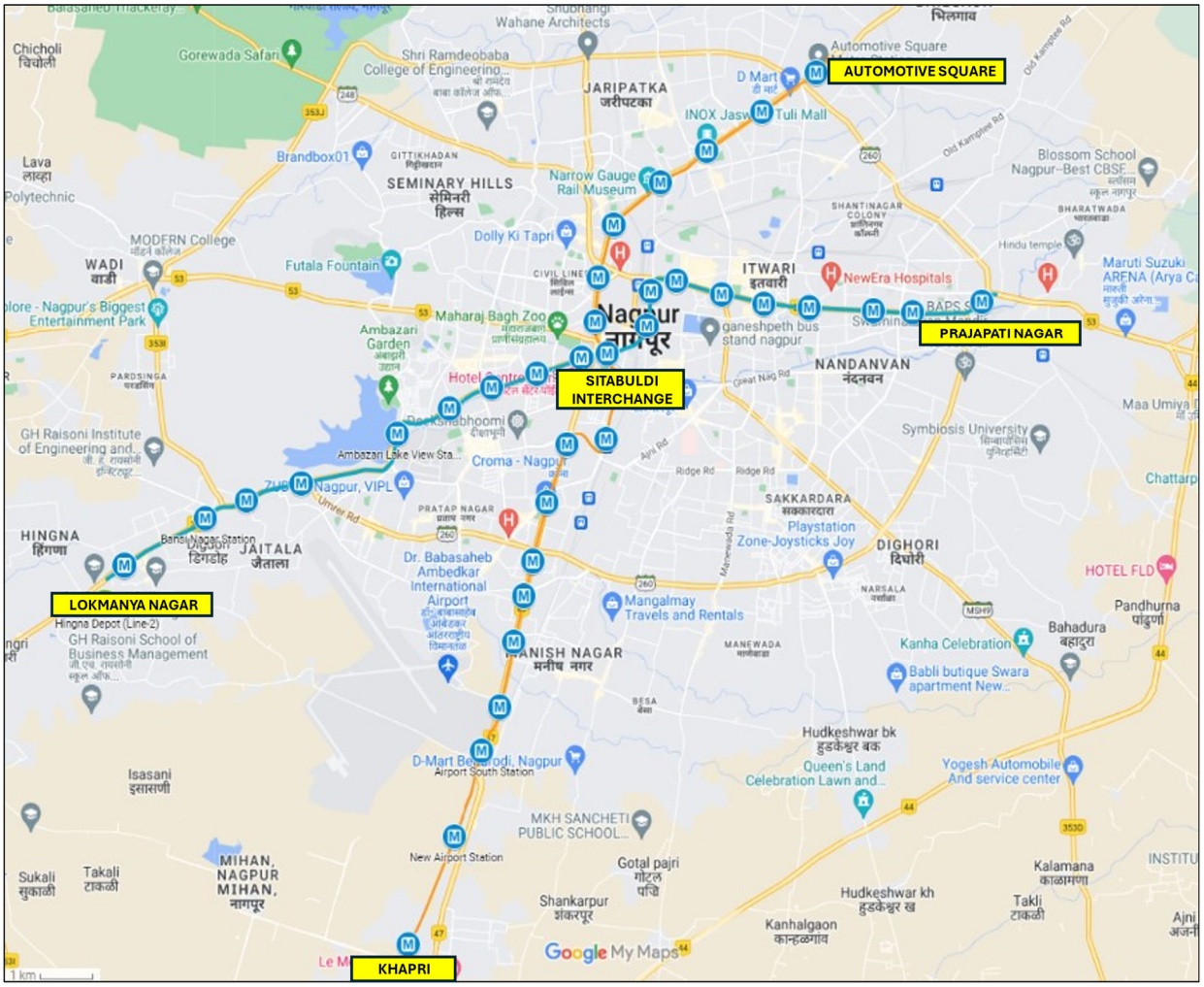
The Maha Metro operates Metro Rail in Nagpur. It consists of a 40.02 Km metro corridor, 38 stations and 2 Depots. The entire stretch is divided into 2 corridors as shows in **Table 2.3** and **Figure 2.3**.

TABLE 2.3 OPERATIONAL METRO CORRIDORS IN NAGPUR

SN	Corridor	Length	No of Stations
1	Automotive Square – Khapri	20.85 Km	18
2	Prajapati Nagar – Lokmanya Nagar	19.17 Km	20

The Nagpur Municipal Corporation operates the city bus service consisting about 100 electric and 237 diesel buses. Around 130 electric buses are to be inducted in the fleet soon while another 500 electric buses are under procurement process. The NMC aims to replace its entire fleet with electric bses by 2027. The Mor Bhavan serves as the main terminal and Khapri Naka, Hingna Naka, Koradi, Octroi Checkpost etc serve as depots for city bus operations. Apart from city buses, there are many private buses which also act as public transport as they connect several towns in the study area such as Butibori, Kamptee, Mauda, Saoner, Ramtek etc. on their way to Wardha, Hinganghat, Chandrapur, Bhandara, Chhindwara, Jabalpur.

FIGURE 2.3 NAGPUR METRO OPERATIONAL ROUTE MAP



v) Vehicular Growth and Composition

The registered vehicles in Nagpur have increased considerably over the years. This growth of vehicles has worsened the transport situation to a significant extent. The average share of registered two wheelers is highest at about 72.6%. About 17% of the registered vehicles in Nagpur are cars.

The increase of private modes demands more road space and has resulted in dense concentration of traffic on roads with limited right of ways. The growth of registered vehicles from year 2019 to 2023 is presented in **Table 2.4** and **Figure 2.4**.

The steep reduction of about 29% in registered vehicles observed in year 2020 due to Covid-19 pandemic.

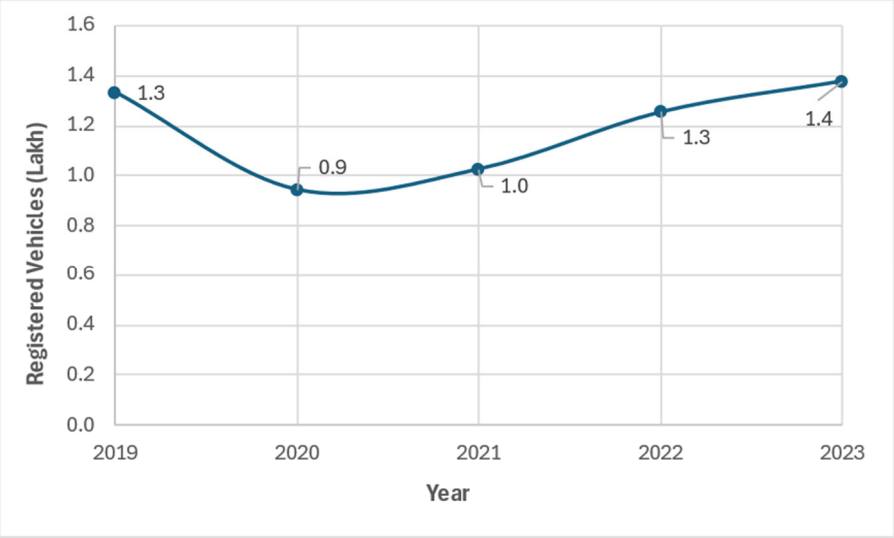
TABLE 2.4: VEHICULAR GROWTH AND COMPOSITION IN NAGPUR

SN	Vehicle Class	2019	2020	2021	2022	2023
1	Motor Car/Cab	17,879	14,813	19,562	22,225	24,391
2	M-Cycle/Scooter/Moped	1,01,509	71,679	73,431	88,975	94,375
3	Three-Wheeler (Passenger)	2,154	607	252	466	1,417
4	E-Rickshaw	753	533	848	2,951	4,625
5	Maxi Cab/Omni Bus	4	0	200	1	25
6	Bus	508	138	19	245	585
7	Goods Carrier	7,202	3,864	4,809	6,291	7,015
8	Three-Wheeler (Goods)	864	431	697	1,101	1,445
9	Agricultural Tractor	1,049	1,245	1,396	1,601	1,522
10	Others	1,285	1,001	1,381	1,547	2,352
Total		**1,33,207**	**94,311**	**1,02,595**	**1,25,403**	**1,37,752**
Growth Rate (per annum)			**-29.2%**	**8.8%**	**22.2%**	**9.8%**

Source: *https://vahan.parivahan.gov.in*

**Table 2.4 includes data of all three RTOs falling in study area*

FIGURE 2.4 VEHICLE REGISTRATION TREND IN NAGPUR



vi) Road Safety

The increase in number of private vehicles and inter mixing of slow and fast moving vehicles on road has led to increase in number of accidents on roads in Nagpur, which is a cause of concern. Considering the urban expanse, population growth and increased trends of vehicles on city roads; the safety of commuters is equally vital.

There are many reasons for the growth in the number of accidents in Nagpur such as increase in population and rise in vehicle ownership. They are also caused due to the casual approach of road users in observing driving rules, adhering to safety precautions and regulations. Over-speeding and negligent driving have proved to be a frequent cause of serious and fatal accidents. Similarly, poor road geometry has also increased the incidence of accidents on urban roads. One of major causes of pedestrian safety is endangered by extended trading activities of shops and commercial activity on footpaths and sidewalks. This compels the pedestrians to clog the road space, hence giving a chance to accidents.

Table 2.5 shows the number of accidents in Nagpur in recent years along-with the number of fatalities and series/ minor injuries occurred.

TABLE 2.5 ACCIDENT IN NAGPUR CITY

Year	Total Accidents	No of Persons Killed	No of Persons Injured
2022	1080	310	1169
2021	958	268	964
2020	773	210	752
2019	1007	250	1042
2018	1117	237	1187
2017	1242	231	1256
2016	1373	307	1510

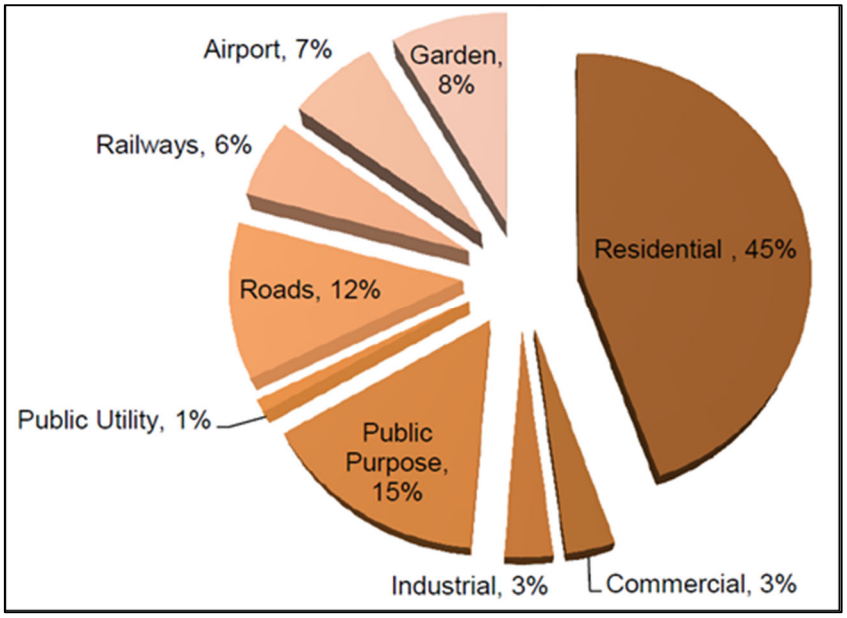
2.2. LANDUSE CHARACTERISTICS

Revised Draft Development Plan 1986- 2011 was prepared by NIT and sanctioned by the Government of Maharashtra (GoM) in 2000. This development plan as given in **Figure 2.6**.

The land use distribution indicates the cosmopolitan nature of the city with a fair distribution of land uses. A comparatively higher percentage of land allocated to public purpose indicates the administrative importance of the city. As per 1984 land use, only 80% of the land was developable, which has increased in 2011 to 100%.

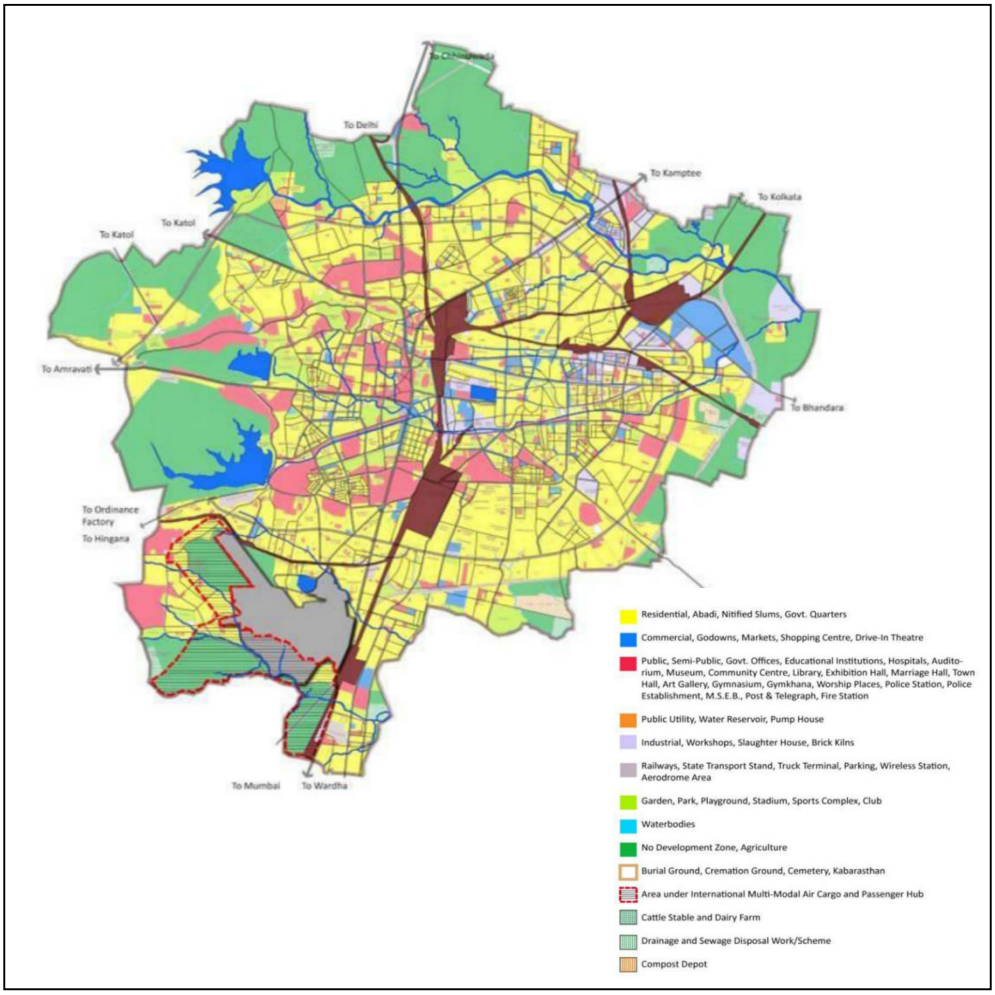
Also, 15033 hectares of area is developed, which is 69% of the total area and developed area in last three decades has doubled. As per the existing land use, majority of the land portion is developed as residential, 45%; commercial and industrial land use is 6%; land under public use is approximately 41%; and 8% is under parks and gardens (**Figure 2.5**).

FIGURE 2.5 EXISTING LANDUSE BREAKUP OF NAGPUR, 2011



Source: Revised Draft Development Plan of Nagpur City, 2011

FIGURE 2.6 REVISED DRAFT DEVELOPMENT PLAN 1986-2011



Source: Revised Draft Development Plan of Nagpur City, 2011

In order to improve the land use and conform to the required norms as per URDPFI guidelines, the Town Planning department has prepared the revised development plan for Nagpur. The proposed land use for horizon years 2021 and 2031 is given in **Table 2.6.**

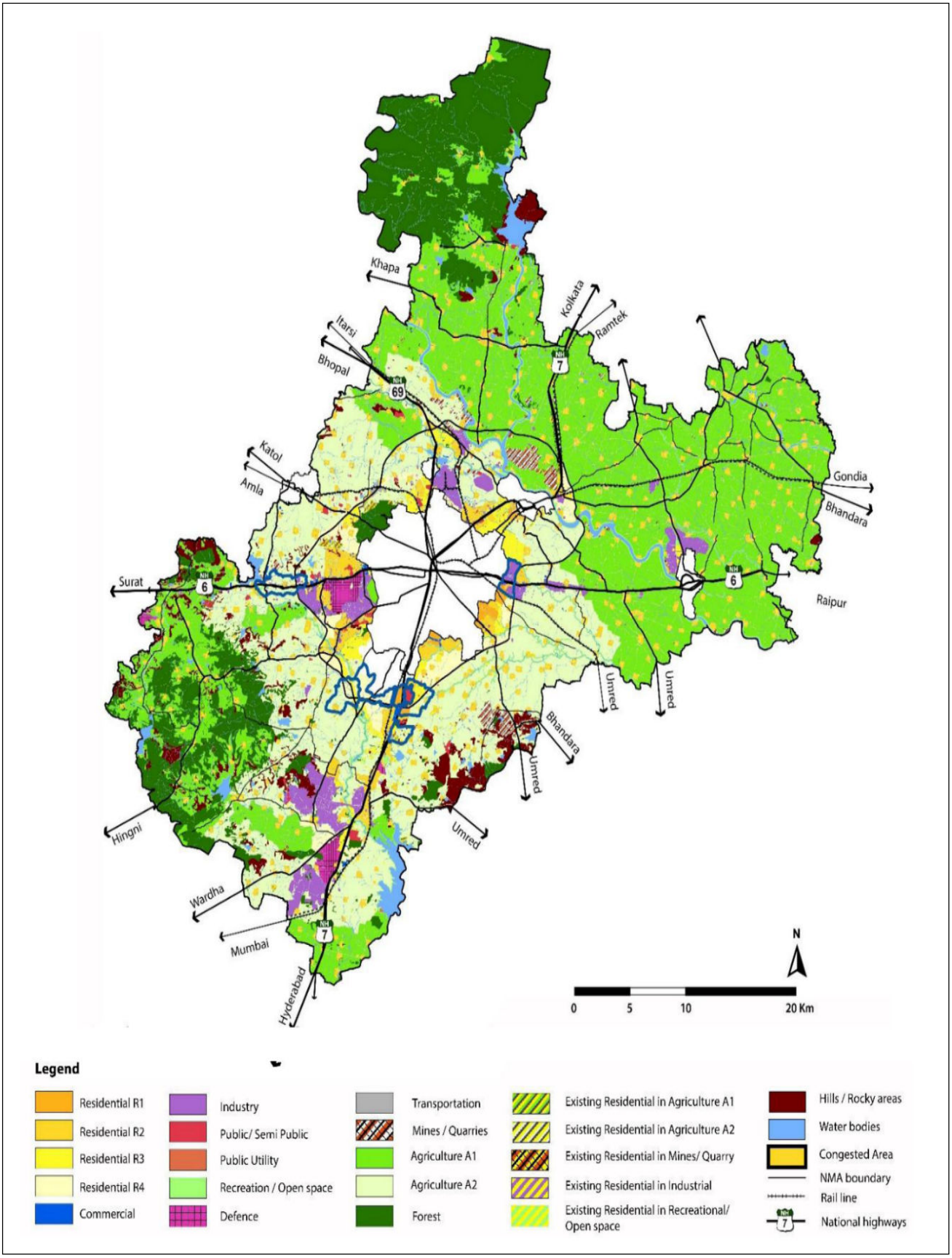
TABLE 2.6 PROPOSED LANDUSE PLAN FOR NAGPUR CITY

SN	Land use	2021			2031		
		Area in Ha.	% of Developed Area	% of Total Area	Area in ha.	% of Developed Area	% of Total Area
1	Residential	6,706	44.6	30.8	7000	46.6	32.2
2	Commercial	501	3.3	2.3	700	4.7	3.2
3	Industrial	495	3.3	2.3	800	5.3	3.7
4	Public Purpose	2,312	15.4	10.6	2312	15.4	10.6
5	Public Utility	149	1.0	0.7	150	1.0	0.7
6	Roads	1,754	11.7	8.1	1800	12.0	8.3
7	Railways	873	5.8	4.0	900	6.0	4.1
8	Airport	993	6.6	4.6	1000	6.7	4.6
9	Garden	1,251	8.3	5.8	1300	8.6	6.0
10	Developable Vacant Land	0	0.0	0.0	0	0.0	0.0
	Total	**15,033**	**100.0**	**69.1**	**15,962**	**100**	**73.4**
11	Agriculture Land	5,774		26.5	4,846		22.3
12	Water Bodies & Nallahs	463		2.1	463		2.1
13	Non-Developable Land	0		0.0	0		0.0
14	Drainage & Sewage Disposal	141		0.6	141		0.6
15	Cattle Stable & Dairy Farm	212		1.0	212		1.0
16	Compost Depot	131		0.6	131		0.6
	Total	**6,723**		**30.9**	**5793**		**26.6**
	Grand Total	**21,756**		**100.0**	**21,756**		**100.0**

Source: Nagpur Environment Assessment Report 2008, CDP for Nagpur 2041, NMC

The State Government formed Nagpur Metropolitan Area (NMA) in 1999. The total metropolitan area considered for carrying out planning and preparing the land use plan is 3,780 sq km, excluding the Nagpur city area. Preparation of the land use plan for NMR was carried out in two phases. In Phase – 1, the land use plan for an area of 1,520 sq km has been prepared by NIT. The areas earmarked under Phase – I and II are shown in the **Figure 2.7**

FIGURE 2.7 PROPOSED LANDUSE PLAN FOR NMA



Source: Nagpur Metropolitan Area Development Plan, 2032

2.3. TRANSPORT DEMAND SURVEYS

A number of traffic & travel surveys including household survey have been conducted to appreciate, analyse, quantify and assessing the existing traffic characteristics of commuter travel within the study area. This collected data would also help in developing the base year Travel Demand Model for the study area.

Various primary traffic surveys conducted as part of the study and their coverage are presented in **Table 2.7.**

TABLE 2.7: PRIMARY TRAFFIC SURVEYS

SN	Survey Type	Coverage
1.	Road Network Inventory Survey	Along all arterial and major roads in the study area for about 640 km length
2.	Speed & Delay Survey	
3.	Mid-Blocks and Screen Lines: Directional Classified Traffic Volume Counts and Vehicle Occupancy Surveys (16 hours)	26 Locations
4.	Intersections: Directional Classified Traffic Volume Counts and Vehicle Occupancy Surveys (12 hours)	21 Locations
5.	Outer Cordon Locations: Directional Classified Traffic Volume Counts and Vehicle Occupancy Surveys and OD Surveys (16 hours)	10 Locations
6.	Terminal Passenger (in + out counts) & OD Surveys including Opinion and Willingness to Pay Survey	
	Bus Terminals	3 Location
	Rail Terminals	4 Location
7.	Air Terminal	1 Location
8.	Goods Terminal Survey (24 hours)	1 Location
9.	Bus Stops/Auto Stand/IPT Stop/ Metro Station (Boarding & Alighting) along with OD Survey	30 Locations
10.	Pedestrian Movement Counts	15 Locations
11.	Parking Surveys	10 Locations
12.	Household Survey including opinion and Willingness to pay	5,000 households
13.	NMT survey	200 Samples
14.	Vehicle Survey at Petrol Pump	1000 Samples

2.4. ZONING AND NETWORK DEVELOPMENT

The Study Area includes Nagpur Municipal Corporation and Nagpur Metropolitan Region, which comprises full tehsils of Parshioni, Mauda, Kamptee and part tehsils of Nagpur Rural, Hingna, Saoner, Kalmeshwar, Umred and Kuhi.

Updated base maps for identified locations, areas, junctions and intersections collected from the respective agencies as a part of secondary data collection exercise helped in the development of base year transport network of the Study Area. The transport network consisting of primary and secondary road network has been coded & developed in Visum software. The link attributes such as Speed, Carriageway, ROW, Distance etc. are derived from the Road Network Inventory and Speed and Delay survey data.

The base map contains all the secondary data such as zone boundaries, ward boundaries and road/rail network details. A traffic zone system is developed for the Study Area on the base map based on the existing ward boundaries and natural physical barriers. The proposed traffic zoning system gives due consideration to the zoning system adopted by previous studies, road and public transportation network distribution. It is sufficiently detailed to capture inter zonal trips.

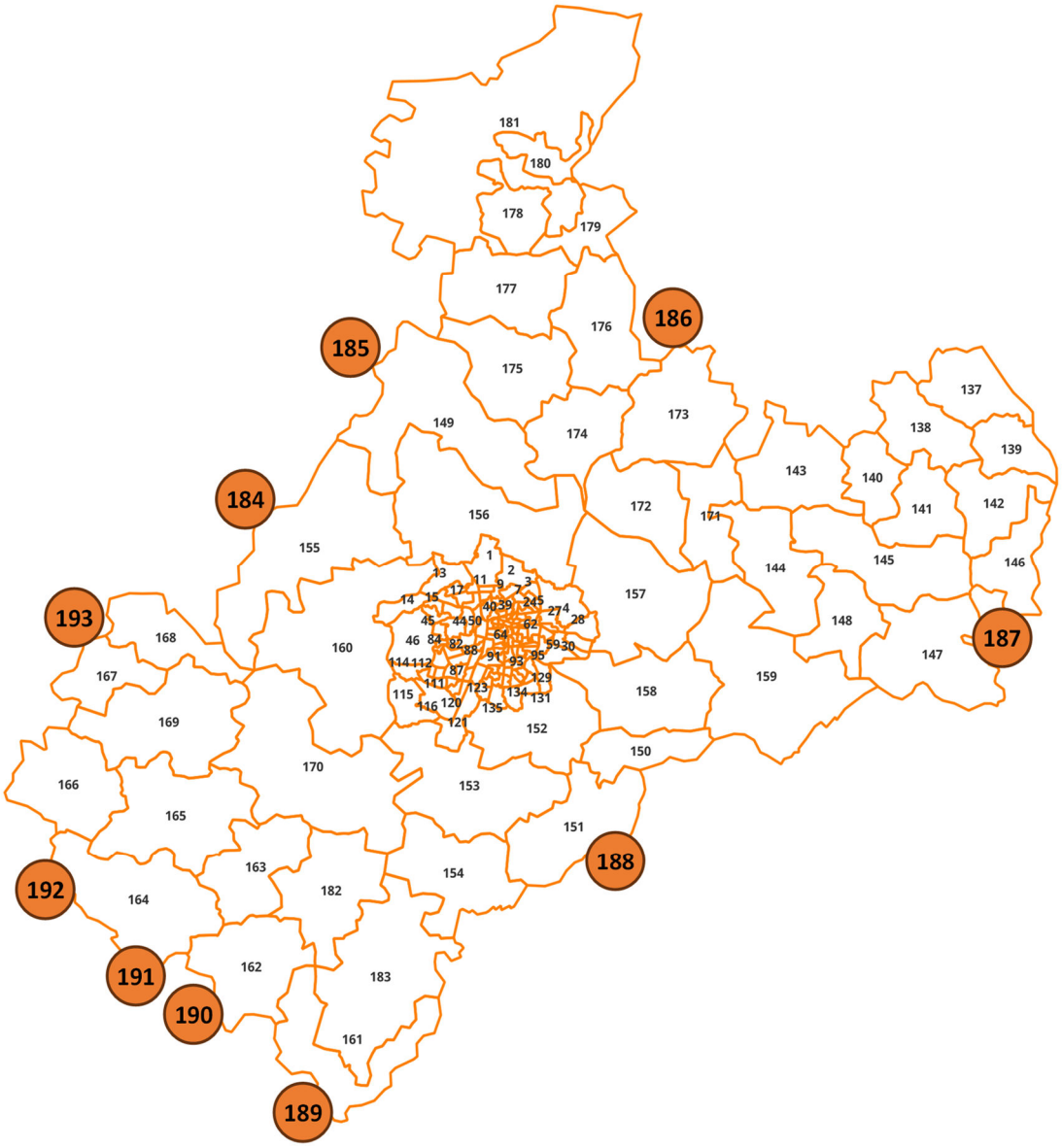
To understand the travel pattern of the city, a total of 183 zones called Traffic Analysis Zones (Zones) have been identified. Considering the ease of getting required zonal information, administrative wards are considered as zones within the Municipal area. The areas that fall under Study Area but outside the municipal boundary have been divided into zones based on homogenous population and land use.

The external areas outside the Study Area boundary have been divided into 10 separate zones. The zoning system adopted for the study is presented in **Table 2.8** and **Figure 2.8.**

TABLE 2.8: PROPOSED ZONING SYSTEM OF STUDY AREA

Type of Zones	Area	Zone No
Internal Zones	Nagpur Metropolitan Region	1 to 183
External Zones	Outer Cordons	184 to 193

FIGURE 2.8: TRAFFIC ANALYSIS ZONE



2.5. ROAD NETWORK AND SPEED & DELAY CHARACTERISTICS

Road Network Characteristics

The road network inventory was carried out along all arterial and major roads in the study area. The data collected as part of this survey include the right of way, carriageway details, footpath, median, street lighting and abutting land use. The survey has been conducted for a total length of about 640 km.

a. Right of Way

The distribution of the road network as per right of way (ROW) is presented in **Table 2.9**. It can be observed from the table that 13.6% of the road network has ROW less than or equal to 10 m, 20% has 11-20 m ROW and about 30% of network has ROW above 30 m.

TABLE 2.9: DISTRIBUTION OF ROAD NETWORK AS PER RIGHT OF WAY

SN	Right of Way (m)	Road Length (Km)	Percentage (%)
1	≤10	87.3	13.6
2	10 - 20	129.5	20.1
3	20 - 30	238.3	37.0
4	>30	188.5	29.3
	Total	**643.6**	**100.0**

Source: RITES Primary Survey, 2024

b. Carriageway Width (CW)

The distribution of the road network as per carriageway width (CW) is presented in **Table 2.10.** It can be observed from the table that about 22% of the road network has carriageway width less than or equal to 2-lane, about 50% of 3-4 lane and about 28% of roads are 6-lane and more.

TABLE 2.10: DISTRIBUTION OF ROAD NETWORK AS PER CARRIAGE WAY WIDTH

SN	Carriageway Width(m)	Road Length (in Km)	Percentage (%)
1	Intermediate Lane (Upto 6m)	69.1	10.7
2	2 Lane (6.0 - <9m)	70.1	10.9
3	3 Lane (9.0 - <12m)	36.2	5.6
4	4 Lane (12.0 - <18m)	285.2	44.3
5	6 Lane and more (18m or more)	183.0	28.4
	Total	**643.6**	**100.0**

Source: RITES Primary Survey, 2024

c. Availability of Footpath

It is observed from the field surveys that more than half of the network (54%) has footpaths, with almost 42% having the footpath of both sides. (**Table 2.11).**

TABLE 2.11: AVAILABILITY OF FOOTPATH

SN	Footpath	Road Length (km)	Percentage (%)
1	**Present**	346.7	53.9
	One Side	75.2	11.7
	Both Sides	271.5	42.2
2	**Absent**	296.9	46.1
Total		**643.6**	**100.0**

Source: RITES Primary Survey, 2024

d. Availability of Service Road

The distribution of road network as per availability of service roads is presented in **Table 2.12**. It is observed that about 20.2% of the roads have service lane. The absence of service lanes affects capacity of road adversely.

TABLE 2.12: AVAILABILITY OF SERVICE ROAD

SN	Service Road	Road Length (km)	Percentage (%)
1	Present	129.8	20.2
2	Absent	513.8	79.8
Total		**643.6**	**100.0**

Source: RITES Primary Survey, 2024

2.6. SPEED & DELAY CHARACTERISTICS

The Speed and delay survey was conducted along the network using the moving car method during peak and off-peak periods. The analysis of the data reflects the journey speed and running speed of the traffic. It also gives the reasons for delays in traffic movement.

a. Journey speed

The journey speed characteristics during peak and off peak period in the city area are presented in **Table 2.14.** It is observed that about 13% of the total road network has journey speeds less than equal to 20 kmph during peak hours. Major part of the road network i.e. 78.2% has journey speed between 21-30 kmph.

During off-peak period, it is observed that about 9% of road network has journey speed less than equal to 20 Kmph. About 80% of the road network observed to have speeds more than 30 Kmph.

TABLE 2.13: DISTRIBUTION OF ROAD LENGTH BY PEAK AND OFF-PEAK HOUR JOURNEY SPEED IN CITY AREA

SN	Journey Speed (in kmph)	Road length (in Km.)			
		Peak Hours	Percentage	Off Peak Hours	Percentage
1	<=10	8.2	2.5	5.1	1.6
2	11-20	33.5	10.4	22.9	7.1
3	21-30	252.5	78.2	37.4	11.6
4	>30	29.0	9.0	257.8	79.8
Total		**323.1**	**100.0**	**323.1**	**100.0**

Source: RITES Primary Survey, 2024

The journey speed characteristics during peak and off peak period in the entire study area are presented in **Table 2.14.** It is observed that about 6.5% of the total road network has journey speed less than equal to 20 kmph during peak hours. 54.3% of the road network has a journey speed between 21-30 kmph.

During off-peak period, it is observed that about 14.3% of road network has journey speed less than equal to 30 Kmph. 85.3% of the road network observed to have speeds more than 30 Kmph.

TABLE 2.14: DISTRIBUTION OF ROAD LENGTH BY PEAK AND OFF-PEAK HOUR JOURNEY SPEED IN THE STUDY AREA

SN	Journey Speed (in kmph)	Road length (in Km.)			
		Peak Hours	Percentage	Off Peak Hours	Percentage
1	<=10	8.2	1.3	5.1	0.8
2	11--20	33.5	5.2	22.9	3.6
3	21-30	252.5	39.2	63.9	9.9
4	>30	349.5	54.3	551.7	85.7
Total		**643.6**	**100.0**	**643.6**	**100.0**

Source: RITES Primary Survey, 2024

b. Running Speed

The running speed characteristics during peak and off peak period for city and study area is given in **Table 2.15** and **Table 2.16** Respectively**.**

In city area, it can be observed that 18.7% of the road network has running speed less than equal to 30 kmph during peak hours. The major share of road network (80.1%) has running speed between 31-40 kmph. During off-peak period, the running speed improve considerably with 74.2% of road network has running speed more than 40 Kmph.

TABLE 2.15: DISTRIBUTION OF ROAD LENGTH BY PEAK AND OFF-PEAK HOUR RUNNING SPEED IN CITY AREA

SN	Running Speed (in Kmph)	Study area Road length (in Km.)			
		Peak Hours	Percentage	Off Peak Hours	Percentage
1.	<=20	17.3	5.4	11.9	3.7
2.	21- 30	42.9	13.3	22.1	6.8
3.	31- 40	258.9	80.1	49.4	15.3
4.	>40	3.9	1.2	239.6	74.2
Total		**323.1**	**100.0**	**323.1**	**100.0**

Source: RITES Primary Survey, 2024

In the study area, it can be observed that 9.4% of the road network has running speed less than equal to 30 kmph during peak hours. A large share of road network (50.4%) has running speed of more than 40 kmph. During off-peak period, majority of the network (82.3%) has a running speed of more than 40 kmph.

TABLE 2.16: DISTRIBUTION OF ROAD LENGTH BY PEAK AND OFF-PEAK HOUR RUNNING SPEED IN STUDY AREA

SN	Running Speed (in Kmph)	Study area Road length (in Km.)			
		Peak Hours	Percentage	Off Peak Hours	Percentage
1.	<=20	17.3	2.7	11.9	1.8
2.	21- 30	42.9	6.7	23.0	3.6
3.	31- 40	258.9	40.2	78.7	12.2
4.	>40	324.4	50.4	529.9	82.3
Total		**643.6**	**100.0**	**643.6**	**100.0**

Source: RITES Primary Survey, 2024

c. Delays

The distribution of causes of stops is presented in **Table 2.17.** It is observed that traffic signal wait time is 90.4%, emphasizing that it is a structured and predictable stop, unlike congestion (9.0%), which is unplanned and disruptive. This presents signal wait time as an efficient traffic management measure rather than a drawback.

TABLE 2.17: DISTRIBUTION OF CAUSES OF STOPS OR DELAYS

SN	Cause of stoppage	No. of Points	Percentage
1	Traffic Jam/Congestion	14	9.0
2	Waiting time at Traffic Signal	141	90.4
3	Toll Plaza	1	0.6
TOTAL		**156**	**100.0%**

Source: RITES Primary Survey, 2024

2.7. TRAFFIC INTENSITY AT INTERSECTIONS & MID BLOCKS/ SCREENLINES

Turning Movement Count at Intersections

a. Background & Survey Locations

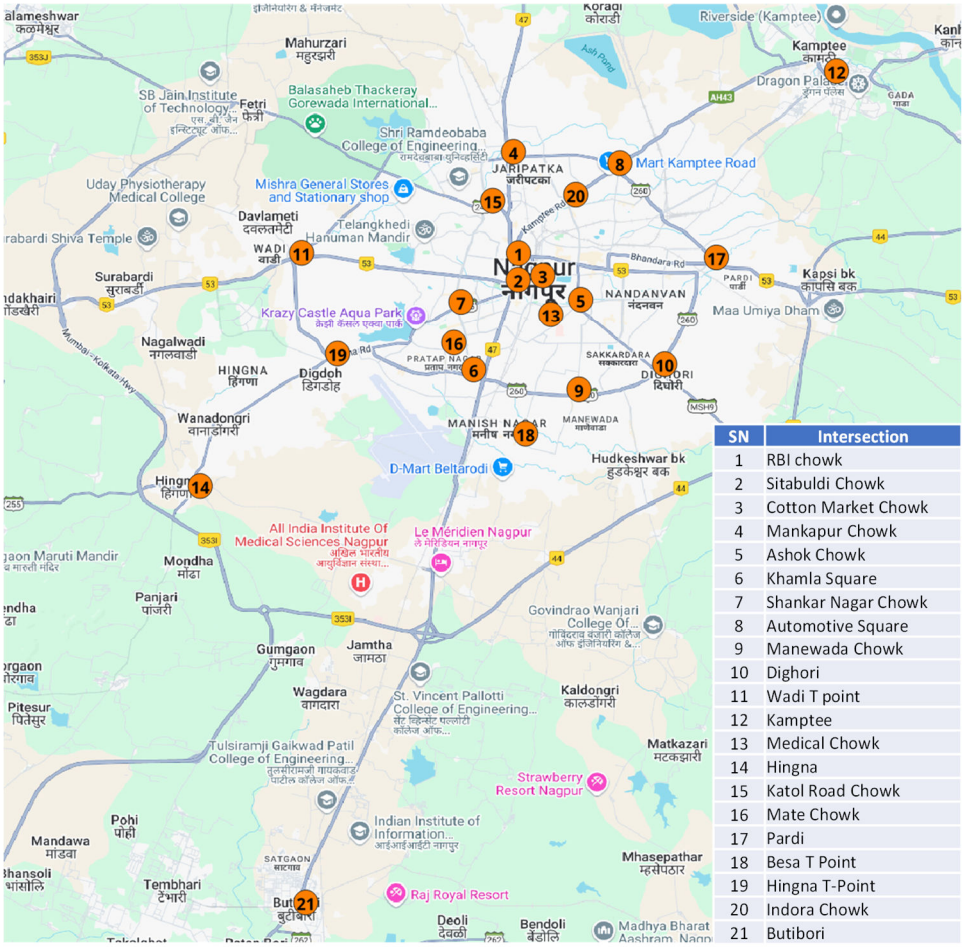
Classified traffic volume count surveys help in assessing the magnitude of volumes of existing traffic in the Study Area and intensity of traffic flow over the day. The output provides daily traffic and peak hour traffic flow/composition for all directional movements and individual arms at each intersection. The data collected is also used to validate transport demand models.

Direction-wise classified traffic volume surveys were carried out at 21 intersections in the study area on average weekday. The survey involved 15 minutes' interval direction wise classified traffic volume counts for each movement at the intersection on a typical working day. The survey locations were selected in a manner that would cover the entire study area and assist in understanding the traffic pattern within the study area as well as with adjacent urban settlements.

b. Average Daily Traffic (14 hours)

The intensity of traffic at intersection locations is given in **Figure 2.2** & **Table 2.18.** It can be seen that Sitabuldi Chock handles the maximum daily traffic of 1,13,458 PCUs (148408 vehicles) followed by Manakpur chowk and Medical Chowk with 108955 PCUs (142412 vehicles) and 104138 7PCUs (159032 vehicles) respectively.

FIGURE 2.9 INTERSECTIONS SURVEY LOCATIONS



SN	Intersection
1	RBI chowk
2	Sitabuldi Chowk
3	Cotton Market Chowk
4	Mankapur Chowk
5	Ashok Chowk
6	Khamla Square
7	Shankar Nagar Chowk
8	Automotive Square
9	Manewada Chowk
10	Dighori
11	Wadi T point
12	Kamptee
13	Medical Chowk
14	Hingna
15	Katol Road Chowk
16	Mate Chowk
17	Pardi
18	Besa T Point
19	Hingna T-Point
20	Indora Chowk
21	Butibori

TABLE 2.18: DAILY TRAFFIC VOLUME AT INTERSECTIONS

SN	Name of Intersection	Total Vehicles	Total PCUs
1.	RBI Chowk	118468	91279
2.	Sitabuldi Chowk	148408	113458
3.	Cotton Market Chowk	118271	83506
4.	Mankapur Chowk	142412	108955
5.	Ashok Chowk	71510	53658
6.	Khamla Square	113949	81572
7.	Shankar Nagar Chowk	63137	48991
8.	Automotive Square	93981	80349
9.	Manewada Chowk	112781	80657
10.	Dighori Chowk	115116	80739
11.	Wadi 'T' Point	81468	70484
12.	Kamptee Chowk	46406	34137
13.	Medical Chowk	159032	104138
14.	Hingna Chowk	39085	25861
15.	Katol Road Chowk	137759	96688
16.	Mate Chowk	128516	86711
17.	Pardi Chowk	121895	107998
18.	Besa 'T' Point	52798	37173
19.	Hingna 'T' Point	89164	66415

SN	Name of Intersection	Total Vehicles	Total PCUs
20.	Indora Chowk	65052	46418
21.	Butibori	60471	63620

Source: RITES Primary Survey, 2024

c. Peak Hour Traffic

The peak hour traffic at Intersection Locations both during morning peak and evening peak along with peak hour factor is presented in **Table 2.19**. The peak hour factor varies from 6.5% to 11.2%. The morning peak hour traffic varies from 2025 PCUs (3114 vehicles) at Hingna to 10659 PCUs (17783 vehicles) at Medical Chowk while evening peak traffic varies from 2098 PCUs (3,298 vehicles) at Hingna to 9,182 PCUs (12559 vehicles) at Sitabuldi.

TABLE 2.19: INTENSITY AND PEAK HOUR TRAFFIC AT INTERSECTIONS

SN	Name of Intersection Location	Total Traffic		Morning Peak				Evening Peak			
		Veh	PCU	Veh	% of Total Traffic	PCU	% of Total Traffic	Veh	% of Total Traffic	PCU	% of Total Traffic
1.	RBI Chowk	118468	91279	9907	8.4	7245	7.9	9644	8.1	7147	7.8
2.	Sitabuldi Chowk	148408	113458	12419	8.4	8835	7.8	12559	8.5	9182	8.1
3.	Cotton Market Chowk	118271	83506	8807	7.4	6033	7.2	9488	8.0	6414	7.7
4.	Manakpur Chowk	142412	108955	11601	8.1	7977	7.3	11556	8.1	8195	7.5
5.	Ashok Chowk	71510	53658	6340	8.9	4460	8.3	4997	7.0	4004	7.5
6.	Khamla Square	113949	81572	8547	7.5	5803	7.1	10103	8.9	7026	8.6
7.	Shankar Nagar Chowk	63137	48991	4641	7.4	3451	7.0	4714	7.5	3742	7.6
8.	Automotive Square	93981	80349	7020	7.5	5530	6.9	6408	6.8	5946	7.4
9.	Manewada Chowk	112781	80657	10015	8.9	6407	7.9	8854	7.9	5890	7.3
10.	Dighori Chowk	115116	80739	9758	8.5	6324	7.8	9185	8.0	6050	7.5
11.	Wadi 'T' Point	81468	70484	6069	7.4	4605	6.5	6607	8.1	5514	7.8
12.	Kamptee Chowk	46406	34137	3679	7.9	2659	7.8	3120	6.7	2440	7.1
13.	Medical Chowk	159032	104138	17783	11.2	10659	10.2	10524	6.6	6904	6.6
14.	Hingna Chowk	39085	25861	3114	8.0	2025	7.8	3298	8.4	2098	8.1
15.	Katol Road Chowk	137759	96688	11735	8.5	7698	8.0	11784	8.6	8022	8.3
16.	Mate Chowk	128516	86711	10410	8.1	6670	7.7	10192	7.9	6660	7.7
17.	Pardi Chowk	121895	107998	8934	7.3	7590	7.0	8316	6.8	7814	7.2
18.	Besa 'T' Point	52798	37173	4588	8.7	3017	8.1	4559	8.6	3068	8.3
19.	Hingana 'T' Point	89164	66415	8550	9.6	5842	8.8	6731	7.5	5132	7.7
20.	Indora Chowk	65052	46418	4589	7.1	3277	7.1	4941	7.6	3444	7.4
21.	Butibori	60471	63620	4024	6.7	4273	6.7	5237	8.7	5112	8.0

d. Traffic Composition

The daily traffic composition at all surveyed intersections is presented **Table 2.20**. The share of fast passenger vehicles varies from 83% at Butibori to 96.6% at Katol Road Chowk, while the share of slow moving vehicles vary from 0.7% at Butibori to 11.8% at Indora Chowk. High share of goods vehicles (more than 10%) is observed at three intersections i.e. Butibori, Pardi and Wadi T Point.

The share of 2-wheeler is observed to be very high at all the major junctions in the city varying from 52.5% to 78%. The share of car varies from 8.5% to 35.6% while the share of auto is varying from 1% to 14%. The maximum share of buses is observed to be 2.9% at Butibori.

TABLE 2.20: DAILY TRAFFIC COMPOSITION AT INTERSECTIONS

SN	Location Name	Composition %					
		Total Fast Moving Passengers				Total Goods	Total Slow
		Car	2-W	Auto/ Sh. Auto	Bus		
1.	RBI Chowk	27.5	59.3	6.1	2.9	2.1	2.1
2.	Sitabuldi Chowk	23.3	60.0	8.5	2.6	1.8	3.7
3.	Cotton Market Chowk	12.9	66.2	8.1	1.3	3.3	8.2
4.	Manakpur Chowk	21.1	65.1	4.2	1.8	5.4	2.5
5.	Ashok Chowk	17.3	56.4	14.0	1.1	2.6	8.6
6.	Khamla Square	24.7	63.2	5.6	1.0	2.3	3.3
7.	Shankar Nagar Chowk	35.6	52.5	6.8	1.5	1.8	1.8
8.	Automotive Square	21.5	55.9	6.6	1.7	9.9	4.4
9.	Manewada Chowk	18.0	67.0	5.7	1.2	3.7	4.5
10.	Dighori Chowk	15.1	68.3	6.8	0.9	4.1	4.8
11.	Wadi 'T' Point	26.0	54.4	4.6	1.6	11.4	2.0
12.	Kamptee Chowk	14.3	68.0	8.4	1.5	4.2	3.7
13.	Medical Chowk	12.3	72.6	6.3	0.8	1.6	6.4
14.	Hingna Chowk	8.5	78.0	6.5	1.6	2.8	2.6
15.	Katol Road Chowk	24.8	65.9	4.8	1.1	2.0	1.4
16.	Mate Chowk	19.2	70.9	4.7	1.2	2.2	1.8
17.	Pardi Chowk	23.4	52.5	5.9	1.5	11.7	5.0
18.	Besa 'T' Point	20.9	66.5	4.0	1.6	2.4	4.6
19.	Hingana 'T' Point	19.6	66.7	5.0	1.6	4.8	2.2
20.	Indora Chowk	13.7	63.5	7.0	1.2	2.8	11.8
21.	Butibori	22.3	56.8	1.0	2.9	16.3	0.7

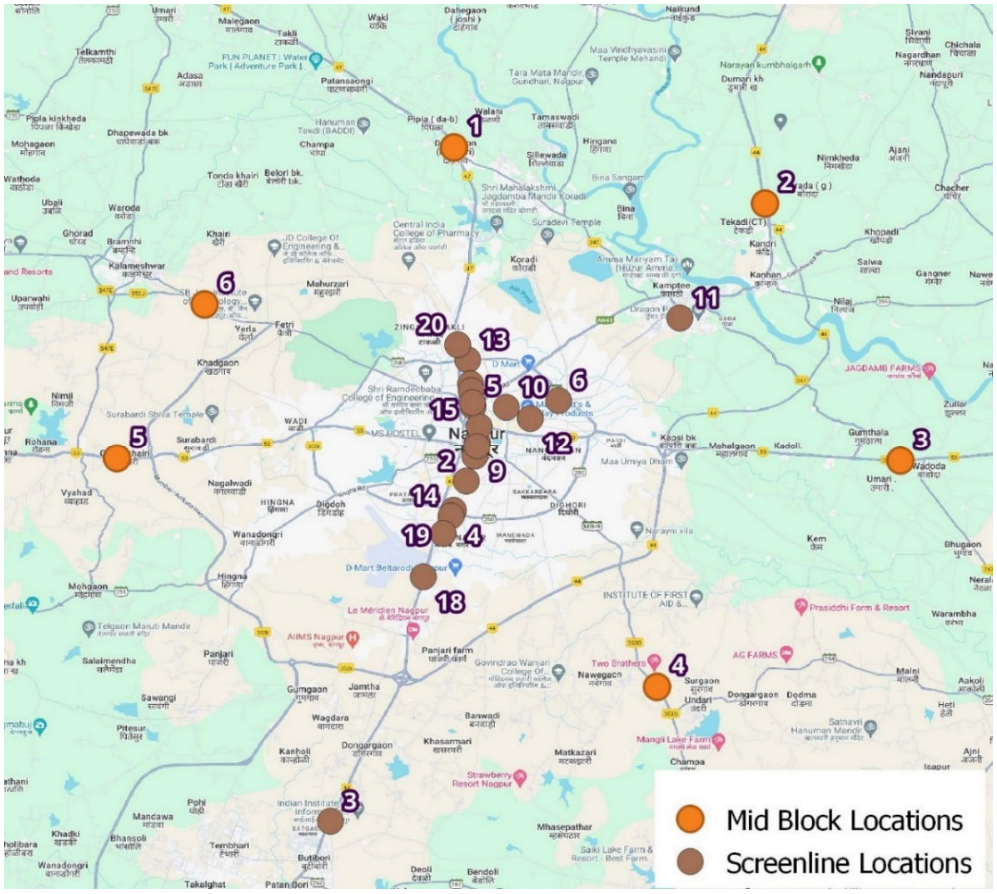
Source: RITES Primary Survey, 2024

2.8. TRAFFIC VOLUME COUNT AT MID BLOCKS

a. Background & Survey Locations

The surveys have been carried out at mid-block and screen line locations in both directions to quantify the classified volume of traffic during different hours of the day. The traffic volume survey was carried out on a fair-weather working day for a period of 16 hours on 26 locations. The survey locations were planned in such a manner so that comprehensive mix of urban and regional traffic is obtained on all the corridors. The traffic volume counts were accompanied with vehicle occupancy surveys with approx 10% sample size. Locations of Mid-blocks and Screen-lines are shown in **Figure 2.7** and **Table 2.21.** The analysis of the data collected reflects the quantum and temporal variation of total and daily vehicles and trips moving in the study area.

FIGURE 2.10 MID BLOCK AND SCREEN LINES SURVEY LOCATIONS



b. Average Daily Traffic (16 hours)

The traffic volume at mid-block and screen line locations have been observed in terms of numbers of vehicles and Passenger Car Units (PCUs) **(Table 2.21).** It is observed that the traffic at mid-block/screen line locations varies from 3795 PCUs (6909 vehicles) at Old Kamptee Road ROB to 76196 PCUs (116552 vehicles) at Humpyard Road.

TABLE 2.21: DAILY TRAFFIC VOLUME AT MID-BLOCK AND SCREEN LINE LOCATIONS

SN	Mid-Block Location	Total Vehicles	Total PCUs
1.	Chhindwara Road	19980	17271
2.	Bhandara Road	22344	31445
3.	Mansar Road	21389	30966
4.	Umred Road	17307	21831
5.	Amravati Road	13534	17067
6.	Katol Road	15144	14075
Screen line Location			
7.	Subhash Road	49294	33809
8.	Ajni Road	87179	55979
9.	Wardha Road (Near Butibori)	35294	49020

SN	Mid-Block Location	Total Vehicles	Total PCUs
10.	Narender Nagar RUB	85443	55584
11.	Gurudwara Bridge (Kamptee Road)	71419	45080
12.	Kawadepeth Railway Overbridge	25188	15934
13.	Ramjhula Bridge	96413	65722
14.	Humpyard Road	116552	76196
15.	Ghat Road	63184	42992
16.	Panchpaoli ROB	64815	38817
17.	Somalwada Railway Crossing	5700	3817
18.	Aurangabad Road	57924	53719
19.	Chhindwara Road	61279	46846
20.	Mecosabagh Road	38832	25193
21.	Jaripatka Cement Road Railway Crossing	42867	26823
22.	Narender Nagar ROB	48379	34233
23.	Ring Road Railway Crossing (Nr. Mankapur Chowk)	64370	50653
24.	Old Kamptee Road ROB	6909	3795
25.	Itwari Railway Station Road	103691	65702
26.	Mangalwari Bazar	33499	23182

Source: RITES Primary Survey, 2024

c. Peak Hour Traffic Characteristics

The peak hour traffic at the mid-block/screen line locations is presented in **Table 2.22**. The morning peak hour volume varies from 296 PCUs at Somalwada Railway Crossing to 6857 PCUs at Itwari Railway Station Road. Evening peak hour volume is varying from 334 PCUs at Somalwada Railway Crossing to 7302 PCUs at Humpyard Road.

d. Daily Traffic Composition

Daily traffic composition at all mid-blocks and screen locations is presented in **Table 2.23.** It is observed that most of the locations exhibit predominance of fast-moving passenger traffic varying from 71.1% at Mansar Road to 95% at Mangalwari Bazar. The highest share of slow-moving traffic is 14.9% at Old Kamptee Road ROB followed by 11.1% at Itwari Railway Station Road. The maximum share of bus traffic is observed to be 4.9% at Lalitpur Aurangabad Road. The maximum share of goods traffic is about 25.5% at Mansar Road and the minimum share of goods traffic is 1.1% at Old Kamptee Road ROB.

TABLE 2.22: INTENSITY AND PEAK HOUR TRAFFIC AT MID-BLOCK AND SCREEN LINE LOCATIONS

SN	Name of Mid-Block Location	Total Traffic		Morning Peak				Evening Peak			
		Veh.	PCUs	Veh.	% of Total Traffic	PCUs	% of Total Traffic	Veh.	% of Total Traffic	PCUs	% of Total Traffic
1	Chhindwara Road	19980	17271	1386	6.9	1148	6.6	1619	8.1	1339	7.8
2	Bhandara Road	22344	31445	1658	7.4	2506	8.0	2132	9.5	2559	8.1
3	Mansar Road	21389	30966	1411	6.6	1972	6.4	1907	8.9	2603	8.4
4	Umred Road	17307	21831	1422	8.2	1618	7.4	1404	8.1	1701	7.8
5	Amravati Road	13534	17067	1146	8.5	1629	9.5	992	7.3	1238	7.3
6	Katol Road	15144	14075	1135	7.5	991	7.0	1160	7.7	1105	7.9
7	Subhash Road	49294	33809	4232	8.6	2732	8.1	3731	7.6	2452	7.3
8	Ajni Road	87179	55979	7387	8.5	4474	8.0	6965	8.0	4370	7.8
9	Wardha Road (Near Butibori)	35294	49020	2384	6.8	3620	7.4	3260	9.2	4446	9.1
10	Narender Nagar RUB	85443	55584	7777	9.1	4780	8.6	8390	9.8	5158	9.3
11	Gurudwara Bridge (Kamptee Road)	71419	45080	5532	7.7	3408	7.6	6149	8.6	3806	8.4
12	Kawadepeth Railway Overbridge	25188	15934	2363	9.4	1426	8.9	2043	8.1	1261	7.9
13	Ramjhula Bridge	96413	65722	7269	7.5	4785	7.3	7376	7.7	4759	7.2
14	Humpyard Road	116552	76196	9914	8.5	6030	7.9	11106	9.5	7302	9.6
15	Ghat Road	63184	42992	4849	7.7	3229	7.5	5678	9.0	3662	8.5
16	Panchpaoli ROB	64815	38817	5160	8.0	3058	7.9	5366	8.3	3132	8.1
17	Somalwada Railway Crossing	5700	3817	458	8.0	296	7.8	527	9.2	334	8.8
18	Aurangabad Road	57924	53719	4209	7.3	3714	6.9	4703	8.1	4099	7.6
19	Chhindwara Road	61279	46846	6006	9.8	4231	9.0	5518	9.0	3789	8.1
20	Mecosabagh Road	38832	25193	3193	8.2	1929	7.7	3499	9.0	2241	8.9
21	Jaripatka Cement Road Railway Crossing	42867	26823	3249	7.6	2021	7.5	3958	9.2	2442	9.1
22	Narender Nagar ROB	48379	34233	4714	9.7	3004	8.8	4841	10.0	3031	8.9
23	Ring Road Railway Crossing (Nr. Mankapur Chowk)	64370	50653	5876	9.1	3922	7.7	5306	8.2	3750	7.4
24	Old Kamptee Road ROB	6909	3795	618	8.9	329	8.7	730	10.6	392	10.3
25	Itwari Railway Station Road	103691	65702	11193	10.8	6857	10.4	6423	6.2	4235	6.4
26	Mangalwari Bazar	33499	23182	3047	9.1	1977	8.5	2773	8.3	1828	7.9

Source: RITES Primary Survey, 2024

TABLE 2.23: DAILY TRAFFIC COMPOSITION AT MID-BLOCK/SCREEN LINE LOCATIONS

SN	Location Name	Composition %					
		Fast Passenger Vehicles				Total Goods	Total Slow
		Car	2-W	Auto/ Sh. Auto	Bus		
1	Chhindwara Road	35.0	53.8	1.7	2.5	6.9	0.1
2	Bhandara Road	27.9	40.0	1.3	2.3	27.8	0.7
3	Mansar Road	24.2	43.9	1.2	1.8	28.5	0.5
4	Umred Road	35.7	38.6	0.6	3.8	21.1	0.2
5	Amravati Road	31.6	43.2	0.9	3.4	20.7	0.3
6	Katol Road	30.4	52.4	2.4	2.7	11.6	0.5
7	Subhash Road	12.5	68.9	7.5	1.2	2.1	7.8
8	Ajni Road	19.0	71.0	4.4	0.1	1.4	4.0
9	Wardha Road (Near Butibori)	33.4	38.0	1.4	4.3	22.6	0.3
10	Narender Nagar RUB	14.5	73.3	6.1	0.6	2.0	3.4
11	Gurudwara Bridge (Kamptee Road)	13.1	72.7	7.8	0.1	1.2	5.3
12	Kawadepeth Railway Overbridge	4.8	76.4	9.9	0.9	1.8	6.1
13	Ramjhula Bridge	14.9	68.3	9.7	0.7	2.3	4.1
14	Humpyard Road	12.6	74.5	4.7	0.9	2.4	4.9
15	Ghat Road	6.7	71.3	10.1	1.5	2.1	8.3
16	Panchpaoli ROB	2.8	81.5	6.4	0.1	1.6	7.7
17	Somalwada Railway Crossing	16.3	73.7	2.5	1.9	1.9	3.8
18	Aurangabad Road	39.4	47.8	2.0	4.9	5.2	0.8
19	Chhindwara Road	24.2	65.5	3.0	2.1	4.5	0.9
20	Mecosabagh Road	18.8	72.9	2.9	0.3	1.9	3.1
21	Jaripatka Cement Road Railway Crossing	15.7	76.5	2.4	0.2	1.5	3.7
22	Narender Nagar ROB	20.0	70.3	2.9	0.9	4.3	1.7
23	Ring Road Railway Crossing (Nr. Mankapur Chowk)	17.4	65.2	3.1	0.8	9.5	4.1
24	Old Kamptee Road ROB	0.6	81.9	1.5	0.0	1.1	14.9
25	Itwari Railway Station Road	4.9	74.5	6.2	0.4	2.9	11.1
26	Mangalwari Bazar	11.5	75.6	4.8	3.1	1.7	3.3

Source: RITES Primary Survey, 2024

e. Average Occupancy

The average occupancy of passenger vehicles at Mid-Block and screenline locations is presented in **Table 2.24.** Bus average occupancy varies from 27.4 to 37.2 and averages of about 35. Average occupancy for cars and two wheelers are found to be 2.4 and 1.3 respectively whereas for auto /shared auto, the average occupancy is 2.8 respectively.

