Sustainable City Strategy - Bhopal

Sustainable Cities - Integrated Approach Pilot (SCIAP)

UN-HABITAT
FOR A BETTER URBAN FUTURE

Bhopal Municipal Corporation
नगर पालिक निगम, भोपाल

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SUBMITTED TO:

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FOR A BETTER URBAN FUTURE

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It documents the Sustainable City Strategies (SCS) which are intended to be targeted and cater to specifically identified issues for each of the five pilot cities - Bhopal, Guntur, Jaipur, Mysuru and Vijayawada during the City Profile and Diagnostic stage. The report is produced using data provided by the state and urban local bodies of the four participating states and additional geospatial data collected from the National Platform for Sustainable Cities, European Space Agency. Knowledge material published by UN-Habitat, The World Bank, other agencies are referred to formulate the Sustainable City Strategies. While UN-Habitat checks data, information to the fullest extent possible, the responsibility for the accuracy of the data, information lies with the original providers of the data. Information contained in this Report is provided without warranty of any kind, either express or implied, including, without limitation, warranties of merchantability, fitness for a particular purpose and non-infringement. UN-Habitat specifically does not make any warranties or representations as to the accuracy or completeness of any such data, information.

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SUSTAINABLE CITY STRATEGY- BHOPAL

Sustainable Cities Integrated Approach Pilot (SCIAP)
Component 1: Sustainable Urban Planning and Management

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List of Acronyms

BCLL	Bhopal City Link Limited
BMC	Bhopal Municipal Corporation
BSCDCL	Bhopal Smart City Development Corporation Limited
COVID-19	Coronavirus Disease-2019
CSR	Corporate Social Responsibility
DoIT&C	Department of Information Technology and Communication
GoAP	Government of Andhra Pradesh
GEF	Global Environment Facility
GIS	Geographical Information System
GoR	Government of Rajasthan
GPSC	Global Platform for Sustainable Cities
LPA	Local Planning Area
MoEFCC	Ministry of Environment, Forests and Climate Change
MoHUA	Ministry of Housing and Urban Affairs
NGT	National Green Tribunal
NIUA	National Institute of Urban Affairs
NPC	National Productivity Council
PWD	Public Works Department
SBM	Swachh Bharat Mission
SPAB	School of Planning and Architecture, Bhopal
SAPCC	State Action Plan on Climate Change
SCIAP	Sustainable Cities – Integrated Approach Pilot
SCS	Sustainable City Strategy
TNCP	Town & Country Planning Department
ULB	Urban Local Body
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UN-HABITAT	United Nations Human Settlements Programme
UN-HABITAT ROAP	United Nations Human Settlements Programme Regional Office for Asia & the Pacific
UNICEF	United Nations Children's Fund
UNIDO	United Nations Industrial Development Organization
USAF	Urban Sustainability Assessment Framework
WHO	World Health Organization

Statue of Raja Bhoj along the VIP Road on Upper Lake

1 INTRODUCTION

1.1 Report Objectives

The Sustainable City Strategy (SCS) consitutes the final step of a three-step process under the Sustainable Cities Integrated Approach Pilot (SCIAP) Component 1 of the project. The first two steps being the application of the Urban Sustainabilty Assessment Framework (USAF) captured in the Urban Sustainability Indicators Report (USIR) and the City Profile and Diagnostic Report. The City Profile and Diagnostic Report identified very specific diagnostic issues, which essentially were the key problem areas, obstacles and developmental challenges being faced by Bhopal. These challenges were ascertained on the basis of evidence collected and assesed through the USAF[1]. As the third and final step, this report documents the SCS for Bhopal which is a spatial strategic plan with very specific actions and interventions designed to be targeted and impact-oriented on ground. These strategies will strengthen and enable city leadership and managers to drive future development based on quantifiable data and assessment using rational decision-making.

In this context, the main objectives of this report are:

i) To identify strategic development opportunities for the city based on spatial evidence aligned with local, state and national policies and regulations.
ii) To design cross-sectoral and intra-sectoral strategies for an inclusive, sustainable and resilient future development of the city, and contribute towards improving the city's climate emissions profile.
iii) To design and develop area-based, transformative interventions to demonstrate change on ground
iv) To ascertain specific actions and interventions necessary for transformative impact over a five-year period
v) Recommend convergence with national/state missions for financing and technical resources

1.2 Approach and Methodology