TABLE 2.24: AVERAGE OCCUPANCY OF PASSENGER VEHICLES AT MID-BLOCK/SCREEN LINE LOCATIONS

SN	Name of Mid-Block/Screen Line	Average Passenger Occupancy			
		Car	2-W	Auto/ Sh. Auto	Bus
1	Chhindwara Road	2.3	1.3	2.9	35.6
2	Bhandara Road	2.6	1.3	3.1	36
3	Mansar Road	2.6	1.4	3.1	36.3
4	Umred Road	2.2	1.3	3.1	36.8
5	Amravati Road	2.4	1.3	3.7	37.1
6	Katol Road	2.5	1.3	3.3	27.4
7	Subhash Road	2.4	1.4	2.7	35.6
8	Ajni Road	2.4	1.3	2.6	35.9
9	Wardha Road (Near Butibori)	2.6	1.3	3.5	35.5
10	Narender Nagar RUB	2.3	1.3	2.8	37.1
11	Gurudwara Bridge (Kamptee Road)	2.4	1.3	2.8	31.2
12	Kawadepeth Railway Overbridge	2.2	1.4	2.9	36.9
13	Ramjhula Bridge	2.4	1.3	2.8	36.5
14	Humpyard Road	2.6	1.4	1.9	33.8
15	Ghat Road	2.3	1.4	3.2	34.1
16	Panchpaoli ROB	2.4	1.4	3.3	30.6
17	Somalwada Railway Crossing	2.2	1.3	2.4	36.3
18	Aurangabad Road	2.5	1.4	2.9	34.7
19	Chhindwara Road	2.6	1.4	2.1	33.3
20	Mecosabagh Road	2.4	1.4	2.1	34.2
21	Jaripatka Cement Road Railway Crossing	2.3	1.3	2.2	35
22	Narender Nagar ROB	2.4	1.3	2.9	35.3
23	Ring Road Railway Crossing (Nr. Mankapur Chowk)	2.4	1.3	2.7	37.2
24	Old Kamptee Road ROB	3.1	1.3	3.5	0
25	Itwari Railway Station Road	2.3	1.3	2.5	36.8
26	Mangalwari Bazar	2.3	1.3	2.1	33.9

Source: RITES Primary Survey, 2024

2.9. TRAFFIC INTENSITY & OD CHARACTERISTICS AT OUTER CORDONS

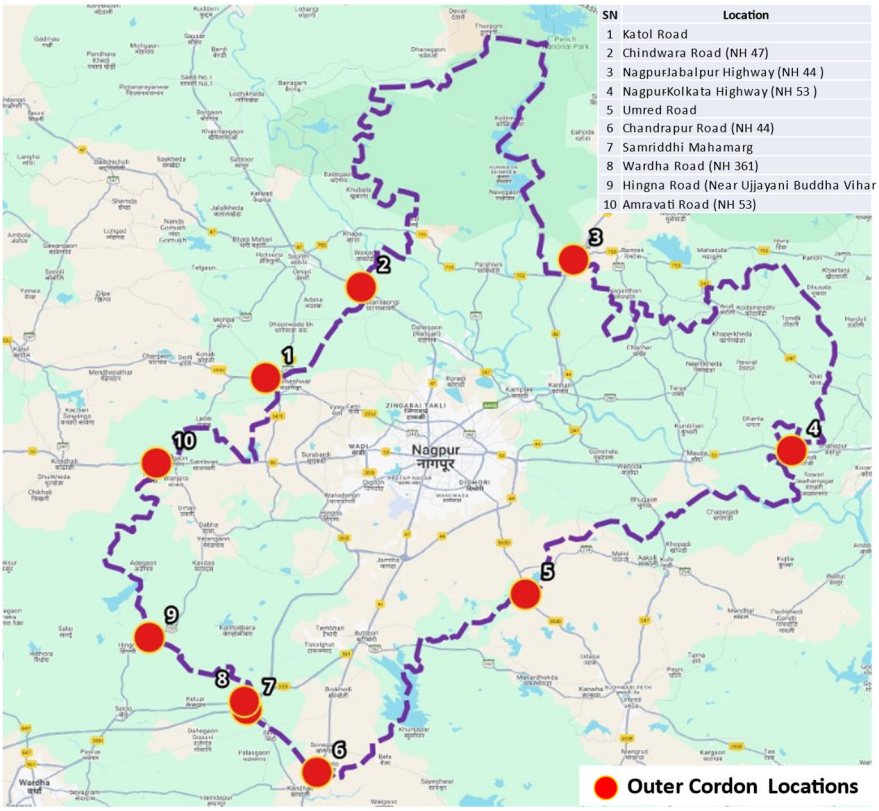
Background & Survey Locations

The objective of classified volume count (CVC) and Origin-Destination (OD) survey at outer cordon locations is to determine the movement pattern of traffic coming into the city from various directions and vice versa. This survey also aims at establishing the travel pattern of through trips.

The O-D survey was carried out simultaneously along with classified volume count surveys at Outer Cordon locations by adopting roadside direct interview method after stopping the traffic at the designated survey locations. The CVC and O-D survey were carried at 10 locations for a period of continuous 24 hrs on a normal working day. The information

collected as part of the OD survey include origin/destination of the trip, trip purpose, occupancy, whether regular commuter/occasional traveler, time etc.

FIGURE 2.11 OUTER CORDON SURVEY LOCATIONS



Average Daily Traffic (24 hours)

The traffic counts both in terms of number of vehicles and Passenger Car Units (PCUs) computed for the total daily (24 hour) traffic at 10 Outer Cordon locations is presented in **Table 2.25.** It is observed that the traffic at different locations varies from 1,532 PCUs (1,992 Vehicle) at Hingna Road (Near Ujjayani Buddha Vihar) to 41,912 PCUs (25,451 Vehicle) at Nagpur-Jabalpur Highway (NH 44) on a normal working day.

TABLE 2.25: DAILY TRAFFIC VOLUME AT OUTER CORDON LOCATIONS

SN	Location	Total Vehicles	Total PCU
1	Katol Road	6458	6191
2	Chindwara Road (NH 47)	15775	15312
3	Nagpur-Jabalpur Highway (NH 44)	25451	41912
4	Nagpur-Kolkata Highway (NH 53)	22555	38217
5	Umred Road	14240	17122
6	Chandrapur Road (NH 44)	20050	32271
7	Samriddhi Mahamarg	5354	12431
8	Wardha Road (NH 361)	9550	12517
9	Hingna Road (Near Ujjayani Buddha Vihar)	1992	1532
10	Amravati Road (NH 53)	8023	13433

Peak Hour Traffic Characteristics

The peak hour traffic at the Outer cordon locations is presented in **Table 2.26.** The morning peak hour volume varies from 118 PCUs (164 vehicles) at Hingna Road (Near Ujjayani Buddha Vihar) to 2406 PCUs (1691 vehicles) at Nagpur-Jabalpur Highway (NH 44) & evening peak hour volume varies from 132 PCUs (199 vehicles) at Hingna Road (Near Ujjayani Buddha Vihar) to 2,765 PCU's (1,848 vehicles) at Nagpur-Jabalpur Highway (NH 44).

TABLE 2.26: INTENSITY AND PEAK HOUR TRAFFIC AT OUTER CORDON LOCATIONS

SN	Location	Total Traffic		Morning Peak				Evening Peak			
		Veh.	PCU's	Veh.	% of Total Traffic	PCU's	% of Total Traffic	Veh.	% of Total Traffic	PCU's	% of Total Traffic
1	Katol Road	6458	6191	523	8.1	471	7.6	611	9.5	568	9.2
2	Chhindwara Road (NH 47)	15775	15312	1175	7.4	1000	6.5	1223	7.8	1061	6.9
3	Nagpur-Jabalpur Highway (NH 44)	25451	41912	1691	6.6	2406	5.7	1848	7.3	2765	6.6
4	Nagpur-Kolkata Highway (NH 53)	22555	38217	1410	6.3	2042	5.3	1523	6.8	2231	5.8
5	Umred Road	14240	17122	1028	7.2	1117	6.5	1019	7.2	1151	6.7
6	Chandrapur Road (NH 44)	20050	32271	1311	6.5	1796	5.6	1265	6.3	1915	5.9
7	Samriddhi Mahamarg	5354	12431	302	5.6	728	5.9	322	6.0	745	6.0
8	Wardha Road (NH 361)	9550	12517	677	7.1	854	6.8	638	6.7	825	6.6
9	Hingna Road (Near Ujjayani Buddha Vihar)	1992	1532	164	8.2	118	7.7	199	10.0	132	8.6
10	Amravati Road (NH 53)	8023	13433	498	6.2	729	5.4	531	6.6	880	6.6

Source: RITES Primary Survey, 2024

Traffic Composition

Daily traffic composition of fast moving passenger, goods and slow moving vehicles at Outer Cordon locations are given in **Table 2.26**. It is observed that most of the locations exhibit predominance of fast moving passenger traffic varying from about 42.2% to 89.8% on outer cordon locations. On an average about 71.7% of traffic consists of fast moving passenger vehicle. The average share of slow moving vehicles is about 0.2%. The maximum share of bus traffic is observed to be 3.8% at Wardha Road (NH 361) with an average of about 2.7%. The share of goods traffic varies from 10.1% to 57.8%, with maximum share on Samriddhi Mahamarg.

TABLE 2.27: TRAFFIC COMPOSITION AT OUTER CORDON LOCATIONS

SN	Location of Outer Cordon	Composition (%)					
		Total Fast Moving Passengers				Total Goods	Total Slow
		Car	2-W	Auto/ Sh. Auto	Bus		
1	Katol Road	30.8	52.6	1.2	3.1	12.0	0.4
2	Chhindwara Road (NH 47)	30.6	54.2	1.5	3.5	10.1	0.2
3	Nagpur-Jabalpur Highway (NH 44)	27.3	32.7	1.8	2.7	35.3	0.2
4	Nagpur-Kolkata Highway (NH 53)	26.3	32.7	0.3	2.4	38.3	0.1
5	Umred Road	34.6	41.9	0.8	3.3	19.2	0.1
6	Chandrapur Road (NH 44)	27.7	31.8	0.4	2.6	37.4	0.1
7	Samriddhi Mahamarg	40.4	0.0	0.0	1.8	57.8	0.0
8	Wardha Road (NH 361)	37.5	37.0	1.2	3.8	20.4	0.1
9	Hingna Road (Near Ujjayani Buddha Vihar)	16.6	69.9	0.8	1.4	10.7	0.6
10	Amravati Road (NH 53)	43.3	13.7	0.2	3.0	39.8	0.1

Source: RITES Primary Survey, 2024

Average Occupancy of Passenger Vehicles

Table 2.28 presents the average occupancy of passenger vehicles at Outer Cordon locations. Average Bus occupancy varies from 30.6 to 35.8 with average of about 33. Average occupancy for cars, two wheelers and auto/sh. auto is found to be 2.9, 1.4 and 3.2 respectively.

TABLE 2.28: AVERAGE OCCUPANCY OF PASSENGER VEHICLES AT OUTER CORDONS

SN	Name of Outer Cordon	Passenger Average Occupancy			
		Car	2-W	Auto/ Sh. Auto	Bus
1	Katol Road	2.8	1.5	3.0	33.8
2	Chhindwara Road (NH 47)	3.1	1.5	3.1	30.6
3	Nagpur-Jabalpur Highway (NH 44)	2.8	1.5	3.2	32.5
4	Nagpur-Kolkata Highway (NH 53)	2.8	1.5	3.6	33.0
5	Umred Road	2.8	1.5	2.4	31.7
6	Chandrapur Road (NH 44)	3.4	1.5	3.6	34.1
7	Samriddhi Mahamarg	2.6	-	5.0	33.5
8	Wardha Road (NH 361)	2.8	1.6	3.9	33.4
9	Hingna Road (Near Ujjayani Buddha Vihar)	3.1	1.6	2.4	35.8
10	Amravati Road (NH 53)	2.9	1.6	2.1	31.6

Source: RITES Primary Survey, 2024

2.10. ORIGIN DESTINATION SURVEY AT OUTER CORDON LOCATIONS

a. Passenger Traffic

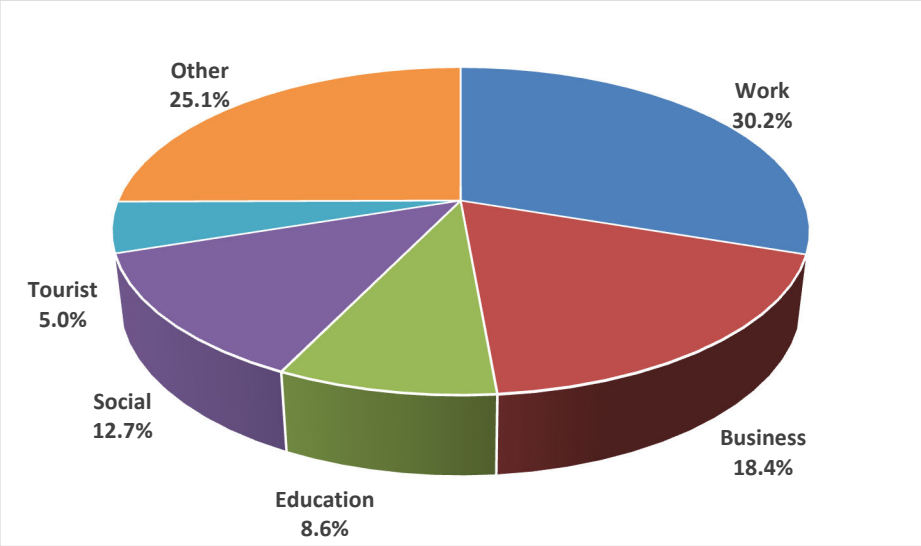
Distribution of passengers by trip purpose **(Table 2.29** and **Figure** 2.12) suggests that the majority of trips (48.6%) are for work and business purpose. Educational trips account for about 8.6% while the social and tourism trips have a share of 12.7% and 5% respectively. About 25.1% trips are performed for other purposes.

TABLE 2.29: DISTRIBUTION OF OUTER CORDON PASSENGERS BY TRIP PURPOSE

Trip Purpose	Work	Business	Education	Social	Tourist	Other	Total
Composition (%)	30.2	18.4	8.6	12.7	5.0	25.1	100.0

Source: RITES Primary Survey, 2024

FIGURE 2.12: DISTRIBUTION OF OUTER CORDON PASSENGERS BY TRIP PURPOSE



Analysis of Travel time data of passengers reflects that 8.6% of total passengers have travel time up to 60 minutes. About 23% of total passengers have travel time ranging between 60-120 minutes and about 50% have travel time more than 180 minutes **(Table 2.30)**.

TABLE 2.30: DISTRIBUTION OF OUTER CORDON PASSENGERS BY TRAVEL TIME

Time (Min)	<=60	60-90	90-120	120-180	>180	Total
Composition	8.6	15.1	7.7	18.6	50.1	100.0%

Source: RITES Primary Survey, 2024

Distribution of passengers by travel distance is presented in **Table 2.31.** It is observed that about 3% of Passengers have trip length up to 20 Km while 17.7% of passengers have trip length in between 20-50 Km. About 47% of the passengers travel for 50 to 200 km. 32.3% passengers have trip length more than 200 km.

TABLE 2.31: DISTRIBUTION OF OUTER CORDON PASSENGERS BY TRAVEL DISTANCE

Distance (Km)	<=20	20-50	50-100	100-200	>200	Total
Composition	2.7	17.7	25.0	22.3	32.3	100.0%

Source: RITES Primary Survey, 2024

The analysis of travel frequency suggests that about 20% of passengers travel on daily basis, 17% weekly, about 28% monthly and about 35% Occasionally at outer cordon locations (**Table 2.31**)

TABLE 2.32: DISTRIBUTION OF OUTER CORDON PASSENGERS BY TRAVEL FREQUENCY

Frequency	Daily	Weekly	Monthly	Occasionally	Total
Composition	20.2	16.8	27.8	35.2	100.0%

Source: RITES Primary Survey, 2024

2.11. PEDESTRIAN CHARACTERISTICS

The pedestrian volume counts were carried out at identified 15 Intersections in the City. The survey was carried out for a period of 16 hours for along and across movements.

The analysed results of surveys indicating total and peak hour pedestrian flows are presented in **Table 2.33.** The maximum pedestrian along and across volume (both side) is 42,009 & 33,693 pedestrians observed at Variety Chowk. Maximum morning peak hour pedestrian along and across volume of 3,211 & 4,084 pedestrians is observed at Variety Chowk. Maximum evening peak hour pedestrian along and across volume of 4,084 & 3,497 pedestrians is observed at Variety Chowk.

TABLE 2.33: DAILY & PEAK HOUR PEDESTRIAN TRAFFIC

SN	Name of Location	Approach	Daily Pedestrian Vol. – both side (16 hours)		Peak Hour Pedestrian Vol. (Morning Peak)		Peak Hour Pedestrian Vol. (Evening Peak)	
			Total Along	Total Across	Along	Across	Along	Across
1	Variety Chowk	Aurangabad Nagpur Road	13490	10954	1332	1083	1329	1080
		Maharajbagh Road	10905	8492	1063	834	940	832
		Chandrapur Road	10095	8481	858	698	1083	991
		Abhyankar Marg	7519	5766	733	596	732	594
2	Nagpur Railway Station	Tekdi Road	14818	12450	1319	1172	1121	1310
3	Cotton Market	Sitabuldi	5512	3015	478	258	555	316
		Bhaji Mandi Chowk	3156	635	273	64	317	66
		Nagpur Junction	4834	5219	181	172	702	694
		Chitnis Park Chowk	6097	5264	499	233	692	667
4	Sitabuldi	Sitabuldi Metro	5458	4333	502	398	466	508

SN	Name of Location	Approach	Daily Pedestrian Vol. – both side (16 hours)		Peak Hour Pedestrian Vol. (Morning Peak)		Peak Hour Pedestrian Vol. (Evening Peak)	
			Total Along	Total Across	Along	Across	Along	Across
		Mor Bhawan Bus Stand	5445	3849	372	213	652	411
		Amravati Highway	6069	2482	491	202	651	263
		Zero Mile	5550	5047	521	560	531	533
		Cotton Market	14176	1680	789	115	1510	156
5	Jhansi Rani Square	Aurangabad Nagpur Road	4900	8334	466	694	465	687
		Ambazari Road	7546	11387	733	1220	732	1242
		Chandrapur Road	5155	8220	497	674	520	873
		Ambazari Road	4042	7876	384	729	341	728
6	Lokmanya Nagar	Sitabuldi	8708	7566	744	707	710	849
7	Butibori MIDC Gate	Butibori	4748	4119	472	449	482	513
8	Hingna 'T' Point	Wana Dongri	3630	2142	239	123	428	219
		Mumbai Kolkata Highway	1676	354	206	43	160	40
		Hingna Bus Stand	3434	1853	217	89	496	224
9	Kamptee	Jabalpur	3733	2814	309	251	320	234
		Khairy	3286	2354	270	218	292	203
		Gold Talkies	4366	3504	360	319	411	289
10	Ganeshpeth Bus Stand	Ganeshpeth	9039	8182	808	793	698	787
11	Liberty Chowk	Mount Road	1413	1255	156	142	144	120
		Chhindwara Road	1700	1520	168	166	195	145
		Kamptee Road	1498	1290	155	151	159	117
		Sadar Bazar Road	1754	1290	162	136	192	132
12	Wadi 'T' Point	Sitabuldi	2971	1030	264	119	264	72
		Hingna 'T' Point	4402	1530	383	172	382	105
		Dhaman	2900	1398	286	158	329	136
13	Ravi Nagar Square	Amravati Road	2039	1557	164	118	221	138
		Ambazari Police Station	2818	2190	233	181	314	195
		Law College Square	1904	1420	161	126	218	132
		Hill Road	1671	1362	133	98	179	128
14	Agarsen Square	Gitanjali Chowk	2107	1956	232	203	223	227
		Indora	2135	1969	244	262	188	182
		Telephone Exchange	2613	2373	250	212	236	256
		Chitra Talkies	1809	1614	180	169	166	162

SN	Name of Location	Approach	Daily Pedestrian Vol. – both side (16 hours)		Peak Hour Pedestrian Vol. (Morning Peak)		Peak Hour Pedestrian Vol. (Evening Peak)	
			Total Along	Total Across	Along	Across	Along	Across
15	Chhatrapati Square	Pardi	1413	1217	132	124	140	112
		Wardha Road	1311	1865	124	175	148	158
		Hingna Road	1299	1875	140	154	115	139
		Butibori Road	1510	1126	142	116	132	108

2.12. PARKING CHARACTERISTICS

Background

The Parking surveys have been conducted at 10 locations at identified on-street parking stretches on major arterial and sub-arterial roads in the study area for 12 hours on fair weather working day.

Parking Accumulation

The observed peak parking accumulation along the surveyed locations is presented in **Table 2.34.** The total peak parking accumulation at the surveyed locations is observed to be 837 ECS with maximum concentration of 199 ECS at Ravinagar Square.

TABLE 2.34: PEAK HOUR PARKING ACCUMULATION

SN	Name of Location	Time	Peak Parking Accumulation		Equivalent Car Spaces (ECS)
			Car	2-Whlr.	
1	Lakadganj Parking	1600-1630	20	26	36
2	Lokmat Parking	1530-1600	14	33	29
3	Agrasen Square	930-1000	96	141	179
4	Civil Lines	1230-1300	48	34	89
5	Kachipura to Alankar Chowk	1830-1900	32	27	43
6	Medical Chowk to Ashok Chowk	1630-1700	41	66	78
7	Mount Road	1800-1830	32	32	66
8	NMC Office	1200-1230	40	30	76
9	Ravinagar Square	1230-1300	106	145	199
10	Variety Chowk to Loha Pul	1430-1500	6	128	43
Grand Total			**435**	**662**	**837**

2.13. TERMINAL CHARACTERISTICS

Following terminal surveys were conducted as part of the study:

- Bus Terminal Survey
- Rail Terminal Survey
- Air Terminal Survey

Bus Terminal Survey

To assess the characteristics of the originating/destined passenger trips by buses, detailed OD surveys including boarding & alighting counts were carried out for 24 hours at three bus terminal in Nagpur. User characteristics have been determined by interviewing passengers to assess their socio-economic characteristics, travel patterns, factors defining mode choice, accessibility, affordability characteristics etc.

The analysis of data (**Table 2.35)** reveals that the Mor Bhawan Bus Terminal caters total 46,387 passengers with 24,427 Boarding and 21,960 Alighting.

TABLE 2.35: DISTRIBUTION OF PASSENGERS AT BUS TERMINALS

SN	Name of Location	Passenger In	Passenger Out	Total Passenger	Peak Hour			
					Time	Passenger In	Passenger Out	Total Passenger
1	Ganeshpeth	20898	17859	38757	1000-1100	3036	2107	5143
2	Hingna	853	658	1511	0800-0900	94	67	161
3	Mor Bhawan	24427	21960	46387	0900-1000	2223	1616	3839

Source: RITES Primary Survey, 2024

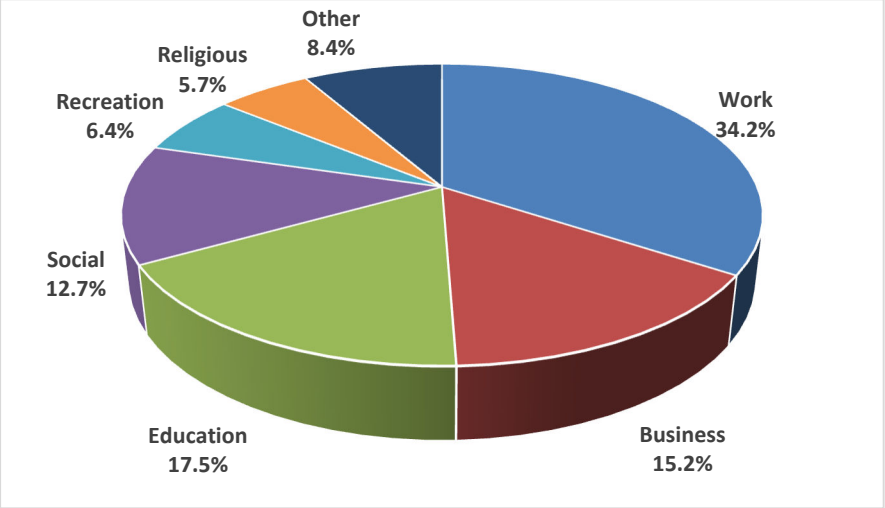
a. Origin Destination Survey at Bus Terminals

The analysis of Origin Destination survey data **(Table 2.36**) reveals that Work and business contribute to major share of total trips at bus terminal i.e. 49.4%. Educational trips have a significant share of 17.5% in the overall trips while social trips contribute to 12.7%. Recreation and Religious contribute 6.4% and 5.7% respectively. Other trips contributes to 8.4% of the overall trips. Distribution of passenger trips by purpose is presented in **Figure 2.13.**

TABLE 2.36: DISTRIBUTION OF BUS PASSENGERS BY TRIP PURPOSE

Trip Purpose	Work	Business	Education	Social	Recreation	Religious	Other
Composition	34.2	15.2	17.5	12.7	6.4	5.7	8.4

FIGURE 2.13: DISTRIBUTION OF BUS PASSENGERS BY TRIP PURPOSE



Source: RITES Primary Survey, 2024

Table 2.37 shows the distribution of access mode used by bus passengers. About 25% of passengers use shared IPT mode (Auto Rickshaw, Shared Auto, E-Rickshaw) to reach bus terminal. While car and two wheelers are 6.9% and 26.0% respectively. The Metro contributes about 7% share while Bus trips are around 32.0%.

TABLE 2.37: DISTRIBUTION OF BUS PASSENGERS BY MODE TO REACH BUS TERMINAL

Distribution of Bus Passengers by Mode to Reach Bus Terminal	Car/ Taxi	2 Wheeler	Metro Rail	Auto Rickshaw/ Sh. Auto/ E-Rickshaw	Bus	Cycle	Walk
Composition	6.9	26.0	6.8	25.2	31.7	2.0	1.6

Table 2.38 presents the cost of access trip to bus terminal. About 4% of cost incurred for travel is in the range of equal to or less than Rs. 10 and major share of passengers i.e. 56% spend between Rs. 21 to 50. Only 1.5% of the passengers incur more than Rs. 100.

TABLE 2.38: DISTRIBUTION OF BUS PASSENGERS BY TRAVEL COST TO REACH BUS TERMINAL

Travel Cost	>=10	10-20	20-30	30-50	50-100	>100
Composition	3.7	18.5	27.5	28.5	20.2	1.5

Source: RITES Primary Survey, 2024

Distribution of passengers by travel time to reach bus terminal is presented in **Table 2.39.** It can be observed that 32.4% of total bus passengers have travel time up to 15 minutes and 34.7% of passengers have travel time ranging between 15-30 minutes. 21% of passengers have travel time ranging between 30-60 minutes. About 12% of passengers have travel time more than 60 minutes.

TABLE 2.39: DISTRIBUTION OF BUS PASSENGERS BY TRAVEL TIME TO REACH BUS TERMINAL

Time (Min)	<=15	15-30	30-60	60-90	90-120	>120
Composition	32.4	34.7	21.0	4.5	3.5	3.8

Source: RITES Primary Survey, 2024

Distribution of passengers by travel frequency is presented in **Table 2.40**. It is observed that about 58% of passengers are daily travelers. About 24% & 10% passengers undertake bus trips weekly and monthly while 7.7% are the occasional travelers.

TABLE 2.40: DISTRIBUTION OF BUS PASSENGERS BY TRAVEL FREQUENCY

Frequency	Daily	Weekly	Monthly	Occasionally
Composition	57.6	24.3	10.4	7.7

Rail Terminal Survey

To assess the characteristics of the originating/destined passenger trips by rail, detailed OD surveys including boarding & alighting counts were carried out for 24 hours at four Railway Stations in Nagpur. User characteristics have been determined by interviewing passengers to assess their socio-economic characteristics, travel patterns, factors defining mode choice, accessibility, affordability characteristics etc.

It is observed from **Table 2.41** that Nagpur Railway Station caters daily boarding of 69,770 passengers & 68,774 Alighting passengers. Peak hour boarding and alighting is 9,262.

TABLE 2.41: DISTRIBUTION OF PASSENGERS AT RAIL TERMINAL

SN	Name of Location	Passengers		Total Passenger	Peak Hour			
		In	Out		Time	Passenger		Total Passenger
						In	Out	
1	Ajni Railway Station	4332	3838	8170	1100-1200	500	382	882
2	Godhani Railway Station	1070	929	1999	1800-1900	101	97	198
3	Itwari Railway Station	8994	7263	16257	1800-1900	937	598	1535
4	Nagpur Railway Station	69770	68774	138544	0900-1000	4541	4721	9262

Source: RITES Primary Survey, 2024

a. Origin Destination Survey

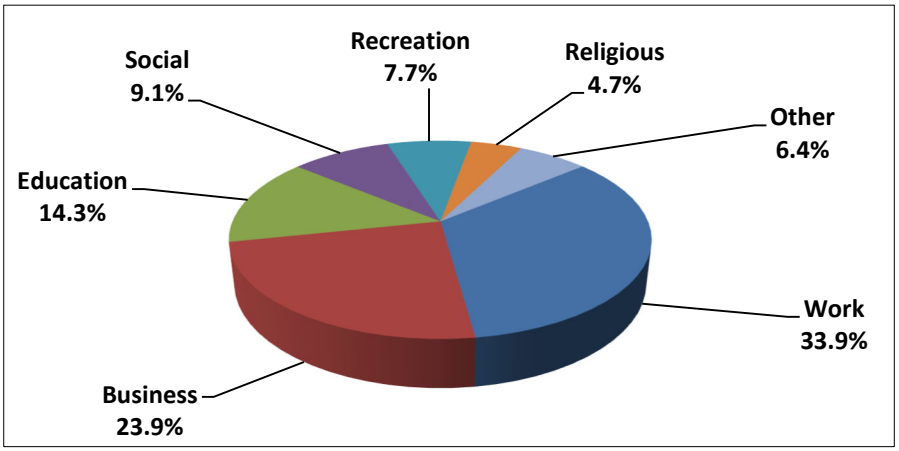
The analysis of OD data of rail passengers reveals that major share (58%) of the passengers travel for work (Govt. Service & Pvt. Service) and business purpose (**Table 2.42).** Educational trips have a significant share of about 14.3%. Social trips contribute to about 9%. Recreation and Religious are 7.7% and 4.7% respectively. Other tips account for 6.4%. Distribution of passenger trips by purpose is presented in **Figure 2.14.**

TABLE 2.42: DISTRIBUTION OF RAIL PASSENGERS BY TRIP PURPOSE

Trip Purpose	Work	Business	Education	Social	Recreation	Religious	Other
Composition	33.9	23.9	14.3	9.1	7.7	4.7	6.4

Source: RITES Primary Survey, 2024

FIGURE 2.14: DISTRIBUTION OF RAIL PASSENGERS BY TRIP PURPOSE



Source: RITES Primary Survey, 2024

Table 2.43 shows that 21.5% of rail passengers use 2 wheeler to reach rail terminal. While the share of Car, IPT and bus is 13.2%, 34.0% and 18.8 respectively.

TABLE 2.43: DISTRIBUTION OF RAIL PASSENGERS BY MODE TO REACH RAIL TERMINAL

Distribution of Passengers by Mode to Reach Railway Station	Car/ Taxi	2 Wheeler	Metro Rail	Auto Rickshaw/ Sh. Auto/ E-Rickshaw	Bus	Cycle	Walk
Composition	13.2	21.5	6.8	34.0	18.8	2.1	3.7

Source: RITES Primary Survey, 2024

Table 2.44 presents the distribution of rail passengers by travel cost they bear to reach railway station. About 7% of cost incurred for travel is in the range of less than or equal to Rs. 10 and share of about 13% being in range of Rs. 10 to 20. Its is also observed that 6.5% of the passengers spend more than Rs. 100 to reach railway station.

TABLE 2.44: DISTRIBUTION OF RAIL PASSENGERS BY TRAVEL COST TO REACH TERMINAL

Travel Cost (Rs)	<=10	10-20	20-30	30-50	50-100	>100
Composition	6.9	13.4	24.0	29.9	19.3	6.5

Source: RITES Primary Survey, 2024

Distribution of passengers by travel time to reach rail terminal is presented in **Table 2.45.** It is observed that 5.4% of total rail passengers have travel time upto 10 minutes and 30% of passengers have travel time ranging between 10-20 minutes. 31.3% of passengers have travel time ranging between 20-30 minutes. About 7% of passengers have travel time more than 60 minutes.

TABLE 2.45: DISTRIBUTION OF RAIL PASSENGERS BY TRAVEL TIME TO REACH RAIL TERMINAL

Time (Min)	>=10	10-20	20-30	30-60	>60
Composition	5.4	29.9	31.3	26.2	7.2

Source: RITES Primary Survey, 2024

Distribution of passengers by travel frequency is presented in **Table 2.46**. It is observed that about 20% of total passengers perform their trips on daily basis. Whereas 11.2% and 24.7% passengers perform weekly and monthly trips. About 48% of total passengers travel occasionally.

TABLE 2.46: DISTRIBUTION OF RAIL PASSENGERS BY TRAVEL FREQUENCY

Frequency	Daily	Weekly	Monthly	Occasionally
Composition (%)	19.7	11.2	27.4	41.7

Source: RITES Primary Survey, 2024

Air Terminal Survey

To assess the characteristics of the originating/destined passenger trips by Air, detailed OD surveys including boarding & alighting counts were carried out for 24 hours at Nagpur Airport. User characteristics have been determined by interviewing passengers to assess their socio-economic characteristics, travel patterns, factors defining mode choice, accessibility, affordability characteristics etc.

It is observed from **Table 2.47** that Nagpur Airport caters daily boarding of 5,017 passengers & 3,545 Alighting passengers. Peak hour boarding and alighting is 1,122.

TABLE 2.47: DISTRIBUTION OF PASSENGERS AT AIR TERMINAL

SN	Name of Location	Passenger In	Passenger Out	Total Passenger	Peak Hour			
					Time	Passenger In	Passenger Out	Total Passenger
1	Dr. Baba Saheb Ambedkar Airport	5017	3545	8562	19:00 - 20:00	683	439	1122

Source: RITES Primary Survey, 2024

b. Origin Destination Survey

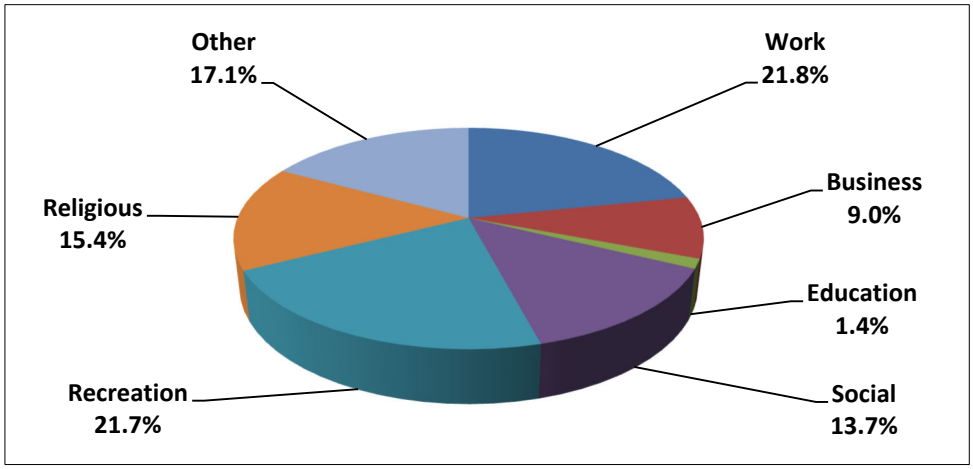
The analysis of OD data of Air passengers reveals that 30.8% of the passengers travel for work (Govt. Service & Pvt. Service) and business purpose (**Table 2.42).** Educational trips have a tiny share of 1.4%. Social trips contribute to about 13.7%. Recreation and Religious are 21.7% and 15.4% respectively. Other tips account for 17.1%. Distribution of passenger trips by purpose is presented in **Figure 2.12.**

TABLE 2.48: DISTRIBUTION OF AIR PASSENGERS BY TRIP PURPOSE

Trip Purpose	Work	Business	Education	Social	Recreation	Religious	Other
Composition	21.8	9.0	1.4	13.7	21.7	15.4	17.1

Source: RITES Primary Survey, 2024

FIGURE 2.15: DISTRIBUTION OF AIR PASSENGERS BY TRIP PURPOSE



Source: RITES Primary Survey, 2024

Table 2.49 shows that a large number of Air passengers (87.5%) use Car/Taxi to reach air terminal. While the share of 2W, Metro, Auto and bus is 2.9%, 5.2%, 3.3% and 1.2% respectively.

TABLE 2.49: DISTRIBUTION OF AIR PASSENGERS BY MODE TO REACH RAIL TERMINAL

Distribution of Passengers by Mode to Reach Airport	Car/ Taxi	2 Wheeler	Metro Rail	Auto Rickshaw	Bus
Composition	87.4	2.9	5.2	3.3	1.2

Source: RITES Primary Survey, 2024

Table 2.50 presents the distribution of Air passengers by travel cost they bear to reach the terminal. About 8% of cost incurred for travel is less or equal to Rs. 30. About 40% of the passengers spend between Rs 30 to 90. Only 7.7% of the air passengers spend more than Rs. 300.

TABLE 2.50: DISTRIBUTION OF AIR PASSENGERS BY TRAVEL COST TO REACH TERMINAL

Travel Cost (Rs)	<=30	30-60	60-90	90-150	150-200	200-300	>300
Composition	7.8	24.4	16.0	19.0	14.5	10.5	7.7

Source: RITES Primary Survey, 2024

Distribution of passengers by travel time to reach Air terminal is presented in **Table 2.51.** It is observed that about 12% of total air passengers have travel time upto 15 minutes and 70% of passengers have travel time ranging between 15-60 minutes. Only 1.6% of passengers have travel time more than 120 minutes.

TABLE 2.51: DISTRIBUTION OF AIR PASSENGERS BY TRAVEL TIME TO REACH RAIL TERMINAL

Time (Min)	<=15	15-30	30-60	60-90	90-120	>120
Composition	11.7	32.3	37.6	13.5	3.4	1.6

Source: RITES Primary Survey, 2024

Distribution of passengers by travel frequency is presented in **Table 2.52**. It is observed that majority of passengers are either weekly (46.4%) or occasional (52.3%) travelers.

TABLE 2.52: DISTRIBUTION OF AIR PASSENGERS BY TRAVEL FREQUENCY

Frequency	Weekly	Monthly	Occasionally
Composition	1.3	46.4	52.3

Source: RITES Primary Survey, 2024

2.14. METRO TRAVEL CHARACTERISTICS

To assess the characteristics of the originating/destined passenger trips by rail, detailed OD surveys including boarding & alighting counts were carried out at 10 major Metro stations in Nagpur. User characteristics have been determined by interviewing passengers to assess their socio-economic characteristics, travel patterns, factors defining mode choice, accessibility, affordability characteristics etc.

It is observed from **Table 2.53** that Sitabuldi station handles about 19,763 daily passengers followed by Lokmanya Nagar with 9378 daily passengers. It is observed that the peak hour for most stations occurs in the evening. On average, 10% of passengers travel during the peak hour at all the stations.

TABLE 2.53: DISTRIBUTION OF PASSENGERS AT METRO STATION

SN	Station	Passenger In	Passenger Out	Total Passenger	Peak Hour			
					Time	Passenger In	Passenger Out	Total Passenger
1	Chhatrapati Square	3741	4047	7788	1600-1700	496	336	832
2	Congress Nagar	1843	1646	3489	1600-1700	230	242	472
3	Jhansi Rani Square	1323	1415	2738	1500-1600	164	97	261
4	Kasturchand Park	2186	2145	4331	0900-1000	164	227	391
5	Khapri	2827	2102	4929	0900-1000	228	215	443
6	Lokmanya Nagar	3546	5832	9378	1100-1200	326	599	925
7	Nagpur Railway Station	4194	5062	9256	1800-1900	413	521	934
8	Prajapati Nagar	4088	4646	8734	1800-1900	176	652	828
9	Shankar Nagar	2603	3866	6469	1000-1100	113	617	730
10	Sitabuldi	11154	8609	19763	1700-1800	1075	1066	2141

Source: RITES Primary Survey, 2024

Origin Destination Survey

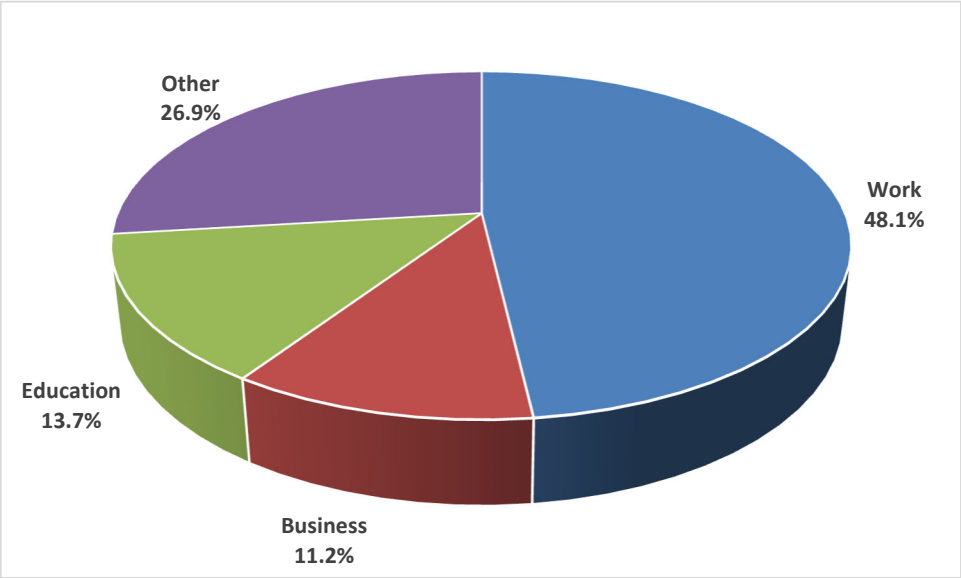
The analysis reveals that major share (59.3%) of the passengers travel for work and business purpose (**Table 2.42).** Educational trips have a significant share of about 13.7% which indicates that the people are travelling in Metro for education purpose. Other trips account for about 27%. Distribution of passenger trips by purpose is presented in **Figure 2.16.**

TABLE 2.54: DISTRIBUTION OF METRO PASSENGERS BY TRIP PURPOSE

Trip Purpose	Work	Business	Education	Other
Composition	48.1	11.2	13.7	26.9

Source: RITES Primary Survey, 2024

FIGURE 2.16: DISTRIBUTION OF METRO PASSENGERS BY TRIP PURPOSE



Source: RITES Primary Survey, 2024

Table 2.44 presents the distribution of passengers by travel cost they bear to reach metro station. A large number of people (86.7%) spend less than Rs. 10 to reach the metro station. Only 0.6% of the passengers spend more than Rs. 50.

TABLE 2.55: DISTRIBUTION OF METRO PASSENGERS BY TRAVEL COST TO REACH METRO STATION

Travel Cost	<=10	11-20	21-50	>50
Composition	86.7	7.5	5.2	0.6

Source: RITES Primary Survey, 2024

Distribution of passengers by travel time to reach metro station is presented in **Table 2.45.** It is observed that about 20.4% of total passengers spend 5 minutes or less to reach the metro station. About 33% of the passengers spend 6-10 minutes. Only 1.8 of the passengers spend more than 30 minutes to reach the metro station.

TABLE 2.56: DISTRIBUTION OF METRO PASSENGERS BY TRAVEL TIME TO REACH METRO STATION

Time (Min)	<=5	6-10	11-15	15-30	>30
Composition	20.4	33.2	15.9	28.6	1.8

Source: RITES Primary Survey, 2024

Distribution of passengers by travel frequency is presented in **Table 2.46**. It is observed that most of the passengers (91.1%) are daily travelers in the metro. Whereas 3.2% and 2.9% passengers perform weekly and monthly trips. About 3% of total passengers travel occasionally.

TABLE 2.57: DISTRIBUTION OF METRO PASSENGERS BY TRAVEL FREQUENCY

Frequency	Daily	Weekly	Monthly	Occasionally
Composition	91.1	3.2	2.9	2.9

Source: RITES Primary Survey, 2024

2.15. PT/IPT CHARACTERISTICS

The following PT/IPT surveys were conducted as part of the study:

- Bus Stop Survey
- Auto Stand Survey

Bus Stop Survey

To assess the characteristics of the originating/destined passenger trips by buses, detailed OD surveys including boarding & alighting counts were carried out at 10 major bus stops in Nagpur. User characteristics have been determined by interviewing passengers to assess their socio-economic characteristics, travel patterns, factors defining mode choice, accessibility, affordability characteristics etc.

The analysis of data (**Table 2.58)** reveals that Kamptee caters total 4,695 passengers with 2,491 Boarding and 2,204 Alighting.

TABLE 2.58: DISTRIBUTION OF PASSENGERS AT BUS STOPS

SN	Name of Location	Boarding	Alighting	Total	Peak Time	Peak Boarding	Peak Alighting	Total Peak Hour
1	Dighori	2305	2160	4465	1700-1800	142	253	395
2	Manakapur	1923	1692	3615	0900-1000	249	107	356
3	Butibori MIDC	2290	2108	4398	1700-1800	172	248	420
4	Hingna Naka	2183	2043	4226	1700-1800	172	233	405
5	Kamptee	2491	2204	4695	1700-1800	171	233	404
6	Ravi Nagar	1981	2186	4167	1700-1800	130	241	371
7	Chhattrapati	2161	1918	4079	1700-1800	131	240	371
8	Lokmanya	1734	1681	3415	1000-1100	227	100	327
9	Old Pardi Naka	2335	2323	4658	1000-1100	269	151	420
10	Koradi Naka	2025	2162	4187	1600-1700	136	249	385

Source: RITES Primary Survey, 2024

Origin Destination Survey at Bus Stops

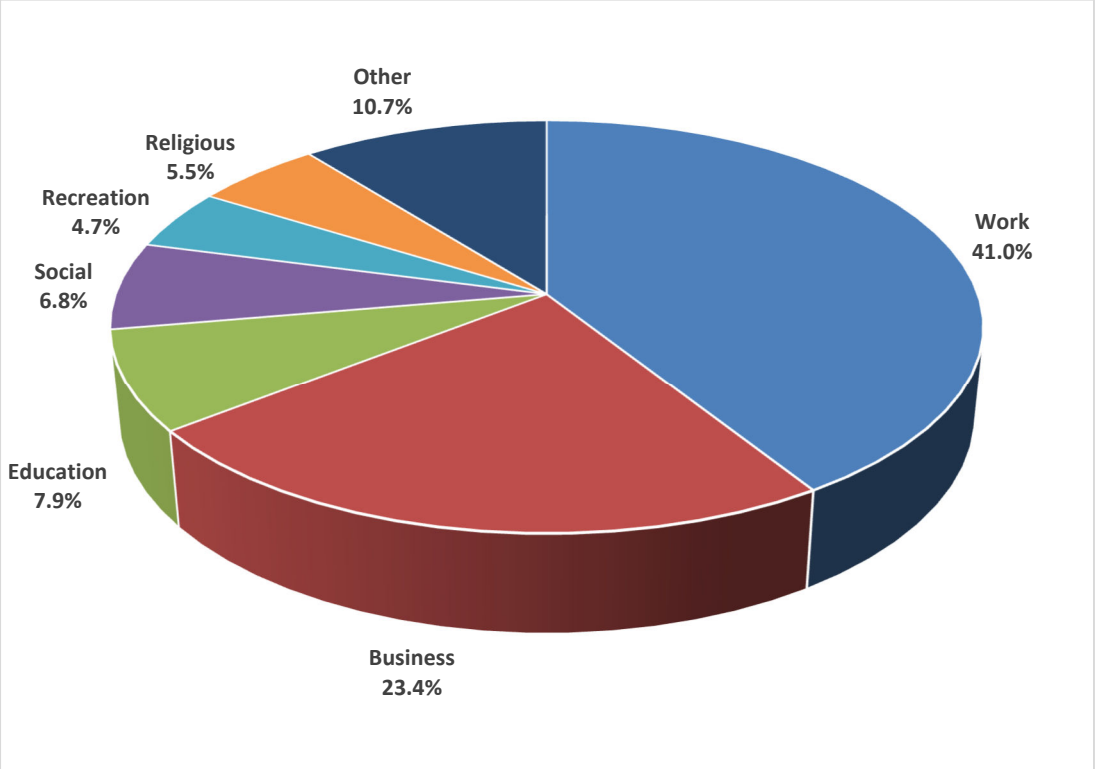
The analysis of Origin Destination survey data **(Table 2.59**) reveals that Work and business contribute to a major share of total trips at bus terminal i.e. 64.4%. Educational trips also have a considerable share of 8% in the overall trips while social trips contribute to about

7%. Recreational and Religious trips contribute 4.7% and 5.5% respectively. The other trips contribute to 10.7% of the overall trips. Distribution of passenger trips by purpose is presented in **Figure** 2.17**.**

TABLE 2.59: DISTRIBUTION OF BUS PASSENGERS BY TRIP PURPOSE

Trip Purpose	Work	Business	Education	Social	Recreation	Religious	Other
Composition (%)	41.0	23.4	7.9	6.8	4.7	5.5	10.7

FIGURE 2.17: DISTRIBUTION OF BUS PASSENGERS BY TRIP PURPOSE



Source: RITES Primary Survey, 2024

Distribution of passengers by travel time to reach bus stop is presented in **Table 2.59.** It can be observed that 28.5% of total bus passengers have travel time up to 10 minutes and 22.5% of passengers have travel time ranging between 10-20 minutes. About 25% of passengers have travel time ranging between 20-40 minutes and about 24% of passengers have travel time more than 40 minutes.

TABLE 2.60: DISTRIBUTION OF BUS PASSENGERS BY TRAVEL TIME TO REACH BUS STOP

Time (Min)	<10	10-20	20-30	30-40	40-60	>60
Composition	28.5	22.5	13.6	11.3	10.6	13.5

Source: RITES Primary Survey, 2024

Distribution of passengers by travel frequency is presented in **Table 2.61**. It is observed that about 70.5% of passengers are daily travelers. About 8.0% & 12.2% passengers undertake bus trips weekly and monthly while 9.2% are the occasional travelers.

TABLE 2.61: DISTRIBUTION OF BUS PASSENGERS BY TRAVEL FREQUENCY

Frequency	Daily	Weekly	Monthly	Occasionally
Composition	70.5	8.1	12.2	9.2

Auto Stop Survey

To assess the characteristics of the originating/destined passenger trips by buses, detailed OD surveys including boarding & alighting counts were carried out at 10 major auto stops in Nagpur. User characteristics have been determined by interviewing passengers to assess their socio-economic characteristics, travel patterns, factors defining mode choice, accessibility, affordability characteristics etc.

The analysis of data (**Table 2.62)** reveals that Nagpur Railway Station auto stand caters total 5,075 passengers with 2,661 Boarding and 2,414 Alighting.

TABLE 2.62: DISTRIBUTION OF PASSENGERS AT AUTO STOPS

SN	Name of Location	Boarding	Alighting	Total	Peak Time	Peak Boarding	Peak Alighting	Total Peak Hour
1	Variety Chowk	578	546	1124	1800-1900	46	43	89
2	Sitabuldi	987	931	1918	1800-1900	113	64	177
3	Ajni Railway Station	490	440	930	1000-1100	52	40	92
4	Chhatrapati Chowk	374	347	721	1700-1800	36	37	73
5	Nagpur Railway Station	2661	2414	5075	0900-1000	197	194	391
6	Mor Bhawan	1858	1785	3643	0900-1000	141	150	291
7	Medical Chowk	259	312	571	1500-1600	16	25	41
8	Butibori	159	114	273	1200-1300	11	12	23
9	Ganesh Peth	470	402	872	1000-1100	39	41	80
10	Itwari Railway Station	573	501	1074	0900-1000	55	44	99

Source: RITES Primary Survey, 2024

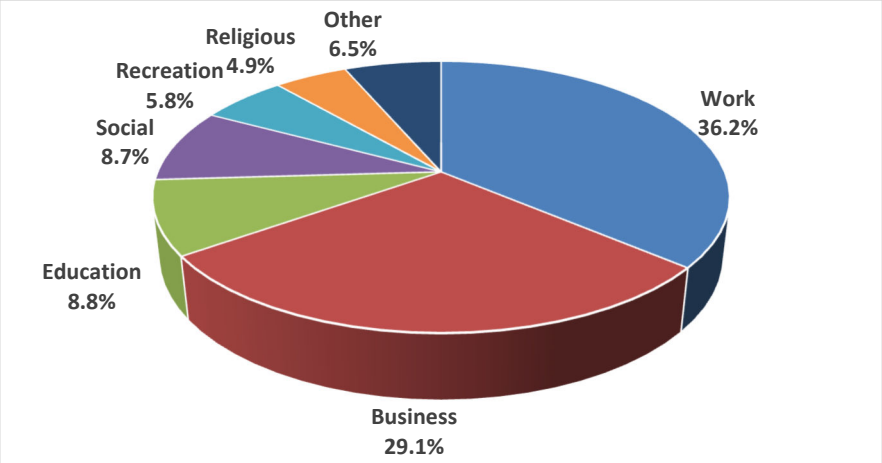
Origin Destination Survey at Auto Stands

The analysis of Origin Destination survey data **(Table 2.63**) reveals that Work and business contribute to the major share of total trips at bus terminal i.e. 65.2%. Educational trips also have a considerable share of about 9% in the overall trips while social trips contribute to 8.7%. Recreational and Religious trips contribute 5.8% and 4.9% respectively. The other trips contribute 6.5% of the overall trips. Distribution of passenger trips by purpose is presented in **Figure 2.18.**

TABLE 2.63: DISTRIBUTION OF AUTO PASSENGERS BY TRIP PURPOSE

Trip Purpose	Work	Business	Education	Social	Recreation	Religious	Other
Composition (%)	36.2	29.1	8.8	8.7	5.8	4.9	6.5

FIGURE 2.18: DISTRIBUTION OF AUTO PASSENGERS BY TRIP PURPOSE



Source: RITES Primary Survey, 2024

Distribution of passengers by travel time to reach auto stop is presented in **Table 2.64.** It can be observed that 4.6% of total bus passengers have travel time up to 10 minutes and around 38.0% of passengers have travel time ranging between 10-20 minutes. About 30% of passengers have travel time ranging between 20-30 minutes and 21.3% of passengers have travel time in the range of 30-40 minutes. About 6.0% of the passengers travel for more than 40 minutes.

TABLE 2.64: DISTRIBUTION OF AUTO PASSENGERS BY TRAVEL TIME TO REACH AUTO STOP

Time (Min)	<10	10-20	20-30	30-40	40-60	>60
Composition	4.6	37.8	30.2	21.3	5.4	0.7

Source: RITES Primary Survey, 2024

Distribution of passengers by travel frequency is presented in **Table 2.65**. It is observed that about 70.4% of passengers are daily travelers. 8.0% & 13.3% passengers undertake bus trips weekly and monthly while 8.3% are the occasional travelers.

TABLE 2.65: DISTRIBUTION OF AUTO PASSENGERS BY TRAVEL FREQUENCY

Frequency	Daily	Weekly	Monthly	Occasionally
Composition	70.4	8.0	13.3	8.3

2.16. HOUSEHOLD SURVEY

Coverage

The household interview survey has been conducted to bring out socio-economic and travel characteristics of the study area like household size, income, and vehicle ownership, per capita trip rates for various purposes viz. Work, education and other trips, expenditure on transport, modal split and origin-destination matrices. To ensure that the sample was

representative, the households interviewed during the survey were distributed throughout the study area in the same proportion as the distribution of population.

A total of 5,000 households were interviewed in the study area representing 183 internal traffic zones. A random sampling technique was used to identify the sample. Further, care was taken that the representative households of all socio-economic strata i.e. High Income Groups (HIG), Middle Income Groups (MIG) and Lower Income Groups (LIG) were covered in the sample.

The survey format consists of three sections. In the first section, the socio-economic information of each household was recorded. This included the information about each member of the family, their education level, and income and vehicle ownership patterns. The second section recorded the trip information about each member of household for the previous working day. The third section was about the revealed preference in terms of extra fare and other parameters for choosing a high-capacity mass transit system. The analysis of socio-economic, travel characteristics and revealed preference for the mass transit system is presented in subsequent sections.

Data Collection and Coding

The data was collected through trained enumerators. The survey was initiated with a pilot survey in the field and amendments in the method of recording the observations were made wherever necessary before starting the actual survey.

A daily programme for the households to be surveyed was prepared and the data was collected back from the enumerators on daily basis. The checked data set was compiled and coded in the office. The coded information was punched and analyzed through computer software.

Socio-Economic Characteristics

a. Household Size

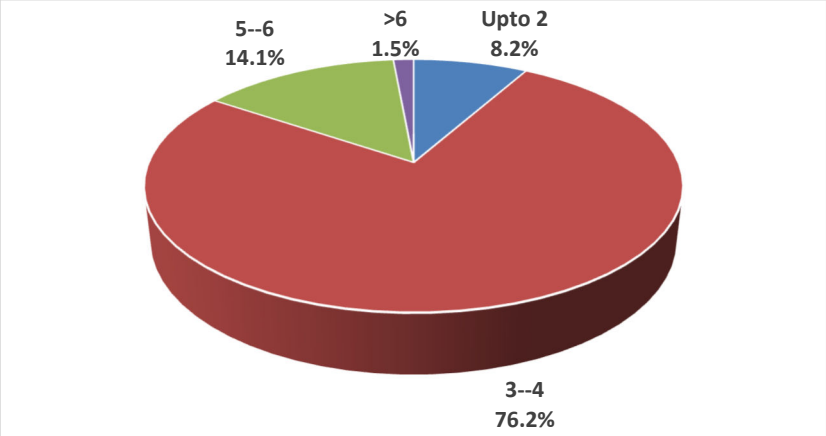
The average household size in the study area is 3.6 persons per household. The distribution of households by size is presented in **Table 2.66** & **Figure 2.19**. It can be observed that majorly i.e. 76.2% of the households fall under the category of 3-4 persons per household and 14.1% of households' falls under category of 5-6 persons' group.

TABLE 2.66: HOUSEHOLD DISTRIBUTION BY SIZE

SN	Household by Size	No. of Households	Percentage
1	Upto 2	412	8.2
2	3--4	3834	76.2
3	5--6	710	14.1
4	>6	73	1.5
Total		**5029**	**100.0%**

Source: RITES Primary Surveys, 2024

FIGURE 2.19: DISTRIBUTION OF HOUSEHOLD BY SIZE



b. Education Level

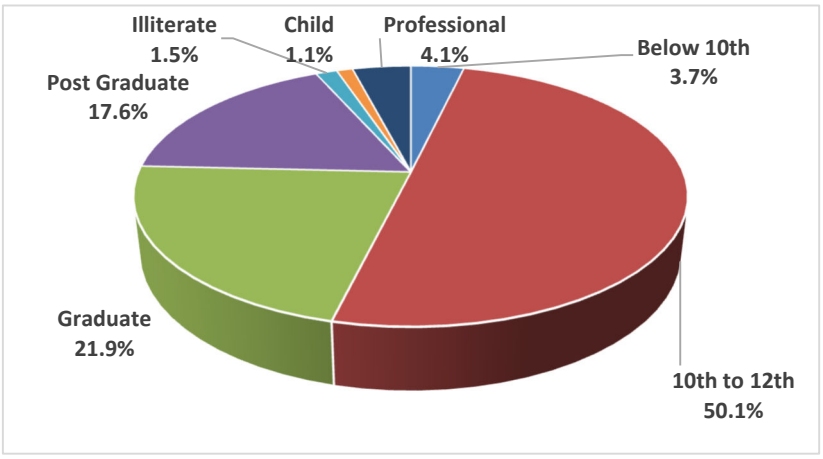
The distribution of population by educational qualifications is presented in **Table 2.67** and **Figure 2.20.** The members of household with age below four years have been considered as children. Therefore, about 54.0% have studied upto 12th standard, 22.0% upto graduation level, 17.6% have done post-graduation and 4.1% have done professional. Only 1.5% of the surveyed sample is Illiterate.

TABLE 2.67: DISTRIBUTION OF SURVEYED POPULATION BY EDUCATION LEVEL

SN	Education	No. of Individuals in Sampled Households	Percentage
1	Below 10th	666	3.7
2	10th to 12th	9047	50.1
3	Graduate	3957	21.9
4	Post Graduate	3172	17.6
5	Illiterate	267	1.5
6	Child	201	1.1
7	Professional	734	4.1
Total		**18044**	**100**

Source: RITES Primary Surveys, 2024

FIGURE 2.20: DISTRIBUTION OF SURVEYED POPULATION BY EDUCATION LEVEL



c. Occupation

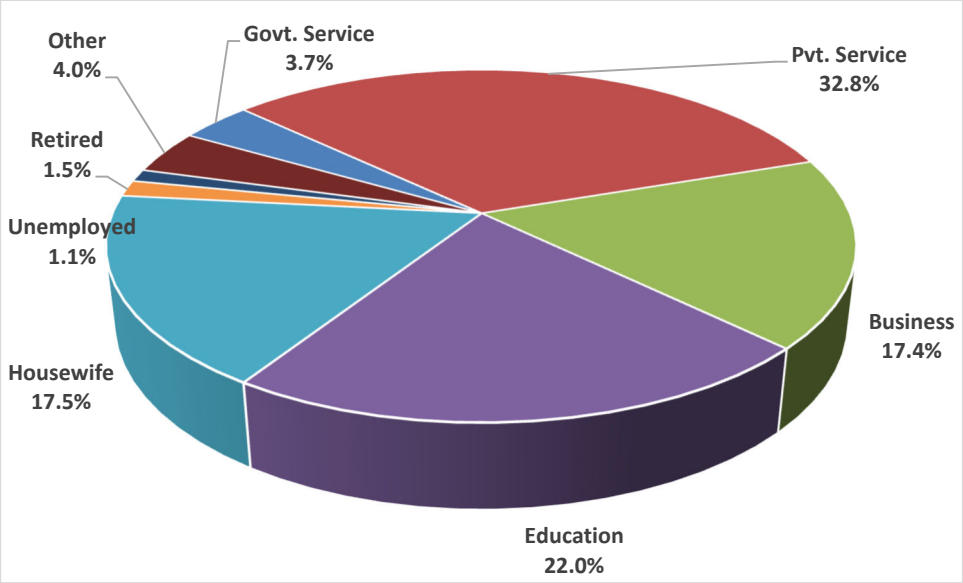
The occupational structure of the surveyed household members is presented in **Table 2.68** and **Figure 2.21.** It is observed that about 46.1% samples are non-workers comprising of students, housewives, retired and unemployed people. 53.9% samples are engaged in occupation out of which 17.4% are engaged in business and 36.5% in service. Among the service class, majorly about 32.8% are engaged in private sector, where about 3.7% are engaged in government services.

TABLE 2.68: OCCUPATION STRUCTURE OF SURVEYED POPULATION

S. No.	Occupation	No of Individuals in Sampled Households	Percentage (%)
1	Govt. Service	667	3.7
2	Pvt. Service	5913	32.8
3	Business	3139	17.4
4	Education	3962	22.0
5	Housewife	3161	17.5
6	Retired	267	1.5
7	Unemployed	206	1.1
8	Other	729	4.0
Total		**18044**	**100**

Source: RITES Primary Surveys, 2024

FIGURE 2.21: OCCUPATION STRUCTURE OF SURVEYED POPULATION



d. Earning Members per Household – Worker/ Non- workers

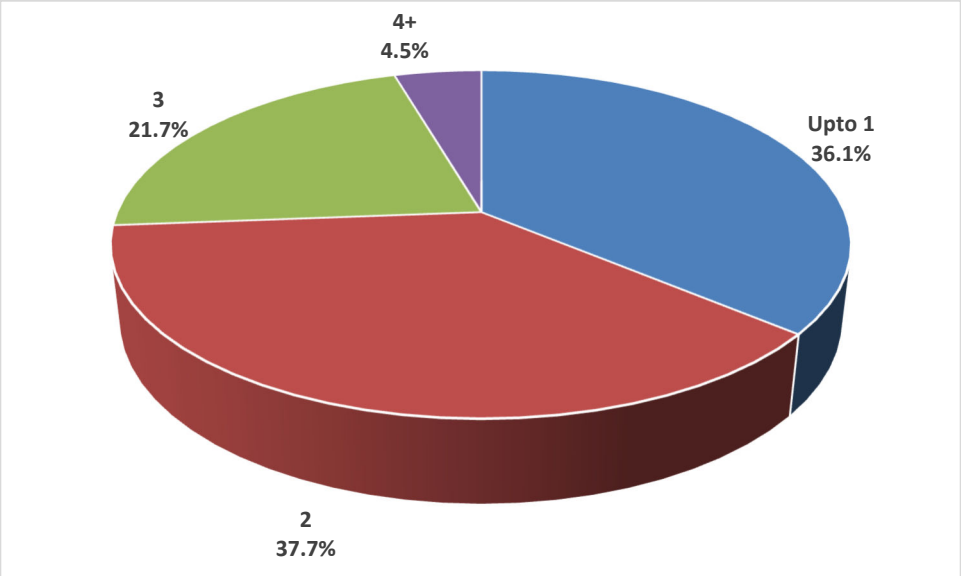
The distribution of earning members per household in the study area is presented in **Table 2.69**. It is seen that 36.1% of the households have only 1 earning member, 37.7% have 2 earning members, while about 21.7% have 3 earning members. 4.5% of the households have more than 4 working members. Household distribution by number of worker per household is presented in **Figure 2.22**.

TABLE 2.69: NUMBER OF WORKERS PER HOUSEHOLD

S. No	Number of workers	Number of Households	Percentage (%)
1	Upto 1	1795	36.1
2	2	1877	37.7
3	3	1079	21.7
4	4+	226	4.5
Total		**4977**	**100.0%**

Source: RITES Primary Surveys, 2024

FIGURE 2.22: HOUSEHOLD DISTRIBUTION BY NUMBER OF WORKER PER HOUSEHOLD



e. Monthly Household Income

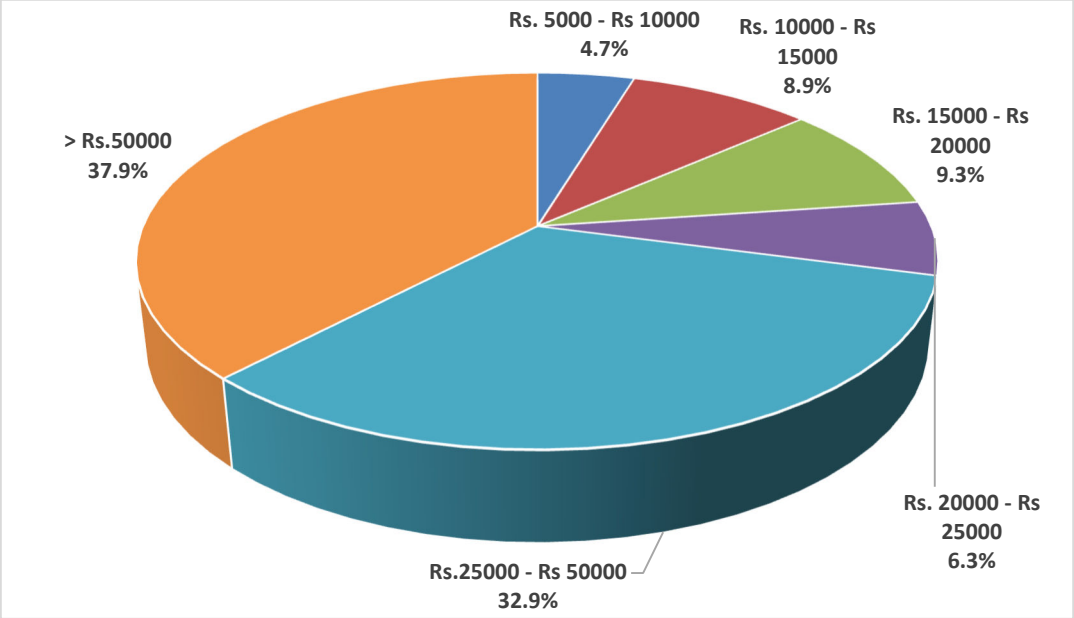
The average monthly household income in the study area is Rs. 42,388. **Table 2.70** and **Figure 2.23** presents the distribution of surveyed population by monthly income. It is observed that 70.8% of the population earning more than Rs. 25000. About 5.0% are earing between Rs. 5000 – 10000, 9.0% between Rs. 10000 – 15000.

TABLE 2.70: DISTRIBUTION OF SURVEYED POPULATION AS PER HH INCOME LEVEL

S. No	Income Group	No of Sampled Households	Percentage
1	Rs. 5000 - Rs 10000	232	4.7
2	Rs. 10000 - Rs 15000	441	8.9
3	Rs. 15000 - Rs 20000	463	9.3
4	Rs. 20000 - Rs 25000	316	6.3
5	Rs. 25000 - Rs 50000	1638	32.9
6	> Rs. 50000	1887	37.9
	Total	**4977**	**100.0%**

Source: RITES Primary Surveys, 2024

FIGURE 2.23: DISTRIBUTION OF SURVEYED POPULATION BY HOUSEHOLD INCOME LEVEL



f. Vehicles owned per Household

Distribution of households owning vehicles is presented from **Table 2.71** to **Table 2.73**.

It is observed shows that about 1.1% of households have no vehicle.

It is observed that about majority of households (52.7%) have only 2-Wheeler and about 20% have cars. About 53% of the households have more than one two wheelers. It is also observed that 70% do not have a bicycle.

TABLE 2.71: DISTRIBUTION OF HOUSEHOLDS BY NUMBER OF CARS OWNED

SN	No. of Cars Owned	No. of Households	Percentage
1	Nil	4030	80.1
2	1	904	18.0
3	2	74	1.5
4	3 and More	21	0.4
Total		**5029**	**100.0**

TABLE 2.72: DISTRIBUTION OF HOUSEHOLDS BY NUMBER OF TWO-WHEELERS OWNED

S. No.	No. of 2-wheelers Owned	No. of Households	Percentage
1	Nil	410	8.2
2	1	1960	39.0
3	2	2038	40.5
4	3	526	10.5
5	4 and More	95	1.9
Total		**5029**	**100.0%**

TABLE 2.73: DISTRIBUTION OF HOUSEHOLDS BY NUMBER OF CYCLE OWNED

S. No.	No. of Cycle Owned	No. of Households	Percentage
1	Nil	3522	70.0
2	1	1108	22.0
3	2	348	6.9
4	3	45	0.9
5	4 and More	6	0.1
Total		**5029**	**100.0**

Trip Characteristics

a. Per Capita Trip Rate

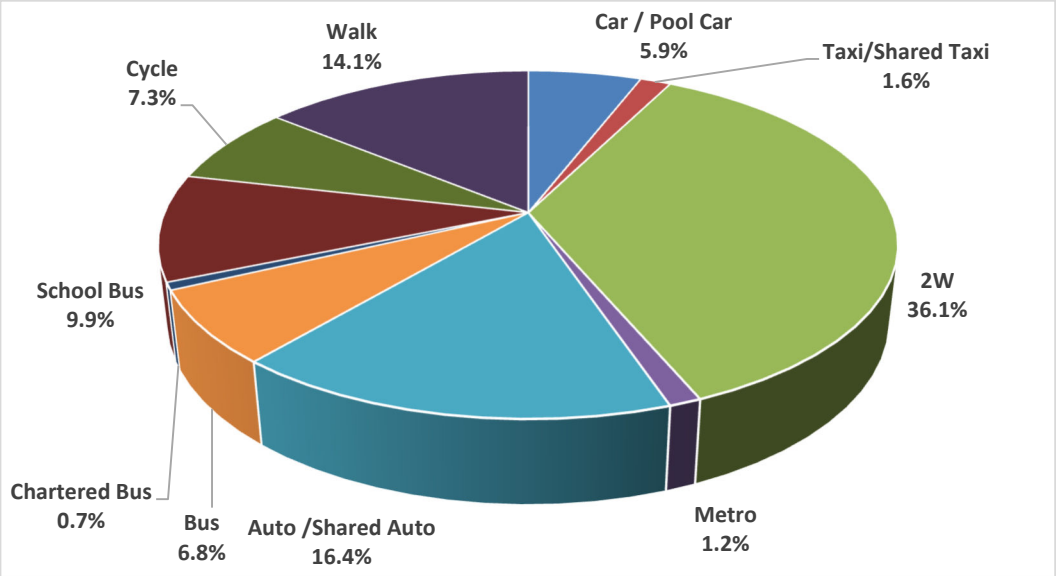
The total daily trips, as derived from the household survey, in the study area are 73.6 lakh. Distribution on daily trips by modes is presented in **Table 2.74** and **Figure 2.24**. About 98.6% of these are vehicular trips while 1.4% are walk trips. The per capita trip rate is found to be 1.7 in the study area.

TABLE 2.74: PER CAPITA TRIP RATE IN THE STUDY AREA

Mode		No. of Trips	Percentage	
Vehicular Trips	Car / Pool Car	437652	5.9	85.9
	Taxi/Shared Taxi	120431	1.6	
	2W	2680846	36.1	
	Metro	90459	1.2	
	Auto /Shared Auto	1215911	16.4	
	Bus	504624	6.8	
	Chartered Bus	54215	0.7	
	School Bus	737733	9.9	
	Cycle	542420	7.3	
Walk Trips	Walk	1044803	14.1	14.1
Total Trips		**7429093**	**100.0**	**100**
PCTR Including Walk		**1.7**		
Total Trip without walk		**6384290**		
PCTR Excluding Walk		**1.5**		

Source: RITES Primary Surveys, 2024

FIGURE 2.24: DISTRIBUTION OF DAILY TRIPS BY MODES



b. Trip Purpose

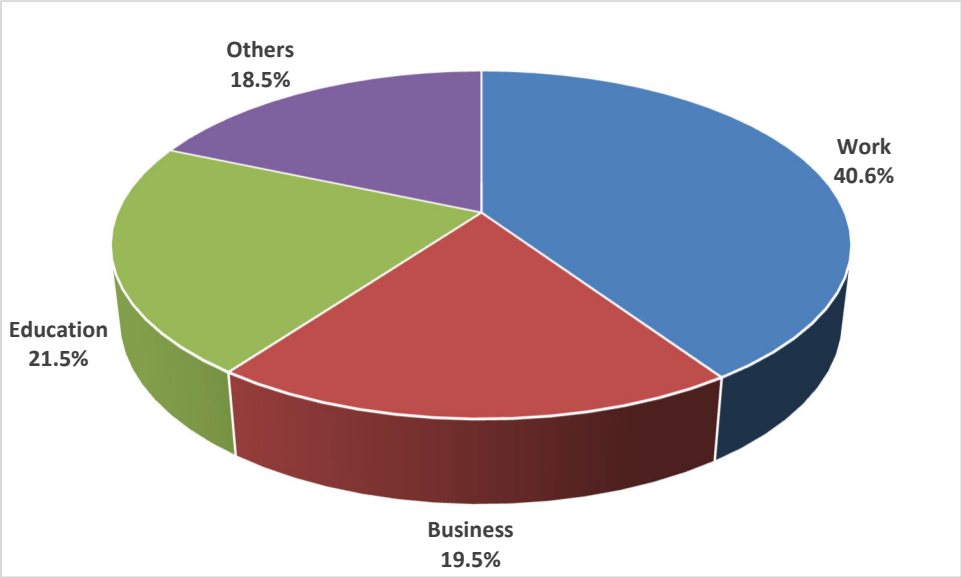
Distribution of daily trips are presented in **Table 2.75** and **Figure 2.25.** These indicate that out of total trips work and business trips account for about 60.0%, education about 21.5% and others account for 18.5% of the trip purpose.

TABLE 2.75: PURPOSE WISE DISTRIBUTION OF PASSENGER TRIPS

SN	Trip Purpose	Total Trips by Purpose	Percentage
1	Work	3030079	40.6
2	Business	1453835	19.5
3	Education	1602147	21.5
4	Others	1381807	18.5
	Total Trips	**7467869**	100.0

Source: RITES Primary Surveys, 2024

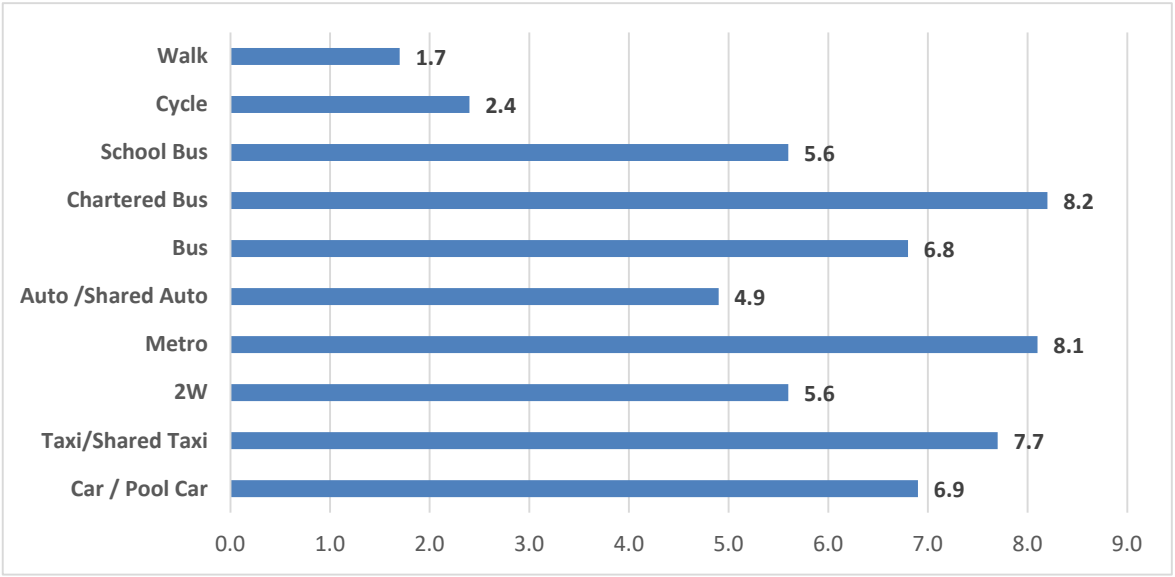
FIGURE 2.25: DISTRIBUTION OF TRIPS BY PURPOSE



c. Trip Length

The analysis of trips lengths covered up by different modes reveals that long distance trips of average trip length 8.1 and 8.2 kilometers are being covered up through metro and chartered bus respectively. **Figure 2.26** indicates that an average trip length of 1.7 kilometers is being covered up by walk. Cars travel an average trip length of 6.9 kilometers, two wheelers 5.6 kilometers, Shared Auto 4.9 kilometers, school Bus 5.6 kilometers, Buses 6.8 kilometers, while cycle covers average trip distance of 2.4 kilometers.

FIGURE 2.26 DISTRIBUTION OF AVERAGE TRIP LENGTH BY MODE



Source: RITES Primary Surveys, 2024

d. Travel Cost

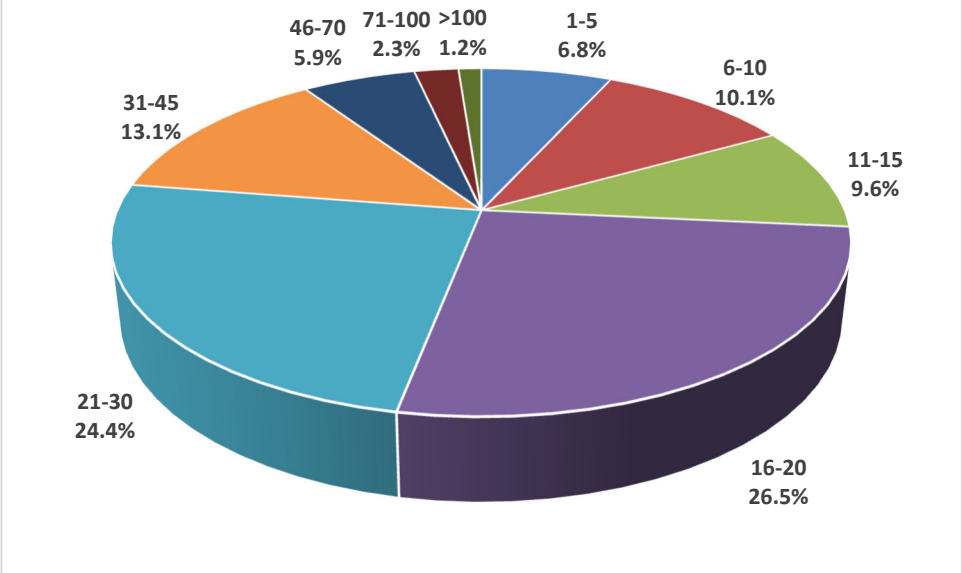
The distribution of trips (excluding walk and cycle) by travel cost in the study area is presented in **Table 2.76** and **Figure 2.27.** It is seen that about 17% of the trips cost upto Rs. 10 for travelling, 36.1% of the trips cost between Rs 11 to 20. Only 1.2% of the trips cost are more than Rs. 100.

TABLE 2.76: DISTRIBUTION OF TRIPS BY TRAVEL COST (EXCLUDING WALK AND CYCLE)

Particulars	Travel Cost (Rs.)								
	1-5	6-10	11-15	16-20	21-30	31-45	46-70	71-100	>100
Number of Trips	398486	596089	565111	1557023	1435503	769148	349358	138135	71794
Percentage	**6.8**	**10.1**	**9.6**	**26.5**	**24.4**	**13.1**	**5.9**	**2.3**	**1.2**

Source: RITES Primary Surveys, 2024

FIGURE 2.27 DISTRIBUTION OF TRIPS BY TRAVEL COST



Source: RITES Primary Surveys, 2024

Opinion and Willingness to Pay Survey

This section focused on the opinion and revealed preference of users with respect to various characteristics of the MRTS in Nagpur. The respondents were queried with regard to preference for a good public transport system along with the quantum of extra fare they are willing to pay. It is observed from **Table 2.77** that 90.0% people expressed their willingness to shift to a good quality mass transport system which gives them comparatively superior travelling experience.

TABLE 2.77: WILLINGNESS TO SHIFT TO NEW MASS TRANSPORT SYSTEM

Would you like to shift to good public transport?	Yes	No	Total
Percentage	90.0%	10.0%	100.0%

With respect to fare of the new mass transport system, about 22% expressed willingness to spend the same amount as they are spending on the existing mode of travel (refer **Table 2.78**). About 67.0% are willing to pay Rs. 1.25 times and about 11.0% expressed willingness to pay 1.5 Times or more.

TABLE 2.78: WILLINGNESS TO PAY FOR NEW MASS TRANSPORT SYSTEM IN RELATION TO EXISTING FARE

How much extra fare are you Willing to pay (in relation to existing Bus Fare)	Same Fare	1.25 Times	1.5 Times and more
Percentage	22.1%	67.1%	10.9%

Source: RITES Primary Surveys, 2024

2.17. FUEL STATION SURVEY

Fuel station survey has been carried out to know the fuel efficiency and fuel mix in the city. The fuel station survey was carried out at fuel stations in Nagpur. Fuel efficiency from the survey and fuel mix data from survey for the base year are given in **Table 2.79** . The survey output forms baseline for the study. It helps to estimate the current quantity of fuel consumed in the city. Fuel efficiency factors listed in CMP Toolkit and national trends in fuel mix will be used with appropriate emission rates listed in CMP Toolkit and draft BS VI standards and veh-km estimated in Travel Demand Model to estimate emissions in future years**.**

TABLE 2.79: FUEL EFFICIENCY OF VEHICLES

SN	Mode	Fuel Type	Fuel Efficiency (Km./Litre)
1	**Two Wheeler**		
	1	Petrol	33.8
2	**Three Wheeler**		
	1	CNG	21.0
	2	Diesel	22.8
	3	LPG	18.8
	4	Petrol	21.1
3	**Car**		
	1	CNG	17.2
	2	Diesel	15.9
	3	Petrol	16.3
4	**SUV**		
	1	Diesel	13.4
	2	Petrol	13.6
5	**Truck**		
	1	Diesel	5.0

Source: RITES Primary Surveys, 2024

TABLE 2.80: FUEL MIX OF VEHICLES

SN	Mode	Fuel Type	%
1	**Two wheeler**		
	1	Petrol	100
2	**Three wheeler**		
	1	CNG	9.3
	2	Diesel	41.9
	3	LPG	18.6
	4	Petrol	30.2
3	**Car**		
	1	CNG	3.1
	2	Diesel	60.0
	3	Petrol	36.9
4	**SUV**		
	1	Diesel	66.7
	2	Petrol	33.3
5	**Truck**		
	1	Diesel	100

Source: RITES Primary Surveys, 2024

2.18. NMT OPINION SURVEY

NMT opinion survey was conducted at major transport activity nodes in the city. In the survey, bicycle users were interviewed to obtain the operational characteristics of NMT along with the opinion of the users.

130 samples were obtained to assess the operational characteristics of Cyclist. The major findings of the operator survey are:

i. Average trip length: 2.6 Km
ii. About 80% of respondents are using NMT for their work purpose.
iii. About 55% of respondents have travel time upto 40 minutes

The opinion survey revealed that there is a lack of NMT facilities in the city. About all the respondents told that the NMT facilities is poor in the city.

NMT users had an opinion that there should be a provision of separate NMT lane for NMT users along with safe parking space/ stands for them.

2.19. SERVICE LEVEL BENCHMARKING

The guidelines and toolkit issued by MoHUA for the preparation of CMP suggests the comparative analysis of Urban Transport environment with benchmark values suggested in the toolkit as the Level of Service (LOS). The existing urban transport environment in Nagpur has been evaluated and compared with benchmarks to diagnose the existing transport conditions and to identify urgent areas for improvement in the city.

2.12.1 PERFORMANCE BENCHMARKS FOR URBAN TRANSPORT

To facilitate comparison between cities and changes in performance over time, it is important that the performance levels are monitored against set benchmarks. It is in this context that the toolkit defines SLBs for various parameters of urban transport. SLBs have been identified for the following parameters:

i. Public transport facilities
ii. Pedestrian infrastructure facilities
iii. Non Motorized Transport (NMT) facilities
iv. Level of usage of Intelligent Transport System (ITS) facilities
v. Travel speed (Motorized and Mass Transit) along major corridors
vi. Availability of parking spaces
vii. Road safety
viii. Pollution levels
ix. Integrated land use transport system
x. Financial Sustainability of public transport

These parameters highlight the performance of urban transport in the study area. Typically, four LOS viz. 1, 2, 3, and 4 have been specified, with 1 being the highest LOS and 4 being lowest to measure each identified performance benchmark. Therefore, the goal is to attain service level 1.

2.12.2 LOS OF PUBLIC TRANSPORT FACILITIES

SLB of Public Transport facilities is based on six parameters namely:

- Presence of Organized Public Transport System in Urban Area (%)
- Extent of Supply Availability of Public Transport
- Service Coverage of Public Transport in the city
- Average waiting time for Public Transport users (mins)
- Level of Comfort in Public Transport
- % of Fleet as per Urban Bus Specification

The city-wide LOS calculated for public transport systems during peak hours include rail or organized bus-based systems. The analysis of public transport facilities in Nagpur has been done based on available primary and secondary data and is presented in **Table 2.80.**

TABLE 2.81: ANALYSIS OF PUBLIC TRANSPORT FACILITIES IN STUDY AREA

SN	SLBs	Units	Analysed Value	LOS
1	Presence of Organized Public Transport System in Urban Area	%	100	1
2	Extent of Supply Availability of Public Transport	ratio	0.15	4
3	Service Coverage of Public Transport in the city	ratio	8.9	1

SN	SLBs	Units	Analysed Value	LOS
4	Average waiting time for Public Transport users	minutes	15	4
5	Level of Comfort in Public Transport	No.	1.0	1
6	% of Fleet as per Urban Bus Specification	%	77	1
Public transport facilities		Overall		2

The Level of Service (LoS) for public transport facilities in the study area is 2, corresponding to an overall LOS=2. This indicates that the city's public transport system requires enhancement. Improvements are needed in average waiting times and supply availability. Urgent upgrades to the public transport system are essential to accommodate the city's increasing transportation demands.

2.12.3 LOS OF PEDESTRIAN INFRASTRUCTURE FACILITIES

The SLB parameters for pedestrian infrastructure facilities include the following:

- Signalized intersection delay (%)
- Street Lighting (Lux)
- % of City Covered

These parameters cover the percentage of road length along the arterial and major road network or Public Transport corridors and at intersections that have adequate barrier free pedestrian facilities (**Table 2.81**).

TABLE 2.82: ANALYSIS OF PEDESTRIAN INFRASTRUCTURE FACILITIES IN STUDY AREA

SN	SLBs	Units	Analysed Value	LOS
1	Signalized intersection delay	%	Majority of signalized junctions in the city have pedestrian waiting time less than 45s	1
2	Street Lighting	Lux	Average Lux levels in Nagpur is above 25 on all major roads	1
3	% of City Covered	%	53.4%	2
Pedestrian Facilities		Overall		1.3

The overall LOS of Pedestrian infrastructure facilities for Nagpur is 1. This signifies that the city needs pedestrian facilities in terms of more coverage of footpaths.

2.12.4 LOS OF NON-MOTORIZED TRANSPORT FACILITIES

The SLB parameters for NMT (**Table 2.82**) facilities include:

- % of network covered
- Encroachment on NMT roads by Vehicle Parking (%)
- NMT Parking facilities at Interchanges (%)

These parameters evaluate the percentage of dedicated cycle track / lane along the arterial & sub arterial road network or public transport corridors with a minimum of 2.5 m width. The service level is characterized by continuous length of NMT lanes, encroachment on NMT lanes, and parking facilities. The LoS for Nagpur corresponds to an Overall of 3.

TABLE 2.83: ANALYSIS OF NON-MOTORIZED TRANSPORT FACILITIES IN STUDY AREA

S.No.	SLBs	Units	Analysed Value	LOS
1	% of network covered	%	1	4
2	Encroachment on NMT roads by Vehicle Parking (%)	%	10	1
3	NMT Parking facilities at Interchanges (%)	%	0	4
		Overall		3

This indicates that the city currently lacks adequate non-motorized transport (NMT) facilities, which need to be improved. Enhancing these facilities will encourage more people to use them.

2.12.5 LOS OF LEVEL OF USAGE OF INTELLIGENT TRANSPORT SYSTEM (ITS)

ITS refers to efforts to add information and communications technology to transport infrastructure and vehicles to manage factors that typically are at odds with each other, such as vehicles, loads, and routes to improve safety and reduce vehicle wear, travel times and fuel consumption GPS/GPRS systems are required so as to cover all the public transport and intermediate public transport vehicles on the "National public transport helpline" besides the use for operational efficiencies. The parameters identified to assess the level of service for level of usage of ITS (**Table 2.83**) are:

- Availability of Traffic Surveillance (%)
- Passenger Information System (PIS) (in %)
- Global Positioning System (GPS)/ General Packet Radio Service (GPRS) (%)
- Signal Synchronization (%)
- Integrated Ticketing System (%)

TABLE 2.84: ANALYSIS OF LEVEL OF USAGE OF ITS FACILITIES

S.No.	SLBs	Units	Analysed Value	LOS
1	Availability of Traffic Surveillance (%)	%	100	1
2	Passenger Information System (PIS) (in %)	%	3%	4
3	Global Positioning System (GPS)/ General Packet Radio Service (GPRS) (%)	%	100	1
4	Signal Synchronization (%)	%	Not available	4
5	Integrated Ticketing System (%)	%	Not available	4

S.No.	SLBs	Units	Analysed Value	LOS
ITS Facilities		Overall		2.8

This means that the ITS facilities in a city need to be improved and strengthened in terms of Integrated Ticketing System, Signal Synchronization and PIS etc.

2.12.6 LOS FOR TRAVEL SPEEDS ALONG MAJOR CORRIDORS

This level of service provides an indication of effective travel time or speed of Public / private vehicles by taking into account indications of congestion or traffic density. This level of service is along corridors, and not indicative of the overall level of service from origin to destination (**Table 2.84**). The parameters identified to assess the level of service include:

- Average Travel speed of Personal vehicles (KMPH)
- Average Travel speed of Public Transport (KMPH)

LOS is defined in terms of average travel speed of all vehicles on the key corridors. It is strongly influenced by the number of vehicles along the corridor, number of signals per kilometer and the average intersection delays.

TABLE 2.85: ANALYSIS OF TRAVEL SPEED (MOTORIZED AND MASS TRANSIT) ALONG MAJOR CORRIDORS IN STUDY AREA

SN	SLBs	Units	Analysed Value	LOS
1	Average Travel speed of Personal vehicles (KMPH)	KMPH	28	2
2	Average Travel speed of Public Transport (KMPH)	KMPH	20	3
Travel Speed		Overall		2

The Overall level of Service (LOS) of travel speed (Personal vehicles and Public Transport) along major corridors is 2. It can be concluded that Small increase in traffic cause substantial increase in approach delay and hence, decrease in travel speeds.

2.12.7 LOS OF AVAILABILITY OF PARKING SPACES

Parameters (**Table 2.85)** to calculate LOS for this SLB include:

- Availability of on street paid public parking spaces (%)
- Ratio of Maximum and Minimum Parking Fee in the City

It indicates the restriction on free parking spaces for all vehicles in a city. In the City Center, the land is generally available at a premium, which makes it difficult to provide for organized parking spaces in these areas. One of the management measures for reducing parking

demand in the City Center is high parking charges, which discourages the use of private vehicles, but to be supported by ensuring citywide and Quality Mass Public Transport System as an alternative to encourage its usage.

TABLE 2.86: ANALYSIS OF AVAILABILITY OF PARKING SPACES IN STUDY AREA

SN	SLBs	Units	Analysed Value	LOS
1	Availability of on street paid public parking spaces (%)	%	Not Available	4
2	Ratio of Maximum and Minimum Parking Fee in the City	Ratio	2	2
Parking Facilities		Overall		3

The Overall level of Service (LOS) of Availability of Parking Spaces obtained is 3 in Nagpur. The parking study shows that demand is still high in major commercial sectors and requires interventions to manage the same. New parking measures/ strategies to be adopted for parking management.

2.12.8 LOS OF ROAD SAFETY

With increasing road traffic, many cities are witnessing rising level of accidents, leading to rising levels of injuries and fatalities. Level of fatality is an indication of road safety. Road design and available road infrastructure, traffic management and other such reasons significantly contribute to road safety. Therefore, fatality rate needs to be monitored. The benchmark for the same is zero, as ideally fatalities and injuries out of accidents should be brought down to zero. The parameters (**Table 2.86**) included to calculate LOS for this SLB are:

- Fatality rate per lakh population
- Fatality rate for pedestrian and NMT (%)

Within the number of accidents, the vulnerable road users are pedestrians and persons with non-motorized vehicles. It is therefore critical to monitor the extent to which such road users are impacted within the overall set of road users. The benchmark value for the same is also zero.

TABLE 2.87: ANALYSIS OF ROAD SAFETY IN STUDY AREA

S.No.	SLBs	Units	Analysed Value	LOS
1	Fatality rate per lakh population	Ratio	10.5	4
2	Fatality rate for pedestrian & NMT	%	30	2
Road Safety Facilities		Overall		3

This shows that city needs improvements in road design, road infrastructure, traffic management and citywide high quality mass public transport system which significantly contributes to road safety.

2.12.9 LOS OF POLLUTION LEVELS

This indicates the Level of air Pollutants in the city i.e. average level of pollution in urban areas. The indicator to calculate the pollution levels is Annual Mean Concentration Range (µg/m3). Parameters (**Table 2.87**) to assess the LOS for this SLB are:

- Level of SO_2
- Level of Oxides of Nitrogen
- Level of RSPM (Size less than 10 microns)

TABLE 2.88 ANALYSIS OF POLLUTION LEVELS IN STUDY AREA

SN	SLBs	Units	Analysed Value	LOS
1	SO_2	µg/m3	14	1
2	Oxides of Nitrogen	µg/m3	16	1
3	RSPM	µg/m3	48	2
Pollution level indicators		Overall		1

The overall level of Service (LOS) of Pollution Levels is 1 in Nagpur. This signifies that the city has low pollution level.

2.12.10 LOS OF FINANCIAL SUSTAINABILITY OF PUBLIC TRANSPORT

The indicators to calculate the financial sustainability of public transport by bus as follows (**Table 2.88**):

- Extent of Non-fare Revenue (%)
- Staff /bus ratio
- Operating Ratio

TABLE 2.89: ANALYSIS OF FINANCIAL SUSTAINABILITY OF PUBLIC TRANSPORT BY BUS IN STUDY AREA

SN	SLBs	Units	Analysed Value	LOS
1	Extent of Non fare Revenue	%	<10	4
2	Staff /bus Ratio	Ratio	6.4	2
3	Operating Ratio	Ratio	2.9	4
Financial Sustainability		Overall		3

The overall level of Service (LOS) of financial sustainability of public transport by bus is 3. This indicates that the bus system in Nagpur lacks financial Sustainability. Significant improvement is required in Non-fare revenue.

Chapter – 3
TRAVEL DEMAND ASSESSMENT

3. TRAVEL DEMAND ASSESSMENT

3.1. DEVELOPMENT OF BUSINESS AS USUAL SCENARIO

3.1.1. COVERAGE

The travel demand assessment in urban environment is a complex exercise involving a large number of parameters and warrants the development of a travel model at the city level. The travel demand modelling process consists of development of formulae (or models), enabling forecast of travel demand, and development of alternative strategies for handling this demand. It is not just one model, but a series of inter-linked and inter-related models of varying levels of complexity, dealing with different facets of travel demand. Through these models, the transportation study process as a whole is checked and calibrated before it is used for future travel predictions.

While a number of commercially acceptable software's are available for the purpose of modelling travel demand, due heed was paid to the observed traffic heterogeneity in study area. After analysing specific model requirements and software compatibility, internationally accepted travel demand modelling software has been used for modelling exercise for this study.

Detailed traffic and travel surveys have been carried out as part of the assignment to establish the existing and future travel demand. The operational travel demand model is also a pre-requisite so that Consultants are able to validate actual travel patterns (as observed) within an acceptable error range (+-15%). The standard 4 stage Urban Transport Planning System model has been adopted that inter-alia consists of:

- Stage 1 - Trip Generation and Attraction Sub Model
- Stage 2 - Trip Distribution Sub Model
- Stage 3 - Modal Split Sub Model
- Stage 4 - Assignment Sub Model

A commuter decides on his/ her selection of travel mode considering a number of parameters including accessibility of travel mode from the house, total travel time, total cost of travel, convenience/comfort of travel and cost for reaching the destination at the other end of the main journey. The commuter evaluates the merits and demerits of all possible alternative modes and their combinations before deciding on the final selection of travel mode(s).

The secondary data pertaining to the study have been collected from the respective agencies helped in development of base year transport network of the Study Area.

The transport network consisting of primary and secondary road network has been coded in Transport Demand Software i.e., VISUM. The link attributes such as speed, carriageway, ROW, length etc. is derived from Road Inventory and Speed & Delay survey data.

Major inputs to an urban travel demand model may be summarized as below:

- Delineation of study area into smaller traffic zones, road and public transport network along with their attributes
- Population and employment (existing and proposed at traffic zone level)
- Various transport systems along with their capacity, headways and speed etc.
- Intermodal integration facilities available and time required for passengers to interchange from one mode to another including walk time.

The sequences of activities involved in the model are given in **Figure 3.1**.

3.1.2. TRAFFIC ANALYSIS ZONE AND ROAD NETWORK

Base map developed on the basis of secondary data contains information such as sector boundaries, ward boundaries and road/rail network. A traffic zone system has been developed based on existing sector/ward boundaries and natural physical barriers. Due consideration has been given to the zone system adopted in previous studies and distribution of road & public transportation network in study area. The zoning system is sufficiently detailed to capture inter zonal trips.

The study area has been divided into a total of 183 internal zones and 10 external zones. The municipal corporation wards (upto 136) have been designated as traffic zones, leveraging the availability of demographic and socio-economic data such as population and employment. The areas within the study boundary but outside the municipal limits, zones have been delineated based on homogeneous land use and key traffic generation points.

Zone connectors are included in the model to allow the trip matrices to be assigned to the road network. All zones are provided with at least one zone connector. The location and definition of connector is intended to assimilate, as far as possible, the actual connectivity of trip generation centers to the road network.

The zone system and coded road network is presented in **Figure 3.2** & **Figure 3.3** respectively.

A public transport (PT) network has been also developed coding the existing PT routes in the study area. About 125 bus routes have been coded in VISUM and presented in **Figure 3.4**. A typical PT route attributes include line name, operator type, headway etc.

FIGURE 3.1: FOUR STAGE TRAVEL DEMAND MODEL

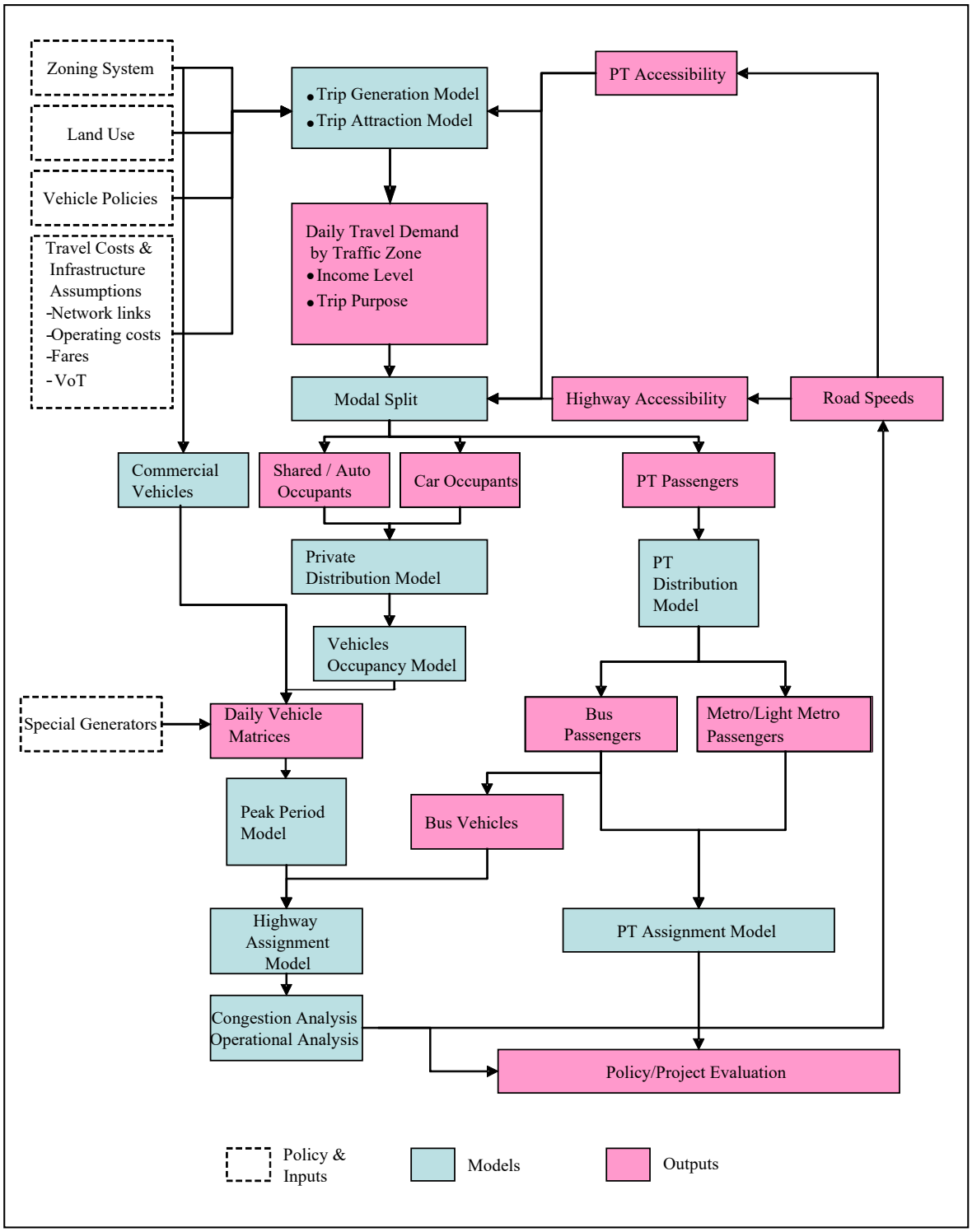
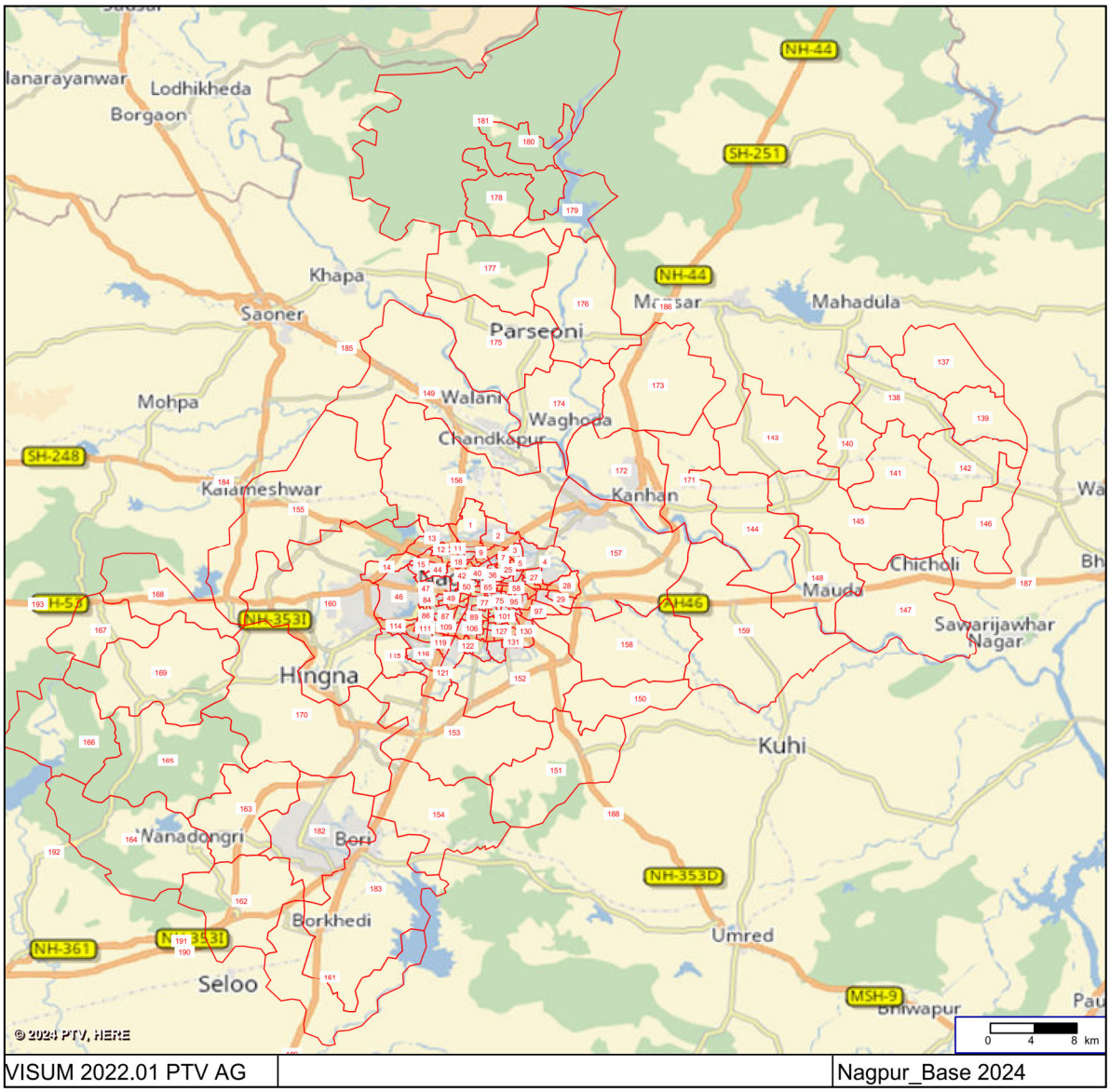


FIGURE 3.2: ZONING SYSTEM FOR NAGPUR METROPOLITAN REGION

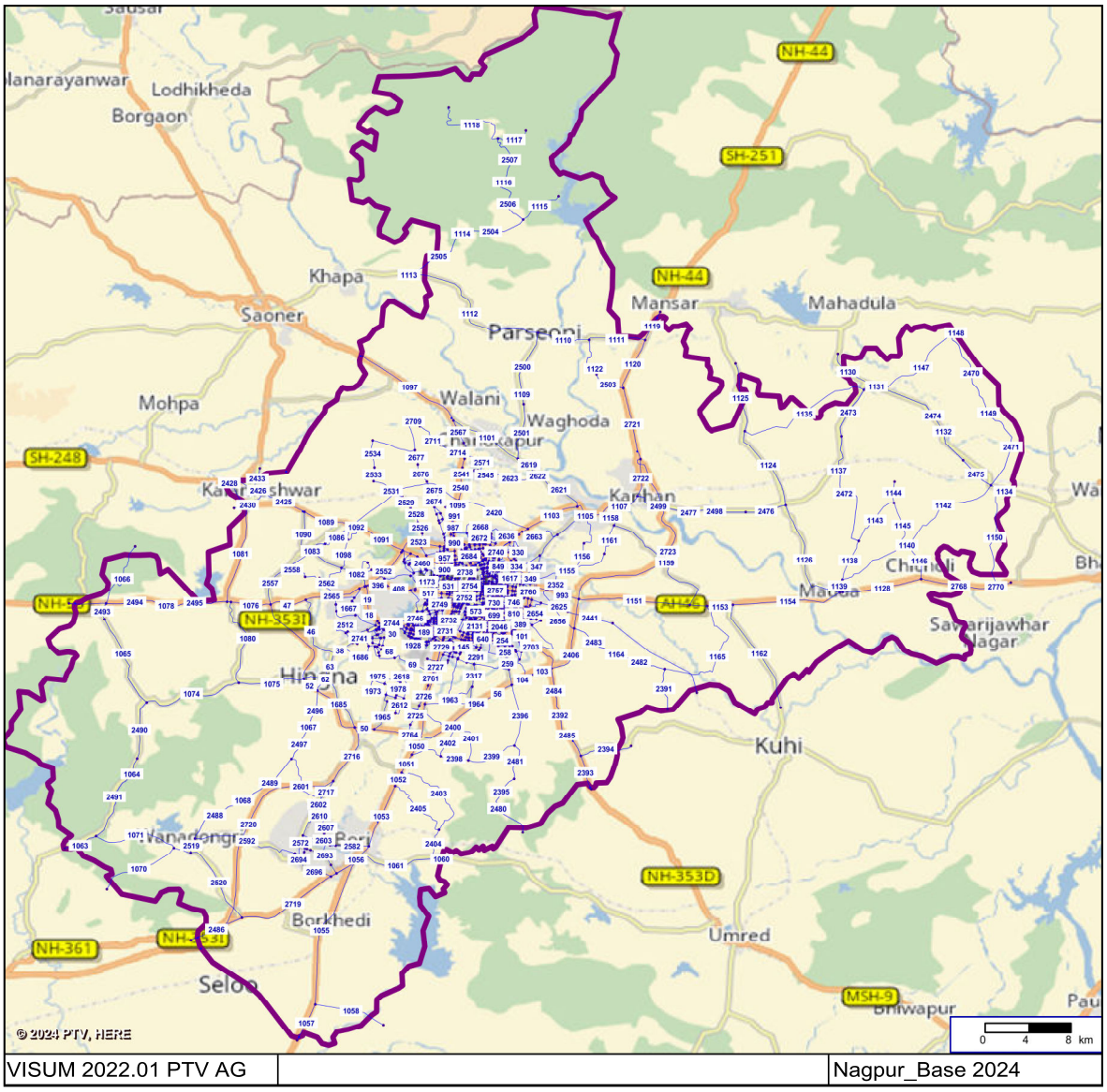


3.1.3. SOCIO-ECONOMIC PROJECTIONS

i. Landuse Transitions

Estimating planning parameters is a critical aspect of traffic demand modeling. These parameters include the population and employment figures within the study area. Land use transitions have been considered when projecting future population and employment. The base year parameters have been derived from past Census data and the secondary data collected from the Maha Metro, Municipal Corporation, and other agencies. Additionally, the RITES team conducted a preliminary reconnaissance to assess the current level of land use development across various traffic zones. Therefore, the projections have been done for the base year (2024) as well as horizon years i.e. 2031, 2041, 2051 and 2054.

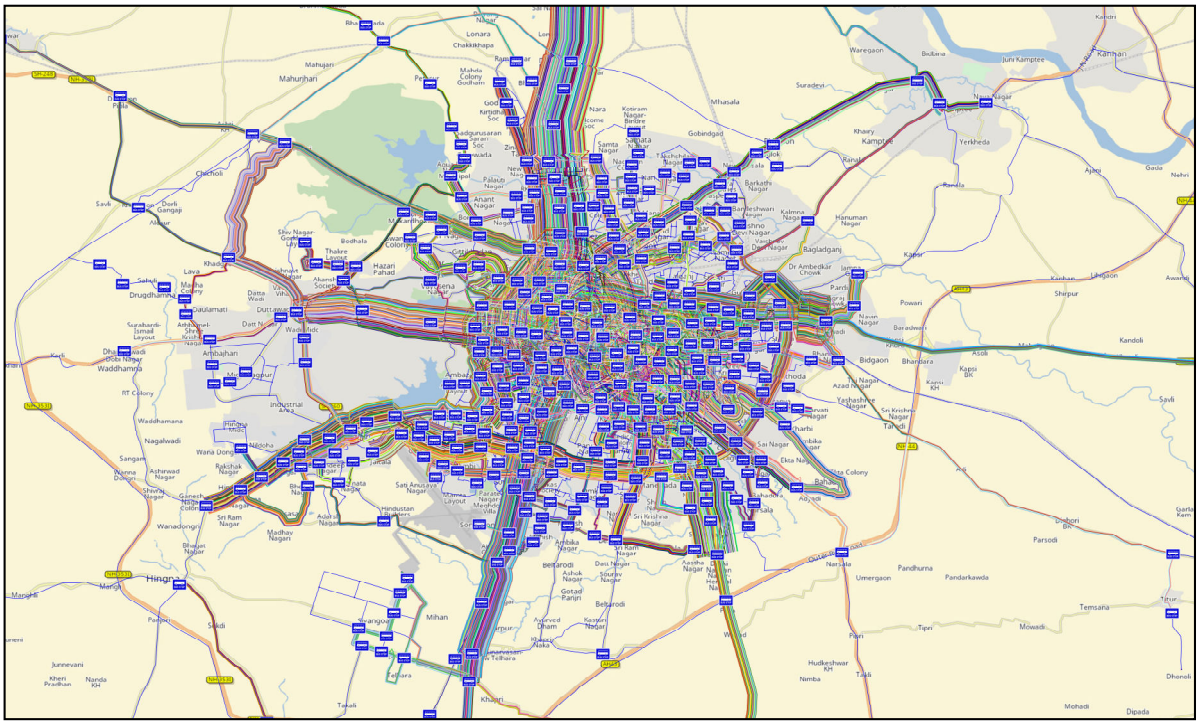
FIGURE 3.3: CODED BASE YEAR ROAD NETWORK



ii. Demographic Projection

The demographic projection for Nagpur Metropolitan Region reflects a steady growth trajectory influenced by natural population growth and migration trends driven by socio-economic factors. The city, with its strategic location and reputation as an emerging educational, IT-ITES industry and commercial center, attracts a diverse population from neighboring rural areas seeking employment, education, and improved living standards. Over the next few decades, the city's population is expected to increase as the local economy expands and urban infrastructure improves, leading to greater demand for housing, transportation, and public services. Additionally, the trend toward urbanization in India further supports the likelihood of accelerated population growth in Nagpur Metropolitan Region.

FIGURE 3.4: CODED BASE YEAR PT NETWORK IN VISUM



iii. Population – Trends and Forecast

The population forecast is based on growth trends analyzed separately for the core, middle, outer, and special areas that collectively form the study area, in addition to existing growth patterns from Census data. The outer areas are expected to grow faster than the Municipal Corporation due to urban expansion. Based on the above considerations, future population projections have been extrapolated for the horizon years 2031, 2041, 2051 and 2054, as shown in **Table 3.1.** The estimated population for the study area in the base year 2024 is 35.6 Lakh.

TABLE 3.1: FORECASTED POPULATION OF STUDY AREA

Years	2011	2024	2028	2031	2041	2051	2054
Municipal Corporation	2405663	2949531	3056489	3139439	3413733	3663130	3737155
Rest of Study Area (outside city)	1155998	1417345	1490791	1548464	1753282	2002180	2084075
Total	3561661	4366876	4547280	4687903	5167015	5665310	5821230
Overall Growth Rate	-	**1.58%**	**1.1%**	**1.0%**	**0.98%**	**0.92%**	**0.91%**

Source: Census 2011 & City Development Plan 2041

iv. Employment – Trends and Forecast

In 2011, the workforce participation rate (WFPR) for the NMC area was recorded at 37%. For the base year 2024, the WFPR is estimated to be 37.7%, based on an extrapolation of 2011 census data. Keeping in view the economic profile of the study area, development prospects and transport intervention policies, WFPR of

38.7%, 39.7%, 40.7% and 40.7% has been assumed for the Horizon years 2028 & 2031, 2041, 2051 and 2054 respectively. Thus, it has been estimated that 23.7 Lakh workers would comprise the workforce in the study area by 2054. **Table 3.2** shows the growth trend in employment in the study area.

TABLE 3.2: WORK FORCE PARTICIPATION IN STUDY AREA

Year	Employment	WFPR (%)
2024	1647264	37.7%
2028	1854042	38.7%
2031	1814828	38.7%
2041	2051314	39.7%
2051	2304806	40.7%
2054	2367918	40.7%

Source: Census 2011 & Past Trends

The distribution of population and employment across various traffic zones for the horizon years is determined by analyzing Census 2011 data, the City Development Plan 2041, existing land use patterns, and population density data. Comprehensive details on the population and employment distribution for each traffic zone for the base year (2024) and the horizon years are provided in **Annexure 3.1.**

3.1.4. DEVELOPMENT OF BASE YEAR TRAVEL DEMAND MODEL

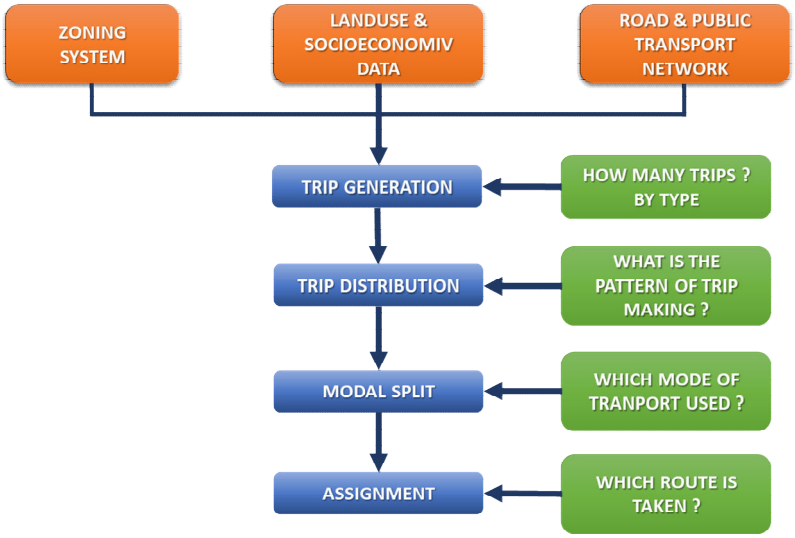
i. Model Structure

The demand model is based on home based motorised trip productions/attractions of study area residents as share of non-home-based trips is negligible in total trips from the household surveys. The motorised modes such as car, two-wheeler, auto rickshaw, shared auto, metro and bus have been considered for demand modelling and these comprise of 58.33 lakh daily trips. The remaining trips relating to slow moving non-motorised vehicles and walk trips have not been considered for modelling purpose.

Four sub models viz. Trip Generation, Trip Distribution, Modal Split and Assignment models have been developed as shown in **Figure 3.5.**

The model development is largely based on the data from Household Interview Survey (HIS) and other primary travel surveys after expansion of the survey samples to total study area population for base year. All the data including population is calculated at traffic zone level.

FIGURE 3.5: FOUR STAGE MODEL STRUCTURE



ii. Trip Generation Model

The two components of trip generation modelling are:

Trip Production: This is defined as the home end of a home-based trip or as the origin of a non-home-based trip. It thus gives the total trips produced by a zone.

Trip Attraction: This is defined as the non-home end of a home-based trip or as the destination of a non-home-based trip. It thus, gives the total trips attracted to a zone.

The factors that may affect trip generation include land use factors such as population, employment, intensity of residential activity and employment opportunities etc. Other household factors including household income etc. also affects the trips generated.

Trip Purpose: The purpose of trip can be broadly categorized in home-based trips & non-home-based trips. Home based trips are those in which one of either trip ends is at home while the non-home based are those in which neither end is at home. The trip generation model has been developed for home-based trips in aggregation while the trip production/attraction model incorporates the two (2) main trip purposes of home-based work & business (HBW&B) and home-based education & other (HBE&O) trips for all motorised modes i.e. Car, 2-Wheeler, Auto Rickshaw, shared Auto, Metro and buses.

(i) Trip Production Sub Model

The linear regression analysis has been used to develop the trip production and trip attraction equations. A zonal regression model is used in which each traffic zone is

treated as one observation. The aggregated analysis is applied for developing the model by various purpose groups which is based on the assumption that contiguous households exhibit a certain amount of similarity in travel characteristics. This assumption allows the data in a zone to be grouped, and the mean value of the independent variable used in further calculations. The general form of the work trip production equation is

$$T_i = a + b*(IV_i)$$

Where,

T_i = Trips produced from zone i

a = constant (unexplained part of the relationship)

b=parameter explaining the dependency on the independent variable and representing the Trip Rate

IV_i = Independent Variable in zone i

Residences produce trips for work, education, business and other purposes including shopping, social and recreation. Activity centres such as industries, commercial centres, offices, educational institutions etc. attract these trips.

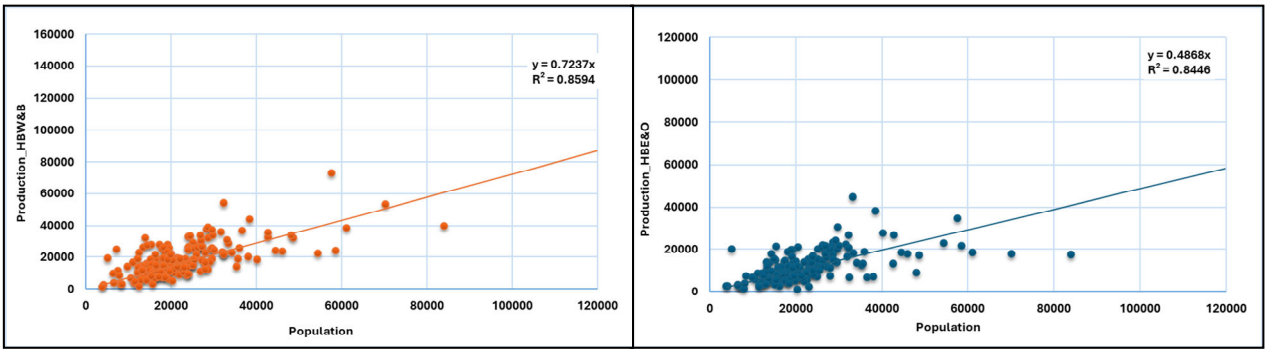
These trip production and attraction equations are calibrated as a first step. Separate equations are developed for the two combined purpose groups viz., Work &Business (HBW&B) and Education & Other (HBE&O) as shown in **Table 3.3**. The trip generation is for home-based trip ends and are therefore based on Productions / Attractions (PA), not on Origins / Destinations. At the end of the generation sub model application, the trips are aggregated by purpose. Scatter plots for trip production is shown in **Figure 3.6**. The regression constant 'a' is assumed to be zero, as home-based trip production is not possible in areas with no population.

TABLE 3.3: TRIP GENERATION MODELS

Person Group	Trip Generation	
	Trip Productions	Trip Attractions
Work & Business	0.7237*[POP]	2.647*[EMP]
Education & Other	0.4868*[POP]	1.468*[EMP]

Where, POP: Population, EMP: Employment

FIGURE 3.6: SCATTER PLOTS FOR TRIP PRODUCTION



(ii) Trip Attraction Sub Model

The production model produces daily person trips (all-purpose combined) generated by zone, whilst the attraction model estimates daily person trips attracted by zone. Separate equations are developed for the two purpose groups, viz., Work & Business and Education & Other. To be consistent with the generation model, the attraction model is based on PA. Scatter plots for trip production is shown in **Figure 3.7.**

The coefficient of Determination R^2 is the deciding factor for linear regression analysis. The more R^2 is near to 1, more the linear regression is reliable.

The general form of the trip attraction equation is

$$T_j = a + b*(IV_j)$$

Where,

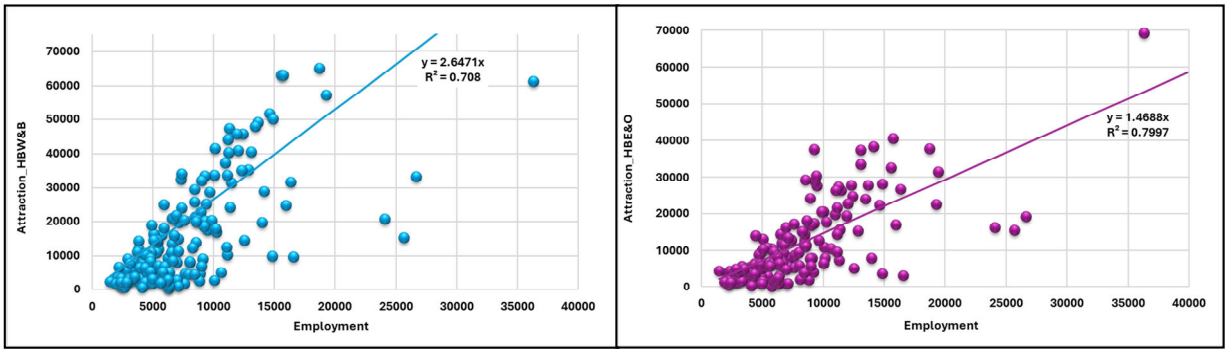
T_j = Trips attracted to zone j

a = constant (unexplained part of the relationship)

b = parameter explaining the dependency on the independent variable

IV_i = Independent Variable in zone j

FIGURE 3.7: SCATTER PLOTS FOR TRIP ATTRACTION



The Trip Generation Model calibration by purpose is summarized in **Table 3.4**. HIS and model figures are very similar, showing a very close correspondence between modelled and observed values.

TABLE 3.4: TRIP GENERATION SUB MODEL CALIBRATION RESULTS

Purpose	HIS	Model	Difference
HBE&O	2296510	2296103	0.02%
HBW&B	3537443	3535859	0.04%
Total	**5833953**	**5831963**	**0.03%**

iii. Trip Distribution Model

After determining the trip productions (Ti) and trip attraction (Tj), the next stage is to link the productions with attractions in order to quantify how the trips are

produced in a zone and are distributed among or attracted to all other zones (Tij).

Trip Distance and Travel Time Skim matrix have been developed according to shortest path between all origin and destination pairs. The distributed OD matrix has been developed using Gravity Model of following form:

$$Tij = A_i * B_j * P_i * D_j * F(U_{ij})$$

Where,

A_i , B_j : Balancing factors

P_i : Production from i^{th} zone

D_j : Attraction to j^{th} zoneand

$F(U_{ij})$: Deterrence Functionwhich can be expressed as

$$F(U_{ij}) = e^{(c*Uij)}$$

where U_{ij} : Generalized cost of travel (distance/time) from 'i' to 'j' zone

c : Calibration parameters calculated in modeling software

The calibration coefficient as per Gravity Model as developed in model are shown in **Table 3.5**. As illustrated, the overall model's results are almost similar to the HIS database.

TABLE 3.5: TRIP DISTRIBUTION SUB MODEL CALIBRATION RESULTS

Person Group	HIS	Model		Difference In Trips (%)
	Daily Trips	c	Daily Trips	
Education & Other	2296510	-0.32	2296103	0.02%
Work & Business	3537443	-0.25	3535859	0.04%
Total	**5833953**	-	**5831963**	0.03%

iv. Modal Split Model

Mode choice models have been developed for all modes of transport including public transport, intermediate paratransit and NMT modes. For our study, mode choice has been computed based on revealed preference of individuals surveyed in the household survey. A multi-nominal logit or Nested logit models has been run to achieve the mode choice equations.

The total trips are split into two major groups of 'Private' and 'Public' mode of travel. Private modes are further divided into Car, 2W and Auto rickshaw. PT trips consist of Buses, Metro and Shared Autorickshaw. It should be noted that the PT matrix produced by the modal split model contains trips using Buses & Shared Auto.

The main features of the modal split model are as follows:

- 4 modes: Car, 2wheeler, & PT (incl. Bus, Metro and shared auto)
- Unit: Person (productions / attractions – PA)
- Period: Daily
- Model Formulation: Combined Split, Multi-Logit Formulas (equations provided below, Where Pr (i) is the probability of decision maker choosing an alternative i and Vj is the systematic component of Utility of alternative J);

$$\mathbf{Pr(i) = \exp(V_i) / \sum_{j=1}^{J} \exp(V_j)}$$

Logit Parameters Estimation: Utility equations are developed using multinomial logit model, this model was developed based on statistical regression analysis. The format for utility equations developed are as given below:

$$V_i = a_i + b_1 X^i_1 + b_2 X^i_2 \_ \ldots + b_k X^i_k \ldots\ldots + b_n X^i_n$$

Where, Vi = Utility of mode i

a= Mode specific constant

b_k= k^{th} Parameter

X^i_k = k^{th} model variable for mode i

n= Number of model variables

Modal Split Calibration & Validation

In this study, the mode choices have been considered for modes car, two-wheeler, auto rickshaw and PT (including Bus and shared Auto Rickshaw). Using the Logistic Regression, various parameters and mode specific coefficients have been calibrated and using those parameters, utility functions have been developed taking “Car” as a reference mode.

For validation of mode choice utility function, the comparison between the existing mode share and estimated mode share as per modelling software is presented in **Table 3.6**.

TABLE 3.6: COMPARISON BETWEEN MODELLED AND OBSERVED MODE SHARE

Purpose	Mode	HIS	Share (%)	Model	Share (%)	Difference
HBE&O	2-Wheeler	394500	17.2%	424887	18.5%	-1.3%
	Car & Taxi	155516	6.8%	169057	7.4%	-0.6%
	IPT (Auto Rickshaw)	587824	25.6%	588436	25.6%	0.0%
	PT (Buses & MRTS)	1158667	50.5%	1113723	48.5%	1.9%

Purpose	Mode	HIS	Share (%)	Model	Share (%)	Difference
	Total	**2296508**	**100.0%**	**2296103**	**100.0%**	**0.0%**
HBW&B	2-Wheeler	2273521	64.3%	2273544	64.3%	0.0%
	Car & Taxi	397801	11.2%	396036	11.2%	0.0%
	IPT (Auto Rickshaw)	616703.7	17.4%	615235	17.4%	0.0%
	PT (Buses & MRTS)	249416	7.1%	251044	7.1%	0.0%
	Total	**3537442**	**100.0%**	**3535859**	**100.0%**	**0.0%**
Overall	2-Wheeler	2668021	45.7%	2698431	46.3%	-0.5%
	Car & Taxi	553318	9.5%	565093	9.7%	-0.2%
	IPT (Auto Rickshaw)	1204528	20.6%	1203672	20.6%	0.0%
	PT (Buses & MRTS)	1408083	24.1%	1364767	23.4%	0.7%
	Total	**5833950**	**100.0%**	**5831963**	**100.0%**	**0.0%**

v. Trip Assignment Model

Trip assignment is the stage wherein the trip interchanges are allocated to different parts of the network forming the transport system. In this stage the route to be travelled is determined and the inter-zonal flows are assigned to the selected routes. All assignment techniques are based on route selection. The choice of the route is made on the basis of number of criteria such as journey time, length, cost comfort, convenience, and safety.

The trip assignment for the present study has been evaluated with respect to both private vehicle assignment (Highway Assignment) as well as Public Transport assignment separately with different assignment methods.

Highway assignment has been developed using the distributed O-D trip matrix for various modes obtained from modal choice stage. For this, User Equilibrium method has been considered. The procedure updates the trip assignment by updating travel time iteratively. The assignment is largely controlled by alternative paths, which are built by the shortest path algorithm through the network. The output of the assignment is a loaded highway network with volumes (in PCU unit) for the base year 2024 is presented in **Figure 3.8**.

For the public transport assignment, the person trips unit is retained. The public transport network is developed from the loaded highway network, representing congested travel times on the road network. The public transport assignment considers multiple routes at an origin / destination level and includes the modelling of generalized costs for different modes. The selection of public transport route choice is based on the travel costs, including walk access time to bus or MRTS stops, wait time, in vehicle time and fare, transfer or interchange walk times and subsequent wait times, and the time to reach the final destination. The output of

the assignment is a loaded public transport network with patronage by service for the base year 2024 is presented in **Figure 3.9**

FIGURE 3.8: ASSIGNED DAILY TRAFFIC (PCU) ON NETWORK IN BASE YEAR 2024

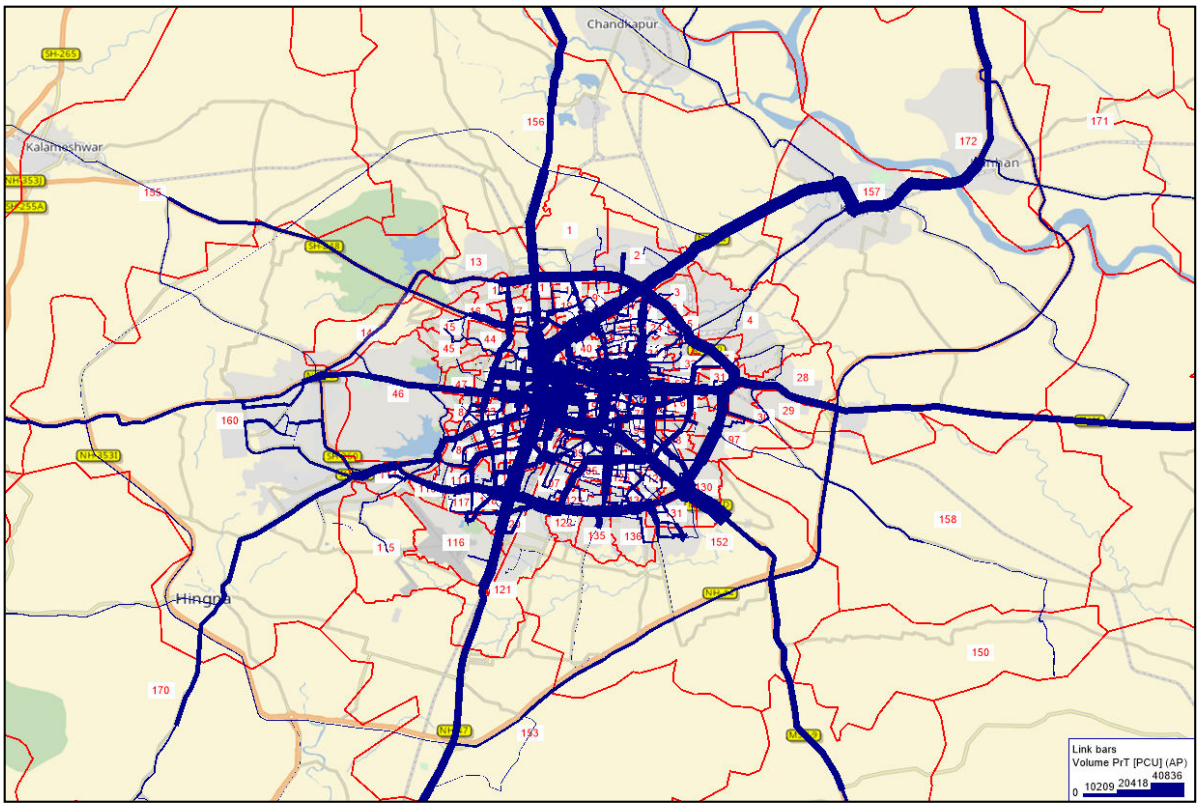
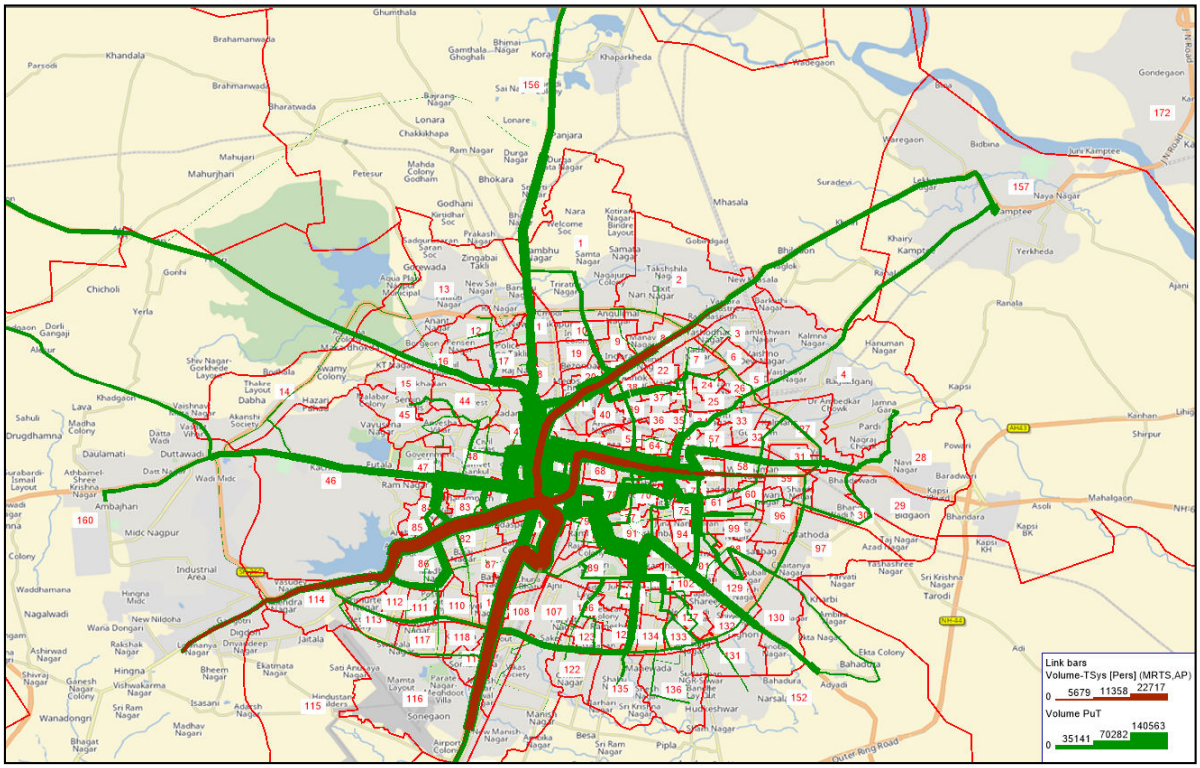


FIGURE 3.9: ASSIGNED PT PASSENGERS IN BASE YEAR 2024



3.1.5. MODEL VALIDATION

The demand model finally provides Daily & Peak Hour person matrices by mode at the end of the process. The travel demand model needs to be validated to determine whether it is reproducing existing traffic conditions. Model validation is undertaken by comparing the observed count data collected from the traffic volume surveys at screen line locations with their equivalent synthesized results as produced by the Model. As per standard practices, the differences between model and actual counts can vary upto 15%.

The comparison of observed and model flows across the identified screenline locations forms essential part of validation process. The validation results are quantified thorough GEH Statistics. The GEH Statistic is a formula used in traffic modelling to compare two sets of traffic volumes. It is an empirical formula that has proven useful for a variety of traffic analysis purposes. The formula for the "GEH Statistic" is:

$$GEH = \sqrt{\frac{2(M-C)^2}{M+C}}$$

Where, M is traffic count from model and C is traffic count from survey.

Using the GEH Statistic avoids some pitfalls that occur when using simple percentages to compare two sets of volumes. This is because the traffic volumes in real-world transportation systems vary over a wide range. For traffic modelling work in the "baseline" scenario, a GEH of less than 7.0 is considered a good match between the modelled and observed GEHs in the range of 7.0 to 10.0 may warrant investigation. GEH greater than 10.0 is not acceptable. **Table 3.7** shows the comparison of observed and model flows at identified midblock/ screen line locations.

TABLE 3.7: COMPARISON OF OBSERVED & MODEL MOTORISED TRAFFIC FLOWS AT SCREEN LINE LOCATIONS

SN	Screen line	Daily Passenger Traffic Volume (in PCU)		GEH
		Observed	Modelled	
1	Subhash Road	30829	29632	6.9
2	Ajni Road	52636	51553	4.7
3	Wardha Road (Near Butibori)	23383	22992	2.6
4	Narender Nagar RUB	55584	56411	3.5
5	Gurudwara Bridge (Kamptee Road)	42714	43752	5.0
6	Kawadepeth Railway Overbridge	14634	13926	5.9
7	Ramjhula Bridge	61385	59723	6.8
8	Humpyard Road	70141	69521	2.3

SN	Screen line	Daily Passenger Traffic Volume (in PCU)		GEH
		Observed	Modelled	
9	Ghat Road	40069	39005	5.4
10	Panchpaoli ROB	36506	37701	6.2
11	Somalwada Railway Crossing	3480	3190	5.0
12	Aurangabad Road	46279	45233	4.9
13	Chhindwara Road	40213	39882	1.7
14	Mecosabagh Road	23646	22625	6.7
15	Jaripatka Cement Road Railway Crossing	25272	23443	5.3
16	Narender Nagar ROB	29480	28470	5.9
17	Ring Road Railway Crossing (Nr. Mankapur Chowk)	37250	36725	2.7
18	Old Kamptee Road ROB	3016	2677	6.3
19	Itwari Railway Station Road	58541	57347	5.0
20	Mangalwari Bazar	21774	20882	6.1

For the present study, traffic flows at identified midblock/screen line locations are within the acceptable error range. The model validation results show that the model replicates the existing travel situation within permissible norms of transport planning in the study area since the model figures are close to the observed data, HIS database and field traffic counts. Therefore, the next stage for travel demand forecasting for future years shall be taken up following the model development, calibration, and validation for base year.

3.1.6. ASSUMPTIONS FOR TRANSPORT DEMAND FORECASTING

The following assumptions have been made for forecasting transport demand for the years 2031, 2041, 2051 and 2054.

(i) Calibrated and validated travel demand model has been used.
(ii) Land use parameters (population and employment) have been distributed in various traffic zones for 2024, 2031, 2041, 2051 and 2054.
(iii) Fare level of buses and Vehicle operating costs of different vehicles have been taken as same as in the base year.
(iv) Inter-city passenger to/from the study area will grow at the growth rate of 3% in various adjoining towns.
(v) The special generator passenger traffic of bus terminal, railway station and airport is expected to grow at 6% per annum respectively.

3.1.7. DEVELOPMENT OF BUSINESS AS USUAL (BAU) SCENARIO, 2054

Considering the above assumptions and calibrated / validated traffic demand model, forecasting of transport demand has been carried out for 'Business as Usual' (BAU) scenario in the year 2054. Overall modal split for various modes in this scenario for the year 2054 is given in **Table 3.8**. It is observed from BAU scenario that there will be rise in share of the private vehicles (Car and 2W) users and fall in shared auto rickshaw & Buses. Also, the total trips will increase from 74.3 Lakh to about 97.7 Lakh indicating a high-capacity mass transport network will be needed to address the travel demand requirements in the study area.

TABLE 3.8: DAILY TRIPS BY VARIOUS MODES IN 2024 & BAU 2054 SCENARIO

Mode	2024		2054 BAU	
	Trips	Model Share	Trips	Model Share
2-Wheeler	2702034	36.4%	3729282	38.2%
Car & Taxi	565848	7.6%	893229	9.1%
Auto Rickshaw	1205279	16.2%	1480156	15.2%
PT incl. Bus, School Bus, Metro, etc.	1366589	18.4%	1671580	17.1%
Cycle	543144	7.3%	674922	6.9%
Walk	1046198	14.1%	1316675	13.5%
Total	**7429093**	100.0%	9765844	**100.0%**

I. MAJOR TRAVEL CORRIDORS IDENTIFIED IN BAU 2054 SCENARIO

The traffic assignment on road network in the BAU scenario 2054 for peak hour traffic (in PCUs) is given in **Figure 3.10**. The expected transport demand on many of the road corridors cannot be met by a normal road-based transport system and mass transport system will be required on many corridors to cater the future transport demand. Therefore, the major travel demand corridors have been identified from BAU scenario through traffic assignment at respective links during peak hour in terms of passenger trips. The same have been listed in **Table 3.9**.

TABLE 3.9: MAJOR TRAVEL CORRIDORS IN STUDY AREA - BAU 2054 SCENARIO

SN	Road name	Sections		Maximum Peak Hour Passenger Trips on Links in 2054
		From	To	
1	NH-47	Kasturchand Park Metro Station	Mankapur Chowk	72748
2	Surat Kolkata Highway (NH-53)	Prajapati Nagar	Nagpur Junction Railway Station	67029
3	Kamptee Road	Automative Square	Kamptee	64988

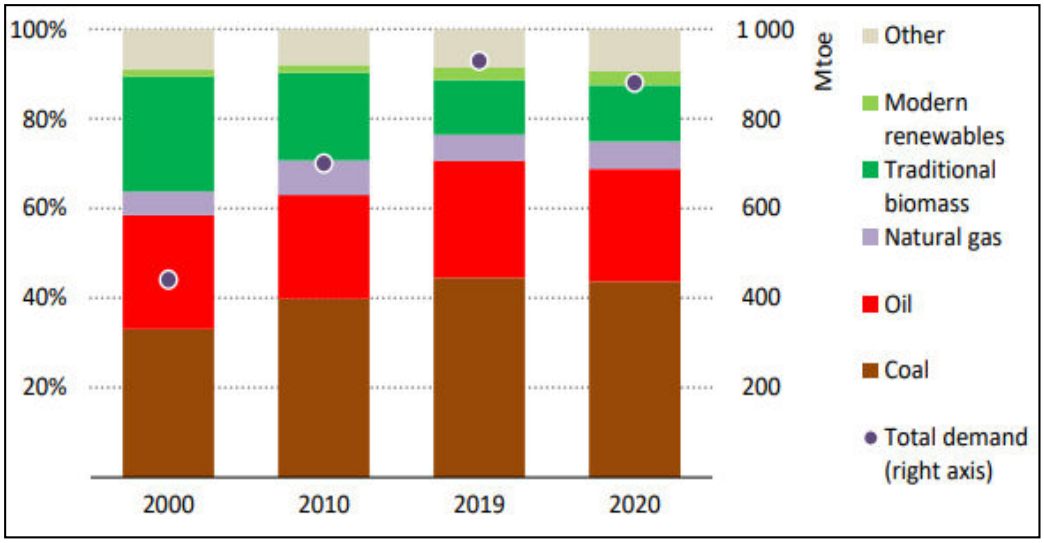
SN	Road name	Sections		Maximum Peak Hour Passenger Trips on Links in 2054
		From	To	
4	Wardha Road NH-47	Chhatrapati Square	Variety Chowk	64534
5	Wardha Road	Variety Chowk	RBI Square	63018
6	Kamptee Road	Kasturchand Park Metro Station	Mankapur Ring Road	61011
7	Amravati Road	T-point Wadi	Variety Chowk	59834
8	Bhandara Road	Prajapati Nagar	Mauda	52224
9	Wardha Road NH-47	Chhatrapati Square	Outer Ring Road Junction	51384
10	Chhindwara Road (NH-47)	Prajapati Nagar	Bokhara Road, Koradi Naka	35410
11	Mankapur Ring Road	Prajapati Nagar	Automative Square	30699
12	Katol Bypass Road(SH-260)	Mankapur Chowk	Katol Naka Chowk	29376
13	Chhindwara Road (NH-47)	Koradi Naka	Koradi	27340
14	Mankapur Ring Road	Dighori Chowk	Prajapati Nagar	26578
15	Hingna Road	Jhansi Rani Square	Hingana T-Point	26232
16	Mankapur Ring Road	Chhatrapati Square	Dighori Chowk	23200
17	Mankapur Ring Road	Chhatrapati Square	Hingana T-Point	21225

3.1.8. ENERGY AND ENVIRONMENT MODELLING

i. Primary Energy Demand

India's energy demand has tripled over the last three decades: the share of traditional biomass has fallen, leaving coal and oil dominant can be seen from **Figure 3.10.** As per Statistical review of world energy-2021," India's primary energy consumption fell by 5.9% in 2020, the first fall in consumption this century due to the corona virus pandemic. The combined share of energy consumption from oil, gas and coal fell from 90.6 to 89.7% and for renewable increased from 3.9 to 4.5%." With increased access to modern energy, the share of biomass particularly, non-commercial biomass is expected to decline fast in the coming decades and will get replaced by other sources of modern and commercial energy. Coal will continue to remain predominant among all other commercial sources of energy in India until the foreseeable future because of its cost advantage relative to other energy sources.

FIGURE 3.10: TOTAL PRIMARY ENERGY DEMAND IN INDIA



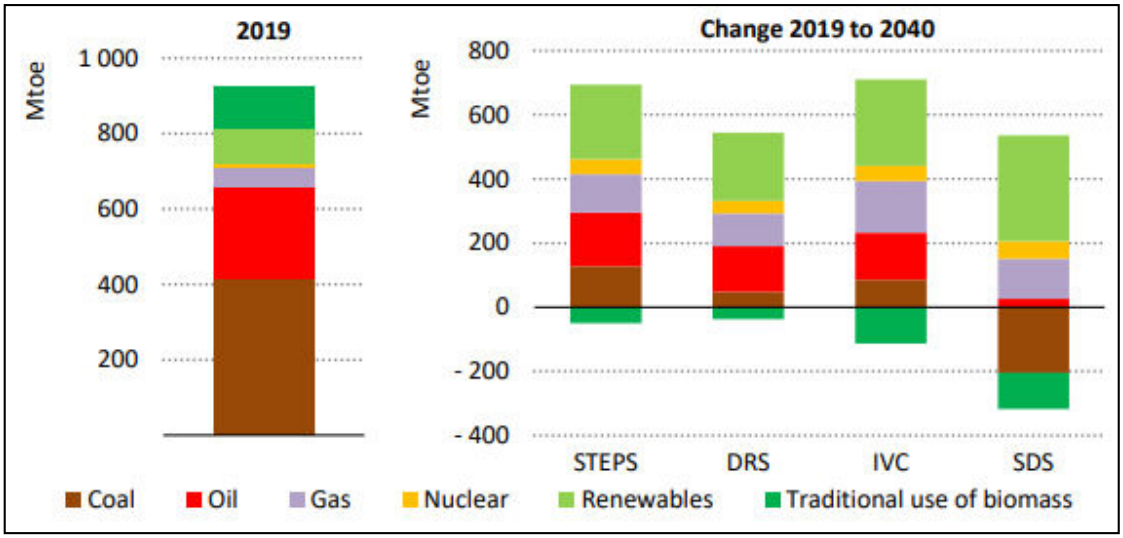
Source: India Energy Outlook 2021

Oil demand has more than doubled since 2000 as a result of growing vehicle ownership and road transport. LPG has also contributed to the growth of oil demand; transport energy demand grew 3.5 times as per India Energy outlook 2021.

Transport and industry sector account for a major share of total final energy demand, boosted by urbanization. The movement of freight across different cities of India to support domestic manufacturing will drive energy demand in the transport sector.

In terms of energy consumption, transportation is currently the fastest expanding end use industry, and urbanization will encourage even more expansion. Increasing demand for transportation in many Indian cities has resulted in traffic congestion and poor air quality. This has sparked a slew of regulatory efforts aimed at improving fuel efficiency and quality, as well as mass transit and transportation electrification. However, current policy policies are insufficient to avoid a huge, anticipated growth in oil consumption for road transport. Total primary energy demand in India by fuel and scenario from year 2019 to 2040 is given in **Figure 3.11**.

FIGURE 3.11: TOTAL PRIMARY ENERGY DEMAND IN INDIA BY FUEL AND SCENARIO



Source: India Energy Outlook 2021

ii. Emissions in base year

The Central Pollution Control Board (CPCB) monitors Ambient Air Quality at Nagpur. The Ambient Air Quality data is available for the year 2019 to 2023 which is summarized in **Table 3.10.**

TABLE 3.10: AIR QUALITY DATA FOR NAGPUR

SN	Year	Air Quality Index
1	2019	100.6
2	2020	73.2
3	2021	77.9
4	2022	107.2
5	2023	130.1

Source: Central Pollution Control Board

The table shows the trend of the Air Quality Index (AQI) over five years from 2019 to 2023. In 2019, the AQI was recorded at 100.6, indicating moderate air quality. In 2020, there was a significant improvement, with the AQI dropping to 73.2, which could be attributed to reduced industrial activity and transportation due to pandemic lockdowns. However, the AQI increased slightly to 77.9 in 2021 as activities resumed. This upward trend continued into 2022, with the AQI rising to 107.2, suggesting a decline in air quality. By 2023, the AQI reached 130.1, the highest in the period, reflecting a concerning increase in air pollution levels over the years.

iii. BAU Scenario (2054)

Fuel consumption and emissions of CO2 as well as other pollutants have been estimated for year 2054 based on the base year 2024. The estimation was done using emission factors for CO2 and other pollutants and fuel efficiency factors. The results are summarized in **Table 3.11** to **Table 3.13**.

TABLE 3.11 DAILY FUEL CONSUMPTION FOR BAU SCENARIO - 2054

Type of Vehicle	Fuel Consumed			
	Petrol in Lit	Diesel in Lit	Gas in Lit	Electricity in MWh
2 - Wheeler	282858.16	-	-	22.33
3 - Wheeler	199.29	26085.93	83932.44	28.12
4- Wheeler	163982.62	51775.51	10532.71	5.22
Bus	-	18791.11	-	300.64

TABLE 3.12 DAILY CO2 EMISSIONS FOR BAU SCENARIO - 2054

Type of Vehicle	CO_2 Emissions kg			
	Petrol	Diesel	Gas	Electricity
2 - Wheeler	650573.77	-	-	14291.68
3 - Wheeler	458.36	70692.87	142685.14	17999.83
4- Wheeler	377160.02	140311.63	17905.61	3339.49
Bus	-	50923.90	-	192410.01

TABLE 3.13 DAILY EMISSIONS OF OTHER POLLUTANTS FOR BAU SCENARIO - 2054

Type of Vehicle	Emissions kg		
	Petrol	Diesel	Gas
$PM_{2.5}$			
2 - Wheeler	532.95	-	-
3 - Wheeler	0.04	38.13	9.44
4- Wheeler	27.62	42.39	1.00
Bus	-	15.84	0.00
NOx			
2 - Wheeler	637.45	-	0.03
3 - Wheeler	0.27	225.86	5.85
4- Wheeler	281.72	423.94	1.02
Bus	-	795.68	-
CO			
2 - Wheeler	10564.92	-	0.85
3 - Wheeler	2.28	378.39	97.45
4- Wheeler	6482.26	543.65	46.97
Bus	-	359.76	-
VOC			
2 - Wheeler	5287.69	-	0.42

Type of Vehicle	Emissions kg		
	Petrol	Diesel	Gas
3 - Wheeler	3.40	151.79	145.41
4- Wheeler	212.67	211.97	1.54
Bus	-	124.46	-

3.1.9. CONCLUSION

The daily CO2 emissions are projected to rise from current 1311 Tonne/day to 1678 Tonne/day in the year 2054 under the Business As Usual scenario. It can be concluded from these results that if we continue on the current path of high motorization and neglecting the role of Walk, NMT and Public Transport based trips in the overall transport scenario of Nagpur, high level of environment degradation will be experienced.

3.2. DEVELOPMENT OF SUSTAINABLE URBAN TRANSPORT SCENARIOS

3.2.1. BACKGROUND

Business As Usual (BAU) scenario with decreasing share of public transport, Non-Motorized Transport (NMT) and walk, will not lead the city towards national goals of sustainable transport and climate change. In order to achieve these goals, Urban Structure, Public Transport, NMT and Technological Transitions have been considered as strategies for developing various Sustainable Urban Transport (SUT) scenarios. It is expected that adoption of SUT scenario will fulfill the objective of enhancing economic and social development while mitigating CO2 emissions within the city. This will enable the city to handle the mobility challenges while considering climate change and the local environment. The SUT scenarios are based on following principles:

- Changes in urban structure
- Enhanced use of non-motorized and public transport infrastructures
- Deep emission cuts using low carbon energy sources
- Use of highly efficient technologies in vehicles

3.2.2. STRATEGIES FOR SUSTAINABLE URBAN TRANSPORT SCENARIO

CMP will identify investment priorities to help achieve sustainable transport goals. Though the sustainable scenarios will assume an increase in motorized transport to some extent, emphasis has been placed on improving technology in terms of efficiency and emissions as presented in **Figure 3.12**. Following four Sustainable Urban Transport Scenarios have been formulated.

i. Urban Structure Scenario

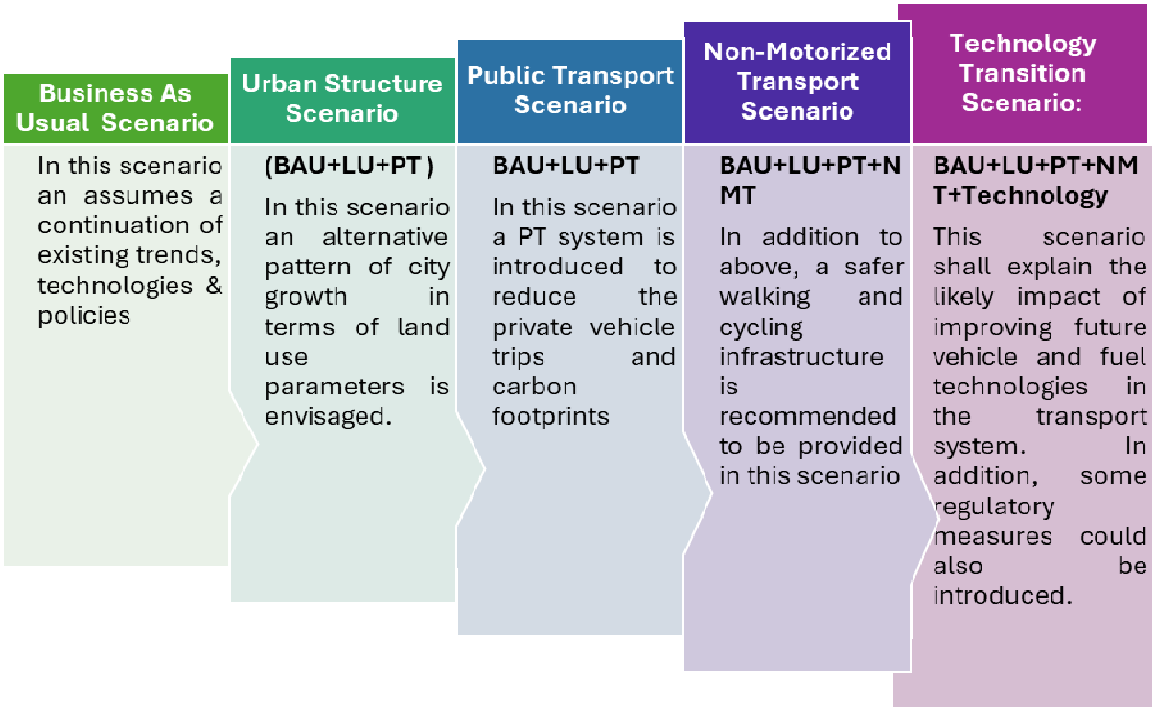
ii. Public Transport Scenario

iii. Non-Motorized Transport Scenario

iv. Technology Transition Scenario

These strategies will deliver desired benefits when implemented collectively. These strategies are presented in subsequent paragraphs to gauge the individual effect in developing sustainable transport in the city.

FIGURE 3.12: SUSTAINABLE URBAN TRANSPORT SCENARIOS



3.2.3. URBAN STRUCTURE SCENARIO

i. Landuse Transition

Urban sprawl and uncontrolled growth of cities result in an increase in trip lengths which is not desirable. Accordingly, compact development of the city is envisaged with high density and multi-nuclei development to increase share of walk and NMT and improve access to public transport. To achieve higher density and compact development, changes in planning and regulatory measures as zoning regulations and floor area ratio (FAR) are required.

The planning of new commercial activities to outgrowths of the city would result in better distribution of population and employment, decongesting the core areas as people in the outgrowths would not need to travel to the core city for their work, shopping and other activities. However, this would not discourage the use of

motorized modes of transport and will increase the carbon footprint of the city.

As such, in the Urban Structure Scenario, an alternative pattern of city growth is envisaged where the commercial activity is spread across the entire city, primarily along the major travel demand corridors. This scenario will promote a better urban structure for the city and will also ensure success of an organized public transport in the city.

3.2.4. PROJECTIONS AND DISTRIBUTION OF POPULATION IN URBAN STRUCTURE SCENARIO

The urban structure strategy envisages higher population along the major travel corridors. Accordingly, some of the high demand corridors identified under the BAU scenario are planned to be developed intensively by increase in FSI/FAR. This presents us with three categories of Traffic Analysis Zones (TAZ) namely:

- Class 1: Zones along major travel corridor
- Class 2: Core Area Zones
- Class 3: Non Core Area Zones

While the overall population for the city is same as that of BAU scenario, the distribution of population by traffic zones changes in the Urban Structure scenario in accordance with the above classification of TAZs. The overall population growth rate in Class 1 is assumed to be increased by 25% from the growth rate of BAU scenario along the major travel corridors from Year 2024 to Year 2054 and the population growth in Class 2 TAZ is assumed to be decreased by 10% in core areas due to saturation of existing development while population growth for Class 3 TAZ is assumed to be unchanged of the growth rate considered for BAU scenario while the outer area population is assumed to be decrease by 25% due to its distance from key transport routes and lower development potential. The overall population in the year 2054 is totaling to 58.2 Lakh.

It is expected that increase in FSI/FAR will not only concentrate the population along travel corridors but will also marginally induce population in the city, not reflected in the projections for BAU scenario. An additional population of about 2% of total population in the year 2054 is assumed to be induced as indirect effect of the land use transitions under this scenario.

Based on the above assumptions, the city's population projected for the year 2054 is 59.3 Lakh. The zone-wise distribution of population projected for each Traffic Analysis Zone (TAZ) under the Urban Structure scenario for various horizon years is presented in **Annexure 3.2**.

3.2.5. PROJECTION AND DISTRIBUTION OF EMPLOYMENT IN URBAN STRUCTURE SCENARIO

Similar to the methodology adopted for projecting population for this scenario, employment figures have also been projected considering increase in employment opportunities along major travel demand corridors. The classification of TAZ with underlying assumptions for projecting employment is given as under:

- Class 1 (Zones along major travel corridor): These are the zones in the influence area of major travel corridors. The share of these zones in city's existing employment is about 39%. The high FSI and FSR coupled with proximity to public transit are expected to make a major impact on creation of employment opportunities in these zones. As such, overall growth rate for employment in horizon year (2054) has been assumed to increase by 25% than BAU scenario.
- Class 2 (High employment zones): These are the zones with high share in overall employment. However, as these zones are already congested, the growth of these zones is assumed to be unimpacted and has been considered as same as BAU scenario.
- Class 3 (Core Area Zones): Apart from the existing high employment zones and future high employment zones assumed along major travel corridors, there are zones which fall in the core area/main city but are not covered under any of the above two classes. The employment growth rate of these zones is assumed to reduce by 25% than BAU scenario due to advent of Class 1 and growth of Class 2 zones.
- Class 4 (Non-Core Area Zones): These zones generally lie in the outgrowths of the city and are not under direct influence of a transit corridor or are an existing high employment zone. The employment growth rate of these zones is also assumed to reduce by 25% than BAU scenario.

As in the case of population, the change in the urban structure is expected to induce new employment in the city. An additional employment of about 2% of total employment is assumed in the year 2054 under the Urban Structure scenario. The overall total employment in the horizon year 2054 is projected to be 24.2 Lakh.

The zone-wise distribution of employment projected for each Traffic Analysis Zone (TAZ) under the Urban Structure scenario for various horizon years is outlined in **Annexure 3.3.**

The modal share for Urban Structure scenario in Year 2054 as derived from transport demand model is presented in **Table 3.14**.

TABLE 3.14 MODAL SHARE IN URBAN STRUCTURE SCENARIO - 2054

Mode	Daily Trips	Modal Share (%)
2-Wheeler	3674373	36.9%
Car & Taxi	861288	8.6%
Auto Rickshaw	1367047	13.7%
PT incl. Bus, School Bus, Metro, etc.	2007134	20.1%
Cycle	688420	6.9%
Walk	1362931	13.7%
Total	9961191	100.0%

It can be seen that the modal share in favor of public transport has increased from 17.1% under BAU Scenario to 20.1% in urban structure scenario.

3.2.6. PUBLIC TRANSPORT SCENARIO

With urban expansion and increasing economic prosperity, there is an increase in vehicle ownership and in the absence of safe and reliable public transport people are forced to use private vehicles for their travel needs. Public transport can serve to mitigate the economic and environmental burden that increased vehicle ownership has imposed on the city or population. This improvement goes beyond infrastructure development to include better accessibility, integration with land use, and non-motorized transport (NMT) infrastructure.

In this scenario, public transport infrastructure is envisioned to be upgraded through the introduction of Mass Rapid Transit System (MRTS) along major travel corridors, offering enhanced comfort and safety compared to existing modes. Low-capacity transport modes will be deployed on arterial and minor roads with limited right-of-way. Improved scheduling, increased network coverage, and enhanced safety and comfort for users are central to this scenario.

Existing shared autos will be the competing modes which may impact the ridership of MRTS. Therefore, operation of shared autos is planned to operate as a feeder to MRTS routes. In addition to the improved service, rail-based mass rapid transit system on selected high demand corridors is considered in this scenario. All these improvements are factored into the transport demand model for the horizon year of 2054.

The Urban Structure scenario's growth patterns, modulated to increase public transport accessibility, serve as the baseline for this iterative analysis. The goal is to encourage a modal shift from private vehicles to public transport. This scenario expects a significant shift from two-wheeler use to public transport, with minimal changes in the modal share of cycling and walking compared to the Urban Structure scenario.

By improving and expanding infrastructure, accessibility to public transit, and integrating land use, changed mode choice have been derived from the 4-stage travel demand model. The Urban Structure scenario growth patterns, which have been modulated as such to provide higher accessibility to public transport, are taken as the base and an iterative process of public transport development is considered for this analysis.

The public transport improvement scenario presents the analysis carried out to estimate the likely shift from cars, 2-wheeler, auto rickshaws to public transport. In this scenario, the availability and quality of public transport is increased incrementally and the likely shift it induces is observed.

With many public transport interventions, the modal share of public transport is expected to increase in this scenario. **Table 3.15** shows the aggregate modal share in Public Transport scenario as derived from the travel demand model. **Figure 3.13** shows the link-wise peak hour public transport loads on the network under public transport scenario.

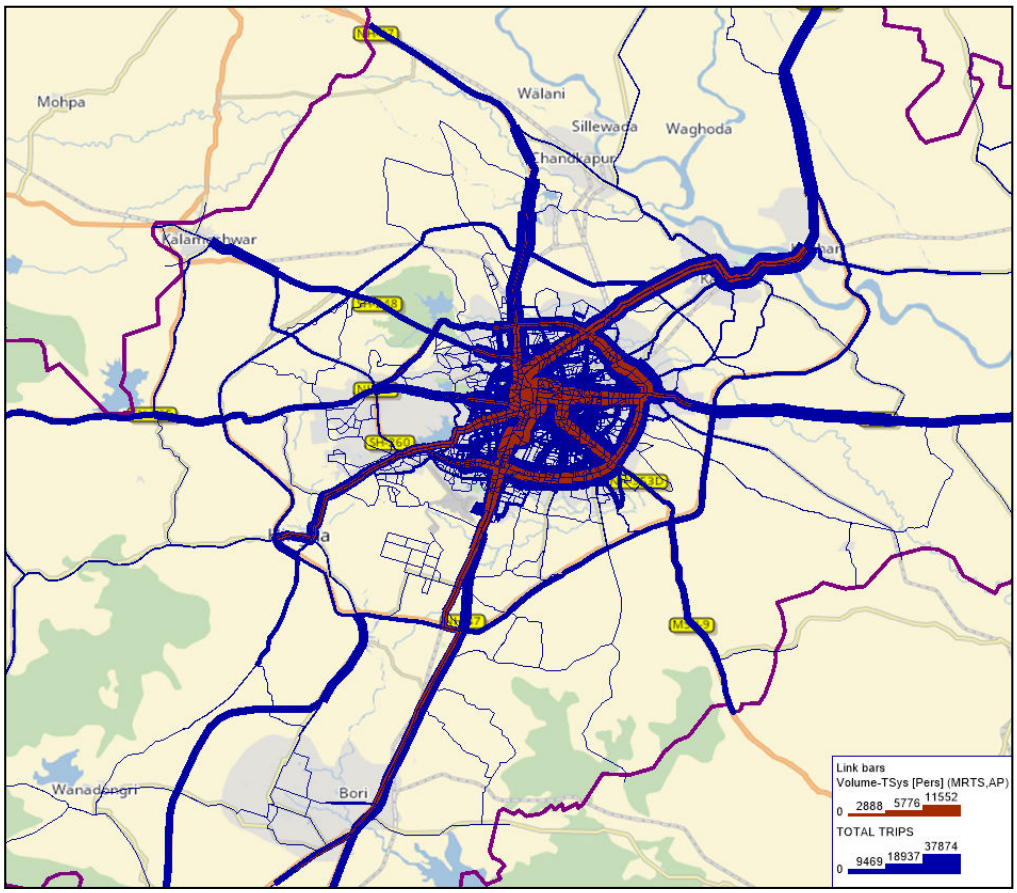
TABLE 3.15 MODAL SHARE IN PUBLIC TRANSPORT SCENARIO - 2054

Mode	Daily Trips	Modal Share (%)
2-Wheeler	3341670	33.5%
Car & Taxi	728823	7.3%
Auto Rickshaw	1141924	11.5%
PT incl. Bus, School Bus, Metro, etc.	2647587	26.6%
Cycle	728265	7.3%
Walk	1372892	13.8%
Total	9961161	100.000%

It can be seen from the above table that the modal share in favor of 2-wheeler has been decreased from 36.9% under Urban Structure Scenario to 33.5%. The modal share in favor of public transport has been increased from 20.1% to about 26.6%.

Due to public transport interventions in this scenario, the trips from private vehicles i.e., car, 2-wheeler and auto have been shifted to public transport. The major shift to public transport can be seen from 2 wheelers.

FIGURE 3.13 PUBLIC TRANSPORT NETWORK IN PUBLIC TRANSPORT SCENARIO (2054)



3.2.7. NON-MOTORIZED TRANSPORT SCENARIO

Non-motorized transport (NMT), including walking and cycling, is the most sustainable and environmentally friendly form of urban mobility. However, the current infrastructure for NMT modes is severely lacking, with 98% of major roads having no footpaths or cycle lanes, leading to high levels of pedestrian-vehicular conflict. The NMT Scenario focuses on developing continuous footpaths and cycle paths, safe pedestrian crossings, secure cycle parking, and implementing signal prioritization to encourage walking and cycling. Strong parking regulations and enforcement will ensure that NMT infrastructure is not obstructed. The goal of this scenario is to increase the share of walking and cycling, promoting a more sustainable and safer urban transport system.

The assumed infrastructure under the NMT scenario will include continuous footpaths and cycle paths, good crossing facilities, parking for cyclists, signal prioritization, strong parking policies and strict enforcement to remove the hindrances on NMT infrastructures. The modal share as derived from travel demand model is presented in **Table 3.16.**

TABLE 3.16 MODAL SHARE IN NMT SCENARIO-2054

Mode	Daily Trips	Modal Share (%)
2-Wheeler	3306806	33.2%
Car & Taxi	659095	6.6%
Auto Rickshaw	1092119	11.0%
PT incl. Bus, School Bus, Metro, etc.	2616708	26.3%
Cycle	883659	8.9%
Walk	1402775	14.1%
Total	9961161	100.000%

3.2.8. TECHNOLOGY TRANSITION

The Technology Transition Scenario envisions a shift from conventional petrol and diesel vehicles to electric vehicles (EVs) as part of a low-carbon future. While motorized transport modes such as buses and shared autos will continue to serve a substantial portion of trips, this scenario focuses on reducing energy consumption by promoting the adoption of EVs for cars, two-wheelers, three-wheelers, and buses by 2054. Vehicle efficiency is also expected to improve, with higher engine output per unit of fuel. This transition is projected to significantly reduce greenhouse gas emissions and improve air quality, contributing to the city's sustainability goals.

3.2.9. EMISSIONS AND AIR QUALITY

Emissions of CO_2 as well as other pollutants have been estimated using emission factors. CO_2 emissions resulting from grid power generation required for rail based mass transport operation have been accounted for. Emissions from passenger vehicles under the various scenarios are presented in **Table 3.17 To Table 3.18** using the following:

- Presence of electric vehicles as in 2054 as per RMI-Niti Aayog report of May 2017: 40% of cars and 2 wheelers and 50% of 3 wheelers
- CO_2 emissions from generation of grid power to operate electric vehicles as well as consumption of electric energy by electric vehicles adopted from industry trends
- CO_2 emissions from generation of grid power to operate rail based mass transport system

TABLE 3.17: DAILY CO_2 EMISSIONS FOR VARIOUS SCENARIOS

Type of Vehicle	Daily CO_2 Emissions kg			
	Petrol	Diesel	Gas	Electricity
URBAN STRUCTURE				
2 - Wheeler	117565.10	-	-	117565.10
3 - Wheeler	14000.93	14311.74	28980.74	14000.93
4 - Wheeler	4722.89	28206.52	5236.25	4722.89
Bus	-	28981.22	27270.15	-
PUBLIC TRANSPORT				
2 - Wheeler	117611.96	-	-	24799.65
3 - Wheeler	12864.81	13150.40	26629.07	12090.12
4 - Wheeler	51220.06	26255.24	56787.46	21154.44
Bus	-	42051.65	39568.90	28431.09
MRTS				1368.67
NMT				
2 - Wheeler	116384.89	-	-	24540.91
3 - Wheeler	12098.26	12366.84	25042.38	11369.73
4 - Wheeler	47823.60	24514.23	53021.81	19751.67
Bus	-	31170.91	32589.51	33719.40
MRTS				1352.71
Technology				
2 - Wheeler	116384.89	-	-	24540.91
3 - Wheeler	-	-	-	22739.46
4 - Wheeler	59779.50	12257.11	53021.81	19751.67
Bus	-	-	32589.51	42149.25
MRTS				1352.71

TABLE 3.18: DAILY EMISSIONS OF OTHER POLLUTANTS

Type of Vehicle	Daily Emissions in kg for Various Scenarios in Year 2054											
	US			PT			NMT			Technology		
	Petrol	Diesel	Gas	Petrol	Diesel	Gas	Petrol	Diesel	Gas	Petrol	Diesel	Gas
PM $_{2.5}$												
2 - W	158.46	-	-	158.52	-	-	320.01	0.00	-	320.01	-	-
3 - W	1.44	6.70	2.15	1.32	6.15	1.98	2.07	10.75	3.10	-	-	-
4 - W	3.45	9.30	3.10	3.21	8.66	2.89	5.99	15.27	4.49	7.49	7.64	4.49
Bus	-	7.92	1.15	-	11.50	1.67	-	8.52	1.38	-	-	1.38
NOx												
2 - W	190.15	-	-	190.22	-	-	382.75	0.00	0.00	382.75	-	-
3 - W	8.13	40.19	1.22	7.47	36.93	1.12	12.82	63.67	1.92	-	-	-
4 - W	37.21	93.02	2.79	34.63	86.58	2.60	61.08	152.70	4.58	76.35	76.35	4.58
Bus	-	398.42	5.98	-	578.10	8.68	-	428.52	7.15	-	0.00	7.15
CO												
2 - W	3194.50	-	-	3195.77	-	-	6343.69	-	-	6343.69	-	-

Type of Vehicle	Daily Emissions in kg for Various Scenarios in Year 2054											
	US			PT			NMT			Technology		
	Petrol	Diesel	Gas	Petrol	Diesel	Gas	Petrol	Diesel	Gas	Petrol	Diesel	Gas
3 - W	67.70	67.70	20.31	62.21	62.21	18.66	106.67	106.67	32.00	-	-	-
4 - W	854.40	119.20	128.16	795.29	110.96	119.29	1405.46	195.82	210.82	1756.83	97.91	210.82
Bus	-	180.73	27.11	-	262.24	39.34	-	194.38	32.40	-	-	32.40
VOC												
2 - W	1597.25	-	-	1597.89	-	-	3174.98	-	-	3174.98	-	-
3 - W	100.72	27.27	30.22	92.54	25.06	27.76	159.18	42.79	47.75	-	-	-
4 - W	28.25	46.51	4.24	26.30	43.29	3.94	46.11	76.35	6.92	57.64	38.18	6.92
Bus	-	62.39	9.36	-	90.53	13.58	-	67.11	11.18	-	-	11.18

- It is seen that CO_2 emissions are likely to decrease from 1678 tons in BAU scenario to 330 tons in Urban Structure scenario; other pollutants are also likely to decrease in Land use scenario. Similarly, CO_2 emissions decreased to 474 tons in Public Transport scenario and to 446 tons in NMT scenario. The decrease in emissions are contributed due to decrease in vehicle km and change in fuel mix for different low carbon scenarios. Urban Structure scenario has more benefits of reducing CO_2 from 1596 tons to 315 tons compared to NMT scenario and benefit in reduction of emissions from other pollutants.

- Reduction of other pollutants during PT, NMT and Technology scenarios has been envisaged by projecting diversification of fuel from existing petrol and diesel to electricity. The improvement in technology has been assumed by the year 2054 such as the vehicle efficiency in terms of engine output / unit of fuel is considerably higher than that in the present scenario.

3.2.10. ANALYSIS AND INDICATORS

On the basis of above analysis, a comparative picture has been drawn to assess the impact each scenario has on the travel pattern. Following parameters have been taken into account for preparing a comparative picture among various scenarios:

- Modal Share: Change in share of various modes, with increase in share of Public Transport and NMT modes and decrease in modal share of private modes indicates a sustainable future.

- Trip Length: Shorter trip lengths indicate shorter time spent in commuting between two places whereas increase in trip length of a particular mode indicates preference to that particular mode due to availability of allied infrastructure.

- Veh-km: Vehicle km travelled by each mode is the most tangible indicator for

comparing scenarios. For example, a scenario with highest vehicle km travelled by car/2 wheelers in comparison to other scenarios, indicates an unsustainable future.

- Environment impacts will be positive for the city wide due to technology transition in favour of electric vehicle.

Table 3.19 presents the comparative picture for various scenarios.

TABLE 3.19 COMPARATIVE ANALYSIS BETWEEN DIFFERENT SCENARIOS (2054)

Scenario		Base Year	BAU	Urban Structure Scenario	Public Transport Scenario	NMT Scenario	Technology Scenario
Horizon Year		**2024**	**2054**	**2054**	**2054**	**2054**	**2054**
Population		**4366876**	**5821230**	**5937655**	**5937655**	**5937655**	**5937655**
Total Trips		7429093	9765844	9961160	9961160	9961160	9961160
PCTR (Total)		1.7	1.7	1.7	1.7	1.7	1.7
PCTR (Motorised)		1.3	1.3	1.3	1.3	1.3	1.3
Modal Share (%)	**2-Wheeler**	36.4%	38.2%	36.9%	33.5%	33.2%	33.2%
	Car & Taxi	7.6%	9.1%	8.6%	7.3%	6.6%	6.6%
	Auto Rickshaw	16.2%	15.2%	13.7%	11.5%	11.0%	11.0%
	PT incl. Bus, School Bus, Metro, etc.	18.4%	17.1%	20.1%	26.6%	26.3%	26.3%
	Cycle	7.3%	6.9%	6.9%	7.3%	8.9%	8.9%
	Walk	14.1%	13.5%	13.7%	13.8%	14.1%	14.1%
Trip Length (Km)	**2-Wheeler**	6.9	7.0	6.9	7.6	7.6	7.6
	Car & Taxi	5.6	6.0	5.6	6.2	6.4	6.4
	Auto Rickshaw	4.9	5.5	4.9	5.4	5.3	5.3
	PT incl. Bus, School Bus, Metro, etc.	7.2	7.5	8.3	9.1	9.1	9.1
	Cycle	2.4	2.2	2.5	2.9	4.2	4.2
Veh-km Travelled	**2-Wheeler**	7768349	10877073	10563821	10568031	10457773	10457773
	Car & Taxi	2263391	3828124	3445151	3206821	2994173	2994173
	Auto Rickshaw	2109238	2907449	2392332	2198204	2067224	2067224
	PT incl. Bus, School Bus, Metro, etc. (	351409	447745	591388	858102	848094	848094

Scenario		Base Year	BAU	Urban Structure Scenario	Public Transport Scenario	NMT Scenario	Technology Scenario
	Cycle	1185042	1349844	1564591	1919971	3373971	3373971
CO_2 Emissions Per Day ('000 Kg)		**1311**	**1678**	**330**	**474**	**446**	**384**

The figures in the above table indicate the differences between various scenarios as follows:

- **Modal Share:** The cumulative modal share of car and 2 wheelers is increasing from 44% under base year to 47.3% under the BAU scenario. However, scenarios formulated under the Public Transport scenario indicate decreasing mode share of car and 2 wheelers with 40.8 %. The share of public transport increases from 18.4 under BAU to 26.6% under Public transport scenario.

- **Trip Length:** The trip length of NMT increased from 2.4 km under Base Year to 4.2 km under the NMT scenario. This is resultant of good NMT infrastructure in place and positively affects the veh-km travelled by each mode as given under.

- **Veh-km:** The veh-km by Car, 2 Wheelers and Private Auto is lower by approx. 9 akh under the NMT scenario as compared to BAU scenario.

- **CO2 Emissions per Day:** As indicated above, with decrease in share of private motorized trips, the CO2 emissions also reduce from BAU (1678 Tonne/day) to PT scenario (474 Tonne/day) by about 71.7%. However, extra savings of are accrued from envisaged change in the vehicle technologies for Urban Structure case from conventional fuel to electricity (330 Tonne/day) i.e. 74.8% lower than the base year and 80% lower than the BAU scenario.

3.2.11. CONCLUSIONS

As evident from above analysis, the city is benefitted from NMT Scenario in terms of increase in Modal Share, Trip Length and veh-km for NMT modes. However, considering improvement in environment, the Technology Scenario is the most suited scenario for the city as it includes the following benefits:

- Improved access to public transport
- Reliable, comfortable and safe public transport
- Increase in modal share of walk and NMT
- Considerably lower emissions from all the other scenarios

ANNEXURE 3.1 : POPULATION AND EMPLOYMENT DISTRIBUTION IN STUDY AREA FOR BASE AND HORIZON YEARS

Zone No.	Population						Employment					
	2024	2028	2031	2041	2051	2054	2024	2028	2031	2041	2051	2054
1	18455	19357	20062	22604	24969	25649	10083	10734	11249	13034	14653	15057
2	28038	29408	30480	34342	37935	38968	8786	9353	9803	11404	12852	13207
3	31894	33452	34671	39064	43151	44327	6845	7287	7637	8964	10156	10438
4	28547	29942	31033	34965	38623	39675	8453	8999	9431	10985	12389	12732
5	14166	14858	15400	17351	19166	19688	2231	2375	2489	3164	3750	3857
6	12393	12999	13472	15179	16767	17224	2052	2184	2289	2939	3501	3602
7	26177	26918	27487	29181	30673	31135	5442	5680	5865	6586	7196	7318
8	23308	23967	24474	25983	27312	27724	5256	5485	5664	6373	6973	7091
9	32411	33328	34033	36131	37979	38552	4457	4652	4803	5459	6012	6116
10	17307	17797	18173	19293	20280	20586	7385	7708	7959	8809	9533	9690
11	16364	16827	17183	18242	19175	19464	5725	5975	6170	6909	7537	7663
12	25099	26326	27285	30742	33958	34883	4763	5070	5314	6347	7265	7468
13	33416	35049	36326	40928	45210	46442	6730	7165	7509	8819	9997	10274
14	19214	20153	20887	23533	25995	26703	3988	4245	4449	5372	6189	6363
15	15212	15956	16537	18632	20581	21142	5036	5361	5619	6690	7644	7858
16	31569	33112	34318	38666	42711	43875	5011	5335	5591	6659	7610	7822
17	25062	26287	27245	30697	33909	34833	3724	3964	4155	5041	5823	5987
18	29271	30099	30736	32631	34300	34817	6597	6885	7109	7907	8586	8728
19	27322	28095	28689	30458	32016	32499	9484	9898	10221	11210	12058	12252
20	20517	21098	21544	22872	24042	24404	13649	14245	14709	15976	17067	17337
21	17209	17696	18070	19184	20165	20469	4857	5069	5234	5916	6493	6604
22	25055	25764	26309	27931	29359	29802	6494	6777	6998	7789	8462	8602
23	17835	18339	18727	19881	20898	21213	2438	2544	2627	3149	3584	3651
24	13872	14264	14566	15464	16255	16500	3828	3995	4125	4739	5255	5348
25	12489	12842	13114	13922	14634	14855	2947	3076	3176	3731	4196	4272

Zone No.	Population						Employment					
	2024	2028	2031	2041	2051	2054	2024	2028	2031	2041	2051	2054
26	16277	16738	17092	18146	19074	19362	2725	2844	2937	3477	3929	4001
27	29526	30362	31004	32915	34598	35120	14613	15251	15748	17078	18226	18514
28	13874	14552	15082	16993	18771	19282	4888	5203	5453	6504	7439	7647
29	18186	19075	19770	22275	24605	25275	12409	13210	13845	15959	17882	18375
30	18466	19368	20074	22617	24983	25664	10026	10673	11186	12962	14573	14975
31	11059	11599	12022	13545	14962	15370	7310	7782	8156	9548	10802	11102
32	12062	12404	12666	13447	14135	14348	2079	2170	2241	2738	3152	3213
33	19758	20317	20747	22026	23152	23501	8431	8799	9086	10006	10791	10967
34	20696	21282	21732	23072	24252	24618	6548	6834	7057	7851	8527	8668
35	20561	21143	21590	22921	24093	24456	5393	5629	5812	6530	7137	7258
36	16741	17215	17579	18663	19617	19913	3043	3176	3279	3841	4311	4389
37	23121	23775	24278	25775	27093	27501	5053	5273	5445	6141	6729	6843
38	19948	20512	20946	22237	23374	23726	8919	9309	9612	10564	11378	11562
39	15896	16346	16691	17720	18626	18907	2352	2455	2535	3050	3480	3546
40	17437	17931	18310	19439	20433	20741	3009	3141	3243	3802	4270	4348
41	23902	24578	25098	26645	28008	28430	11302	11796	12180	13290	14244	14471
42	26296	27040	27612	29314	30813	31278	11460	11960	12350	13471	14434	14664
43	28294	29677	30758	34655	38281	39324	36290	38633	40489	45978	51043	52439
44	12268	12867	13336	15026	16598	17050	2816	2998	3142	3899	4562	4691
45	15368	16119	16706	18823	20792	21358	5882	6261	6562	7753	8819	9064
46	5061	5308	5502	6199	6848	7035	7343	7817	8193	9590	10849	11150
47	28599	29997	31090	35029	38694	39748	9631	10253	10745	12466	14025	14412
48	42691	44777	46409	52289	57760	59334	10237	10898	11421	13228	14867	15277
49	35258	36255	37022	39304	41314	41937	13065	13636	14080	15307	16364	16623
50	18113	18625	19019	20191	21224	21544	111155	119280	125761	127527	134326	136364
51	15905	16355	16701	17731	18638	18919	9267	9672	9987	10962	11797	11988

Zone No.	Population						Employment					
	2024	2028	2031	2041	2051	2054	2024	2028	2031	2041	2051	2054
52	19359	19907	20328	21581	22685	23027	11922	12443	12848	14000	14990	15229
53	24947	25653	26195	27810	29232	29673	7107	7417	7659	8491	9199	9350
54	24073	24754	25278	26836	28208	28633	3701	3863	3989	4594	5103	5192
55	21448	22055	22521	23909	25132	25511	19408	20255	20915	22564	23992	24367
56	26236	26978	27549	29247	30743	31206	3948	4121	4255	4876	5400	5494
57	24995	25702	26246	27864	29289	29731	4437	4631	4782	5436	5988	6091
58	19398	19947	20369	21625	22731	23074	6700	6993	7221	8025	8710	8854
59	29053	30473	31583	35584	39307	40378	6564	6988	7323	8611	9766	10037
60	7201	7405	7561	8027	8438	8565	2196	2292	2366	2872	3293	3355
61	24061	24742	25265	26822	28194	28619	4188	4371	4513	5151	5688	5787
62	15834	16282	16626	17651	18554	18834	8983	9375	9681	10637	11455	11641
63	13147	13519	13805	14656	15406	15638	6897	7198	7433	8250	8946	9094
64	21926	22546	23023	24442	25692	26079	10973	11452	11825	12914	13848	14069
65	22521	23158	23648	25106	26390	26788	11995	12519	12927	14083	15077	15318
66	21872	22491	22966	24382	25629	26015	8444	8813	9100	10020	10807	10982
67	23695	24366	24881	26415	27766	28185	13433	14020	14477	15729	16807	17073
68	13249	13624	13912	14770	15525	15759	11233	11724	12106	13212	14161	14387
69	15314	15747	16080	17071	17944	18215	5347	5580	5762	6477	7082	7202
70	21653	22266	22737	24139	25373	25756	9317	9724	10041	11020	11857	12049
71	19547	20100	20525	21790	22904	23249	4439	4633	4784	5438	5990	6093
72	14836	15256	15578	16538	17384	17646	2464	2571	2655	3178	3615	3682
73	15081	15508	15836	16812	17672	17938	2344	2446	2526	3041	3471	3536
74	16070	16525	16874	17914	18830	19114	2311	2412	2490	3003	3431	3496
75	10481	10777	11005	11683	12280	12465	5898	6156	6356	7107	7744	7874
76	25154	25866	26413	28041	29475	29919	7066	7375	7615	8444	9149	9300
77	12255	12602	12868	13661	14360	14576	3317	3462	3575	4154	4641	4724

Zone No.	Population						Employment					
	2024	2028	2031	2041	2051	2054	2024	2028	2031	2041	2051	2054
78	27926	28716	29323	31131	32723	33216	14850	15498	16003	17349	18510	18802
79	9791	10068	10281	10915	11473	11646	3848	4016	4147	4762	5279	5372
80	24387	25077	25607	27186	28576	29007	71685	74815	77252	82375	86861	88184
81	14946	15369	15694	16661	17513	17777	9401	9811	10131	11115	11957	12151
82	19316	19863	20283	21533	22634	22975	4170	4352	4494	5130	5667	5765
83	13449	13830	14122	14993	15760	15998	15555	16234	16763	18157	19359	19665
84	44492	46667	48367	54495	60196	61836	11364	12098	12679	14645	16431	16884
85	12054	12643	13104	14764	16309	16753	4443	4730	4957	5945	6821	7012
86	42652	44736	46366	52240	57705	59277	12853	13683	14340	16516	18498	19008
87	29774	30617	31264	33191	34888	35414	18691	19507	20143	21744	23129	23491
88	26125	26864	27432	29123	30612	31073	8622	8999	9292	10224	11020	11199
89	22839	23485	23982	25460	26762	27165	8547	8920	9211	10138	10930	11108
90	7484	7696	7859	8343	8770	8902	15741	16429	16965	18369	19583	19891
91	13074	13444	13728	14574	15319	15550	3688	3849	3974	4579	5087	5176
92	6438	6620	6760	7177	7544	7658	1450	1514	1563	2018	2396	2445
93	18920	19455	19867	21092	22171	22505	4185	4368	4510	5148	5685	5784
94	13645	14031	14328	15211	15989	16230	1915	1999	2064	2550	2955	3012
95	13191	13564	13851	14705	15457	15690	9272	9677	9992	10968	11802	11993
96	21038	22066	22870	25767	28463	29238	13062	13905	14573	16779	18789	19305
97	26946	28263	29293	33004	36457	37450	4578	4874	5108	6114	7009	7205
98	13419	13799	14091	14960	15725	15962	2325	2427	2506	3020	3448	3513
99	17908	18415	18804	19963	20984	21300	4304	4492	4638	5284	5828	5929
100	17442	17936	18315	19444	20438	20746	3537	3692	3812	4406	4905	4992
101	18253	18769	19166	20348	21389	21711	3342	3488	3602	4183	4671	4754
102	20539	21120	21567	22897	24068	24431	4770	4979	5141	5817	6388	6498
103	18161	18675	19070	20246	21281	21602	5062	5283	5455	6151	6739	6854

Zone No.	Population						Employment					
	2024	2028	2031	2041	2051	2054	2024	2028	2031	2041	2051	2054
104	22994	23645	24145	25633	26944	27350	4384	4576	4725	5375	5924	6026
105	17972	18480	18871	20034	21059	21376	2642	2757	2847	3382	3829	3900
106	20056	20624	21060	22358	23501	23855	2847	2971	3068	3617	4076	4150
107	35935	36952	37733	40059	42108	42743	8269	8630	8911	9820	10596	10769
108	19097	19638	20053	21289	22378	22715	2965	3094	3195	3752	4218	4294
109	13407	13786	14078	14946	15710	15947	11151	11638	12017	13118	14062	14287
110	23678	24348	24863	26396	27746	28164	6762	7057	7287	8096	8784	8929
111	27241	28012	28604	30367	31920	32401	4886	5099	5265	5950	6528	6639
112	20598	21181	21629	22962	24136	24500	4696	4901	5061	5732	6299	6407
113	20216	20788	21228	22537	23690	24047	3906	4076	4209	4829	5349	5443
114	32241	33153	33854	35941	37779	38349	6213	6485	6696	7468	8123	8259
115	14357	15058	15607	17584	19424	19953	3070	3268	3425	4218	4914	5053
116	57537	60349	62548	70472	77845	79966	19233	20475	21458	24536	27358	28108
117	26938	28255	29284	32994	36446	37439	4360	4641	4864	5840	6706	6894
118	23888	25055	25968	29258	32319	33199	4750	5056	5299	6330	7247	7450
119	26779	28088	29111	32799	36231	37218	4340	4620	4842	5815	6678	6865
120	33156	34776	36043	40609	44858	46080	9846	10482	10985	12736	14323	14719
121	32321	33901	35136	39587	43729	44920	6493	6912	7244	8521	9668	9936
122	29493	30934	32061	36123	39902	40989	5446	5798	6076	7205	8214	8443
123	27160	28487	29525	33266	36746	37747	5052	5378	5636	6710	7667	7881
124	21993	22616	23094	24518	25772	26161	3263	3406	3517	4093	4576	4658
125	23901	25069	25982	29274	32337	33218	4326	4605	4826	5797	6659	6845
126	16673	17145	17507	18586	19536	19831	2370	2473	2554	3071	3502	3568
127	18207	18722	19118	20297	21335	21657	2992	3122	3224	3783	4250	4327
128	19229	19773	20191	21436	22532	22872	7583	7914	8172	9035	9771	9932
129	19772	20738	21494	24217	26751	27480	3507	3734	3913	4768	5521	5677

Zone No.	Population						Employment					
	2024	2028	2031	2041	2051	2054	2024	2028	2031	2041	2051	2054
130	38435	40313	41782	47075	52000	53417	14126	15038	15760	18116	20266	20824
131	29632	31080	32213	36294	40091	41183	7080	7537	7899	9259	10483	10773
132	16481	17286	17916	20186	22298	22905	2818	3000	3144	3902	4565	4694
133	25847	26578	27140	28813	30287	30744	4752	4959	5121	5796	6367	6476
134	32234	33809	35041	39480	43610	44798	11110	11827	12395	14325	16078	16521
135	26843	28155	29181	32878	36318	37307	12268	13060	13687	15781	17687	18174
136	30040	31508	32656	36793	40642	41749	5946	6330	6634	7834	8908	9156
137	17810	18533	19095	21621	25092	26433	7624	8055	8395	9877	11884	12510
138	22872	23801	24522	27766	32224	33946	8592	9078	9461	11084	13285	13985
139	12946	13472	13880	15716	18239	19213	6353	6712	6995	8293	10045	10572
140	11376	11838	12197	13810	16027	16883	6962	7356	7666	9052	10926	11500
141	22419	23795	24882	28173	31742	32704	6987	7530	7964	9390	11012	11356
142	20566	21828	22825	25844	29118	30000	7121	7674	8117	9562	11207	11557
143	24181	25163	25925	29354	34067	35887	9084	9598	10002	11697	13996	14735
144	34236	36337	37997	43023	48474	49943	16352	17622	18639	21476	24631	25387
145	27975	29692	31048	35155	39609	40809	8896	9587	10140	11853	13788	14217
146	21362	22229	22903	25932	30095	31703	10142	10716	11167	13016	15527	16347
147	38022	39566	40765	46157	53567	56429	10617	11218	11691	13609	16214	17071
148	35577	37760	39485	44708	50372	51898	8807	9491	10039	11738	13659	14083
149	70124	72971	75182	85126	98792	104070	14827	15666	16326	18857	22305	23488
150	7879	8199	8447	9564	11099	11692	6652	7028	7324	8665	10476	11027
151	22985	23918	24643	27903	32383	34113	8058	8514	8873	10418	12512	13171
152	58490	62079	64915	73501	82813	85322	25666	27659	29255	33497	38174	39341
153	36607	38853	40628	46002	51830	53401	11142	12007	12700	14752	17054	17581
154	19800	20604	21228	24036	27895	29385	7945	8394	8748	10277	12348	12998
155	83979	87389	90037	101946	118312	124633	16555	17492	18229	21012	24806	26122

Zone No.	Population						Employment					
	2024	2028	2031	2041	2051	2054	2024	2028	2031	2041	2051	2054
156	48621	51605	53962	61100	68841	70927	15945	17183	18175	20951	24039	24777
157	196647	208714	218248	247116	278424	286861	78166	84237	89097	101254	114515	117996
158	17631	18713	19568	22156	24963	25719	11041	11898	12585	14622	16907	17430
159	46007	47875	49326	55850	64816	68279	12525	13234	13792	15988	18975	19979
160	61037	64783	67742	76702	86420	89039	26634	28703	30359	34746	39582	40792
161	23917	24888	25642	29034	33695	35495	7560	7988	8324	9797	11791	12412
162	18726	19486	20077	22733	26383	27792	8006	8459	8816	10354	12437	13092
163	11502	11969	12332	13963	16205	17071	5780	6107	6365	7578	9216	9699
164	20260	21082	21721	24594	28542	30067	6302	6658	6939	8229	9970	10494
165	8057	8384	8638	9781	11351	11957	4964	5245	5466	6561	8035	8455
166	12512	13020	13415	15189	17627	18569	6225	6578	6855	8133	9859	10377
167	15672	16309	16803	19026	22080	23260	5931	6267	6531	7767	9434	9929
168	14219	14797	15245	17261	20032	21102	6383	6745	7029	8330	10088	10617
169	18492	19627	20523	23238	26182	26975	6949	7489	7921	9340	10957	11299
170	54302	57634	60267	68239	76884	79214	24075	25945	27442	31444	35860	36958
171	25412	26971	28203	31933	35979	37069	7080	7630	8070	9509	11147	11495
172	17068	17761	18299	20719	24045	25330	9184	9703	10112	11822	14140	14887
173	28535	29693	30593	34640	40201	42349	8440	8917	9293	10895	13064	13753
174	19568	20769	21717	24590	27705	28544	6326	6817	7210	8536	10051	10366
175	15498	16127	16616	18814	21834	23000	6104	6449	6721	7982	9684	10192
176	27967	29102	29984	33950	39400	41505	8996	9505	9905	11588	13868	14600
177	15348	15971	16455	18632	21623	22778	6253	6607	6885	8168	9900	10419
178	4144	4312	4443	5031	5839	6151	8538	9021	9401	11018	13208	13904
179	6572	6839	7046	7978	9259	9754	4929	5208	5427	6517	7984	8402
180	8412	8754	9019	10212	11851	12484	5600	5917	6166	7354	8955	9424
181	3829	3984	4105	4648	5394	5682	4086	4317	4499	5466	6764	7116

Zone No.	Population						Employment					
	2024	2028	2031	2041	2051	2054	2024	2028	2031	2041	2051	2054
182	40138	42601	44547	50439	56829	58551	10032	10811	11435	13319	15440	15918
183	48046	50994	53324	60377	68026	70087	13959	15043	15911	18388	21150	21802
Total	**4366876**	**4547280**	**4687903**	**5167015**	**5665310**	**5821230**	**1647270**	**1740484**	**1815697**	**2054697**	**2302759**	**2365865**

ANNEXURE 3.2: ZONE-WISE DISTRIBUTION OF POPULATION IN URBAN STRUCTURE SCENARIO

Zone	Population					Zone	Population				
	2028	2031	2041	2051	2054		2028	2031	2041	2051	2054
1	19639	20271	22572	24728	25367	93	19778	20144	21258	22273	22609
2	30343	31718	36812	41723	43179	94	14261	14521	15324	16066	16317
3	34110	35342	39821	44028	45261	95	13786	14037	14814	15533	15777
4	30385	31369	34927	38241	39211	96	22496	23305	26258	29046	29870
5	15144	15686	17674	19563	20129	97	28817	29856	33640	37200	38246
6	13248	13719	15458	17116	17616	98	14025	14281	15071	15802	16050
7	27445	28014	29740	31300	31805	99	18719	19065	20119	21082	21401
8	24605	25246	27204	28993	29573	100	18233	18568	19594	20533	20845
9	33890	34523	36432	38145	38696	101	19080	19432	20507	21489	21813
10	18091	18424	19442	20375	20685	102	21472	21869	23079	24178	24539
11	17104	17420	18383	19266	19561	103	18984	19334	20403	21379	21702
12	26714	27578	30706	33625	34482	104	24039	24486	25840	27066	27466
13	35569	36724	40889	44762	45892	105	18786	19132	20190	21156	21477
14	20447	21106	23500	25743	26407	106	20966	21355	22535	23608	23961
15	16186	16706	18601	20384	20917	107	37680	38465	40836	42964	43645
16	33603	34692	38627	42289	43359	108	20158	20682	22286	23759	24241
17	26675	27538	30661	33576	34432	109	14149	14513	15639	16684	17033
18	30605	31176	32901	34452	34953	110	24824	25338	26900	28315	28775
19	28566	29099	30708	32158	32628	111	28561	29154	30950	32572	33096
20	21659	22222	23946	25525	26039	112	21593	22039	23397	24632	25037
21	18164	18634	20080	21410	21848	113	21193	21630	22963	24178	24575
22	26195	26682	28158	29490	29923	114	34040	34931	37641	40101	40891
23	18643	18986	20036	20995	21313	115	15276	15765	17553	19240	19745
24	14498	14762	15579	16334	16589	116	61253	63249	70422	77064	78985
25	13052	13289	14023	14706	14939	117	28809	29847	33629	37189	38235

Zone		Population				Zone		Population			
	2028	2031	2041	2051	2054		2028	2031	2041	2051	2054
26	17062	17411	18485	19469	19797	118	25545	26465	29819	32979	33910
27	30958	31602	33549	35304	35870	119	28979	30292	35156	39849	41242
28	15008	15684	18203	20652	21390	120	35883	37512	43535	49335	51052
29	19677	20565	23869	27067	28024	121	34980	36567	42438	48093	49767
30	19980	20881	24235	27482	28454	122	31541	32680	36821	40714	41856
31	11962	12497	14504	16464	17060	123	29046	30093	33907	37495	38549
32	12605	12834	13544	14205	14432	124	22993	23419	24715	25889	26274
33	20655	21036	22199	23257	23606	125	25438	26260	29238	32019	32837
34	21636	22036	23255	24362	24726	126	17428	17748	18729	19628	19928
35	21494	21892	23103	24203	24564	127	19085	19478	20679	21775	22138
36	17499	17821	18807	19709	20010	128	20157	20572	21840	22996	23377
37	24172	24621	25983	27215	27617	129	21142	21901	24677	27300	28077
38	20853	21238	22413	23481	23833	130	41108	42595	47992	53054	54533
39	16615	16920	17855	18714	19002	131	31690	32835	36995	40907	42054
40	18227	18563	19589	20528	20840	132	17621	18252	20565	22758	23411
41	25234	25891	27899	29732	30326	133	27098	27660	29365	30906	31406
42	27762	28487	30696	32709	33360	134	34474	35719	40245	44496	45741
43	30116	31092	34618	37904	38866	135	28707	29742	33511	37058	38101
44	13051	13468	14996	16442	16877	136	32127	33287	37504	41469	42631
45	16353	16877	18792	20593	21131	137	18703	19113	20969	23475	24439
46	5377	5543	6172	6792	6992	138	24021	24551	26936	30144	31372
47	30441	31427	34992	38313	39285	139	13592	13887	15237	17069	17778
48	45445	46923	52245	57184	58618	140	11942	12200	13386	15000	15627
49	37227	38202	41165	43851	44712	141	24260	25357	28712	32391	33406
50	19119	19614	21134	22533	22992	142	22253	23259	26336	29714	30647
51	16787	17221	18557	19789	20197	143	25397	25957	28478	31867	33163

Zone		Population				Zone		Population			
	2028	2031	2041	2051	2054		2028	2031	2041	2051	2054
52	20238	20611	21751	22789	23132	144	37053	38735	43859	49457	50989
53	26081	26567	28037	29363	29795	145	30275	31647	35834	40415	41673
54	25169	25636	27054	28335	28752	146	22435	22929	25155	28153	29302
55	22422	22838	24101	25246	25623	147	39940	40829	44794	50101	52119
56	27430	27941	29486	30880	31332	148	38504	40252	45578	51393	52983
57	26132	26619	28091	29420	29853	149	73671	75318	82633	92387	96081
58	20477	21008	22638	24133	24622	150	8267	8443	9263	10392	10837
59	31442	32866	38144	43231	44740	151	24140	24673	27070	30293	31527
60	7520	7652	8074	8485	8633	152	63309	66191	74947	84483	87076
61	25155	25622	27039	28321	28738	153	40208	42501	49631	57641	59863
62	16712	17143	18473	19701	20107	154	21214	22008	25700	30990	33102
63	13740	13990	14764	15481	15724	155	88229	90205	98966	110639	115057
64	22922	23347	24637	25807	26191	156	53408	56458	65929	76556	79495
65	23775	24393	26285	28015	28577	157	216041	228412	266720	309582	321371
66	23089	23690	25528	27209	27756	158	19076	19937	22575	25476	26281
67	25014	25666	27657	29475	30066	159	48331	49408	54207	60619	63055
68	13982	14341	15454	16487	16832	160	67049	70882	82771	96102	99785
69	16163	16580	17865	19054	19448	161	25120	25673	28167	31519	32802
70	22637	23057	24332	25488	25868	162	19665	20097	22049	24682	25693
71	20634	21169	22810	24316	24808	163	12075	12336	13534	15167	15801
72	15658	16061	17306	18459	18841	164	21276	21744	23857	26702	27794
73	15763	16052	16939	17757	18031	165	8455	8634	9474	10628	11082
74	16797	17105	18051	18919	19209	166	13136	13421	14725	16496	17182
75	10951	11149	11765	12343	12545	167	16456	16816	18450	20660	21511
76	26299	26788	28269	29607	30042	168	14930	15255	16736	18744	19519
77	12807	13040	13760	14431	14660	169	20008	20911	23678	26719	27562

Zone		Population				Zone		Population			
	2028	2031	2041	2051	2054		2028	2031	2041	2051	2054
78	29198	29742	31388	32868	33347	170	58775	61450	69579	78435	80846
79	10230	10413	10989	11533	11722	171	27499	28745	32547	36712	37858
80	25746	26416	28465	30334	30940	172	17922	18315	20094	22497	23422
81	15774	16181	17436	18596	18981	173	29972	30635	33611	37603	39126
82	20390	20919	22541	24030	24516	174	21173	22129	25057	28273	29162
83	14193	14558	15689	16738	17088	175	16273	16629	18245	20430	21273
84	47364	48904	54451	59595	61088	176	29375	30025	32941	36854	38347
85	13039	13623	15811	17944	18590	177	16115	16467	18066	20231	21066
86	46163	48261	56010	63460	65659	178	4343	4430	4860	5473	5723
87	31130	31712	33465	35041	35550	179	6894	7038	7721	8670	9048
88	27581	28300	30495	32495	33140	180	8828	9016	9892	11095	11567
89	23877	24321	25665	26884	27281	181	4012	4091	4489	5058	5291
90	7817	7955	8394	8818	8971	182	44087	46604	54421	63200	65632
91	13663	13912	14681	15394	15637	183	52776	55791	65148	75649	78554
92	6723	6839	7217	7587	7724	**Total**	**4638291**	**4781736**	**5270355**	**5778616**	**5937655**

ANNEXURE 3.3: ZONE-WISE DISTRIBUTION OF EMPLOYMENT IN URBAN STRUCTURE SCENARIO

Zone		Employment				Zone		Employment			
	2028	2031	2041	2051	2054		2028	2031	2041	2051	2054
1	10921	11424	13207	14807	15253	93	4428	4550	5163	5660	5546
2	9662	10224	12320	14264	14342	94	2011	2055	2513	2875	2591
3	7290	7531	8463	9252	9432	95	9843	10142	11100	11899	12166
4	9151	9570	11117	12498	12802	96	13937	14416	15994	17368	18108
5	2357	2421	2871	3223	2986	97	4867	5021	5716	6292	6267
6	2166	2223	2655	2989	2737	98	2448	2506	2993	3378	3124
7	5704	5822	6319	6708	6712	99	4554	4681	5302	5805	5701
8	5627	5836	6731	7490	7311	100	3737	3838	4406	4864	4701
9	4716	4849	5480	5993	5900	101	3530	3624	4179	4625	4448
10	7835	8068	8897	9584	9710	102	5050	5194	5846	6377	6307
11	6067	6244	6959	7549	7550	103	5361	5514	6186	6735	6686
12	5145	5370	6386	7271	7256	104	4640	4770	5395	5903	5805
13	7281	7609	8908	10058	10213	105	2785	2854	3362	3766	3536
14	4303	4488	5392	6174	6091	106	3003	3079	3602	4018	3803
15	5442	5681	6736	7658	7666	107	8682	8872	9509	10022	10255
16	5414	5653	6704	7623	7630	108	3162	3270	3970	4557	4267
17	4017	4188	5054	5800	5695	109	11970	12437	13843	15055	15163
18	6995	7201	7977	8619	8686	110	7094	7246	7808	8255	8366
19	10068	10376	11347	12160	12444	111	5118	5221	5691	6055	6014
20	14657	15235	16859	18265	18495	112	4918	5017	5476	5833	5776
21	5198	5389	6250	6979	6781	113	4086	4164	4584	4906	4785
22	6885	7088	7857	8492	8552	114	6658	6909	7886	8716	8584
23	2567	2630	3124	3517	3271	115	3306	3444	4215	4873	4711
24	4047	4158	4746	5221	5081	116	20857	21837	24939	27766	29006

Zone		Employment				Zone		Employment			
	2028	2031	2041	2051	2054		2028	2031	2041	2051	2054
25	3110	3190	3718	4141	3934	117	4634	4779	5453	6008	5964
26	2843	2891	3251	3521	3305	118	5050	5210	5924	6516	6506
27	15363	15716	16668	17455	18201	119	4759	5025	6288	7438	7257
28	5363	5665	7033	8281	8131	120	10831	11463	13758	15892	16032
29	13658	14460	17237	19829	20118	121	7134	7542	9209	10744	10688
30	11029	11673	14002	16169	16319	122	5795	5981	6768	7425	7479
31	8035	8498	10316	11997	11989	123	5373	5545	6290	6911	6929
32	2186	2236	2705	3076	2804	124	3447	3537	4087	4528	4345
33	8947	9218	10118	10868	11072	125	4670	4873	5825	6653	6600
34	6943	7148	7920	8558	8622	126	2495	2555	3045	3433	3182
35	5713	5878	6573	7141	7117	127	3123	3178	3553	3834	3639
36	3212	3295	3830	4258	4058	128	7959	8132	8734	9217	9394
37	5351	5504	6176	6724	6676	129	3722	3834	4419	4892	4771
38	9468	9754	10688	11466	11707	130	15075	15594	17282	18756	19592
39	2477	2536	3023	3410	3159	131	7542	7791	8748	9560	9760
40	3175	3258	3790	4216	4014	132	2986	3071	3584	3993	3810
41	12132	12606	14025	15250	15365	133	4978	5078	5540	5899	5848
42	12302	12784	14217	15454	15576	134	11849	12253	13628	14819	15383
43	39378	41249	46810	51925	54642	135	13089	13537	15033	16333	17001
44	3030	3155	3889	4514	4330	136	6329	6535	7374	8078	8176
45	6360	6643	7820	8856	8938	137	8190	8513	9987	11983	13027
46	7947	8307	9694	10927	11135	138	9232	9600	11218	13412	14635
47	10431	10910	12628	14166	14573	139	6819	7085	8371	10107	10917
48	11088	11600	13405	15025	15485	140	7476	7769	9145	11005	11928
49	14029	14581	16152	17513	17714	141	7511	7813	8812	9893	10116
50	123780	132202	134490	143461	148445	142	7656	7964	8976	10073	10309

Zone		Employment				Zone		Employment			
	2028	2031	2041	2051	2054		2028	2031	2041	2051	2054
51	9943	10328	11570	12637	12654	143	9762	10152	11843	14137	15451
52	12664	13055	14192	15151	15618	144	17616	18354	20384	22553	23651
53	7538	7762	8573	9244	9349	145	9572	9962	11171	12474	12876
54	3913	4019	4598	5066	4915	146	10903	11340	13189	15698	17207
55	20633	21283	22928	24333	25362	147	11415	11875	13793	16399	17996
56	4175	4290	4886	5369	5238	148	9476	9862	11061	12354	12747
57	4696	4828	5457	5969	5874	149	15952	16603	19146	22612	24984
58	7182	7454	8473	9344	9235	150	7141	7421	8751	10546	11412
59	7211	7625	9305	10851	10800	151	8657	9001	10539	12623	13747
60	2309	2363	2842	3220	2957	152	27666	28837	31891	35139	37104
61	4431	4553	5166	5663	5549	153	12449	13329	16041	19188	19452
62	9638	10010	11228	12273	12276	154	8653	9088	11084	13907	13972
63	7314	7532	8327	8986	9076	155	17814	18544	21345	25163	27853
64	11654	12012	13085	13986	14382	156	17828	19099	22777	27005	27566
65	12879	13382	14860	16138	16287	157	87498	93817	110024	128255	132662
66	9058	9407	10577	11582	11558	158	11886	12377	13822	15374	15976
67	14426	14994	16598	17987	18207	159	13471	14018	16220	19215	21163
68	12058	12530	13943	15162	15274	160	29796	31934	37763	44396	45618
69	5725	5938	6841	7607	7432	161	8120	8441	9905	11888	12920
70	9891	10192	11153	11955	12227	162	8601	8942	10473	12547	13662
71	4749	4922	5746	6443	6224	163	6202	6442	7642	9261	9966
72	2623	2709	3365	3915	3601	164	6765	7028	8306	10030	10831
73	2467	2527	3014	3401	3149	165	5322	5525	6605	8057	8611
74	2432	2490	2975	3360	3106	166	6682	6942	8208	9917	10704
75	6251	6433	7161	7760	7774	167	6365	6612	7835	9484	10216
76	7495	7717	8525	9193	9295	168	6852	7120	8409	10151	10967

Zone		Employment				Zone		Employment			
	2028	2031	2041	2051	2054		2028	2031	2041	2051	2054
77	3504	3597	4149	4595	4415	169	7470	7771	8765	9842	10061
78	15780	16273	17608	18741	19428	170	25950	27046	29927	32989	34807
79	4069	4180	4770	5245	5106	171	7612	7918	8926	10018	10250
80	77098	80224	86890	92795	95855	172	9870	10264	11971	14284	15616
81	10087	10478	11731	12808	12830	173	9068	9429	11025	13186	14381
82	4459	4620	5420	6098	5866	174	6798	7070	7995	8999	9161
83	16708	17369	19158	20711	21033	175	6550	6806	8054	9739	10503
84	12312	12883	14850	16620	17178	176	9668	10053	11732	14006	15304
85	4873	5145	6429	7597	7421	177	6712	6973	8244	9959	10751
86	14147	14979	17838	20511	20826	178	9174	9539	11151	13333	14546
87	19870	20496	22091	23452	24428	179	5285	5486	6560	8005	8553
88	9249	9605	10792	11808	11793	180	6008	6239	7413	8995	9666
89	9071	9345	10253	11009	11223	181	4376	4539	5488	6760	7153
90	16730	17254	18649	19835	20590	182	11207	11997	14484	17382	17579
91	3898	4004	4583	5050	4898	183	15604	16713	19992	23772	24211
92	1516	1544	1971	2305	1986	**Total**	**1777203**	**1854042**	**2097832**	**2350865**	**2415236**

Chapter – 4
DEVELOPMENT OF COMPREHENSIVE MOBILITY PLAN

4. DEVELOPMENT OF COMPREHENSIVE MOBILITY PLAN

Based on projected transport demand, an integrated multi-modal mass transport system plan has been suggested to cater traffic for horizon years. The balance traffic should be carried by road system to satisfy the needs of the normal bus system and other modes such as two-wheelers, autos, cars etc. The proposed traffic and transport plan for Nagpur and its linkages to nearby towns contains the following proposals, which will cater to the requirements of the projected travel demand up to the year 2054.

While framing proposals priority has been given to public transport and non-motorized transport such as pedestrian facilities. For the balance travel demand, road improvement proposals have been formulated. Considering the existing problems and expected traffic demand levels, phasing of implementation of various projects has been suggested in three phases, Phase 1- Short-term proposals (2-5 years), Phase 2- Medium-term Proposals (5-10 years) and Phase 3- Long-term Proposals (more than 10 years). The details of these proposals are given in the following paragraphs.

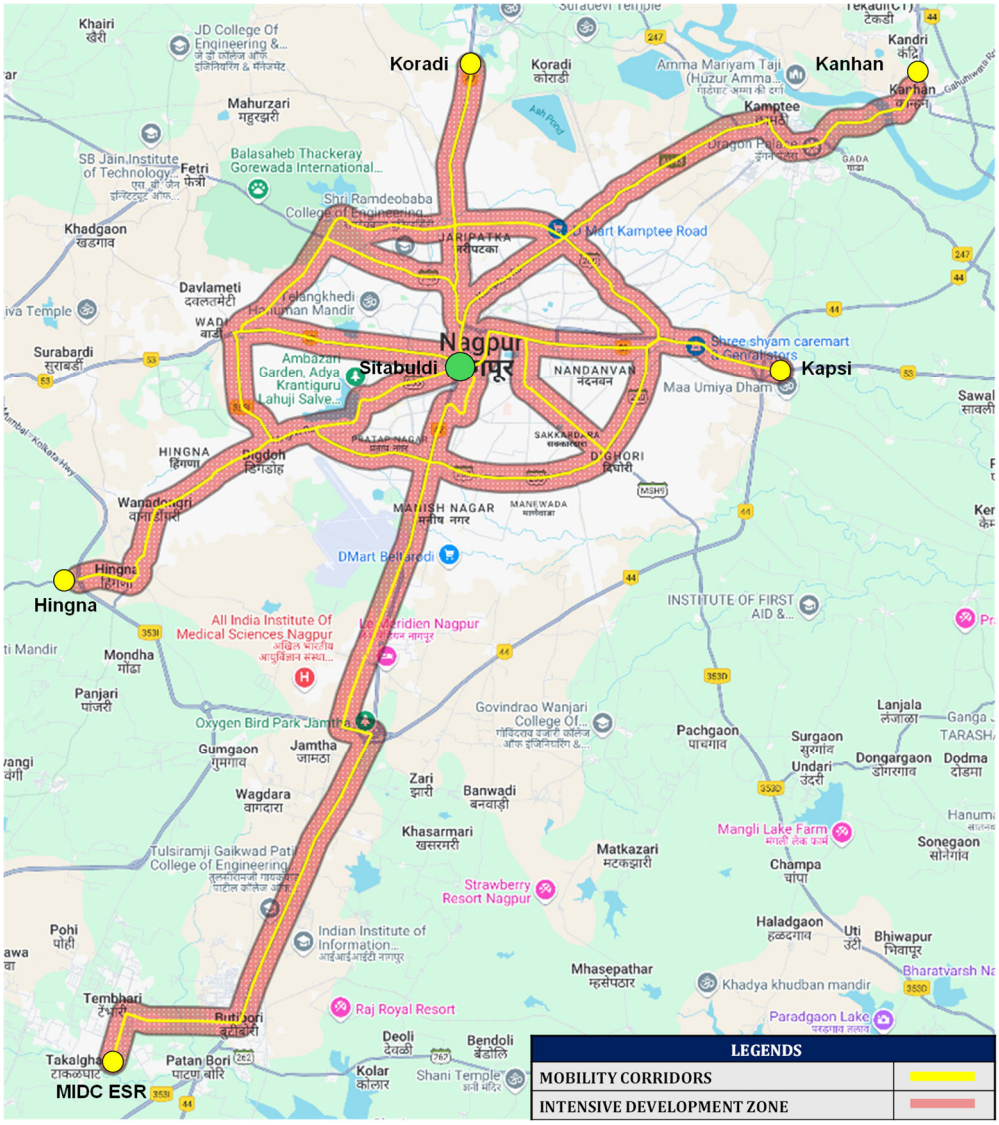
4.1. INTEGRATED LAND USE AND URBAN MOBILITY PLAN

Transport is an induced demand dependent on the land use. Conversely, availability of transport influences the urban structure. Integrated land use and transport is the key factor towards planning sustainable cities. As per the National Urban Transport Policy (NUTP), transport planning is intrinsically linked to land use planning and both need to be developed together in a manner that serves the entire population and yet minimizes travel needs. An integrated master plan needs to internalize the features of sustainable urban transport. In developing such plans, attention is paid to channeling the future growth of a city around a pre-planned urban transport network rather than developing urban transport after uncontrolled sprawl has taken place. In line with this, an integrated landuse and urban mobility plan has been envisaged under this Study.

4.1.1. Recommended Urban Structure

Under the present study, it is recommended that intensive development to be taken up along major travel demand corridors. Higher grade of public transport system could be planned along these corridors for facilitating passenger movement. The major travel corridors are indicated under the Public Transport Improvement Plan in subsequent section. The intensive development corridor is presented in **Figure 4.1.**

FIGURE 4.1: INTENSIVE DEVELOPMENT CORRIDOR



4.2. PUBLIC TRANSPORT IMPROVEMENT PLAN

Public transportation system is planned to be a combination of high and medium capacity corridors. The network is proposed for mass transport operations and has been planned for development of intensive land use generating high passenger demand.

Choice of mode to be proposed depends mainly on the expected public transport demand on selected corridors, capacity of the considered modes and availability of RoW. Other considerations are the landuse along the corridor, the location of building lines, and the potential for increasing the RoW. Cost of the same mode of transport can vary at different locations depending on engineering constraints. It is therefore, important that the final choice of mode is based on techno-economic considerations.

Using the same principle, mass rapid transit system has been proposed on high-capacity corridors. The description of the same has been given in subsequent sections.

4.2.1. Proposed High and Medium Capacity Mass Rapid Transit Corridors

High- and medium-capacity demand corridors have been identified based on various factors, including population coverage, employment hubs, activity centers, mobility parameters, existing infrastructure, and multimodal integration. A total of two high-capacity and four medium-capacity corridors have been identified. The high-capacity corridors and two medium-capacity corridors are planned for Phase 1, while the remaining three medium-capacity corridors are part of Phase 2. The proposed high-capacity corridors span a total of 36.5 km, while the medium-capacity corridors cover 40.5 km. Proposed corridors are given in **Table 4.1** & **Table 4.2** and shown in **Figure 4.2**. Expected daily ridership and maximum PHPDT at high capacity corridors has been given in **Table 4.3**.

TABLE 4.1: PROPOSED HIGH CAPACITY MASS RAPID TRANSIT CORRIDORS

SN	Corridors	Length (Km)	Phase
1	Mankapur Chowk to Rachana Junction on Inner Ring Road	25.0	Phase - 1
2	Sitabuldi to Koradi	11.5	

TABLE 4.2: PROPOSED MEDIUM CAPACITY MASS RAPID TRANSIT CORRIDORS

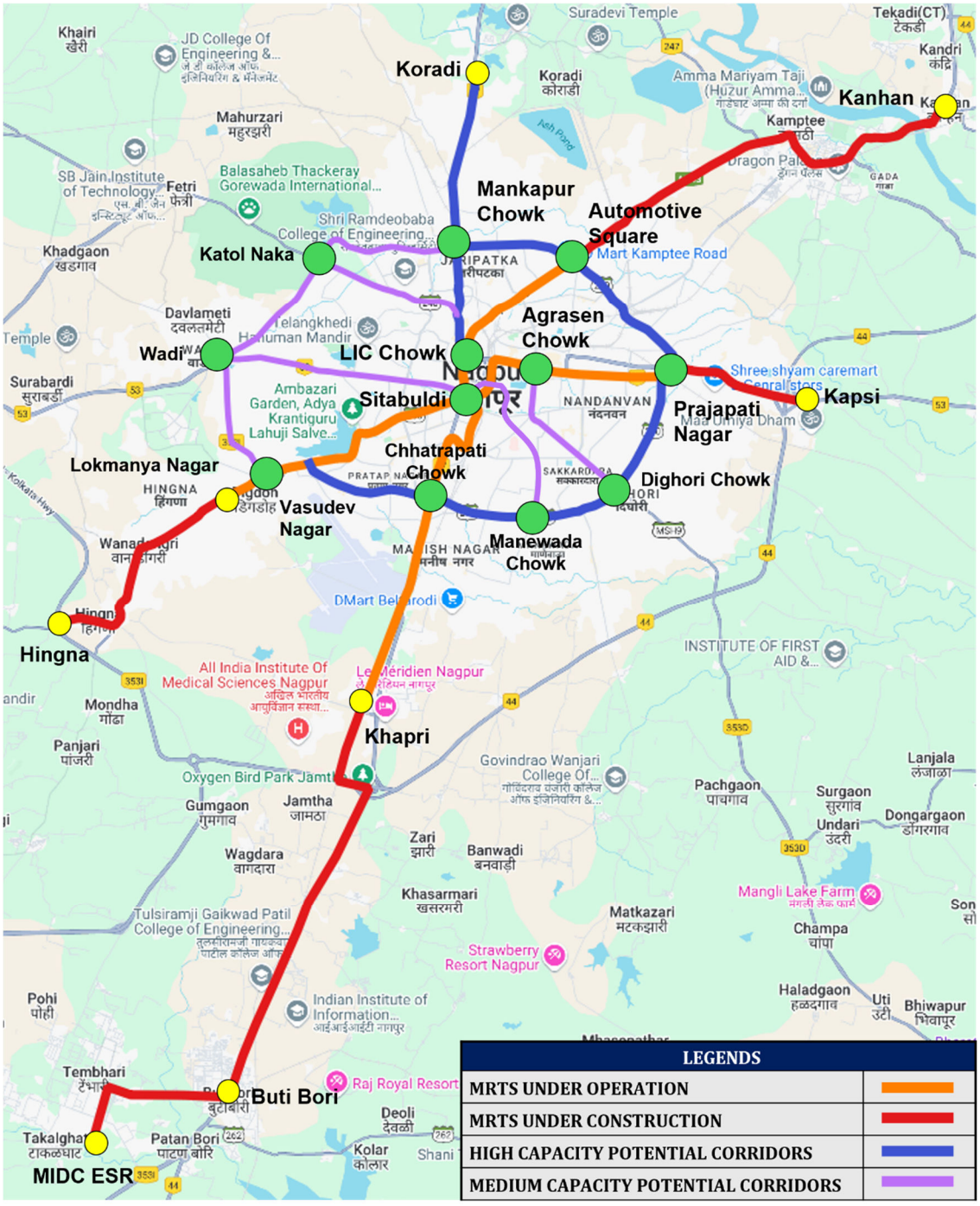
SN	Corridors	Length (Km)	Phase
1	Agrasen Chowk to Dighori Chowk	5.5	Phase 1
2	Wadi to Sitabuldi	8.1	
3	Katol Naka to Chhaoni T Point	5.1	Phase 2
4	Mankapur Chowk to Vasudev Nagar via Katol Naka, Wadi	14.6	
5	Variety Chowk to Manewada Chowk via Medical Chowk	7.2	

TABLE 4.3 PROPOSED MASS RAPID TRANSIT CORRIDORS

Corridor Details		Maximum PHPDT			Daily Ridership (in Lakh)		
		2031	2041	2054	2031	2041	2054
Operational/ expected to be operational	1. Kanhan - Automative Square -MIHAN -MIDC ESR	12400	16800	21900	2.14	2.83	3.90
	2. Kapsi -Prajapati Nagar - Lokmanya Nagar -Hingna	11250	15300	20300	1.92	2.65	3.75

Corridor Details		Maximum PHPDT			Daily Ridership (in Lakh)		
		2031	2041	2054	2031	2041	2054
Proposed High Capacity MRTS Corridors in Phase 1	3. Mankapur Chowk to Rachana Junction on Inner Ring Road	9700	12300	15900	1.59	2.10	2.85
	4. Sitabuldi to Koradi	5600	8050	11800	0.65	0.91	1.47

FIGURE 4.2: PROPOSED MASS RAPID TRANSIT CORRIDORS



4.2.2. Intermodal Integration

Integration of various modes of transport is vital to evolution of a least-cost and viable transport system. Objective of an integrated transport system is to offer maximum advantage from economic, traffic and planning considerations. Various transport modes have been integrated in such a way that each mode supplements the other. It is not possible to provide direct origin to destination service and vice a versa for all commuters. The need to interchange modes and or corridors is an essential feature of any public transport system. The planning objective is to minimize the need to change and when change is essential to make it as convenient as possible and with minimum time loss. Depending upon the forecast transport demand and other parameters along various corridors, an appropriate transport system giving least-cost option has been proposed. The major Interchange stations on the high and medium capacity corridors are mentioned in **Figure 4.2**.

4.2.3. Bus Corridors

The Nagpur Municipal Corporation currently operates city bus services on approximately 125 routes, covering major areas of the city and surrounding localities. However, some of these routes overlap with existing or planned MRTS corridors, leading to redundancy, inefficient resource utilization, and potential financial losses. To enhance the overall public transportation network, reduce congestion, and ensure seamless connectivity, these overlapping bus routes must either be discontinued or rationalized into a well-coordinated feeder system. **Table 4.4** outlines the major routes that require to be rationalized to optimize the city's public transport infrastructure.

TABLE 4.4 BUS ROUTES FOR RATIONALIZATION

SN	Route No	Route Name
1	312	Koradi Depot to Kamptee
2	35	Pardi to YCCE College
3	61	Panchsheel Square to Butibori MIDC Gate
4	61ASTL	Khapri Naka to Maharajbagh Terminal 3
5	304	Sitabuldi to Ita Bhatti Square (Binaki)
6	322	Godhani to Bodhala (Fetri Godown)
7	329	Yashodhara Nagar (Shivaji Chowk) to Bada Taj Bagh
8	59	Sitabuldi to Amar Nagar
9	277	Sitabuldi to Asoli (Haldiram)
10	90	Gorewada Water Tank to Gandhibagh
11	70	Vishwakarma Nagar to CGO Jilha Feri

4.2.4. Feeder Routes for MRTS

The planning of seamless transport integration facilities in the influence areas of various Metro stations is of utmost importance. Feeder services are essential for the Metro network for convenient and quick transfer of passengers. Since not all passengers will be in the influence area or within walking distance of the network, proper planning for feeder services is essential.

The feeder service facilities are proposed at Metro stations to connect the trip generation/ attraction areas in the influencing zones. It should be ultra-modern, and customer oriented that can deliver fast, comfortable, and cost-effective urban mobility.

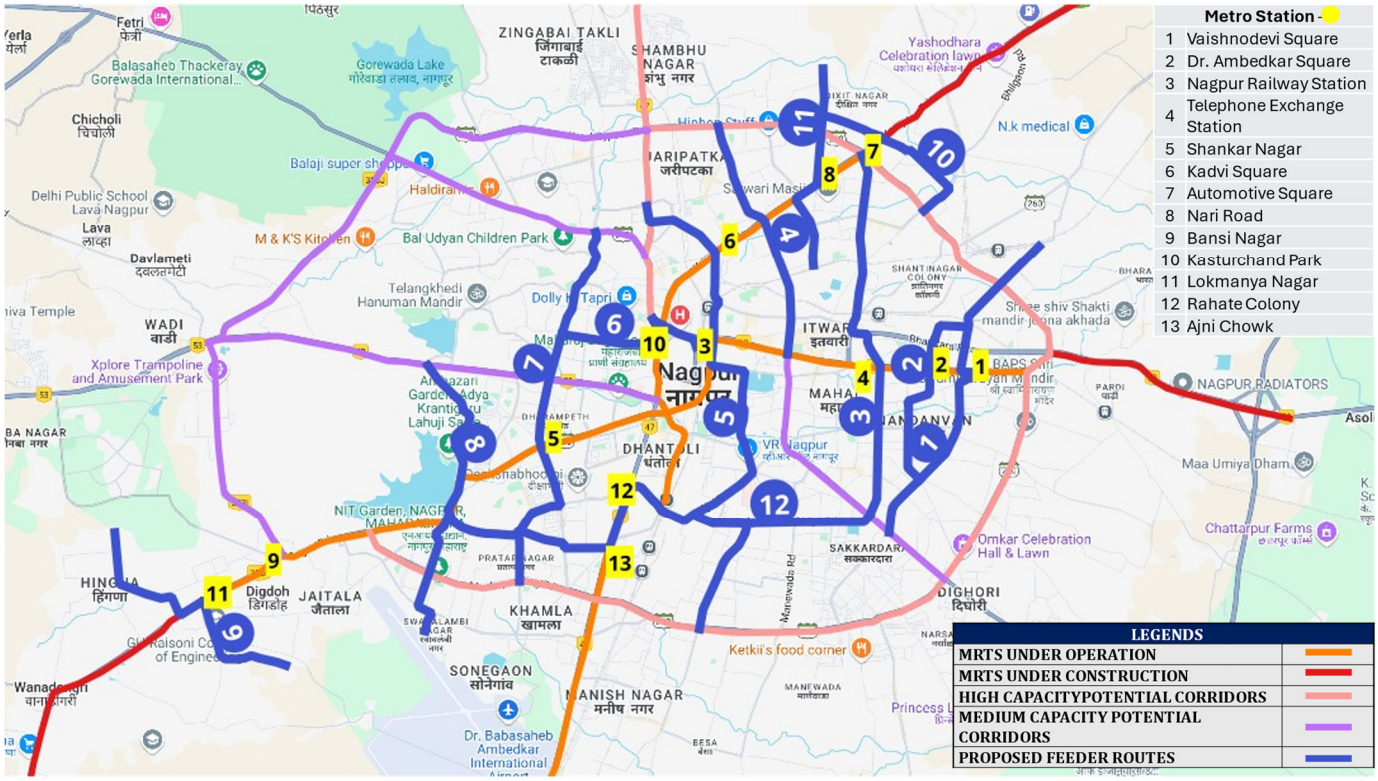
The suggested routes on which the feeder services can be planned at metro stations are listed in **Table 4.5** and shown in **Figure 4.3.**

TABLE 4.5 PROPOSED FEEDER ROUTES

Route No.	Route	Metro Stations Served	Length (km)	Areas Covered
1	Kalmana Bhaji Market to Shitla Chowk (EPFO office)	Vaishnodevi Square	6.8	Kalmana, Vardhman Nagar, Garoba Maidan, Nandanvan, Ishvar Nagar
2	Lakadganj Chowk to Kadari Chowk	Dr. Ambedkar Chowk	3.7	Satnami Nagar, Shashtri Nagar, Ahmed Raja Chowk
3	Itwari Railway Station to Bande Plot Chowk	Telephone Exchnage	7.0	Lakadganj, Mangalwari, Old Bagadganj
4	Jariptka Police St. to Agrsen Chowk	Agrasen Chowk	4.5	Jaripatka, Bezenbagh, Kamal Chowk
5	Hazrat Tajuddin Baba Chowk to Shatabdi Chowk	Nagpur Railway Station, Kadbi Chowk	10.8	Byramji Town, Mescobagh, Motibagh, Railway Sttaion, Cotton Market, Gandhisagar Lake, Ganeshpeth,Medical Chowk, Gulmohar Colony, Rameshwari, Bhagwan Nagar
6	PWD Office to Nagpur Junction	Kasturchand	3.4	CBI Colony, Civil Lines, Kasturchand Park, Mohanpura
7	Old Katol Naka to Pratapnagar Chowk	Shankar Nagar	7.2	Seminary Hills, High Court, Tilak Nagar, Gokulpeth, Khare Town, Dharampeth,Shankar Nagar, Bajaj Nagar, Pratap Nagar
8	Futala Chowk to Pannase Layout	Subhash Nagar	5.7	Nagpur University, Verma Layout, Ambazari, Trimutree Nagar, Swavlami Nagar
9	Priyadarshini College to	Lokmanya	5.1	MIDC Hingna, Nidoh Village,

Route No.	Route	Metro Stations Served	Length (km)	Areas Covered
	MIDC Hingna	Nagar		Raisoni College, Priyadarshini College
10	Nari Road to Ita Bhatti Chowk (Binaki)	Automotive Chowk	3.4	Kabir Nagar, Pawan Nagar, NIT Colony
11	GTB Nagar to Bunkar Colony	Nari Road	4.0	GTB Nagar, Bank Colony, Teka Naka, Balabhaupeth, Bunkar Colony
12	Subhash Chowk to Bande Plot Chowk	Ajni Square, Rahate Colony	9.1	VNIT, Kotwal Nagar, Vivekanand Nagar, Ajni Railway Station, Medical College

FIGURE 4.3 PROPOSED FEEDER ROUTES



4.2.5. Augmentation and Improvement in City Bus System

As part of public transport, augmenting the existing city bus services has been considered. The proposed public transport system is derived considering all the factors of existing situation and best possible reorganization factoring all components of an efficient and sustainable system.

While the MRTS will be operational on selected routes, the other areas will in any case continue to be served by local bus system which will also act as feeder system to the MRTS.

In addition to MRTS corridors, augmentation of bus services is proposed by taking 60 buses per lakh population as per LoS 1 of SLB (Reference: Service Level Benchmark in Urban Transport for Indian Cities, MoHUA, Govt. of India).

The proposed city bus fleet size for future years based on projected population of the study area is given in **Table 4.6**.

TABLE 4.6 BUS FLEET REQUIREMENT IN HORIZON YEARS

Year	2024	2028	2031	2041	2051	2054
No. of buses required	2620	2728	2813	3100	3399	3493

A shift towards clean energy for public transport brings multi-dimensional benefits. The induction of Electric buses (E-buses) will target towards the emission reduction commitments at the local level. However, use of motorized modes will increase the carbon footprint in the city.

E-buses, when compared to the conventional bus, have fewer moving parts. This results in lower and more predictable operating costs. The dependence on fossil fuels poses uncertainties due to price fluctuations, while the cost of electricity is stable for e-buses. Electric vehicle charging infrastructure has been proposed to be set up in various PT depots & terminals along with major commercial areas.

It is proposed that along with Global Positioning System (GPS), all the buses shall have security cameras and panic buttons linked to a control center for incident detection and swift response. The existing shared autos will act as intermediate paratransit modes, serving as a feeder mode to the intra-city bus corridors providing last-mile connectivity.

4.2.6. Bus Terminal Improvement Plans

a. Redevelopment/Improvement of Existing Bus Terminal:

Presently, the Mor Bhawan bus terminal mainly serves intracity passengers with few intercity buses operating as well, while the MSRTC bus terminal at Ganeshpeth serves intercity passengers only. It is proposed to redevelop Mor Bhawan and Ganeshpeth terminals and utilise them for intracity bus travel. Unauthorized auto-rickshaws currently operating outside the station may be relocated within the premises, streamlining traffic flow and improving overall organization. Pedestrian infrastructure facilities and commercial activities are also proposed within the bus station premises (**Table 4.7**).

b. New Intercity Bus Terminals

The main bus terminal of Nagpur is currently being operated from city core area (Ganeshpeth). It caters primarily for the intercity bus movements from surrounding cities. The MSRTC buses are operating from this terminal.

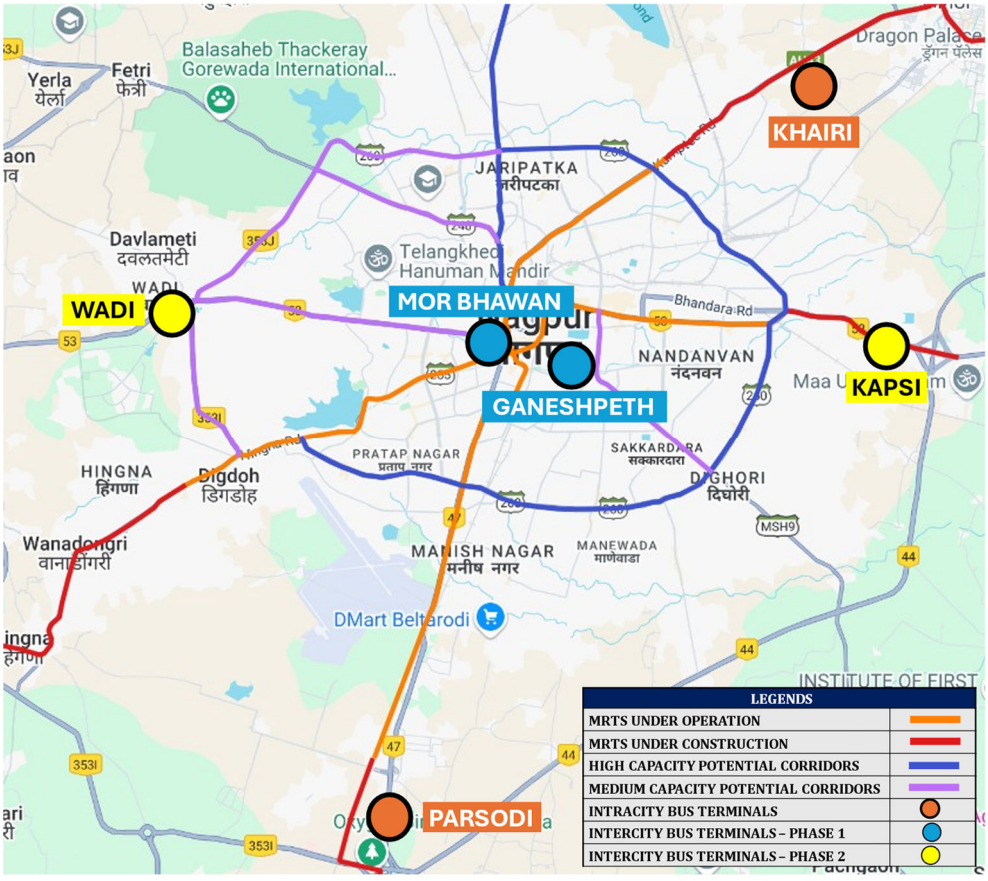
To alleviate the movement of intercity bus traffic within the city, four new bus terminals are being proposed to be implemented direction-wise at Parsodi & Khairi in Phase 1 and Wadi & Kapsi in Phase 2. (**Figure 4.4**)

These new terminals will intercept intercity and interstate buses before they enter the city center. Passengers will board/alight at these terminals and use the Mass Rapid Transit System (MRTS), city buses, or other public transportation options to reach their destinations within the city. This strategy aims to streamline traffic flow, reduce congestion in the urban core, and improve overall transportation efficiency.

TABLE 4.7 BUS TERMINAL PROPOSALS

SN	Bus Terminal Location	Phase
Redevelopment/ Improvement of Existing Bus Terminals		
1	Mor Bhawan	Phase – 1
2	Ganeshpeth	
New Intercity Bus Terminal		
3	Parsodi	Phase - 1
4	Khairi	
5	Wadi	Phase – 2
6	Kapsi	

FIGURE 4.4: PROPOSED LOCATIONS FOR BUS TERMINALS



4.2.7. Para-transit System

At present para-transit operation is mainly auto rickshaws operated by individuals. The infrastructure required for their parking/ stops/ terminals etc. is very limited. As para-transit play an important role in total transport system envisaged for the city, following recommendations have been proposed to improve their operations:

- Appropriate parking/stands at all locations, such as:
  - Commercial areas like shopping malls and retail areas
  - Public spaces like parks and tourist locations
  - Residential colonies: each colony to have an authorized auto-rickshaw stand.
- Stopping and boarding facilities in sync with MRTS and bus-stops so that the shared auto services are integrated with MRTS and city buses and act as a feeder mode to them.
- Shared autos to be used as both a primary public transport system in the outgrowth areas where the demand is not justified for an MRTS or a bus system.

4.2.8. Improvements of Existing Railway Stations

Nagpur is well connected with rail system and Nagpur Junction Railway Station is a major junction for Passenger movement in study area which connects Nagpur to the rest of India. The passenger trains running/passing through Nagpur provide intercity mobility. Other important railway stations in Nagpur include Ajni and Itwari.

Ajni and Itwari Railway Stations have been redeveloped recently, while the redevelopment of Nagpur Junction is underway. Presently, Ajni and Itwari stations are being utilized mainly for local passengers trains. It is proposed that some of the trains destined for Nagpur junction may be stopped on these stations so that the Nagpur junction can be decongested.

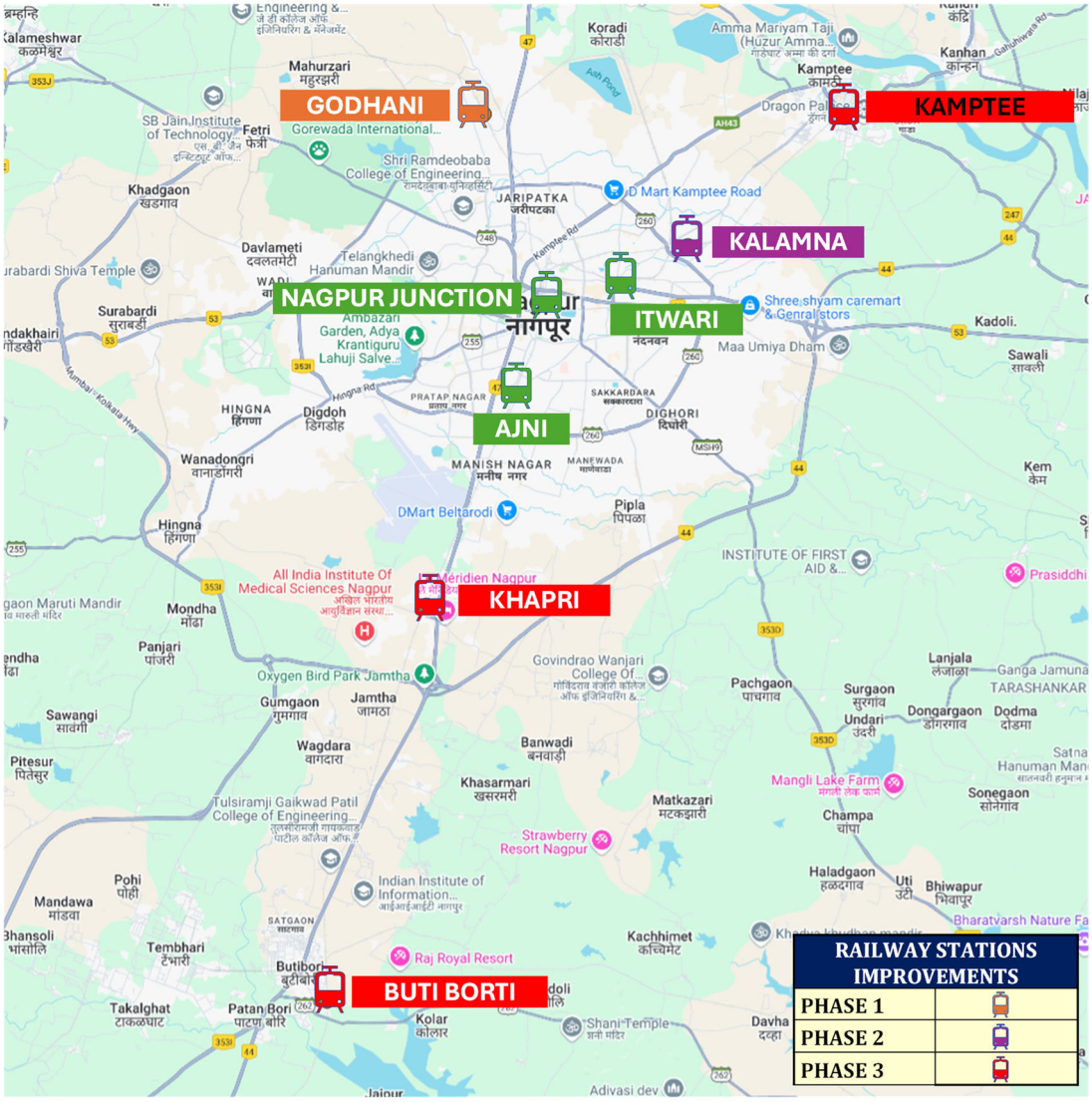
In addition to the above-mentioned stations, five more stations are proposed to be redeveloped in various phases. The proposed list of Railway Station improvements is given in **Table 4.8**. The suggested improvements to the existing stations include:

- Provision of passenger facilities such as shelters, seating arrangements, drinking water and toilet facilities.
- Improvement of road connectivity from the main road to the railway station with better roads and street lighting
- Removal of on-street parking from the access roads
- Provision of demarcated PT/IPT bays.
- Installation of CCTV cameras for safety and security
- Redesign of parking spaces with all infrastructure facilities.
- Pedestrian FOB to cross the tracks, if not there

TABLE 4.8 IMPROVEMENT OF EXISTING RAILWAY STATIONS AND PHASING

SN	Railway Stations	Phase
1	Godhani Railway Stations	Phase-1
2	Kalamna Railway Stations	Phase-2
3	Buti Bori Railway Stations	Phase-3
4	Khapri Railway Stations	
5	Kamptee Railway Stations	

FIGURE 4.5: PROPOSED RAILWAY STATIONS FOR IMPROVEMENTS



4.3. ROAD NETWORK DEVELOPMENT PLAN

4.3.1. Road Widening

Nagpur has a well-developed road network that spans across the city, with the majority of roads being sufficiently wide to accommodate smooth traffic flow. However, certain stretches of roads have been identified where widening is

necessary to ensure a seamless and efficient road network. Addressing these bottlenecks will help improve connectivity, reduce congestion, and enhance overall transportation efficiency. The road stretches requiring widening are presented in **Figure 4.6** and **Table 4.9**.

FIGURE 4.6: PROPOSED ROAD NETWORK IMPROVEMENT

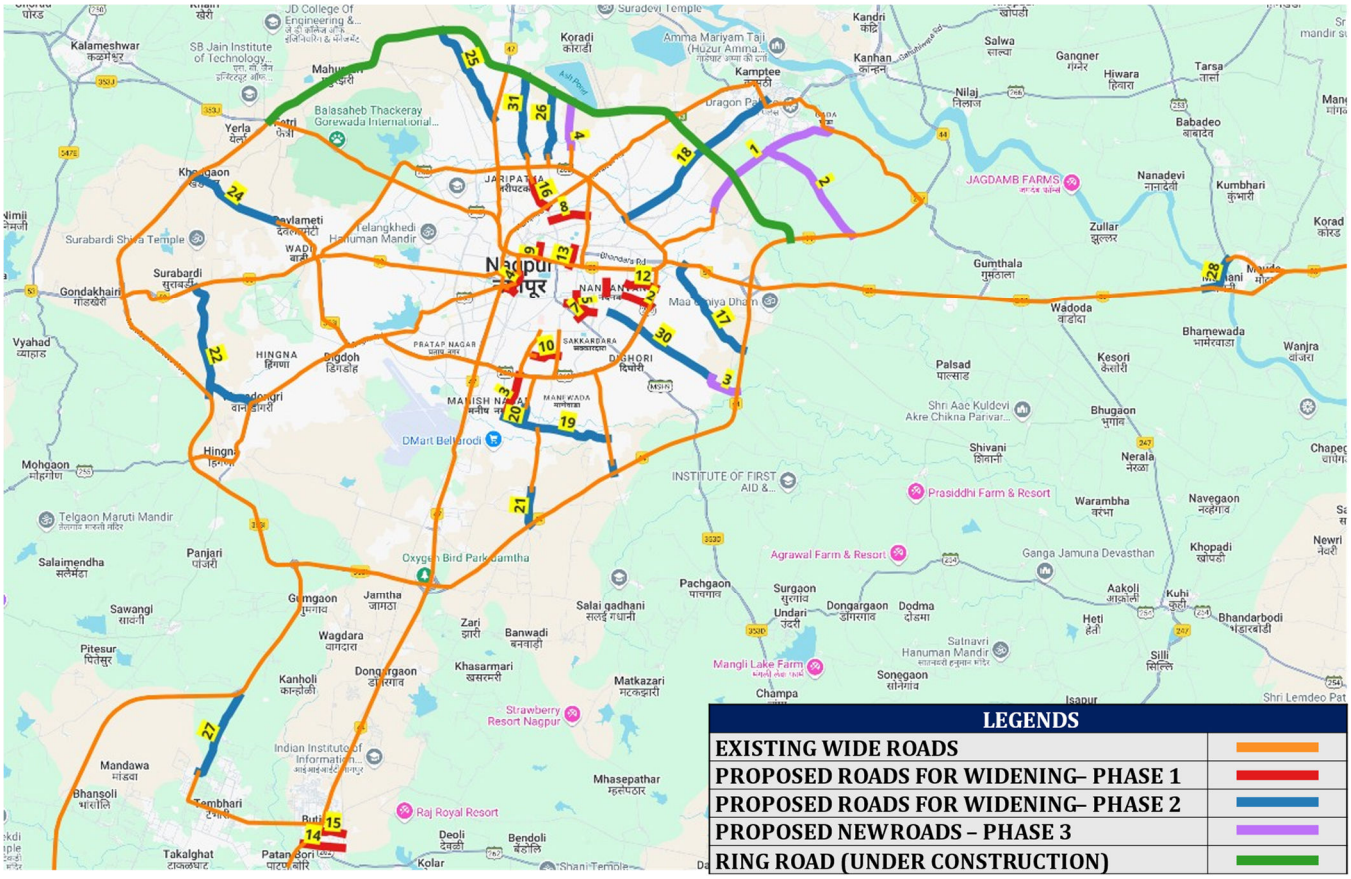


TABLE 4.9: PROPOSED ROADS FOR WIDENING

SN	Name of Road	Existing Lane	Widening Lane	Length (km)	Phase
1	Wathoda Road from Middle RR to IRR	2	4	1.2	Phase 1
2	Shatabdi Nagar Chowk to Ambedkar Chowk	2	4	1.9	
3	Anand Talkies Chowk to Manas Chowk	2	4	0.4	
4	Bhola Ganesh Chowk to Sangam Talkies Road	2	4	0.7	
5	Reshimbagh Ground to Nandanvan Main Road	2	4	1.3	
6	Sakkardhara Flyover to Tiranga Square	2	4	0.4	
7	Kamal Chowk to Itwari Station Road	2	4	1.6	
8	Mominpura Chowk to Bhagwaghar Chowk	2	4	0.5	
9	Bhagwan Nagar Road	2	4	1.2	
10	KDK College Chowk to Old Bagadganj Road	2	4	0.5	
11	Wathoda Road Bhim Chowk to IRR	2	4	1.3	
12	Mirchi Bazar Chowk to Chitroli Squire	2	4	0.8	

SN	Name of Road	Existing Lane	Widening Lane	Length (km)	Phase
13	Butibori Bus Stand to Butibori Railway Station	2	4	1.7	
14	NH 44 Govt. ITI to Buti Bori	2	4	1.1	
15	Indora Chowk to Bhim Chowk on Nara Road	2	4	1.3	
16	Munje Chowk to Humpyard Road along the drain	1	2	0.3	
17	Bhandara Road from Navin Nagar to Outer RR via Bhandewadi	2	4	5.1	Phase 2
18	Old Kamptee Road	2	4	8.2	
19	Besa Pipla Road	2	4	4.9	
20	Besa Road	2	4	0.8	
21	Ghogli Road from Podar School to ORR	2	4	1.5	
22	Sangam Road from Takia to Wanadongri	2	4	6.8	
23	Sangam Road to ORR	2	4	0.6	
24	Khadgaon Road	2	4	4.4	
25	Koradi Naka to ORR	2	4	4.7	
26	Nari Village to ORR	2	4	3.1	
27	MIDC Buti Bori to Samriddhi Mahamarg Interchange	1	4	4.0	
28	Mauda NH 53 to Hotel Gajraj	2	4	1.8	
29	Hudkeshwar Road from Dange Chowk to ORR	2	4	0.4	
30	Kadari Chowk to Pandhurna	2	4	5.3	
31	Pili Nadi to ORR on Nara Road	2	4	3.5	
Total				**71.3**	

4.3.2. Proposed New Road Links

There are certain gaps within the existing road network, where some crucial road connections are either absent or incomplete. These missing links disrupt the overall connectivity, leading to inefficiencies in traffic movement and accessibility. To address this issue and ensure a well-integrated road system, the construction of new roads has been proposed. These additions will help bridge the gaps, enhance connectivity between different parts of the city, and improve overall transportation efficiency. The proposed new roads are presented in **Figure 4.6** and **Table 4.10**.

TABLE 4.10 PROPOSED NEW ROAD LINKS

SN	Road Name	Length (KM)	Phase
1	Bharatwada to Gada	6.6	3
2	Ghorpad to Lihigaon	5.4	
3	Pandhurna to Ring Road	1.5	
4	Pili Nadi to ORR near Koradi Ash Pond	2.1	
	Total	**15.6**	

4.3.3. Proposed Ring Road

At present, Nagpur's outer ring road is partially developed, with a southern section extending from Fetri on Katol Road to Kapsi on Bhandara Road via Gondakhairi, Hingna, Gavsi, and Pandhurna, covering a distance of approximately 58 km. This section plays a crucial role in diverting traffic away from the city's core, improving connectivity, and facilitating the movement of goods and passengers.

However, a missing northern link currently prevents the formation of a fully functional ring road around the city. To address this gap, a northern section of the ring road is under construction, stretching from Fetri to Bharatwada via Mahurzari, Koradi, and Khairy, covering a distance of 28 km.

Once completed, this northern segment will seamlessly connect with the existing southern portion, thereby forming a complete 86 km ring road encircling Nagpur. This fully integrated ring road will significantly enhance regional connectivity, reduce congestion within the city, and support economic growth by improving access to industrial zones, logistics hubs, and freight terminals. (**Figure 4.6**).

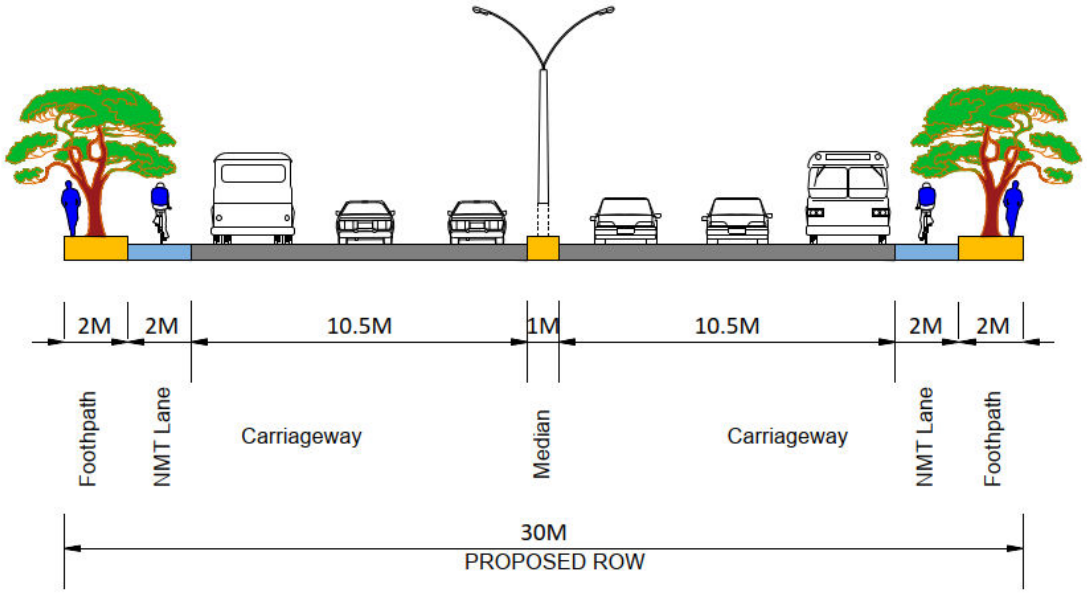
4.3.4. Proposed Cross Sections

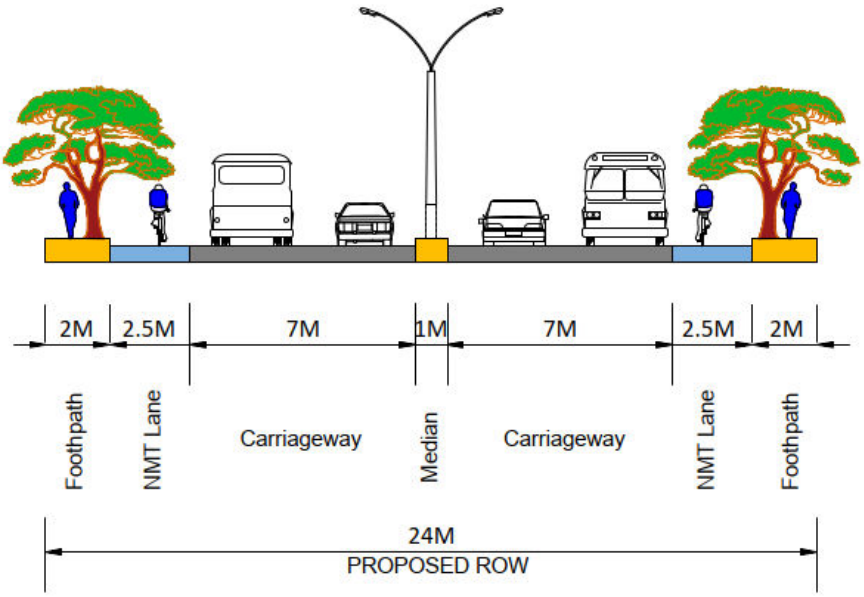
An overall hierarchy of roads has been indicated in the above sections. To allow road network to perform efficiently, continuous stretch of the road needs to be developed as per the recommended cross sections. Four typical cross-sections have been proposed for corridors of 30m, 24m, 20m and 12m ROW. The details of the cross sections are presented in **Figure 4.7**

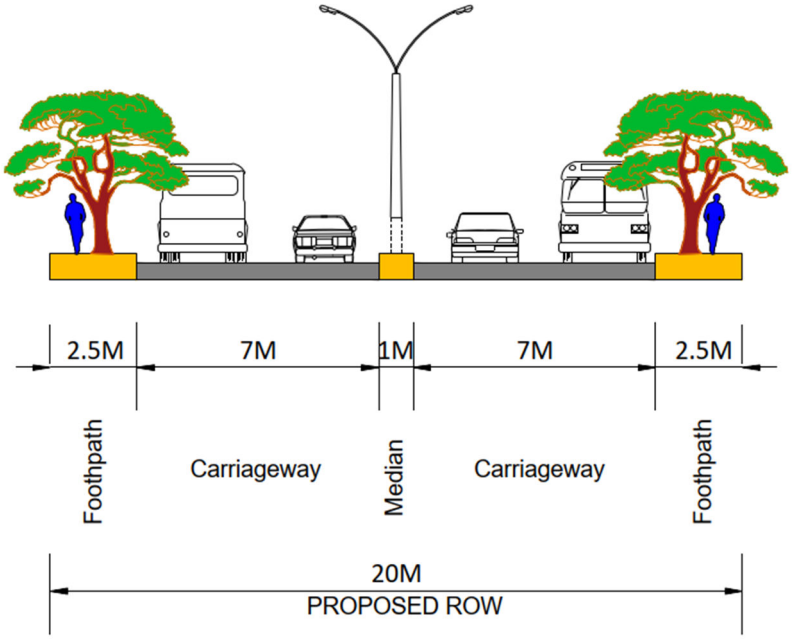
- **30m ROW:** For corridors with 30m ROW, recommended cross section includes Median (1m), 6 lane divided carriage way for traffic movement (10.5m both sides), NMT lane (2m both sides), Footpath (2m both sides). The Railway Station – Tipling Tinali Road is proposed to be widened to be 6-lane with 30m ROW.
- **24m ROW:** For corridors with 24m ROW, recommended cross section includes Median (1m), 4 lane divided carriage way for traffic movement (7m both sides), NMT lane (2m both sides), Footpath (2.5m both sides). The Peepal Tal to Hukuta Charali Road is proposed to be widened to be 4-lane with 24m ROW
- **20m ROW:** For corridors with 20m ROW, recommended cross section includes Median (1m), 4 lane divided carriage way for traffic movement (7m both sides), and Footpath (2m both sides). The PGCIL Road is proposed to be widened to be 4-lane with 20m ROW
- **12m ROW:** For corridors with 12m ROW, recommended cross section includes 2 lane undivided carriage way for traffic movement (7m) and Footpath (2.5m both

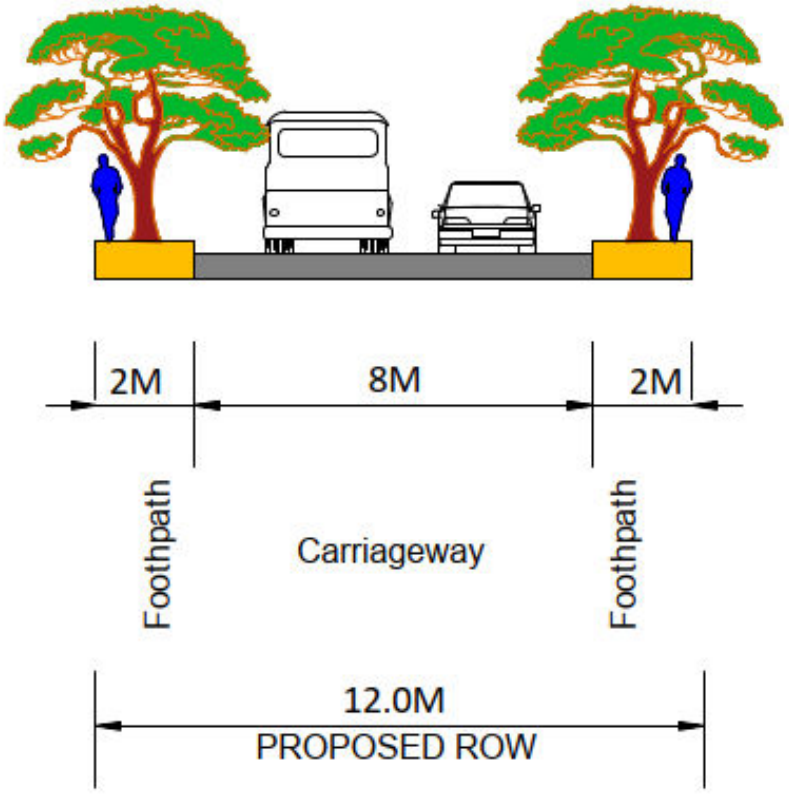
sides). Some internal roads such as Helipad road and roads around Dx turning are proposed to be widened to be 2-lane with 12m ROW

FIGURE 4.7 CROSS-SECTIONS FOR PROPOSED ROW






2.5M
7M
1M
7M
2.5M
Foothpath
Carriageway
Median
Carriageway
Foothpath
20M
PROPOSED ROW


2M
8M
2M
Foothpath
Carriageway
Foothpath
12.0M
PROPOSED ROW

4.3.5. Proposals of Grade Separators & Rail Over/Under Bridge (ROB/RUB)

Most of the city roads will suffer from congestion because of increasing use of private modes (Cars and 2-Wheeler) resulting in over utilization of their limited capacity. Some of the critical junctions where normal signaling cannot effectively manage the traffic volumes, the grade separators (Flyover/Underpass) are proposed. The grade separators are suitable only where the traffic demand far exceeds the capacity and at-grade expansion is not possible due to restriction of available right of way. Eight intersections have been identified and proposed to implement grade separators (**Table 4.11** & **Figure 4.8).**

TABLE 4.11: PROPOSED LOCATIONS FOR GRADE SEPARATORS

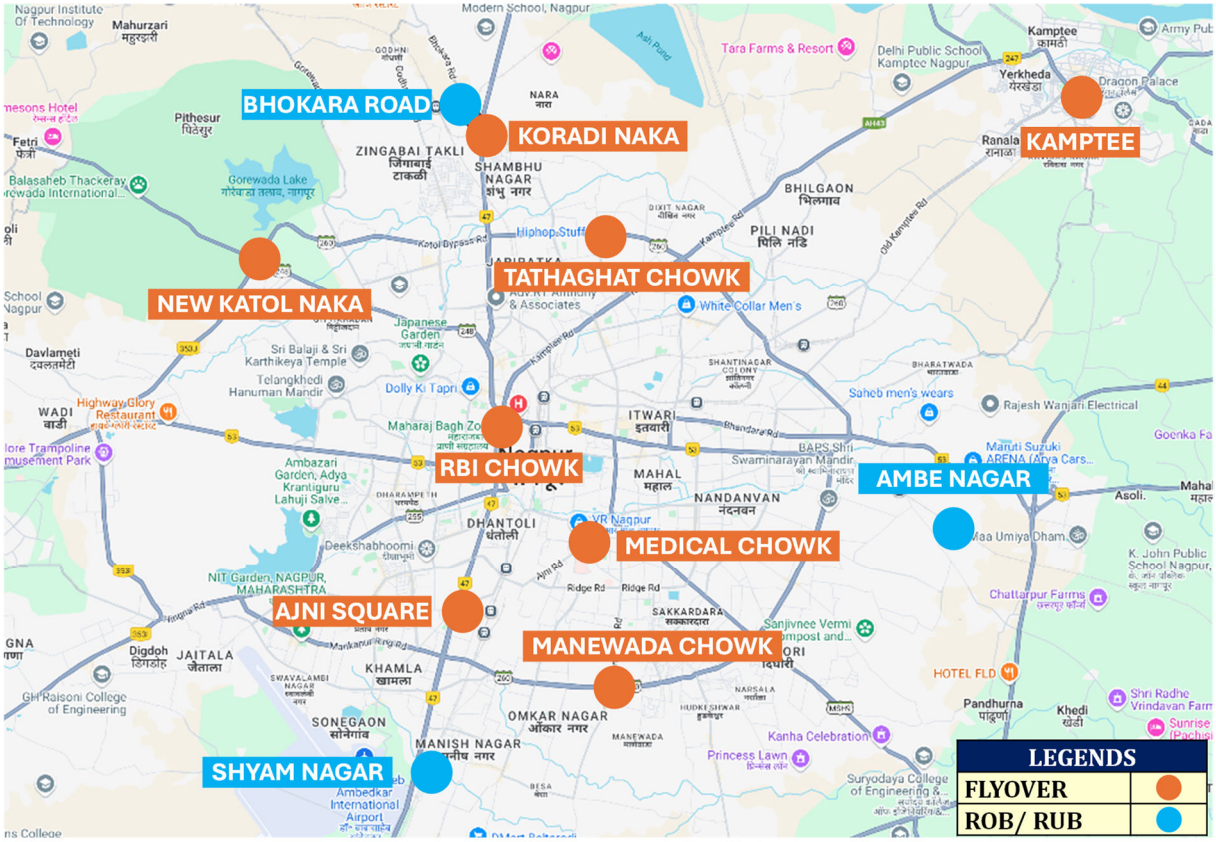
SN	Location Names	Phase
1	RBI Chowk	Phase-1
2	Manewada Chowk	
3	Ajni Square	Phase-2
4	Koradi Naka	
5	Kamptee	
6	Medical Chowk	Phase-3
7	Tathaghat Chowk	
8	New Katol Naka	

The level crossings are bottlenecks for traffic movements. Therefore, 3 Rail over/ under bridges are proposed in the study area to reduce the congestion /accidents at level crossings. The ROBs/ RUBs are to be implemented under medium and long term (Phase- 2 & 3) proposals (**Table 4.12 & Figure 4.8).**

TABLE 4.12 PROPOSED ROB/RUB LOCATIONS AND PHASING

SN	Locations	Phase
1.	Shyam Nagar	Phase-2
2.	Bhokara Road	
3.	Ambe Nagar	Phase-3

FIGURE 4.8 PROPOSED GRADE SEPARATORS /ROB/ RUB



4.4. PREPARATION OF NMT FACILITY IMPROVEMENT PLAN

NMT/Pedestrian infrastructure is a fundamental component of sustainable transport for any city. The provision of NMT facilities in Nagpur are proposed to be developed as a part of the overall road development program. Pedestrian and NMV safety should be given priority to promote the use of NMT. This will be addressed by separating NMTs from motorized vehicles. It is observed that footpaths, wherever available in the city, are underutilized. The facility becomes unusable due to discontinuity at frequent intervals arising out of various factors as encroachment, design flaws and natural deterioration etc. Provision of continuous footpaths and NMV lanes for cycle in the study area has been recommended to provide the safe mobility environment for NMTs. The use of cycling and walking should be encouraged by creating a safe and attractive NMT network of footpaths, cycle tracks, greenways and other facilities. The design of city streets should follow best practices in pedestrian-friendly, multi-modal street design.

- All residents would get benefit from improved access and mobility.
- Improved low-cost mobility contributes to social and economic empowerment.
- Social inclusion in the design of NMT facilities that adhere to universal design principles and are accessible to the maximum number of people, regardless of age, ability, or social position.

- City's transportation system reduces the local and global environmental consequences by increasing the usage of zero-pollution alternatives.
- A shift in culture that recognizes cycling and walking as viable and desirable modes of transportation in the city.
- Involvement of local people, companies, and other stakeholders in the development of designs and standards in order to encourage active usage and ownership of these spaces by the community.

The proposals under Non-Motorized Transport (NMT) Improvement Plan are:

i. Development of Footpaths
ii. Pedestrian Crossing Facilities
iii. Development of Non-motorized vehicle (NMV) lanes

The street design components and pallets are suggested based on the available right of way (ROW) for pedestrian-friendly environment and smooth circulation. The street design components and palettes are presented in **Figure 4.9** & **Figure 4.10**.

FIGURE 4.9 STREET DESIGN COMPONENTS

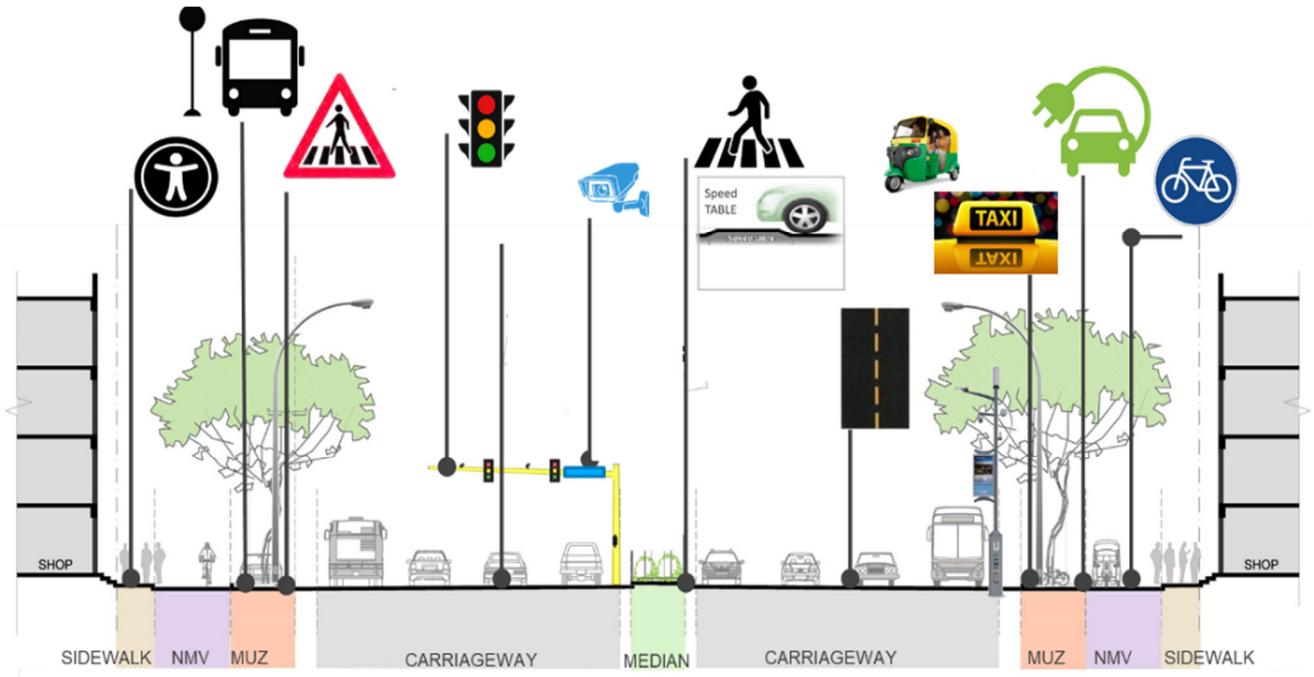


FIGURE 4.10 STREET DESIGN PALETTES

	• SIGNAGES WITH ENGLISH AND LOCAL LANGUAGE TO EASILY UNDERSTAND THE LOCAL PEOPLE • STONE CARVED FOR MAJOR STREET NAMES
	• BOLLARDS • TO PREVENT TRAFFIC FROM ENTERING AN AREA • GRANITE STONE AND STEEL BOLLARD • WROUGHT IRON WITH LIGHTING INBUILT
	• FOOTPATH MATERIAL • LOCALLY SOURCED MATERIAL • FLAGSTONE (FLAT STONES) • GRASS PAVERS TO SOFTEN TEXTURE • PATTERNS RELEVANT TO LOCAL CULTURE

	• STREETLIGHT • TRADITIONAL LAMP POSTS • MORDEN STREET LIGHTS AS SCULPTURAL ELEMENTS • SOLAR PANEL INTEGRATED IN THE CANOPY DESIGN
	• STREET FURNITURE • USE OF URBAN STREET FURNITURE • FIXED BENCHES WITH DIFFERENT DESIGN/FORMS 

4.4.1. Development of Footpaths

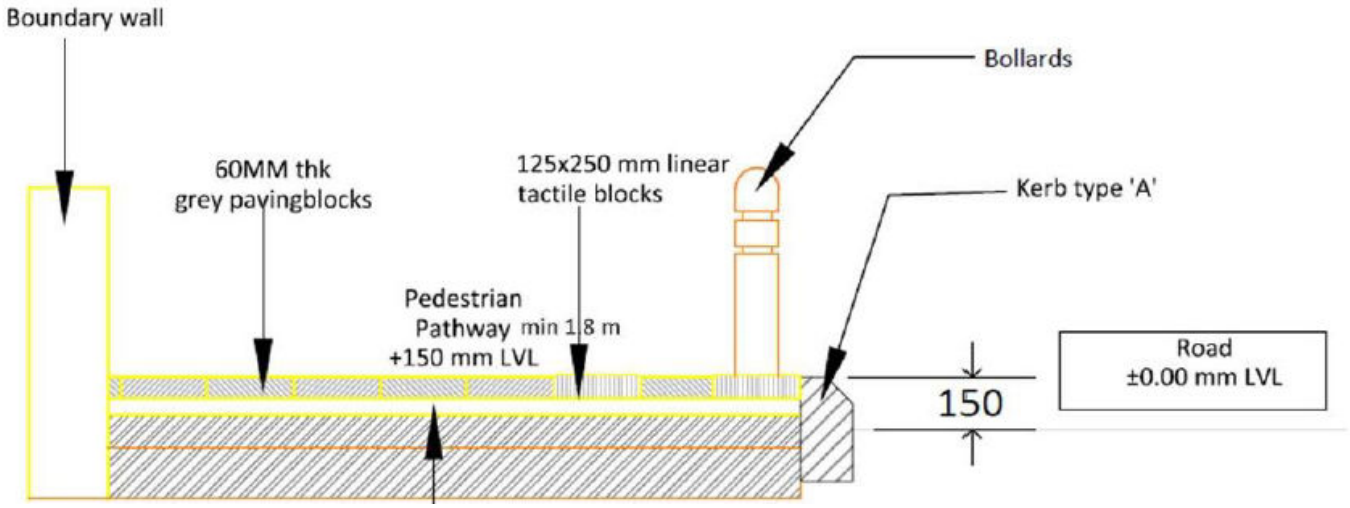
Pedestrian excursions are often brief and may be found throughout a city. As a result, pedestrian walkways should ideally be provided on all main arterial roads and streets. However, pedestrians should be given extra care around crossings (dangerous intersections) and significant activity hubs (like schools, colleges, etc.).
The following parameter are suggested for the development of footpath.

- The design of the city's footpaths should be consistent.
- Footpaths to be installed on all the mobility corridors throughout the study area based on land availability.
- As per IRC 86, 2018, the minimum recommended width for footpaths is 1.8 m
- Footpaths to be raised by unmountable kerbs of height 150 mm.
- Footpaths wherever discontinued, to be raised by table top crossing.
- Strict enforcement to restrict motorized vehicles from entering NMV lanes, footpaths and also to discourage encroachment and vandalism of the NMV infrastructure.

- All roads with medians to have rail guards to discourage jaywalking along with opening at every 1 km distance to allow pedestrians to cross with a pedestrian crossing signal as a minimum requirement.
- Zebra crossings to be provided at all at grade junctions.

The sample design of footpath is given in **Figure 4.11.**

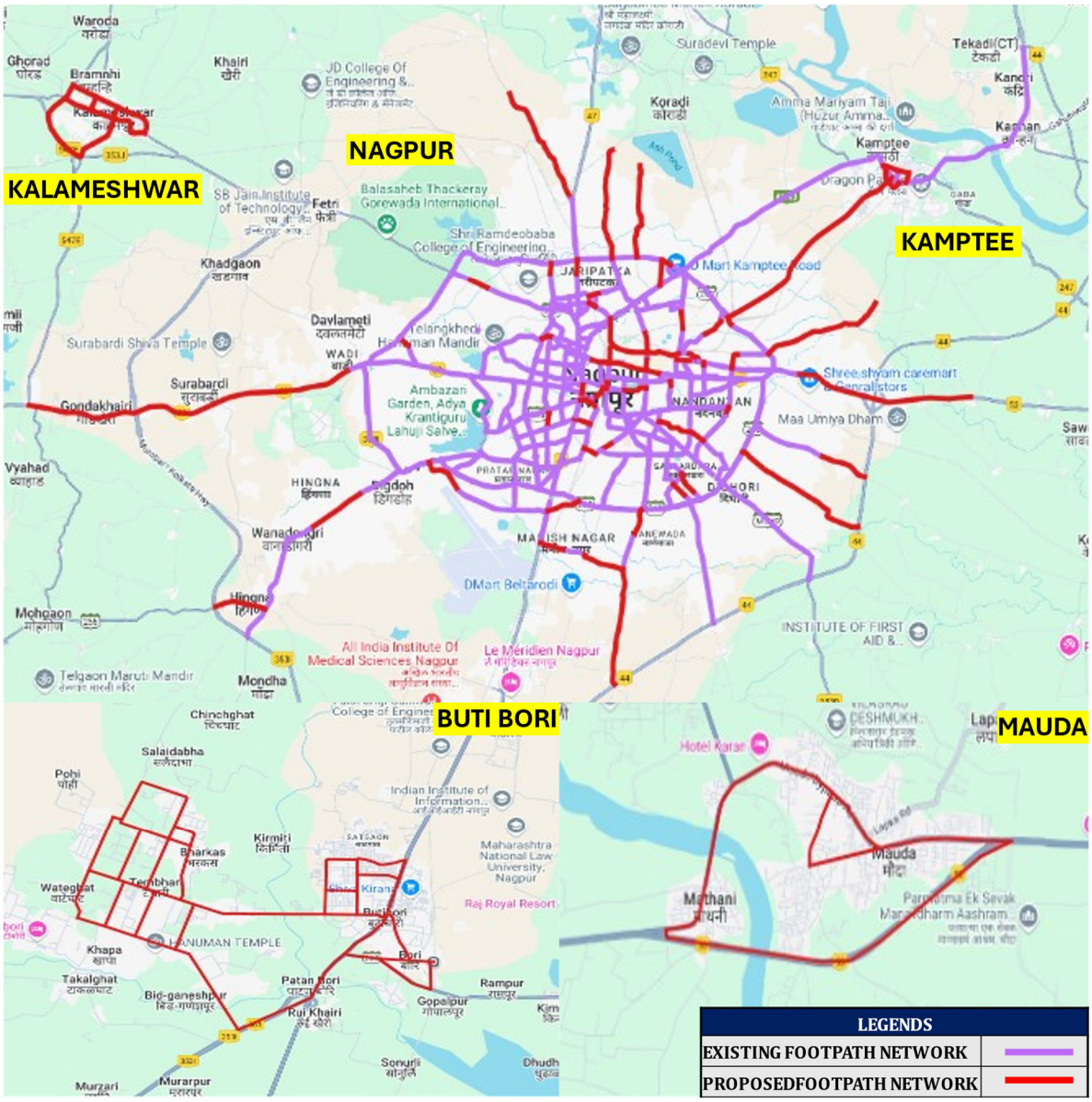
FIGURE 4.11 SAMPLE DESIGN OF FOOTPATH



Based on primary traffic and travel survey analysis, it has been observed that a major part of the road network in Nagpur already has footpaths. However, many of these footpaths are discontinuous, narrow and encroached. Due to the encroached/ discontinuous footpaths, pedestrians are forced to use the carriageway and compromising the safety.

Total of about 156 km footpath are proposed on major roads along with all infrastructure facilities for smooth pedestrian movement. The proposed footpath network in the study area is presented in **Figure 4.12.**

FIGURE 4.12: PROPOSED NETWORK OF FOOTPATHS IN STUDY AREA



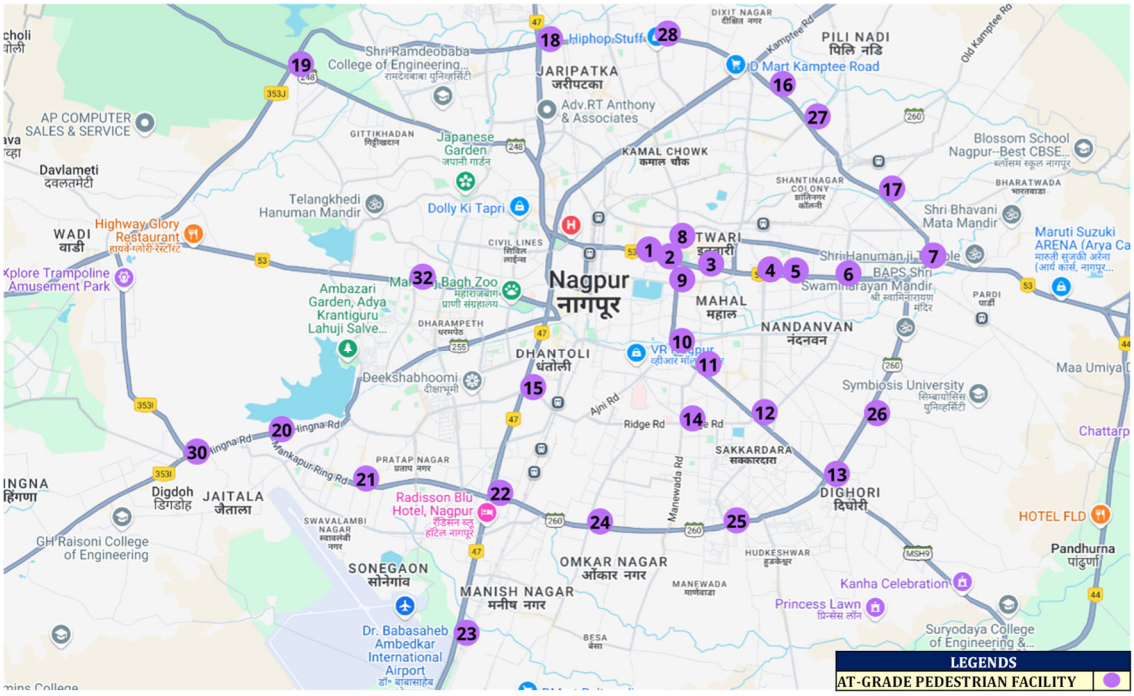
4.4.2. At Grade Pedestrian Crossing Facilities

Pedestrian crossing facilities in the city are either inadequate to handle the current demand or very poor to ensure the safety of pedestrians and road users. Conflicts between pedestrians and vehicles are very frequent, especially where the footpaths are encroached therefore pedestrian have to walk on the road. There is a need for effective pedestrian crossing facilities at selected locations to ensure safety of pedestrians. The proposed at grade pedestrian crossing facilities (Table Top) in the study area is presented in **Figure 4.13** & **Table 4.13**.

TABLE 4.13: PROPOSED LOCATIONS FOR AT GRADE PEDESTRIAN CROSSING FACILITIES

SN	Junction/ Location Names
1.	Gitanjali Chowk
2.	Agrsen Chowk
3.	Chitroli Chowk
4.	Itwari Telephone Exchange Chowk
5.	Chhapru Nagar
6.	Vaishnodevi Chowk
7.	Pardi Naka
8.	Ganjakhet Chowk
9.	Chitnis Park
10.	Ashok Chowk
11.	Reshim Bagh
12.	Bande Plot
13.	Dighori Naka
14.	Tukdoji Putla
15.	Rahate Colony Chowk
16.	Nandi Chowk
17.	Chikhli Chowk
18.	Mankapur Chowk
19.	Katol Naka
20.	Rachana Ring Road Junction
21.	Sambhaji Chowk
22.	Chhatrapati Chowk
23.	Dr. Hedgewar Chowk
24.	Shatabdi Nagar Chowk
25.	Uday Nagar Chowk
26.	Kharbi Chowk
27.	Ita Batti Chowk
28.	Tathagat Chowk
29.	Hingna
30.	Hinga T Point
31.	Wadi T Point
32.	Ravi Nagar Chowk

FIGURE 4.13: PROPOSED LOCATIONS FOR AT GRADE PEDESTRIAN CROSSING FACILITIES



4.4.3. Grade Separated Pedestrian Crossing Facilities

In India, experience of cities shows that foot over bridges are not utilized even 5% due to difficulty in climbing up the stairs and to poor enforcement. To resolve this, half sunk and half elevated pedestrian subway can be designed along with proper drainage system. Fully elevated FOBs with escalator and lift can also be planned so that more pedestrians can use it.

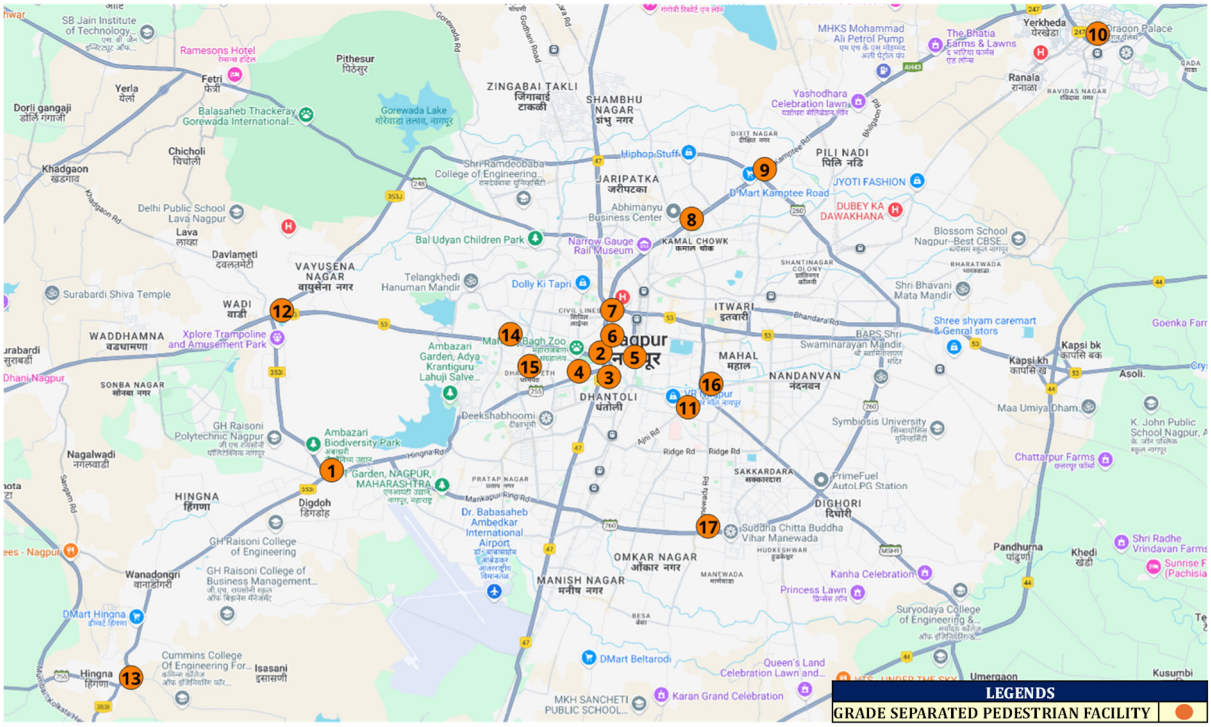
The identified locations of grade separated pedestrian crossing facilities is presented in the **Table 4.14** & **Figure 4.14**.

TABLE 4.14 : GRADE SEPARATED PEDESTRIAN CROSSING FACILITIES

SN	Grade Separated Pedestrian Crossing Facilities	Phase
1	Hingna T-Point	Phase 1
2	Variety Chowk	
3	Jhansi Rani Square	
4	University Library Chowk	
5	Anand Talkies Chowk	
6	Zero Mile	
7	RBI Chowk	
8	Indora Chowk	
9	Automotive square	
10	Kamptee	
11	Medical Chowk	

SN	Grade Separated Pedestrian Crossing Facilities	Phase
12	T-point Wadi	
13	Hingna	
14	Ravi Nagar Chowk	
15	Lakshmi Bhawan Dharampeth	
16	Ashok Chowk	
17	Manewada chowk	

FIGURE 4.14: PROPOSED LOCATIONS FOR GRADE SEPARATED PEDESTRIAN CROSSING FACILITIES



4.4.4. Development of NMT Lanes

Cycling is becoming more widely acknowledged as a clean, sustainable form of transportation and an important component of a multi-modal transportation strategy for sustainable urban travel. More cycling in metropolitan areas instead of driving might result in lower energy usage and fewer traffic congestion. Increasing cycling as a mode of transportation might be a viable method to help reduce greenhouse and other emissions.

The construction of cycle tracks should encourage more disinterested persons to use bicycles for transportation rather than only catching captive customers. The following concepts are used to create bicycle-friendly streets:

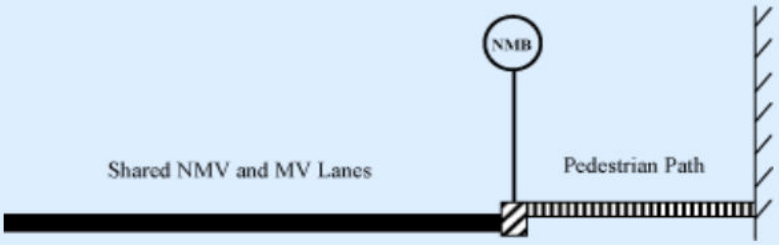
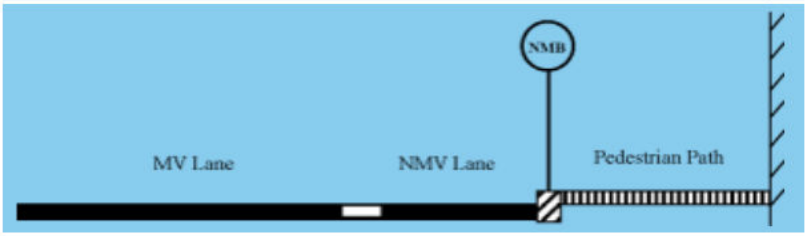
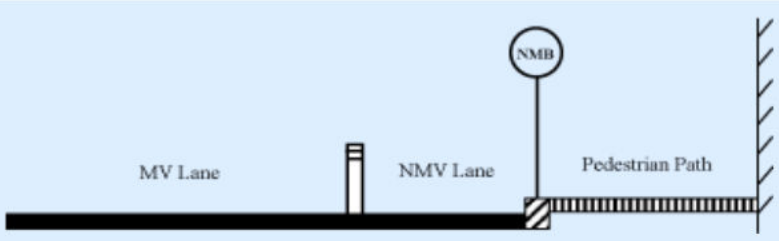
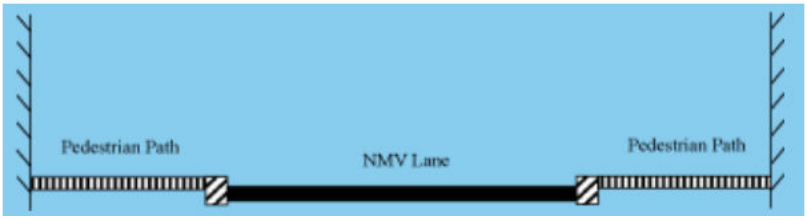
- **Safety:** Separated cycling lanes provide a sense of security and provide a secure route to schools and bus stations.

- **Connectivity:** The NMT network should link important attractions and provide a seamless network with fewer gaps.
- **Convenience:** A more pleasant pedestrian and cycling path with amenities to encourage and support the usage of NMT.
- **Ambience:** To provide riders with a pleasurable and enjoyable riding experience

The minimum required width for NMT lanes lies between 2.5 to 3 meters which can accommodate bicycle. There are 4 types of NMT lanes recommended for any urban road presented **Figure 4.15**.

In line with the objectives of CMP, the share of NMT traffic is to be increased to promote the sustainable development. IRC also recommends that NMT lane (cycle track) should be an integral part of the road cross section.

FIGURE 4.15 TYPES OF NMT LANES

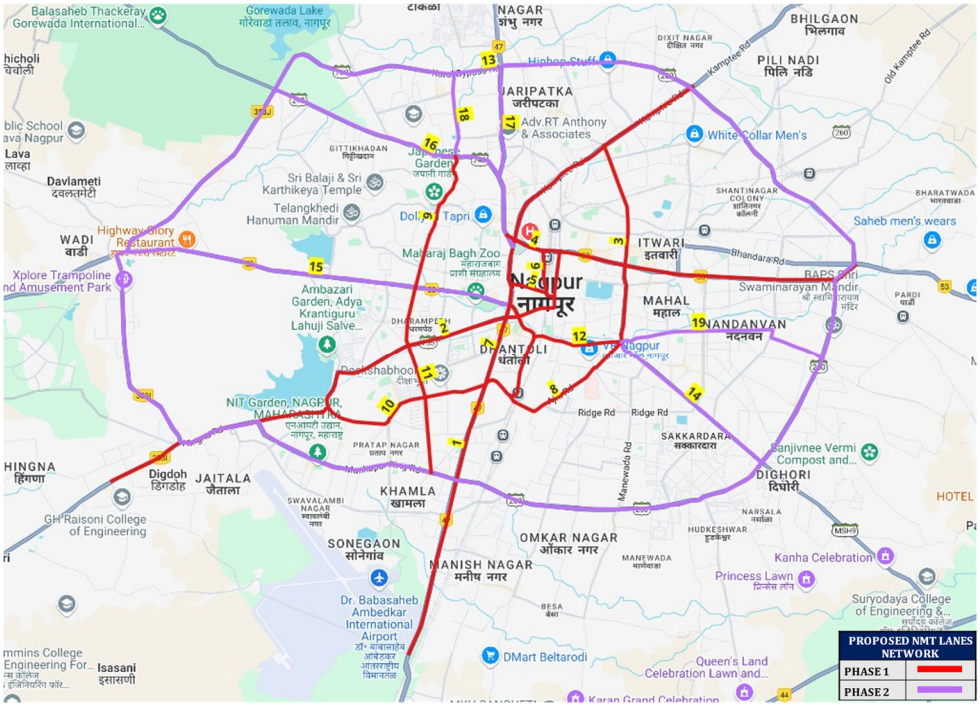
Type	Cross Section
Type I NMV Lane NMV lanes shared with MVs and designated by signs	
Type II NMV Lane NMV lanes designated by lane markings (e.g. striping) and within the highway right-of-way	
Type III NMV Lane NMV-exclusive lanes physically separated from MVs by barriers (e.g. concrete blocks, steel railing, raised curb) and within the highway right-of-way	
Type IV NMV Lane NMV-exclusive lanes within an independent right-of-way (often referred to as NMV paths)	

NMT lanes are proposed on all major arterial/sub arterial roads and orbital roads connecting the arterial roads (**Table 4.15** & **Figure 4.16**). The total length of the proposed NMT corridors is about 125 Km.

TABLE 4.15 PROPOSED ROAD NETWORK FOR NMT LANES

SN	Name of Roads	Length (km)	Phase
1	Airport South to Automotive Chowk	15.1	Phase 1
2	Lokmanya Nagar to Prajapati Nagar	17.8	
3	Indora CHowk to Ashok Chowk	4.2	
4	NIT Office to Dosar Chowk	1.2	
5	Zero Mile to Cotton Market Chowk	0.8	
6	Manas Chowk to Jaystambh Chowk	0.9	
7	Rahate Colony to Varaety Chowk	1.7	
8	Ajni to Ashok Chowk via Medical	3	
9	Old Katol Naka to Law College Chowk	2.9	
10	VNIT to Rahate Colony	3.6	
11	Law College Chowk to Khamla Chowk	3.9	
12	Humpyard Road to Ashok Chowk	1.8	
13	Inner Ring Road	41.3	Phase 2
14	Ashok Chowk to Dighori Chowk	3.9	
15	Wadi to Variety Chowk	8.1	
16	New Katol Naka to RBI Chowk	6.8	
17	Chhaoni T Point to Mankapur Chowk	2.3	
18	Awasthi Nagar Road	1.7	
19	Ashok Chowk to Wathoda Ring Road	4.5	
	Total	**125.5**	

FIGURE 4.16 PROPOSED NMT CORRIDORS



4.5. PUBLIC BIKE SHARING (PBS)

One of the newest means of transportation is public bike sharing. Bike docking stations are located around the city in strategic areas as part of this system. A user can hire a bike for a short period of time from one docking station and return it to that same docking station or any other docking station in the city. The users are charged a fee based on the length of time they utilize the bike. Such a system may serve as a feeder to other public transportation systems, enhancing first and last-mile connectivity. The basic elements of the PBS system include coverage area, system size, bikes, station design etc. as shown in **Figure 4.17**.

Apart from these basic elements the system requires more interventions by supporting elements such as NMT Infrastructure, Integration with transit, engagement with private sector etc. as shown in **Figure 4.18.** The pictures of docking stations are presented in **Figure 4.19**.

FIGURE 4.17 ELEMENTS OF PBS

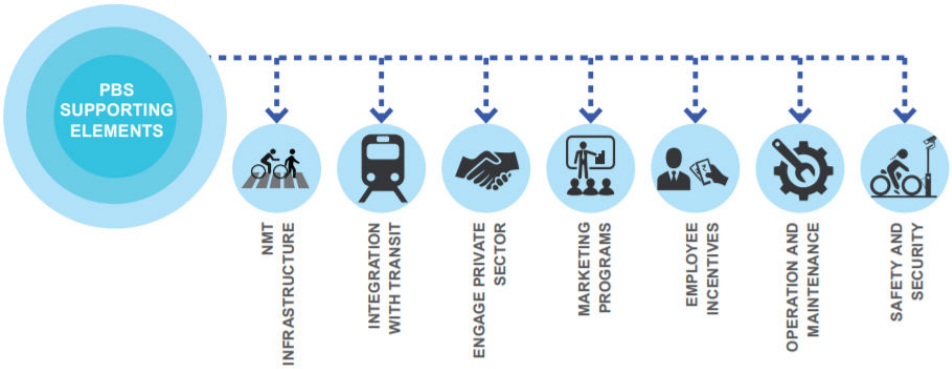


FIGURE 4.18 SUPPORTING ELEMENTS OF PBS SYSTEM

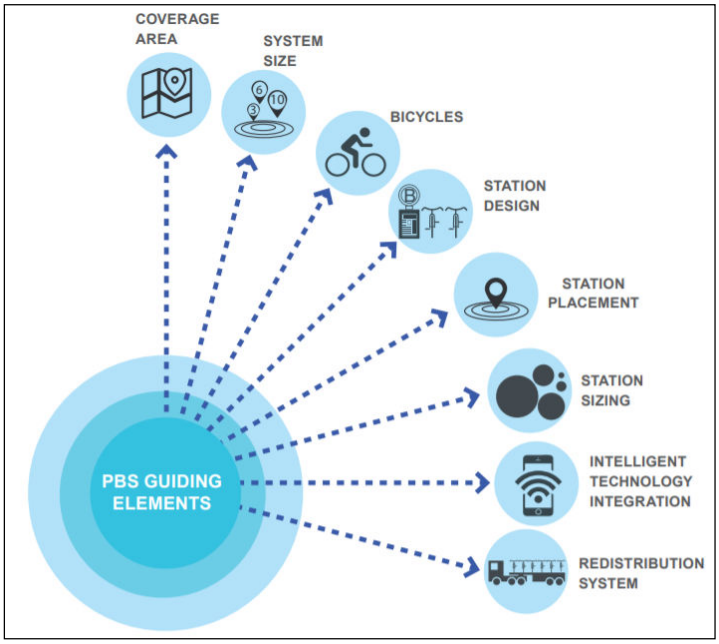


FIGURE 4.19 BIKE IN DOCKING STATIONS UNDER PBS

The system is designed around a hub-and-spoke concept. Within a 2.5-to-3-kilometer catchment area, there is usually a primary docking station and 6-7 sub-stations. The primary docking station, which is generally located close to a transportation hub, can hold about 10-30 bikes. Sub-stations might be found near residential colonies, job areas, or commercial hubs, depending on the situation. A person interested in renting a bike goes to the main docking station or any of the sub-stations, pays a membership fee and fills out a membership form including specific personal information (both of which are one-time events), swipes a smart card provided to him, and takes the bike. Bike can be returned to any docking station by swiping the card to deduct the rent for the duration of use. The guidelines for planning of PBS as per the report by ITDP (Institute for Transportation and Development Policy) are given under

- Minimum System Coverage Area: 10 km^2
- Station Density: 10–16 stations per km^2
- Bikes/Resident: 10–30 bikes for every 1,000 residents (within coverage area)
- Docks per Bike Ratio: 2–2.5 docking spaces for every bike

PBS system has come up in many cities for sustainable first and last-mile connectivity solutions that are affordable, eco-friendly, and viable.

On the same footsteps, public bike sharing system is proposed to be introduced in Nagpur. The short trip lengths in the city can be greatly served by a new system of bike sharing. The system can be implemented in phases. Based on the success rate of PBS system, the same can be implemented in other commercial and institutional areas where high footfall of city residents is witnessed. However, more details shall be worked out during the DPR/ execution stage of the project.

4.6. FREIGHT MANAGEMENT STRATEGY

Currently, the Transport Plaza on Kamptee road primarily functions as a truck parking facility, while the Kapsi Transport Nagar on Bhandara road serves as a truck terminal but lacks essential freight handling infrastructure. To enhance logistics

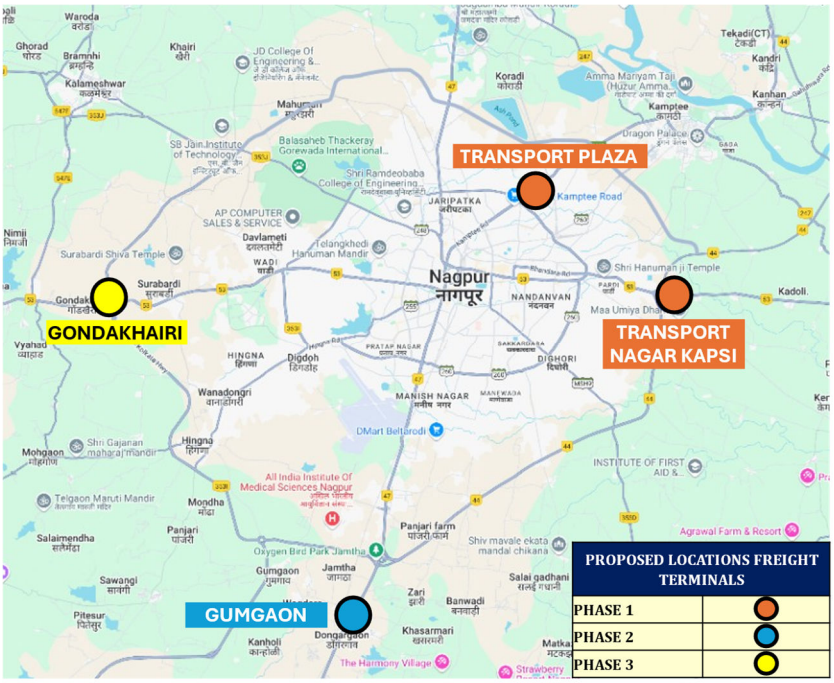
efficiency and support commercial transport, it is proposed that both facilities be upgraded and transformed into fully-equipped freight terminals with modern amenities as part of Phase 1. In Phase 2 and 3, two direction-wise new freight terminals are proposed to be developed at Gumgaon on Wardha road and Gondakhairi on Amravati road respectively. The locations of the proposed freight terminals are presented in **Figure 4.20** & **Table 4.16**. Various strategies of increasing the efficiency of freight and commercial transport in Nagpur include:

- Segregation of long-distance commercial vehicles from city roads
- Shifting of CFS, godowns and yard from core city area
- Freight terminals development close to ring roads
- Use of small and medium size vehicles with modern emission controls in the central city areas
- Restricted movement of commercial vehicles in the city core area (8 AM - 8 PM prohibition) and other mobility corridors (morning and evening peak periods)

TABLE 4.16 : PROPOSED FREIGHT TERMINALS

SN	Locations	Phase
1	Transport Plaza (Automotive Chowk)	Phase - 1
2	Kapsi Transport Nagar	
3	Gumgaon	Phase - 2
4	Gondakhairi	Phase - 3

FIGURE 4.20 PROPOSED LOCATIONS FOR FREIGHT TERMINALS



4.7. PLANS FOR INTELLIGENT TRAFFIC MANAGEMENT SYSTEM

In modern urban environments, increasing traffic congestion, violations, and inefficient traffic signal management pose significant challenges to smooth mobility and road safety. To address these issues, it is proposed to implement of an Intelligent Traffic Management System - a smart traffic management solution that optimizes traffic flow, enhances enforcement, and improves overall transportation efficiency. This system leverages adaptive traffic control, automated violation detection, real-time monitoring, and data-driven decision-making to create a seamless and efficient urban traffic network.

Key Components of the Intelligent Traffic Management System

4.7.1. Adaptive Traffic Control System (ATCS)

- Traffic signals equipped with advanced controllers and video detectors that dynamically adjust signal timings based on real-time traffic conditions.
- Reduction in congestion, improved travel time, and efficient traffic flow.
- Traffic simulation software for analyzing and optimizing traffic patterns.

4.7.2. Automated Traffic Violation Detection and Enforcement

- AI-driven cameras and video analytics for detecting violations such as speeding, red-light jumping, lane indiscipline, unauthorized parking, and helmet or seat belt violations.
- Automatic issuance of eChallans with photographic or video evidence, reducing manual enforcement efforts.
- Alerts and notifications sent to law enforcement officers for prompt action.

4.7.3. Citizen Engagement and Real-Time Communication

- Variable Messaging System (VMS) to display real-time traffic updates, congestion alerts, and road safety messages at strategic locations.
- A mobile application enabling citizens to check traffic violations, report incidents, and receive important alerts.
- Integration with public transport for better traffic coordination.

4.7.4. Centralized Command and Control Center

- Realtime monitoring of traffic through a video wall and integrated dashboard.
- Remote access to surveillance footage, traffic data, and system analytics.
- Ability to detect incidents and respond swiftly with appropriate measures.

4.7.5. Robust IT and Infrastructure Support

- Hosting and data storage capabilities ensuring smooth operation of the system.
- Network security and power backup to maintain system functionality under all conditions.
- Integration with external applications like NIC's eChallan system, Vahan, and Sarathi for seamless enforcement and coordination.

The system provides a scalable, efficient, and technology-driven solution for managing traffic in any growing city. By implementing adaptive signals, automated enforcement, and real-time monitoring, cities can significantly reduce traffic congestion, improve road safety, and enhance commuter convenience. Moreover, the integration of digital tools ensures better law enforcement, streamlined penalty collection, and active citizen participation.

4.8. JUNCTION IMPROVEMENT PLAN

The junction improvement with pedestrian infrastructure facilities proposes not only improvement at the junction but also alignment improvement of the approach roads which could be extended further by the authorities on site. This approach provides a comprehensive solution towards traffic management in the study area.

The approach adopted by RITES to prepare junction improvement plan is junction specific. It focuses on nature and type of the traffic on the junction, number of arms, etc. The major problems observed at each junction will be analyzed with its root cause analysis and low-cost solutions in line with National Urban Transport Policy (NUTP) 2006 giving priority to pedestrianized NMT and public transport movement will be proposed. The general improvement measures adopted to prepare junction improvement are given in **Table 4.17.**

TABLE 4.17 : IMPROVEMENT MEASURES AT JUNCTIONS

SN	Improvement Measure	Brief Description
1	Geometric Design	• Involves improvement in roundabout size and shape (if it exists), channelizer length and curves, intersection entry and exit radius, weaving length & width etc. • Providing signages/lane-markings/lighting/street furniture
2	Pedestrian & NMT Infrastructure	• Provision of continuous footpaths and zebra markings, rail guard at all the junctions. • Installation of pelican signals with beepers for disabled pedestrian. • Installation of high mast light for pedestrian crossing for use at night. • Installation of pedestrian phases for crossings at signalized

SN	Improvement Measure	Brief Description
		junctions • Grade separated pedestrian crossing at junctions such as Foot Over Bridge, Subway, Skywalk etc. • Dedicated NMT lanes based on land availability
3	On street Bus Terminal/ Bus Stop/Auto Stand	• Provision of bus bays with shelter and auto bays away about 100 m from the junction along with demarcations. • Relocation of existing Bus stops located near junctions
4	Uncontrolled Junctions	• Installation of traffic signals and conversion of roundabout to Signalized Junctions can be proposed where the traffic volume is higher • Closing of junctions with provision of U-turns and channelizers, where required.
5	Approach to Service Roads	Service Roads can be proposed to be closed on the intersections. The service road entry/exit can be provided on the approach arms at appropriate distance from the junction at an angle which allows smooth movement of traffic to and from service road to major carriage way.
6	Median Separators	The height of median separator should be increased to 3'6" considering the height increase of roads due to redevelopment of the road.
7	Speed Breakers	The speed breakers should follow the IRC 99-1988 standards along with proper markings.
8	Alignment Improvement of Approach Roads	Improvement in alignment of approach roads including medians can be proposed to remove bottlenecks for easy discharge of traffic from the intersection
9	Encroachments	To discourage the encroachments at junctions, organized space for hawkers/ kiosks can be proposed away from the junction
10	Safety & Security	Installation of CCTV security cameras for incident detection and overall safety near the junction

It has been identified that the factors affect accident occurrence at intersections may include traffic volume, frequency of access points, number of arms, speed limit, median type and width, number of traffic lanes, existing turn lanes, lighting levels etc. Based on discussion with the local stakeholder, reconnaissance survey and traffic survey data analysis following general issues have been identified at the junctions in the study area.

- Poor Junction geometrics
- Inadequate turning movement provision
- Lack of pedestrian and NMT infrastructure
- Absence of traffic islands
- Higher boarding/ alighting activities in absence of PT/IPT bays
- Encroachments in the form of informal commercial activities

Junction improvements plans are recommended at various Junctions based on available Right of Way (RoW). The proposed locations for junctions' improvement plan are presented in **Table 4.18** & **Figure 4.21**. The brief description of improvement measures is enlisted in **Table 4.17** and junction improvement drawings are given in **Annexure 4.1.**

FIGURE 4.21 PROPOSED LOCATIONS FOR JUNCTIONS IMPROVEMENT

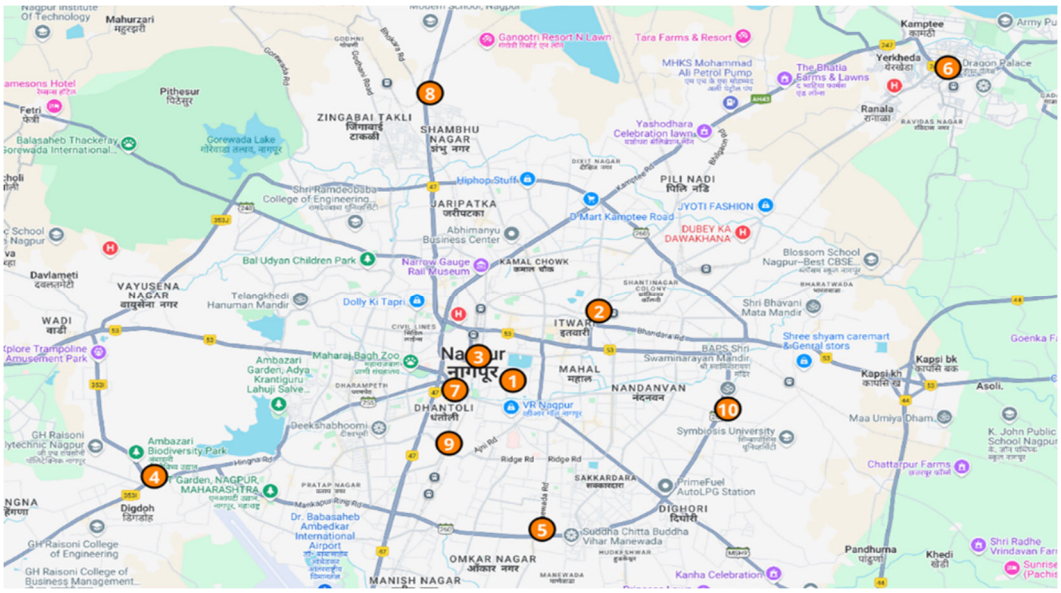


TABLE 4.18 : PROPOSED LOCATIONS FOR JUNCTIONS IMPROVEMENT MEASURES

SN	Name of Location	No. of Arm	Phase
1	Ganeshpeth Chowk	4	Phase-1
2	Dahi Bazar Chowk	4	
3	Manas Chowk	5	
4	Hingna T-Point	3	
5	Manewada Chowk	4	
6	Durga Chowk Kamptee	3	
7	Yashvant Rao Stadium Chowk	4	
8	Koradi Naka	3	
9	Ajni Rail Bridge Junction	4	
10	Kharbi Wathoda Junction	5	

4.9. PARKING MANAGEMENT MEASURES

4.9.1. Parking management Measures

The CMP aims at promoting use of public transport for sustainability. Providing more and more parking spaces does not solve the purpose of mobility, as the parking spaces get eventually exhausted with a high rate of vehicle growth. Therefore, various parking strategies/measures will be developed as discussed in subsequent paragraphs.

i. Multi-Level Parking

Smart city applications are being implemented in many cities, as they improve the quality of life of their citizens and help reduce environmental pollution by optimizing time and fuel consumption. RFID Based multi-level parking is popular among smart cities, as it can be of use to transit hubs, commercial business hubs, to control access and parking allocations. The system resolves and highlights the smart parking reduces congestion, increases revenue as applicable, has a pricing system that is adjusted based on the demand for availability on-peak hours and reinforces traffic laws by using the integrated ticket system **Figure 4.22.**

FIGURE 4.22 RFID BASED AUTOMATIC MULTI-LEVEL PARKING

Five locations are identified for the development of automatic Multilevel parking. These locations will take care of both existing on-street parking and future demand of the surrounding area. All multi-level parking facilities shall be provided with all infrastructure facilities such as smooth vehicle circulation, signages, marking, CCTV cameras, safety, and security. These multi-level parkings may be developed in PPP mode. More details shall be worked out during the DPR/ execution stage of the project. The proposed locations for multilevel car parking are shown in **Table 4.19** and **Figure 4.24.**

TABLE 4.19 : PROPOSED LOCATIONS FOR MULTILEVEL CAR PARKING

SN	Locations	ECS	Phase
1	Near Patwardhan Ground	400	Phase 1
2	Near Mor Bhawan Bus Terminal	350	
3	Near Ganeshpeth Bus Terminal	350	
4	Near Dikshabhumi	300	Phase 2
	Total	1400	

ii. On-Street Parking

The Roads having the space between the carriageway and footpath has been used for parking. Redesign the roads to include these features, creating space for paid parking. If successful, this can be replicated in wide roads across the city.

In order to reduce the width of parking and leaving more space for carriageway, angular on-street parking can be proposed instead perpendicular parking. The angular parking will also ease the drivers while parking.

FIGURE 4.23 ON-STREET– ANGULAR PARKING

Some sections of major roads have been identified where high parking demand has been observed. Therefore, on-street parking is proposed on these locations along with all infrastructure facilities. The identified on-street parking locations are presented in **Table 4.21** & **Figure 4.24.**

iii. No-Parking Zone

Unauthorized on-street parking areas have been identified on some important roads. These roads are narrow and lying-in commercial areas and witness high degree of traffic congestion. To curb on-street parking, the following roads proposed as "No Parking zones" and imposed electronic ticketing/fining system for better enforcement and transparency if someone parks. The roads proposed for No-Parking zones are given in **Table 4.20**.

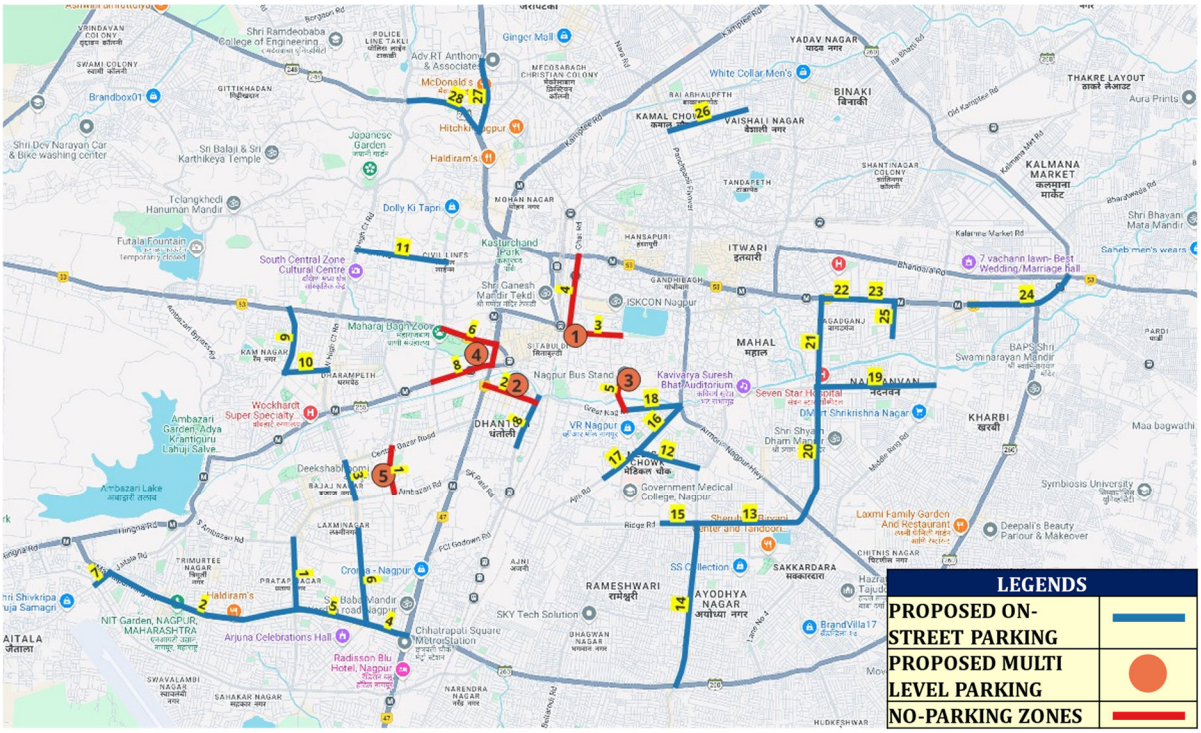
TABLE 4.20 PROPOSED BANNING OF ON-STREET PARKING

SN	Name of Road	Length (m)	Phase
1	Kachipura Chowk to Annabhau Sathe Chowk	559	Phase-1
2	Panchsheel Chowk to NMC Zone IV Chowk	655	
3	Cotton Market to Agyaramya Devi Chowk	647	
4	Santara Market to Cotton Market	945	
5	Ganeshpeth Bus Stand Chowk to Baidhyanath Chowk	466	
6	Agriculture College Chowk to Veriety Chowk	689	
7	Variety Chowk to Jhansi Rani Chowk	263	
8	University Liberty Chowk to Jhansi Rani Chowk	762	
Total Length (m)		**4985**	

TABLE 4.21 PROPOSED ON-STREET PARKING ON MAJOR ROADS SECTIONS

SN	Identified Stretches	Length (m)
1.	Mate Chowk to Pratap Nagar Chowk	850
2.	Pratap Nagar Chowk to Mangalmurti Chowk	2460
3.	Bajaj Nagar Chowk to Dindayal Upadhyay Chowk	470
4.	Chatrapati Chowk to Orange City Hospital Chowk	530
5.	Orange City Hospital to Pratap Nagar Chowk	900
6.	Orange City Hospital to Aath Rasta Chowk	1160
7.	Mangal murti Chowk to London Street Intersection	230
8.	NMC Zone IV Square to Congress Nagar T point	660
9.	Ravi Nagar Square to Ramnagar Rotary	820
10.	Laxmi Bhavan Square to Ramnagar Rotary	540
11.	Ladies Club Chowk to Akashwani Chowk	1120
12.	Medical Square to Krida Square	770
13.	Bande Plot Chowk to Tukdoji Chowk	1420
14.	Manewada Chowk to Tukdoji Chowk	2020
15.	Tukdoji Chowk to Rajkamal Chowk	420
16.	Medical Chowk to Ashok Chowk	760
17.	Medical Chowk to Medical College Entrance	510
18.	Baidhyanath Square to Ashok Nagar Square	690
19.	Jagnade Square to T Point (Middle Ring Road)	1460
20.	Bande Plot Chowk to Jagnade Square	1610
21.	Jagnade Square to Itwari Telephone Exchange Chowk	1110
22.	Telephone exchange to Chhapru Nagar square	490
23.	Chhapru square to Ambedkar square	430
24.	Vaishno Devi to Prajapati square	1350
25.	Vaishno Devi square to Shastri Nagar Chowk	440
26.	Kamal Chowk to Vaishali Nagar	980
27.	Chhaoni T Point to Taj Aulia Baba Square	900
28.	Katol road Sub Post Office junction to Chhaoni T Point	1030

FIGURE 4.24 PARKING PROPOSALS



4.10. REGULATORY AND INSTITUTIONAL MEASURES

An efficient regulatory mechanism is required for the effective development of urban land use and transport systems. The suggested regulatory mechanism includes:

4.10.1. Regulatory Measures

Limited road capacity, increasing vehicle ownership and limited penetration of public transport are the main reasons for the present chaotic traffic scenario in the City. Following regulatory measures are required to bring in improvements in the present scenario.

a. Public Transport Improvement

Priority Lanes: Regulations, such as bus and high occupancy vehicle lanes, achieve their effect by reducing the road space available for cars and help in mass transportation (proposed for MRT system)

Concession for physically challenged people, senior citizens, etc.

b. Traffic safety improvement.

Ban of aged vehicles: Another regulatory measure required in urban transport is ban of vehicles above 15 years. This will reduce accidents, air pollution and also offer savings in fuel consumption.

Physical control on moving vehicles: Ban of motorized vehicles on certain streets and allowing only NMV (suggested pedestrian precinct areas).

Training programme for drivers: Awareness training on traffic rules, regulations and safety aspects for drivers, traffic police and common people.

Enforcement measures such as pedestrians to use footpath, crossing at designated locations and facilities and imposing penalty on violations. Fine/removal of vehicles for parking at 'No parking' stretches.

c. Transport Demand Management (TDM) measures

Transportation Demand Management or TDM refers to various strategies that change travel behavior (how, when and where people travel) in order to increase transport system efficiency and achieve specific objectives such as reduced traffic congestion, increased safety, improved mobility for non-drivers, energy conservation and pollution emission reductions. **Table 4.22** gives the TDM Measures used worldwide to manage the transport demand in the cities.

TABLE 4.22: TRANSPORT DEMAND MANAGEMENT MEASURES

Type of Measures	Measure
Economic Measures	Road user charges
	Parking charges
	Public transport subsidization
	Fuel Tax
	Restraint on Vehicle Ownership
Land use	Car free developments and location of new developments
	Park and Ride Facilities
	Public transport promotion
	Intensive development along major PT routes
Information for Travelers	Travel Information before a trip is undertaken
	Car Sharing
Administrative Measures	Parking Controls
	Pedestrianised Zones
	Alternative working patterns (Flexi time etc.)
	Different weekly offs days for various market areas
Technology transition	Vehicle Technology and alternative fuels reduce vehicle emissions

i. Park and Ride and PT Promotion

Park & Ride facilities and promotion of public transport are the key components of the strategy adopted to meet the demand in horizon years. Public transport

promotion needs to be carried out through policy interventions as well as awareness programs. The mass transport system plan detailed in previous sections will promote public transport and would help to increase its targeted modal share.

ii. Preferential parking and carpool promotion and coordination

Preferential parking and carpool promotion and coordination provide opportunities for socializing and reduce commute times through the usage of dedicated carpool lanes. The designation of premium parking spaces for High Occupancy Vehicles (HOV) modes is an inexpensive way to encourage employees to carpool or vanpool. It is intended to make HOV spaces highly valued among employees over single occupant vehicle spaces. The priority spaces are located close to the building entrances to reduce the walk time for carpool and vanpool users. Reduced walk times yield a relative reduction of travel times for HOV users. In addition to demonstrating employer support for HOV commuting, preferential HOV parking may also reduce the demand for employee parking spaces. Parking permit fees may also be waived or reduced for HOVs as an added incentive.

Carpool promotion and coordination is successful when implemented by employers because they can efficiently market the programs at the workplace and provide matching functions based on employer records. As employees commute from areas further away from employment centers to buy affordable housing, vanpools become increasingly attractive as a means to reduce single-occupant trips.

iii. Parking regulations

Parking regulations by limiting duration and by specifying designated places for various modes and discounts and exemptions for physically challenged and senior citizens. Higher parking fee during peak traffic hours and festival seasons. No parking fee for bicycles

iv. Alternative Measures

Alternative work-hour programs offered by individual employers such as the compressed work week, flexi time, and telecommuting are TDM strategies that directly reduce the number of trips taken by employees to travel to work.

A compressed work week allows employees to work longer days in exchange for an additional day off that would normally be worked. For example, employees may work eight nine-hour days and one eight-hour day, in a 10-day (2-week) pay period, totaling 80 hours and permitting one day off each two weeks. In other cases, employees may work four ten-hour days each week, with one day off each week. This program not only reduces the amount of peak hour commute trips, but also is often attractive to employees, increasing morale and job satisfaction.

Other strategies such as "flexi time" or staggered work hours can be used to reduce peak hour trips and spread trips throughout non-peak times by allowing employees to begin and end work at a time that is different from the typical 9 A.M. to 6 P.M. work schedule. Flexi work time can be particularly attractive to employees with commutes that are congested during peak times, but do not result in the elimination of daily trips in the manner achieved by the compressed work week strategy.

All over the world, cities have adopted TDM measures to control congestion and promote public transport. The lessons learnt from the experience suggest that TDM should be sold as a part of an overall transport strategy. The public has to see the big picture. TDM is only one part of a package of measures, which included others like building roads, sophisticated traffic management, priority for bus movements, and new rail system. All the parts of the package need to be done in parallel to get the desired result.

d. Reduce vehicle emissions of Vehicle Technology and alternative fuels:

Enforcing the use of advanced technology vehicles operated with electric and hybrid technologies and environmentally friendly and by switching to low carbon fuels such as LPG and CNG (Energy efficient/Alternate fuels and Cleaner Development mechanism, Development and maintenance of urban green belt.

e. Para Transit Improvement Plan

At present IPT modes are playing major role in the total transport scenario of Nagpur. Fragmented and disorganized operation is the major drawback of the existing IPT operation. IPT should be made an integral component of the transportation system in Nagpur for more meaningful role and structured operation. Thus, there is a necessity to effectively integrate operations of PT and IPT modes to give ultimate benefit to the user and operator. This would require:

- Identification of areas of operation for IPT operation based on demand and road network constraints. Major demand corridors have been identified as PT corridors to be operated by MRTS /Bus. IPT modes are proposed to operate on secondary/ tertiary roads to serve as feeder to PT corridors.
- Parking and terminal facilities for para-transit operation.
- Removal of disparity in fare structure followed by PT and IPT modes.
- Control on illegal operation of IPT modes.
- Driver Training, registration of only licensed drivers for driving of IPT modes are some other areas that need immediate attention of concerned authorities to bring improvements in IPT operation.

f. Intensive development along major PT routes and trip minimization:

Intensive development along major PT routes is another method of controlling the travel. For example, mixed land use planning reduces the travel length and also the parking space requirements, as a large part of the travel can be carried out by walk or cycling (Integrated transport and land use plan adopted in the CMP.

g. Zoning regulations and controlled densities:

Regulatory measure on zoning regulations and controlled density measures in the city core area can help decongest the city further as per Development Control rules.

4.10.2. Institutional Measures

Urban transport is made up of multiple components managed by many agencies with overlapping responsibilities. There is no integrated planning or coordination between various agencies or even integration of services. Transport professionals are seldom employed. Each agency seeks its own budget and spends as per its own priorities. Urban transport thus becomes the secondary responsibility of several agencies in the City and at State and Central Government level.

a. Existing Institutional Arrangements

The problems of urban management lie basically in the multiplicity or departments, organizations and agencies which impact efficiency and effectiveness. In many tasks, role of various agencies is overlapping. The Government bodies Involved in transportation sector in Nagpur include:

- Local bodies – Nagpur Municipal Corporation
- Nagpur Metropolitan Region Development Authority (NMRDA)
- Public Works Department
- National Highways
- Regional Transport Office (RTO)
- Traffic Police
- Maharashtra State Road Transport Corporation (MSRTC)

Additionally, private organizations such as Bus operators, Truck operators and IPTs are involved in providing services to public in transport sector. Due to the multiplicity of institutions has resulted in fragmentation of functional responsibilities, lack of local resources, paucity of financial resources and lack of privatization strategy for the sector, as a whole. This calls for developing and maintaining an integrated transport system by an appropriate authority. In order to have an integrated approach to improve the transportation infrastructure in Nagpur and to utilize the available infrastructure facilities and resources for development efficiently, proper

coordination and streamlining the activities of different agencies, there is need for a statutory organization.

b. Enforcement Measures by Traffic Police

Strict enforcement by Police is required to ensure the smooth flow of traffic and implementation of the proposals. Following measures are proposed for the same:

- Traffic education and public awareness programs on regular basis to educate the public on traffic rules and their benefits.
- It is proposed that scheme of Traffic police on motorbikes to impose on the spot fines on traffic offenders may be started to ensure traffic discipline in the city.
- Heavy fines for habitual offenders
- Scheme of mobile courts to check on encroachments on traffic infrastructure and to punish the habitual traffic offenders may also be introduced.
- To play the envisaged role in enforcement, the strengthening of Traffic Police is recommended.

c. Proposed Institutional Framework:

Need for Unified Metropolitan Transport Authority (UMTA)

The above discussion suggests that there are many agencies involved in the urban transport in Nagpur. As such there is nothing wrong in multiplicity of authorities. However currently there is no mechanism to ensure coordination among various institutions which is one of the key roadblocks affecting formulation and implementation of major schemes and initiatives to improve the traffic situation and mobility in the city.

The National Urban Transport Policy 2006 has recommended setting up of Unified Metropolitan Transport Authorities (UMTA's) in million plus cities. The policy document stipulates following on UMTA

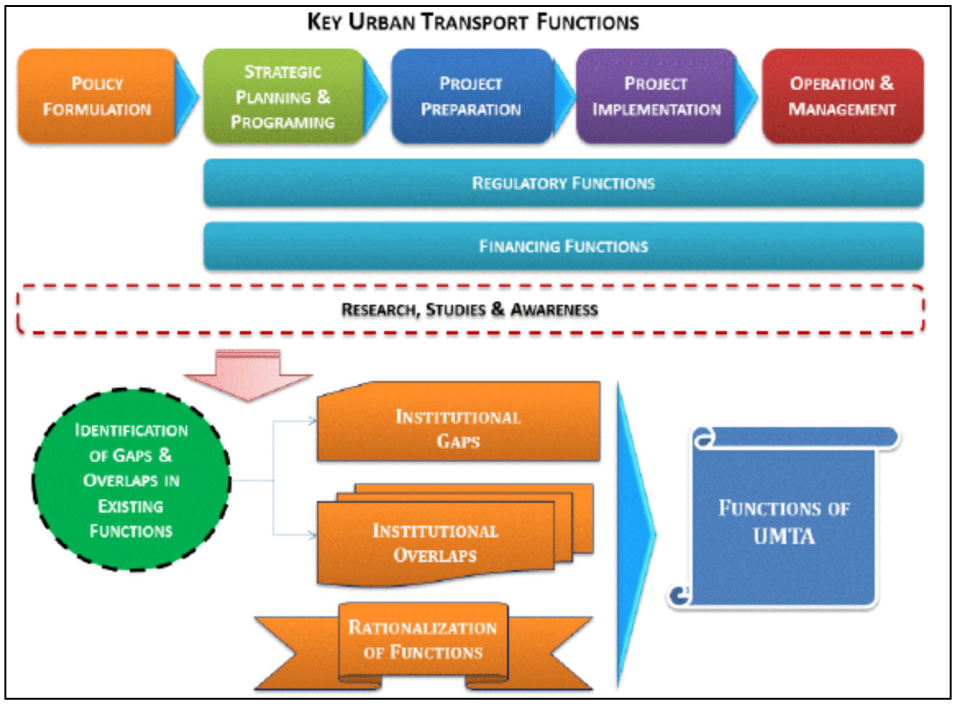
"The current structure of governance for the transport sector is not equipped to deal with the problems of urban transport. These structures were put in place well before the problems of urban transport began to surface in India and hence do not provide for the right coordination mechanisms to deal with urban transport. The central government will, therefore, recommend the setting up of Unified Metropolitan Transport Authorities (UMTA's) in all million cities to facilitate more coordinated planning and implementation of urban transport programs & projects and integrated management of urban transport systems. Such Metropolitan Transport Authorities would need statutory backing in order to be meaningful."

The metro rail policy - 2017 makes it mandatory for the cities which are planning to have MRTS to address their mass transport requirements to have city level UMTA. Major functions of UMTA as envisaged in the study are presented in **Figure 4.25**.

The study proposes that UMTA could be given a larger set of functions through legislation, but be assigned these functions in stages, as the organization evolves and builds capacity, and as higher level of acceptance is achieved about UMTA's role amongst key stakeholders. UMTA could thus first take up the range of functions that today are the key gaps or overlaps and gradually it can look towards rationalizing functions of existing agencies and taking over an appropriate group of functions. In this light, UMTA may be assigned functions which lie between the aforesaid two extremes arrangements, and less complex and feasible in operationalization. The extent of functions involved under this arrangement are given below:

- Assist and advise government on urban transport matters
- Prepare, adapt and administer urban transport policies, strategies, standards and guidelines for the urban area under its jurisdiction.
- Prepare a multi-modal transport master plan integrated with land use
- Prepare Alternatives Analysis Report to identify best alternative MRTS mode
- Preparation & Updation of Comprehensive Mobility Plan (CMP)
- Prepare a detailed multi-year program for urban transport
- Monitor and audit compliance with CMP and the Multi-year Programme
- Approve urban transport projects and activities
- Promote development of integrated facilities and systems for urban transport
- Oversee operation of integrated facilities and systems for public transport
- Contract public transport services so as to provide mobility and integrated public transport
- License (issue permits for) public transport services
- Monitor and advise on fees and charges for roads, public transport, parking, and other public transport facilities and services and regulate fares for urban bus services
- Enforce regulations for which UMTA is responsible
- Fund, or arrange/ recommend/ approve funding for urban transport infrastructure in whole or in part

FIGURE 4.25 UMTA'S FUNCTIONS



Source: Study by Deloitte Touche Tohmatsu India Pvt. Ltd. on behalf of MoUD 2014

- Monitor and Audit use of UMTA funding
- Maintain records relating to urban transport, including details of projects, services, funding, and public transport safety
- Develop and manage local performance indicators for urban transport
- Monitor and advice on public transport safety
- Conduct research, studies, education and awareness about good practices in urban transport

The proposed compositions of the governing board for UMTA are presented below.

Representatives	Role
District Administration (Collector), Nagpur	Chairperson
Representatives from Central Government	
National Highways Authority of India	Member
Indian Railways	Member
Representatives from State Government	
Transport Department	Member
Public Works Department	Member
Police Department	Member
Representatives from Local Government	
Municipal Corporation (Mayor / Commissioner)	Member
Nagpur Metropolitan Region Development Authority (Metropolitan Commissioner)	Member

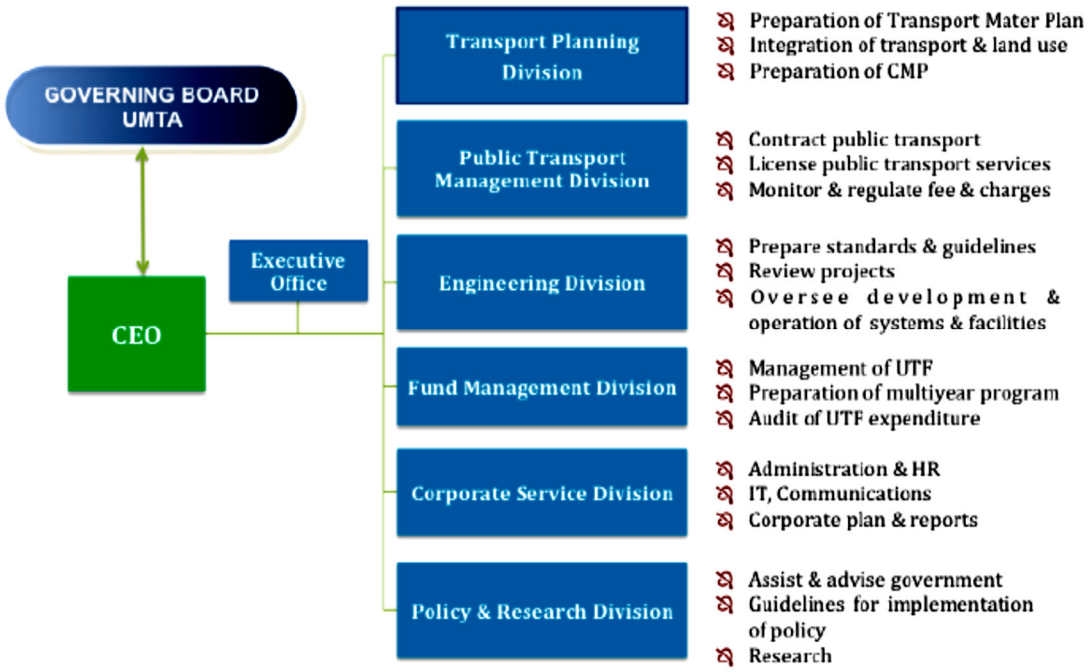
Representatives	Role
Members from Private Sector	
Corporate Governance Expert	Member
Finance Expert	Member
Law Expert	Member
Urban Transport Institutions' Representative	Member
Public Transport Beneficiaries' Representative	Member
Representative of Cyclists and Pedestrians	Member
Employers' Representative	Member

There is an urgent need to create this authority for smooth handling of the issues related to traffic and transport in the city.

The governing board of an UMTA for a particular metropolitan or urban area will be assisted by a fully-fledged organisation headed by a full time Chief Executive. The CEO will be responsible for all day-to-day activities of UMTA in accordance with the policies approved by the board and the delegations given by the board.

A schematic organisation structure for a UMTA with the preferred range of functions is illustrated in **Figure 4.26**.

FIGURE 4.26 ORGANISATION STRUCTURE FOR UMTA



Some aspects of UMTA activities, such as UTF management, accounting, IT, and communications, can be out-sourced to service providers. Activities such as issuing licenses could be delegated and contracted to agents. Consultants could be

employed for distinct activities such as preparation of the Transport Master Plan and the Comprehensive Mobility Plan, development of standards and guidelines, review of proposals and audit of implementation, preparation of contracts, preparation and delivery of awareness campaigns, and research.

d. Traffic Engineering Cells (TEC)

A large number of agencies deal with roads such as Nagpur Municipal Corporation, Local Planning Authority, Traffic Police, PWD, NHAI, etc. There are numerous issues of proper road geometrics, traffic circulation, junction design, traffic signals, road signs/markings, street furniture etc. which are properly attended to by these agencies due to lack of traffic engineering expertise. Traffic planning is a continuous affair. It is therefore important that Traffic Engineering Cells are established within Municipal Corporation, Development Authority & Traffic Police with qualified and adequate staff such as traffic engineers. This will ensure that the traffic schemes are properly implemented with better results and fine-tuned later, if necessary. This will go a long way to improve traffic flow in Nagpur.

4.11. INFORM AND ENGAGE STAKEHOLDERS INCLUDING CITIZENS

The proposed measures given in previous sections have been derived with extensive Stakeholder consultations held during the course of the Study. The stake holder consultations were carried out through meetings held with various stakeholders at different stages of the study.

4.12. DEVELOPMENT OF FISCAL MEASURES

4.12.1. Fare Policy for Public Transport

a. Principles for Rational Public Transport Tariff Design

Public transport tariff design is the key for creating an enabling environment for dynamic and sustainable growth of public transport sector. The fundamental principle of tariff determination is to ensure that prices lead to an optimum level of investment, operation, and demand in the sector.

Generally, there is a conflict between the different objectives of fare. For example, to increase the share of public transport and to address issues of social sustainability require that the fares be kept sufficiently low, while efficiency improvement and viability issues require periodic fare increases with the increase in cost of input of the service. The agencies in this sector need to balance these objectives to achieve a sustainable outcome. Similarly, to ensure environmental and social sustainability, it may be necessary to subsidize public transport operations.

b. Effect on Demand of Bus Services

An increase in public transport fares could lead to modal shift to private modes. Thus, public transport fares would have to be benchmarked on the cost of alternative modes of transport to ensure that a modal shift is checked. For addressing issues of social sustainability, it is imperative that the fares be kept sufficiently low. However, tariffs should provide incentives for efficiency improvements so as to reduce the cost of operation.

c. Subsidy Administration

Whenever the government desires that a particular class of consumers be provided public transport services at subsidized fares, it is recommended that the government to that effect make the allocation explicitly.

d. Fare Revisions

Fare Revision mechanism should be reasonable, transparent, and accepted to both, the passenger and the operator. Generally, the fare revision process is not transparent or scientific. Today the fare revisions are usually a compromise between competing pressures from operators for an enhancement in the fares and pressures from commuters for not affecting any increase. Invariably, there is a time lag between such an increase in the input costs and the increase in fares leading to delays in fleet augmentation and replacement and thus poor quality of service. However, for improvements in the service quality fare revisions should be rationalized and made systematic

e. Fare Integration

Fare integration is essential for seamless travel for passengers using more than one mode to reach their destination. It can be achieved through common ticket for different Public and Para transit modes.

4.12.2. Parking Pricing Strategy

The land in urban areas is limited and there is a limit to the parking space that can be created in the City. The parking demand is growing with growth of vehicles in Nagpur. The institutional, public semipublic and busy/commercial areas are major attractors to the long-term parking. This results in the vehicle parking spilling to streets (main roads or side streets). One of the important tool to control the parking is Parking Pricing. This may include following measures:

- Levy incremental parking fee on on-street parking
- Off street parking charges to be less than the on-street parking charges
- Differential parking fee in the core areas and outside the core area

- Phasing out of on-street parking from major roads and development of off street parking
- Stringent enforcement measures by way of fine and other penal actions need to be provided for violation of parking rules

a. Parking Pricing for Core Area

It is proposed to levy incremental parking charges upon on-street parking in the areas identified for the City. Along with this, off street parking complexes need to be developed to accommodate private vehicles as well as to provide defined space for goods IPT vehicles facilitating goods transaction without hurdling the traffic. It is proposed that about 20% ECS shall be left reserved for goods IPT vehicles in each off street parking complex. For an efficient utilization of available space, long term parking shall be discouraged by levying incremental fares.

b. Other measures:

As parking is un-satiated demand, it is proposed that regulatory tools need to be adopted to cater parking demand generated by a building inside its own premise. This will cater to the parking demand likely to be generated by upcoming developments in the City. Broad measures to ensure availability of parking inside a building premise include:

- Traffic Impact Assessment (TIA) of new developments
- Provision of ground level and basement parking for estimated parking demand in TIA
- Incremental fee at surface / lower ground level to ensure short term parking

4.13. MOBILITY IMPROVEMENT MEASURES PROPOSED IN CMP AND NUTP OBJECTIVES

The objective of National Urban Transport Policy (NUTP) of Government of India is to plan for the people rather than vehicles by providing sustainable mobility and accessibility to all citizens to jobs, education, social services and recreation at affordable cost and within reasonable time. This will involve:

- Incorporating urban transportation as an important parameter at the urban planning stage rather than being a consequential requirement.
- Bringing about a more equitable allocation of road space with people, rather than vehicles, as its main focus
- PT should be citywide, safe, seamless, user friendly, reliable and should provide good ambience with well-behaved drivers and conductors
- Walk and cycle should become safe modes of UT

- Introducing Intelligent Transport Systems for traffic management
- Addressing concerns of road safety and trauma response
- Raising finances, through innovative mechanisms
- Establishing institutional mechanisms for enhanced coordination in the planning and management of transport systems.
- Building capacity (institutional and manpower) to plan for sustainable urban transport and establishing knowledge management system that would service the needs of all urban transport professionals, such as planners, researchers, teachers, students, etc.

The land use and transport measures proposed in the CMP will improve mobility in the metropolitan area and cover the critical issues addressed in the NUTP. **Table 4.23** summarizes the relationship between the NUTP objectives and the measures proposed in the CMP.

TABLE 4.23 SUMMARY OF MOBILITY IMPROVEMENT MEASURES PROPOSED IN CMP IN RELATION TO NUTP

S. No.	NUTP Objectives	Proposed Mobility Improvement Measure
1	Priority for Pedestrians	Footpath proposed along all major corridors Recommended cross section includes footpaths
2	Priority for Non-Motorized	NMV lane proposed along major corridors Recommended cross sections include NMV lanes
3	Priority for Public Transport	Development of MRTS and Bus corridors is proposed. Recommended Network for bus operation and IPT operation Requirement of bus fleet and bus infrastructure is provided
4	Parking	Restrictive on street parking in Core Area. Proposal of 5 multilevel parking
5	Integration of Land Use and Transport Planning	Intensive land use along major mobility corridors Mass transport along major mobility corridors
6	Equitable Allocation of Road space	MRTS corridors and Bus routes are proposed. Pedestrian and NMV lanes are recommended.
7	Integrated Public Transport Systems	Recommended 4 bus terminals directional wise on peripheral areas of the city and integrated with various modes Existing 2 bus terminals to be upgraded and integrated with various modes like MRTS and IPTs.
8	Introduction of	Recommended the organization of Para-transit operation

S. No.	NUTP Objectives	Proposed Mobility Improvement Measure
	Para-transit Services	as a feeder mode to main MRTS corridors
9	Freight Traffic Improvement	Proposed 2 new direction oriented freight terminals and 2 terminals have been planned to be upgraded. Management measures such as entry and time restrictions for heavy vehicles recommended Loading unloading by IPT during daytime in off street parking locations

4.14. IMPACT OF THE PROPOSED MEASURES ON SERVICE LEVEL BENCHMARK

Performance levels of Nagpur were monitored against service level benchmarks (SLBs) in Chapter 2 wherein four LOS viz. 1, 2, 3, and 4 were specified, with 1 being highest LOS and 4 being lowest. Though the goal was to attain the LOS 1.

- Public transport facilities
- Pedestrian infrastructure facilities
- Non Motorized Transport (NMT) facilities
- Level of usage of Intelligent Transport System (ITS) facilities
- Travel speed (Motorized and Mass Transit) along major corridors
- Availability of parking spaces
- Road safety
- Pollution levels
- Integrated land use transport system
- Financial sustainability of public transport

Now, with proposals drafted for preferred sustainable transport scenario, the benchmarking against all the SLBs are again taken up to assess the benefits to be accrued in future by adopting the proposals in this report.

4.14.1. LOS of Public Transport Facilities

The city-wide LOS is being calculated for public transport systems during peak hours for bus based systems. The criteria as listed under SLBs are as follows:

- Presence of Organized Public Transport System in Urban Area (%)
- Extent of Supply Availability of Public Transport
- Service Coverage of Public Transport in the city
- Average waiting time for Public
- Transport users (mins)
- Level of Comfort in Public Transport

- % of Fleet as per Urban Bus Specification

By optimizing existing bus routes and introducing feeder routes alongside the current and planned MRT system, Nagpur is expected to develop a widespread, accessible, and comfortable transport network, achieving the highest Level of Service (LOS 1).

4.14.2. LOS of Pedestrian Infrastructure Facilities

The SLB parameters for pedestrian infrastructure facilities include the following:

- Signalized intersection delay (%)
- Street Lighting (Lux)
- % of City Covered

These parameters cover the percentage of road length along the arterial and major road network or Public Transport corridors and at intersection that has adequate barrier free pedestrian facilities. With about 156 km of road network identified for provision of pedestrian infrastructure, Nagpur is expected to achieve LOS 1.

4.14.3. LOS of Non-Motorized Transport Facilities

The SLB parameters for NMT facilities include:

- % of network covered
- Encroachment on NMT roads by Vehicle Parking (%)
- NMT Parking facilities at Interchanges (%)

These parameters indicate the percentage of dedicated cycle track/ lane along the arterial & sub arterial road network or public transport corridors with a minimum of 2-3 m width as per land availability. The service level is characterized by continuous length of NMT lanes, encroachment on NMT lanes, and parking facilities. With 125 km of road network identified for provision of NMV / pedestrian infrastructure, Nagpur is expected to achieve LOS 1.

4.14.4. LOS of Level of Usage of Intelligent Transport System (ITS)

ITS refers to efforts to add information and communications technology to transport infrastructure and vehicles to manage factors that typically are at odds with each other, such as vehicles, loads, and routes to improve safety and reduce vehicle wear, transportation times and fuel consumption. GPS/GPRS systems are required so as to cover all the public transport and intermediate public transport vehicles on the "National public transport helpline" besides the use for operational efficiencies. The parameters identified to assess the level of service for level of usage of ITS are:

- Availability of Traffic Surveillance (%)
- Passenger Information System (PIS) (in %)
- Global Positioning System (GPS)/ General Packet Radio Service (GPRS) (%)
- Signal Synchronization (%)
- Integrated Ticketing System (%)

With proposals of Passenger Information System (PIS) at all bus stops, signals Synchronization at all major junctions and Fare integration between different modes, Nagpur is expted to achive LOS of 1 in Usage of Intelligent Transport System (ITS).

4.14.5. LOS for Travel Speeds along Major corridors

This level of service provides an indication of effective travel time or speed of Public / private vehicles by taking into account indications of congestion or traffic density. This level of service is along corridors, and not indicative of overall level of service from origin to destination. The parameters identified to assess the level of service include:

- Average Travel speed of Personal vehicles (KMPH)
- Average Travel speed of Public Transport (KMPH)

With an extensive road network improvement plan, along with footpath and NMV network to avoid vehicular – pedestrian conflict, it is expected that Nagpur will be placed in the LOS 1 for Travel Speeds.

4.14.6. LOS of Availability of Parking Spaces

All off street parking locations have been proposed to be available on chargeable basis. This will place Nagpur in the LOS of 1.

4.14.7. LOS of Road Safety

Recommendations for road design (cross sections) to avoid conflict between different modes, strict enforcement to avoid traffic rules violations and extensive incident monitoring and response system are expected to reduce the fatalities to minimum. However, as responsibility for road safety also rests in the hands of users, conduct of public awareness campaigns have also been recommended in the CMP. It is expected that Nagpur will achieve zero tolerance against road fatalities.

4.14.8. LOS of Pollution Levels

This indicates the Level of air Pollutants in the city i.e. average level of pollution in urban areas. The indicator to calculate the pollution levels is Annual Mean Concentration Range ($\mu g/m^3$). Parameters to assess the LOS for this SLB are:

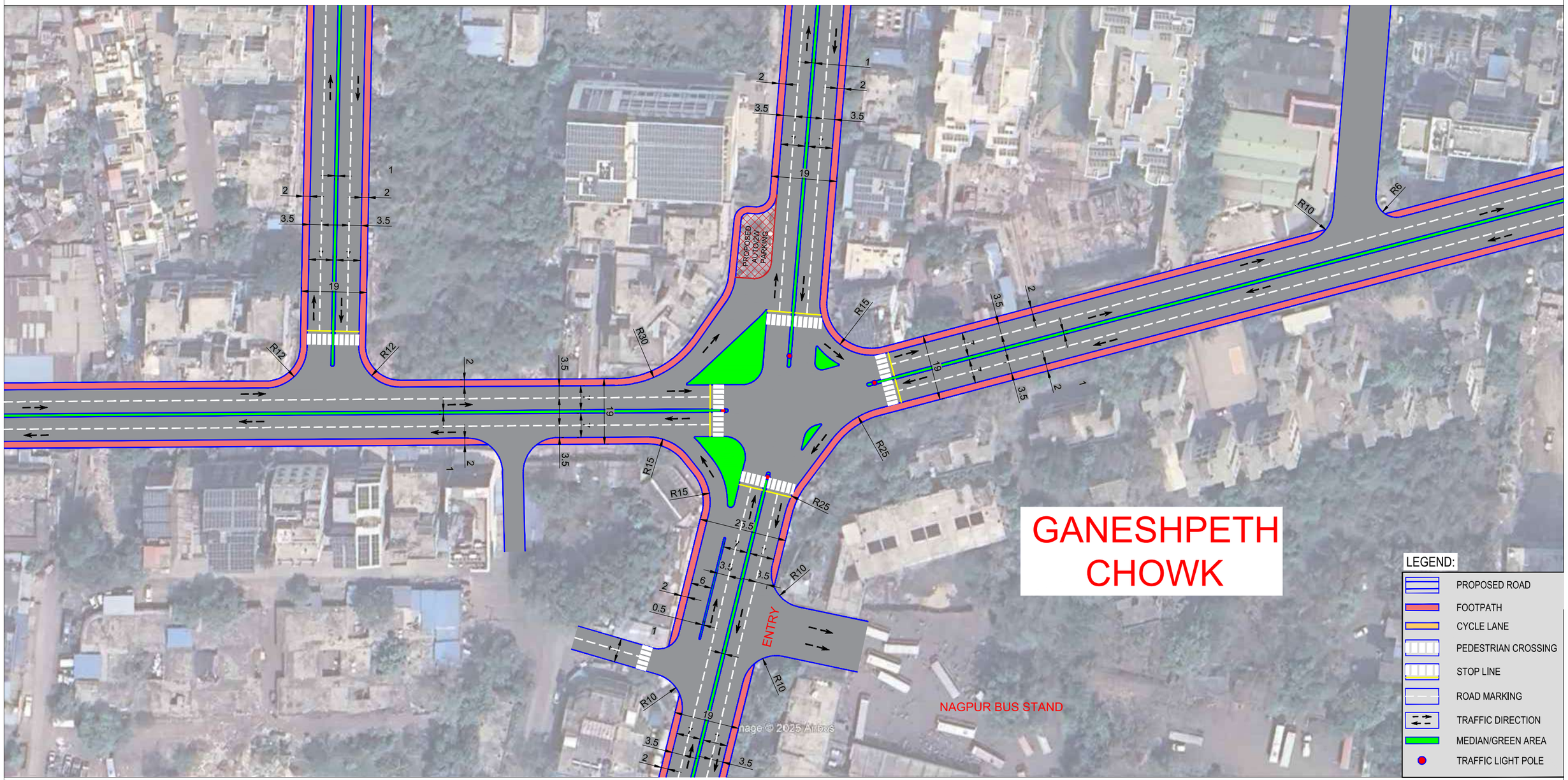
- Level of SO_2
- Level of Oxides of Nitrogen
- Level of RSPM (Size less than 10 microns)

CO_2 emissions are expected to decrease under the urban structure scenario.

4.14.9. LOS of Financial Sustainability of Public Transport

By optimizing existing bus routes and introducing feeder routes alongside the current and planned MRT system, financial performance of the public transport is expected to increase, resulting in achieving the highest Level of Service (LoS 1).

Annexure 4.1
JUNCTION IMPROVEMENT PLANS


GANESHPETH CHOWK
NAGPUR BUS STAND
PROPOSED AUTO/CAR PARKING
ENTRY
R12
R12
R30
R15
R15
R25
R25
R10
R10
R10
R10
R6
19
3.5
2
1
0.5
6
LEGEND:
PROPOSED ROAD
FOOTPATH
CYCLE LANE
PEDESTRIAN CROSSING
STOP LINE
ROAD MARKING
TRAFFIC DIRECTION
MEDIAN/GREEN AREA
TRAFFIC LIGHT POLE

EK RUPAYA CHOWK

EXISTING BUILDING

EXISTING CAR PARKING

EXISTING AUTO/ 2 WHEELER PARKING

R20

R12

R40

10

4

2

3.15

3.75

1.5

1.6

3

4.5

3.5

1

1.7

19

5

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LEGEND:

- PROPOSED ROAD
- FOOTPATH
- CYCLE LANE
- PEDESTRIAN CROSSING
- STOP LINE
- ROAD MARKING
- TRAFFIC DIRECTION
- MEDIAN/GREEN AREA
- TRAFFIC LIGHT POLE

MANAS CHOWK

PROPOSED CAR/AUTO/2W PARKING

TEMPLE

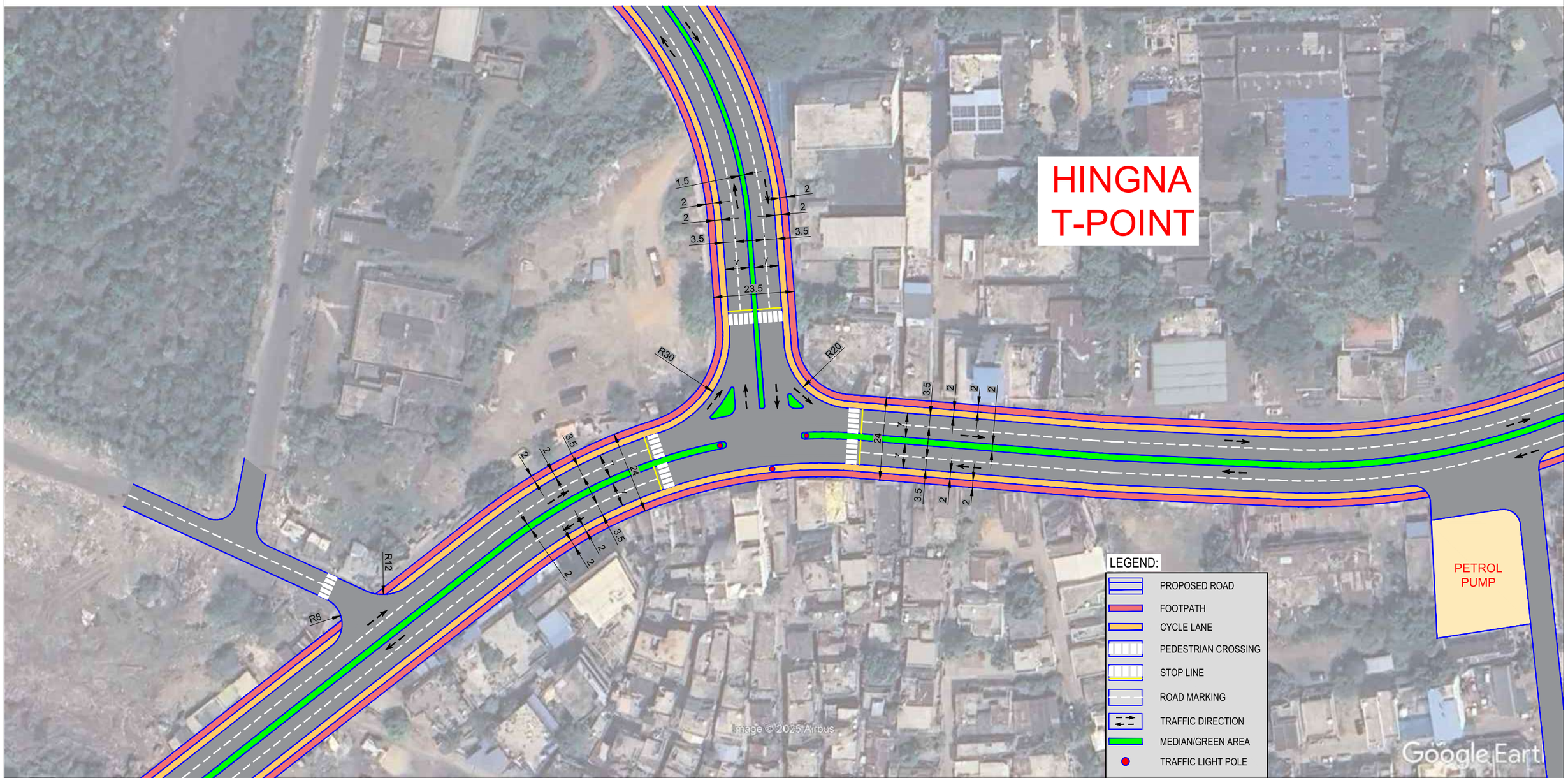
RUB

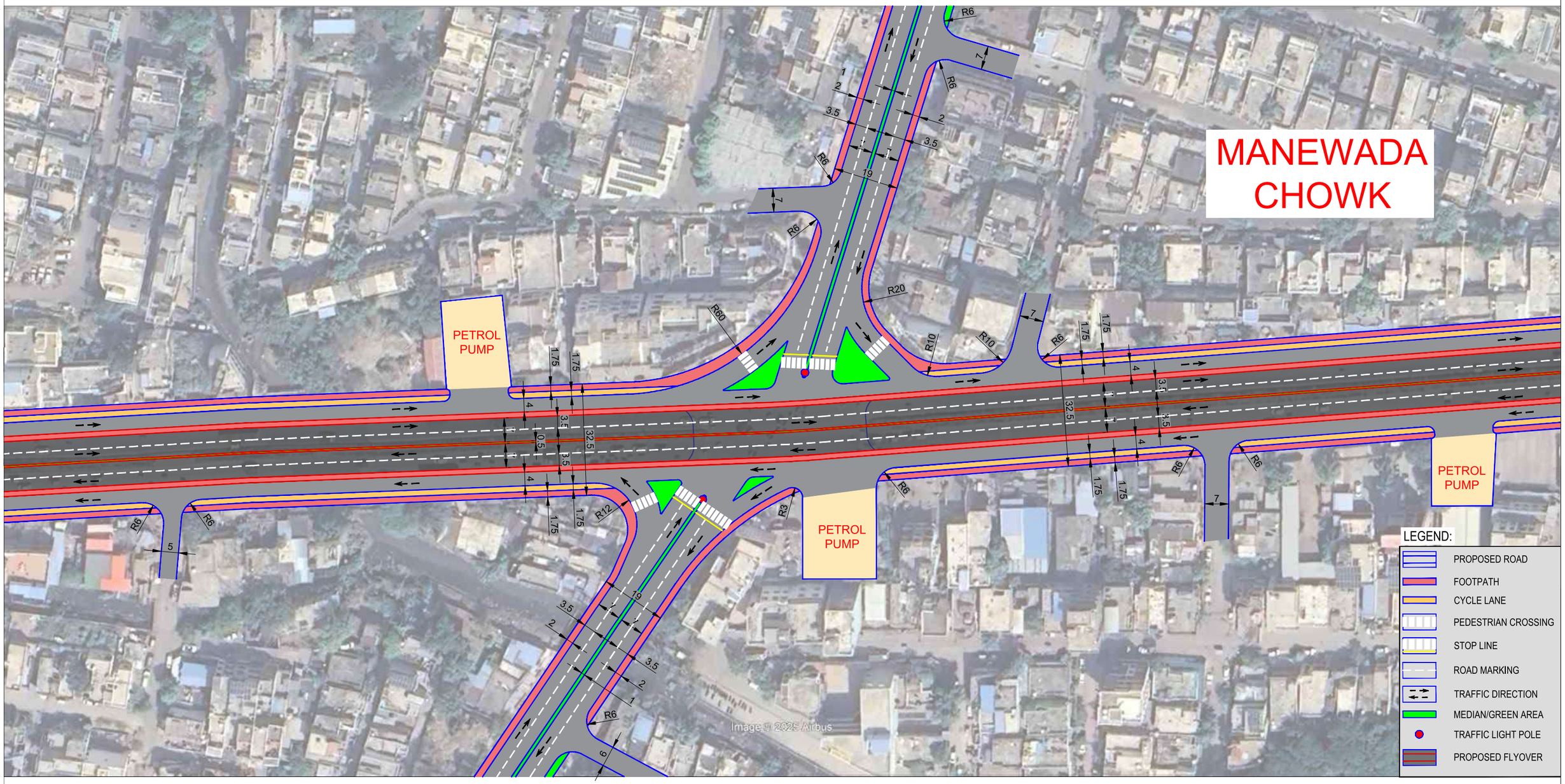
RUB

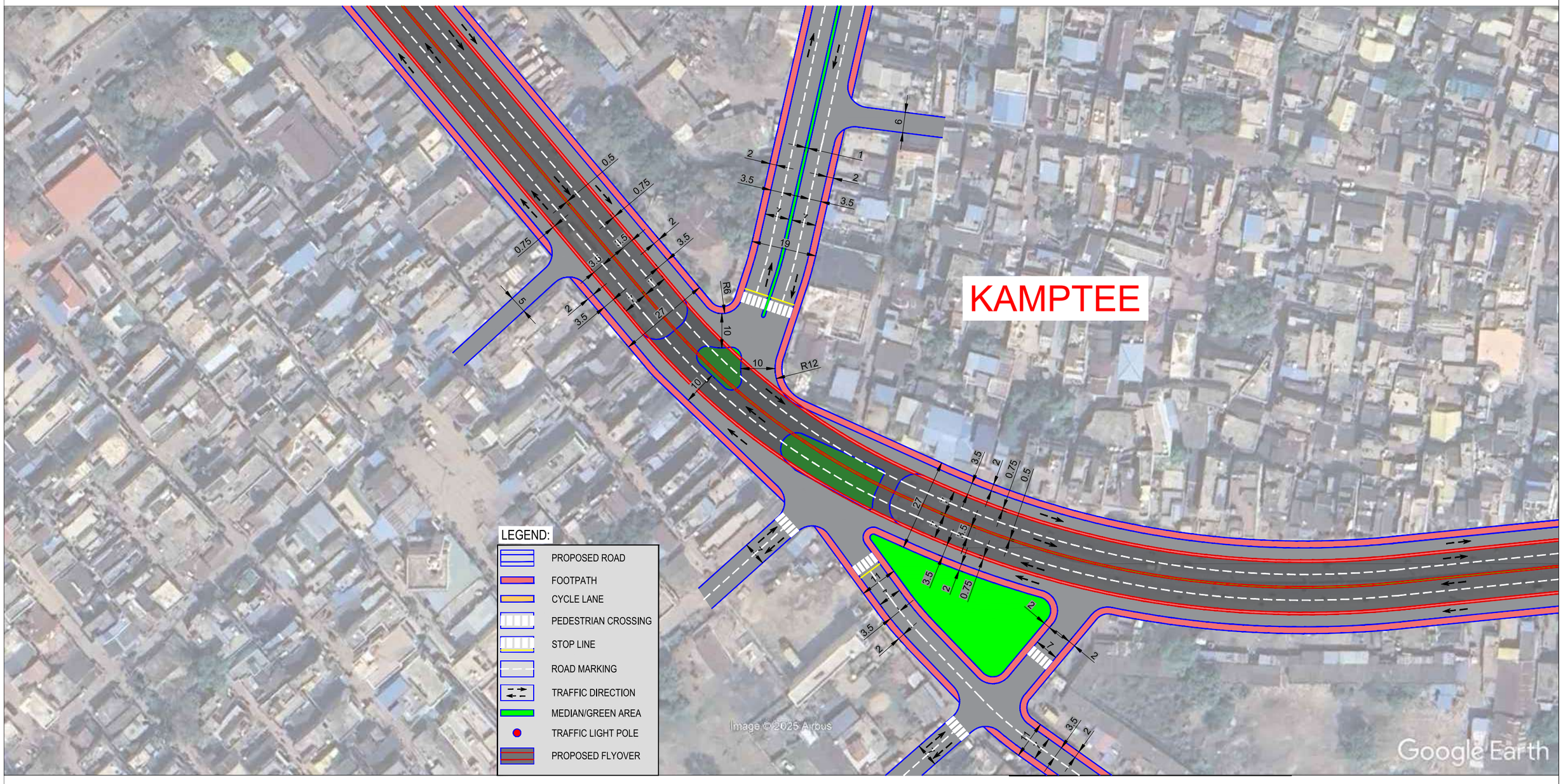
PROPOSED 2 WHEELER PARKING

LEGEND:

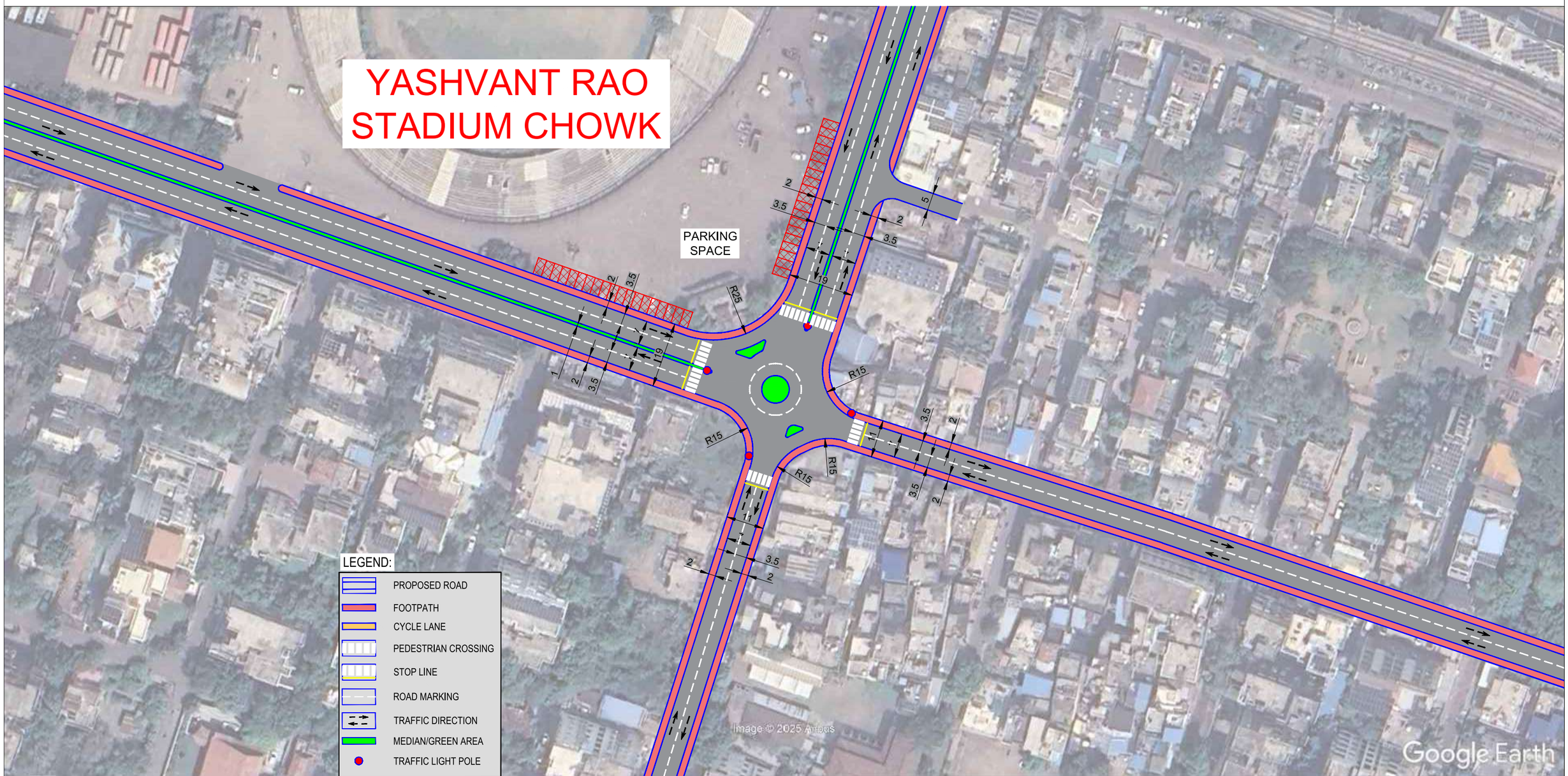
- PROPOSED ROAD
- FOOTPATH
- CYCLE LANE
- PEDESTRIAN CROSSING
- STOP LINE
- ROAD MARKING
- TRAFFIC DIRECTION
- MEDIAN/GREEN AREA

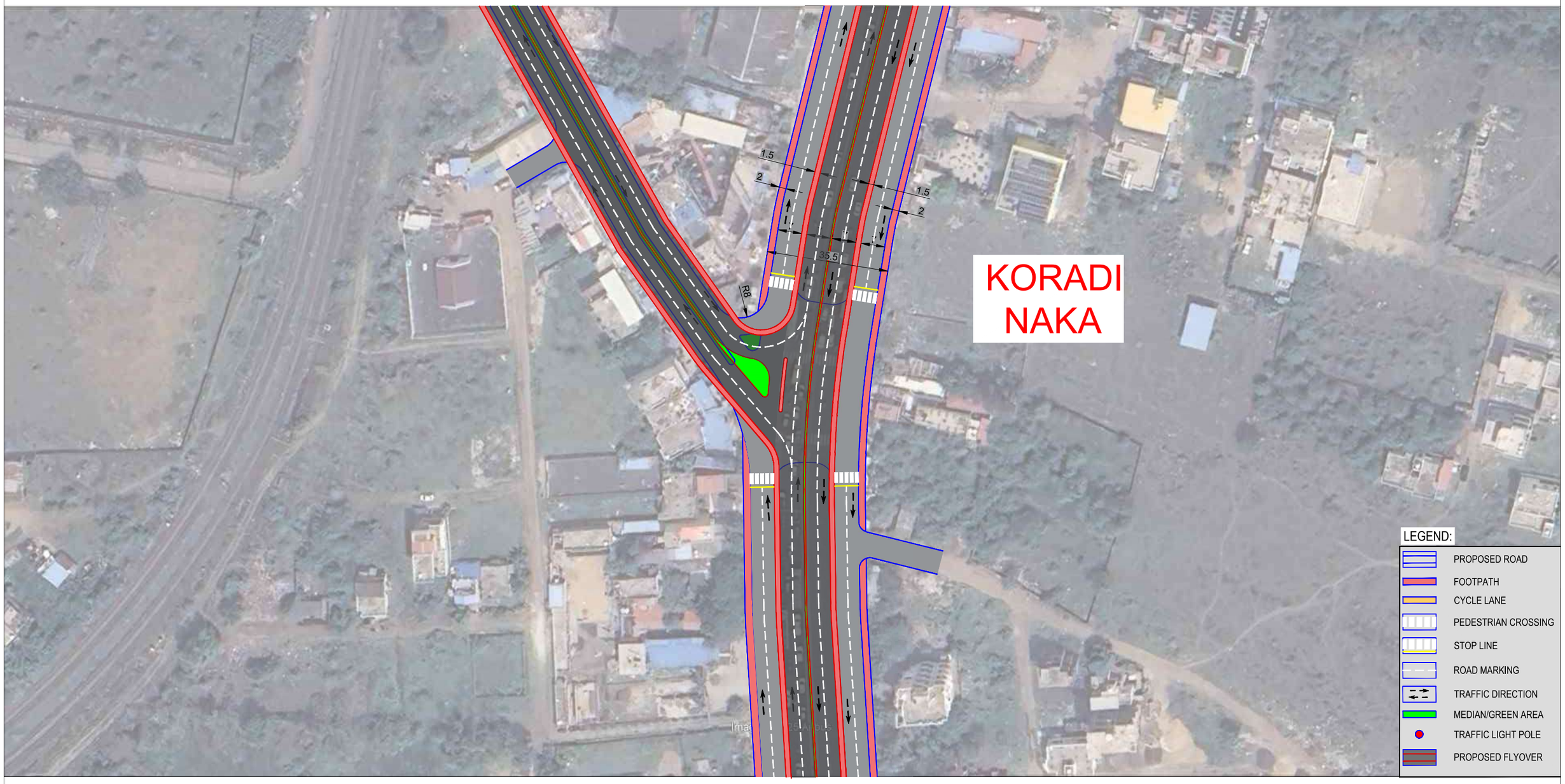

HINGNA
T-POINT
PETROL
PUMP
R30
R20
R12
R8
1.5
2
3.5
23.5
24
LEGEND:
PROPOSED ROAD
FOOTPATH
CYCLE LANE
PEDESTRIAN CROSSING
STOP LINE
ROAD MARKING
TRAFFIC DIRECTION
MEDIAN/GREEN AREA
TRAFFIC LIGHT POLE
Image © 2025 Airbus
Google Earth


MANEWADA CHOWK
PETROL PUMP
PETROL PUMP
PETROL PUMP
R6
R20
R60
R10
R9
R12
R3
1.75
3.5
32.5
19
LEGEND:
PROPOSED ROAD
FOOTPATH
CYCLE LANE
PEDESTRIAN CROSSING
STOP LINE
ROAD MARKING
TRAFFIC DIRECTION
MEDIAN/GREEN AREA
TRAFFIC LIGHT POLE
PROPOSED FLYOVER
Image © 2025 Airbus

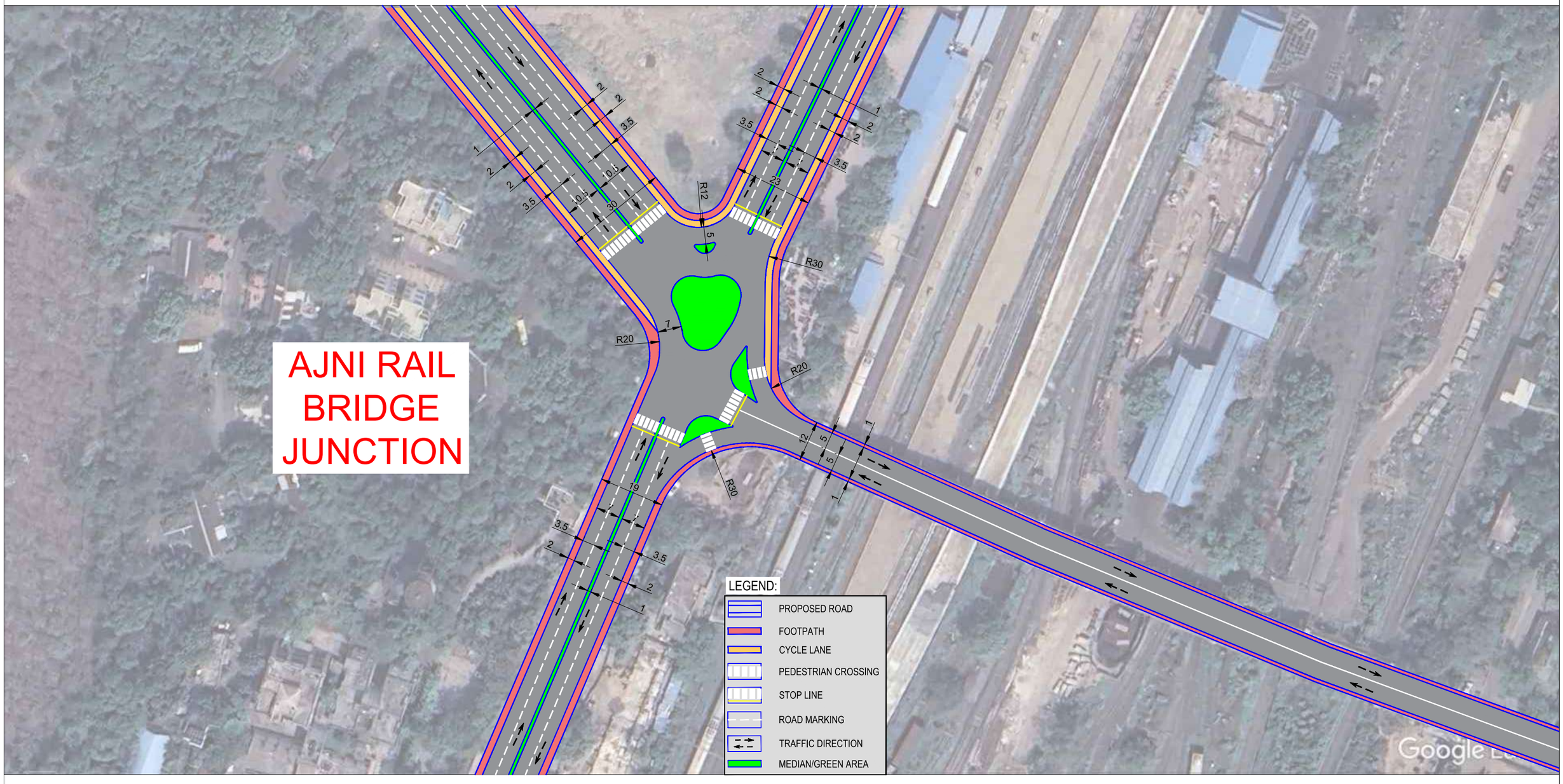

KAMPTEE
LEGEND:
PROPOSED ROAD
FOOTPATH
CYCLE LANE
PEDESTRIAN CROSSING
STOP LINE
ROAD MARKING
TRAFFIC DIRECTION
MEDIAN/GREEN AREA
TRAFFIC LIGHT POLE
PROPOSED FLYOVER
Image © 2025 Airbus
Google Earth

YASHVANT RAO STADIUM CHOWK

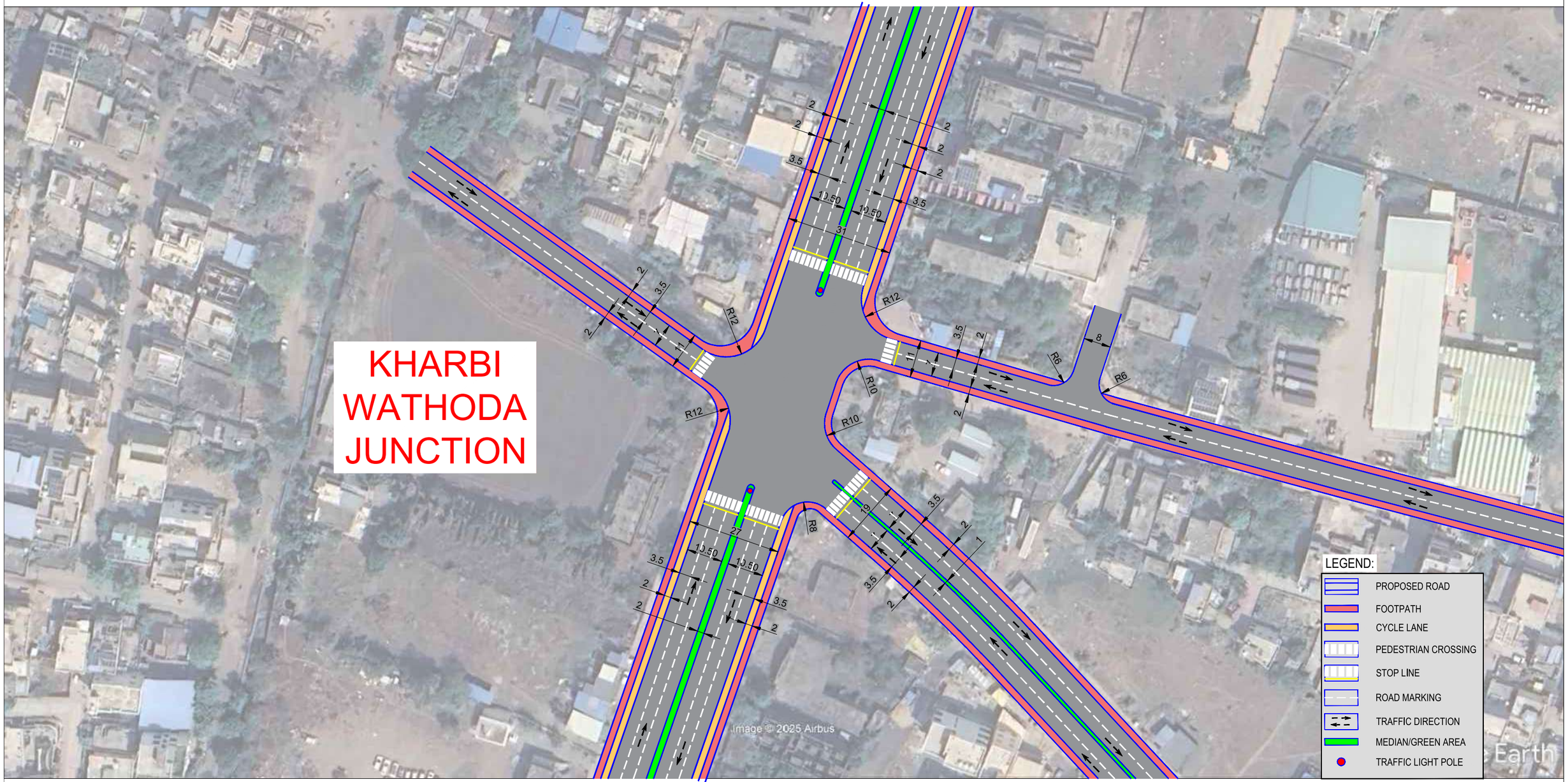



KORADI
NAKA
1.5
2
35.5
R8
LEGEND:
PROPOSED ROAD
FOOTPATH
CYCLE LANE
PEDESTRIAN CROSSING
STOP LINE
ROAD MARKING
TRAFFIC DIRECTION
MEDIAN/GREEN AREA
TRAFFIC LIGHT POLE
PROPOSED FLYOVER

AJNI RAIL BRIDGE JUNCTION



KHARBI WATHODA JUNCTION



Chapter – 5
IMPLEMENTATION PLAN

5. IMPLEMENTATION PLAN

5.1. PREPARATION OF IMPLEMENTATION PROGRAM

The implementation program of various projects like Public Transport Improvement Plans, Road Development Plans, NMT Facility Improvement Schemes and Mobility Management Measures will be implemented on the basis of prioritization. The distribution of proposals in the study area is presented in **Table 5.1.**

TABLE 5-1 DISTRIBUTION OF PROPOSALS IN STUDY AREA

SN	Projects	Units	Total Quantity
1	**NMT Facility Improvement Plan**		
a	Footpath (1.5-2 m wide)	Km	156
b	NMV Lane (2-2.3 m wide)	Km	125
c	At Grade Pedestrian Crossing Facilities	Nos.	32
d	Grade Separated Crossing Pedestrian Facilities	Nos.	17
2	**Mobility Management Measures**		
a	Automatic Off-Street Parking	ECS	1400
b	Intelligent Traffic Management System	Location	175
c	Public Bicycle Sharing (PBS)	Location	120
d	Intersection Improvements	Nos.	10
3	**Public Transport Improvement Plan**		
a	High Capacity MRTS	Km	36.5
b	Medium Capacity MRTS	Km	40.5
c	Electric Buses	Nos.	3493
d	Bus Terminal Improvements	Location	2
e	New Bus Terminals	Location	4
f	Railway Station Improvement	Location	5
4	**Freight Infrastructure Improvement**		
a	Freight Terminals	Nos.	4
5	**Road Improvement Projects**		
a	Road Widening and Improvement (existing 1/2 lanes to 2/4 lanes)	Km	71.3
b	New Road (4 lane divided C/W)	Km	15.6
c	Rail Over Bridges (4 lane carriageway) (30m Rly span, 6.5m vertical clearance)	Nos.	3
d	Flyovers/ Underpass	Nos.	8

Source: RITES estimation

5.1.1 Unit Rates Adopted

The CMP recommends various transport infrastructure proposals for the Study Area to cater the travel demand up to the horizon year. The unit rates of various components have been adopted after reviewing previous reports for past studies/projects. The rate for various proposals is presented in **Table 5-2.**

TABLE 5-2 UNIT RATES (AT 2024 PRICES LEVELS)

SN	Projects	Adopted Units	Unit Rate (Rs)
1	**NMT Facility Improvement Plan**		
a	Footpath (1.5-2 m wide)	Sq. m	2,100
b	NMV Lane (2-2.3 m wide)	Sq. m	2,100
c	At Grade Pedestrian Crossing Facilities	Sq. m	1,000
d	Grade Separated Crossing Pedestrian Facilities	per location	20,00,000
2	**Mobility Management Measures**		
a	Automatic Off-Street Parking	ECS	4,00,000
b	Intelligent Traffic Management System	per location	1,00,00,000
c	Public Bicycle Sharing (PBS)	per location	20,00,000
d	Intersection Improvements	per location	55,00,000
3	**Public Transport Improvement Plan**		
a	High Capacity MRTS	per km	2,50,00,00,000
b	Medium Capacity MRTS	per km	1,10,00,00,000
c	Electric Buses	Nos.	1,00,00,000
d	Bus Terminal Improvements	Nos.	5,00,00,000
e	New Bus Terminals	Nos.	20,00,00,000
f	Railway Station Improvement	Nos.	5,00,00,000
4	**Freight Infrastructure Improvement**		
a	Freight Terminals	Nos.	20,00,00,000
5	**Road Improvement Projects**		
a	Road Widening and Improvement (existing 1/2 lanes to 2/4 lanes)	sq. m	4,100
b	New Roads (4 lane divided C/W)	sq. m	4,100
c	Rail Over Bridges (4 lane carriageway) (30m Rly span, 6.5m vertical clearance)	per location	50,00,00,000
d	Flyovers/ Underpass	per location	45,00,00,000

Source: tentative rates based on past studies/projects.

Based on the above unit rates, Broad cost estimates of the proposal schemes have been worked out at the 2024 prices level. Total cost has been calculated to assess the requirement for funds **(Table 5.3).**

TABLE 5-3 PHASE WISE COSTING OF THE PROJECTS

SN	Proposals	Units	Quantity				Cost (Rs. In Cr)			
			Phase-I	Phase-II	Phase-III	Total	Phase-I	Phase-II	Phase-III	Total
1	**NMT Facility Improvement Plan**									
a	Footpath (1.5-2 m wide)	Km	156.0	-	-	156	131.0	-	-	131.0
b	NMV Lane (2-2.3 m wide)	Km	56.9	68.6	-	125.5	47.8	57.6	-	105.4
c	At Grade Pedestrian Crossing Facilities	Location	32.0	-	-	32	12.8	-	-	12.8
d	Grade Separated Crossing Pedestrian Facilities	Location	17.0	-	-	17	3.4	-	-	3.4
2	**Mobility Management Measures**									
a	Automatic Off-Street Parking	ECS	1,100.0	300.0	-	1400	44.0	12.0	-	56.0
b	Intelligent Traffic Management System	Location	175.0	-	-	175	175.0	-	-	175.0
c	Public Bicycle Sharing (PBS)	Location	50.0	40.0	30.0	120	10.0	8.0	6.0	24.0
d	Intersection Improvements	Location	10.0	-	-	10	5.5	-	-	5.5
3	**Public Transport Improvement Plan**									-
a	High Capacity MRTS	Km	36.5	-	-	36.5	9,125.0	-	-	9,125.0
b	Medium Capacity MRTS	Km	13.6	26.9	-	40.5	1,496.0	2,959.0	-	4,455.0
c	Electric Buses	Nos.	2785	143	565.2	3493.2	2,785.0	143.0	565.2	3,493.2
D	Bus Terminal Improvements	Location	2.0	-	-	2	10.0	-	-	10.0
e	New Bus Terminals	Location	2.0	2.0	-	4	40.	40.0	-	80.0
f	Railway Station Improvement	Location	1.0	1.0	3.0	5	5.0	5.0	15.0	25.0
4	**Freight Infrastructure Improvement**									
a	Freight Terminals	Nos.	2.0	1.0	1.0	4	40.0	20.0	20.0	80.0
5	**Road Improvement Projects**									-
a	Road Widening and Improvement (existing 1/2 lanes to 2/4 lanes)	Km	16.2	55.1	-	71.3	46.5	158.1	-	204.6
b	New Road (4 lane divided C/W)	Km	-	-	15.6	15.6	-	-	89.5	89.5
C	Rail Over Bridges (4 lane carriageway) (30m Rly span, 6.5m vertical clearance)	Nos.	-	2.0	1.0	3	-	100.0	50.0	150.0
d	Flyovers/ Underpass	Nos.	2.0	3.0	3.0	8	90.0	135.0	135.0	360.0
	Total						**14,067.0**	**3,637.8**	**880.7**	**18,585.5**

Source: Tentative rates based on past studies/projects.

5.2. PRIORITIZATION OF SUB-PROJECTS

The proposals will be implemented in phases, with funding requirements outlined accordingly. The suggested three-phase approach (Phase I, Phase II, and Phase III) is based on city needs, Land acquisition, and Feedback from stakeholders. The projects evolved in the CMP are prioritized in the following manner as presented in **Table 5.3.**

i. NMT Improvement Projects

The NMT Improvement Projects involves development of footpath, NMV lanes, pedestrian crossing facilities, public bicycle sharing schemes, foot over bridge/subway along major roads having more pedestrian movement etc. **Table 5-3** gives the phasing and broad cost estimates of sub projects under NMT improvement projects.

Based on the ROW availability and need for providing NMT connectivity, the NMT corridors are considered either on one side or both sides of the road. In case of constraints with the ROW, the NMT corridor is planned along with Footpath. The width of the development of NMT corridor along with footpath is considered as per the IRC standards.

ii. Mobility Management Measures

Mobility Management Projects include parking management, provision of multilevel parking and on-street parking proposals, signages and markings, rectification of accident-prone locations, junction improvements and ITS. **Table 5-3** gives the phasing and broad cost estimates of sub projects under mobility management projects.

iii. Public Transport Improvement Projects

The Public Transport projects proposals include major travel corridors (MRTS), existing bus/rail terminals improvements, new directional bus terminals and bus routes are also proposed which need to be developed in synchronization with the municipal corporation. **Table 5-3** gives the phasing and broad cost estimates of sub projects under public transport.

iv. Freight Terminals

Directional wise Freight Terminals are proposed at the periphery of the arterial roads of the city in different locations. **Table 5-3** gives the phasing & broad cost estimates of sub projects under terminals.

v. Road Network Improvement Projects

Road Infrastructure Improvement includes development of flyovers, rail over bridges, road widening, new road links etc. **Table 5-3** gives the phasing & broad cost estimates of sub projects under road infrastructure improvement.

The urban mobility plan has a total cost of ₹18,585 Cr, spread over three phases as presented in **Table 5.4**. The Public Transport Improvement Plan is the largest component, costing ₹17,188 Cr, emphasizing enhanced mass transit. Road Improvement Projects account for ₹804 Cr, focusing on arterial upgrades. NMT Facilities and Mobility Management Measures receive ₹253 Cr and ₹260 Cr, respectively, promoting sustainable and inclusive mobility. Freight infrastructure improvements are allocated ₹80 Cr, ensuring comprehensive urban transport development.

TABLE 5-4 URBAN MOBILITY PROJECT PHASING

SN	Urban Mobility Components	Cost (Rs in Cr)			
		Phase 1	Phase 2	Phase 3	Total
i.	NMT Facility Improvement Plan	195.0	57.6	-	**252.7**
ii.	Mobility Management Measures	234.5	20.0	6.0	**260.5**
iii.	Public Transport Improvement Plan	13,461.0	3,147.0	580.2	**17,188.2**
iv.	Freight Infrastructure Improvement	40.0	20.0	20.0	**80.0**
v.	Road Improvement Projects	136.5	393.1	274.5	**804.2**
	Total (Rs in Cr)	**14,067.0**	**3,637.8**	**880.7**	**18,585.5**

5.3. FUNDING OF PROJECTS & MONITORING OF CMP

5.3.1 Financing Options

The financing options considered for various transport infrastructure proposals for Nagpur are shown below:

- **Equity Sharing Model** - Under this model, a Special Purpose Vehicle (SPV) is set up as a joint venture between Central Government and State Government for the implementation of the project and for its subsequent Operation & Maintenance. Here, the Government of India and State Government make equal equity contribution and run SPV as a commercial enterprise. The remaining amount can be arranged as soft loan from funding agencies.

- **Public Private Partnership** - PPP is cooperation between a public authority and private companies, created to carry out a specific project. In a PPP for a new transport infrastructure development project, the public authority creates a secure environment for the private sector to carry out the project, and the private partner offers its

industry know-how, provides funding and shares in the project's risk. The decision to undertake a public-private partnership and the kind of PPP to be developed depends on the following factors:

- Cost of the project
- A well-structured institutional framework and the local authority's experience in developing transport projects
- The tasks entrusted to the private sector (design, construction, development, operation, maintenance)
- If the project is not self-financing, How the sharing of responsibilities and risks are undertaken etc.

- **Government Sources of funding -** One of the particularities of the urban transport sector is that it depends on funding from several sources and involves various partners, public and private, individual and collective.

  - Viability Gap Funding
  - Dedicated Urban Transport Fund at city level etc.

5.3.2 Implementation Mechanism

The possible areas of the urban transport projects for various implementation agencies are involved. Low capital intensive with moderate technical requirements and high social responsibility projects can be taken up by ULBs. High capital intensive and more technical required projects like MRTS and structural projects shall be through the co-operation of State and Central governments on SPV format with loan from multilateral funding agencies. Projects with overlapping responsibilities but with high return potential with less risk and less gestation period shall be through private sector by BOT/Annuity formats. Private sector participation will be in the areas of high profitability with less/medium risks. Hence it is necessary to identify the appropriate areas for different types of private sector participation for implementing urban transport components. Private sector involvement in urban transport component can be in following forms:

- Projects with social responsibility on sponsorship patterns (eg: improvement and maintenance of junctions).
- Annuity format of BOT projects which have less return potentials and high capital intensive (eg: Development and maintenance of City Roads in Trivandrum City).
- Commercial projects BOT projects (eg: Coimbatore Bypass in Tamil Nadu, Bridge connecting Wellington Island and Mattancherry in Kochi in Kerala).
- PPP for urban bus services (eg. AICTSL for Indore city bus operation for the bus services proposed for the Study Area)

5.3.3 Indirect sources for funding Urban Transport infrastructure

A number of reports by various organizations (CRISIL, Price Waterhouse Coopers, the World Bank, the Asian Development Bank, and others) have drawn attention to the indirect values created by transportation projects, suggesting that these could be tapped for potential funding of the projects themselves. Among the indirect benefits identified in these reports, the two most important are:

Transit Oriented development and Land value capture: Investments in urban transport lead to higher property values in developed areas (and to higher municipal rates linked to those properties), to greater orientation of development along transit directions, to better anchors for land use planning, etc. Not only do private property owners indirectly benefit from the higher values of their holdings around new infrastructure, sometimes their rights to develop their properties are also gifted freely by cities and transit systems hoping to boost ridership.

According to various studies, the value is estimated at between 5% - 10% for residential properties, and between 10% - 30% for commercial properties. To generate funding from the value created in the proximity zones, a 'Betterment Levy' or 'Land Value Tax' can be imposed. This tax is aimed at landowners as it focuses on land value rather than property value. The tax is designed to capture the value created by the provision of public services surrounding the areas in which the services have been provisioned.

Revenue Estimation investigates and assesses the potential revenue generation that may be derived from the transit-oriented development planning initiatives along the MRTS corridor, bus terminals, truck terminals, ring roads etc. through various value capture techniques. Revenue from TOD planning initiatives may be generated through various ways like sale of additional FSI, revenue from stamp duty, property tax, sale of premium towards ancillaries, development charges etc.

Property development is a key factor for success of the project. Evidence continues to mount that transit can generate tremendous value by concentrating development and activity around stations and that this value can be captured and used to fund station area improvements and community benefits. Process of property development requires land, labour, capital, entrepreneurship and management as major inputs.

Development rights granted by cities to the areas near the transportation project, either at very low cost to owners or in some cases free. These benefits could instead be held in escrow by the transport project itself and made available to property owners on a paid basis, with the money earned through such transactions available to under-write a portion of the project costs.

Fuel Cess: Another source of income is from private vehicles through taxes levied on their consumption of fuel. Typically, cities can add taxes or cess applicable within their jurisdiction, collecting money for use in making improvements to public transport schemes. Given the rising use of private vehicles, and the large amounts of money that can be collected by even a small cess on fuel purchases, this could be an important source of money for cities.

Urban Transport Tax: Urban Transport Tax or Cess may be levied on the purchase of new cars and two wheelers.

Carbon Credits: Another source of funds that has emerged in recent years is carbon credits, typically traded between industrialized countries that operate at high levels of per-capita pollution, and less industrialized economies where the per-capita climate impacts are much smaller. In the short run, these credits allow richer economies to phase out their shift from carbon-intensive production, and also allow poorer countries to source funds for their project needs. Credits are also available for countries' willingness to choose less carbon-intensive choices for their own industries, and some Indian entities (e.g. bus operators in some states) are examining ways of seeking such credits for the use of biodiesel in their vehicles. However, the overall trading scenario around such credits is full of uncertainty and is likely to be determined by global climate talks. Wherever they are available, however, they can be tapped to augment other sources of funds.

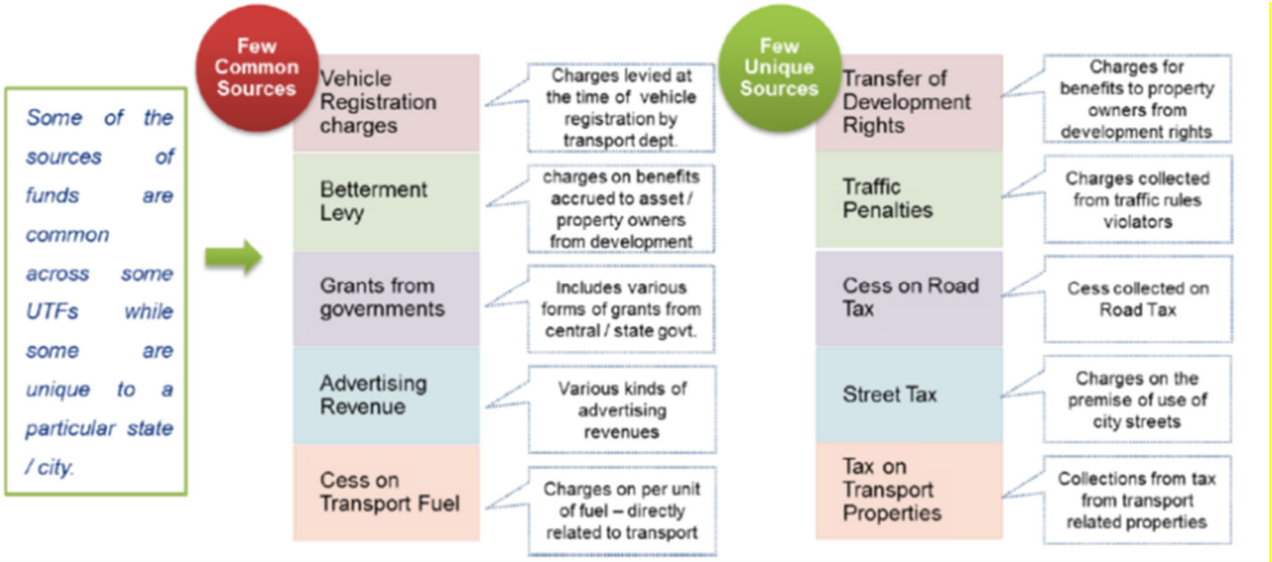
Urban Transport Fund (UTF): As recommended in the NUTP, states and cities are being encouraged to set up UTFs in order to receive dedicated revenues to be used exclusively for meeting the needs of urban transport. The NUTP mentions some of the potential revenue sources for such UTFs, which include a supplement to the petrol and diesel taxes, a betterment levy on landowners, and tax on employers etc.

Four options for geographical coverage of an UTF have been identified: UTF at the state level for the whole state; UTF for a particular municipal / urban area; UTF at the state level for urban areas that do not have their own UTF or UTF for UMTA jurisdiction. There are multiple advantages of having UTF at municipal / urban area level. One is that the funds are specifically available for meeting the urban transport needs of a single city. Another is that the amount of funding is better known at the local level than at the state level and therefore a UTF at a municipal / urban area will allow for better planning. Third is that the use of the funds can better be prioritised according to the local needs. Since it is envisaged that UMTA should be established at municipal levels, the preferred option is to have UTF with jurisdiction similar to UMTA jurisdiction.

Different sources of funds have been identified by different states while setting up UTFs. In most of the UTFs, a major source of funding is from the Government. This

has taken different forms such as budgetary allocations, government grants, grants through schemes etc. Several other sources of funds have been identified to supplement funding from government resources. Some of these sources of funds are common across various UTFs while others are less common. For example, cess on vehicle registration is used as a common source of funding in many of the UTFs. Similarly, betterment levy (which is also a suggested source of fund in the NUTP) is one of the common sources in some of the UTFs. In some of the UTFs, there are provisions of receiving funds from international funding agencies such as World Bank, ADB etc.

FIGURE 5.1 FIGURE SOURCES OF FUNDS



5.4. ACTION PLAN AND BUDGET PLAN

The implementation of all the proposals made under Transport System Plan require number of activities to be undertaken by city municipal corporation, local planning authority, State Government and other concerned organizations. It is important that a multi-pronged effort is initiated on all fronts to enable speedy, concerted and coordinated action. The following agenda for action is suggested:

- Approval of CMP by Maha Metro, and other concerned departments/ agencies, GoM & MoHUA, GoI
- Prepare Detailed Project Reports for all projects recommended, tendering, and award of contract, construction and project management
- Mobilization of resources from various sources
- Set up of Maharashtra Transport Development Fund
- Budget allocation for projects
- Identification and selection of Private Sector enterprise for projects to be developed under PPP model.

- Identification of land for the various components of the Plan (road widening, multi-level parking areas, bus terminals, freight terminals etc.)
- Setting up of Unified Metropolitan Transport Authority (UMTA) constituted by GoM.
- Strengthening logistics support to Traffic Police
- Review and revision of Transport Polices and Transport Plan on a periodic basis (every 5 years)
- Promotion and facilitation of private sector participation in all components of Transport Plan (Roads, Parking Facilities, Terminals, Public Transport, etc.).
- Private sector Involvement in development, operation and management of parking areas (both on street and off-street).
- Wide publicity and public education programs

5.5. STAKEHOLDER CONSULTATION

The CMP proposals as presented in Chapter 4 of this Report have been finalised with Stakeholder Consultation held during the Study. The major stakeholders are:

- Maha Metro
- Divisional Commissioner, Nagpur Region
- Commissioner of Police, Nagpur
- District Collector, Nagpur
- NMC
- NIT
- MSRDC
- Public Works Department
- MSRTC
- MIDC
- AAI
- NMRDA
- RAILWAY
    - Divisional Railway Manager, Central Railway, Nagpur
    - Divisional Railway Manager, South East Central Railway, Nagpur
- RTO
    - Regional Transport Officer, Nagpur (Urban)
    - Regional Transport Officer, Nagpur (Rural)
- NHAI
    - RO, NHAI
    - PD, NHAI (2)
- Zila Parishad, Nagpur
- Nagar Parishad (City Council)
- Tahsildars

    - Tahsildar, Nagpur City
    - Tahsildar, Nagpur Rural
    - Tahsildar, Hingna
    - Tahsildar, Kamptee
- Gram Panchayats
    - Sarpanch, Nagar Panchayat, Hingna
    - Sarpanch, Gram Pachayat, Butibori
    - Sarpanch, Gram Pachayat, Kapsi
    - Sarpanch, Gram Pachayat, Kanhan
- Butibori Manufacturers' Association (BMA)
- Kamptee Cantonment Board
    - Brigadier, Kamptee Cantonment Board, Kamptee
- MADC

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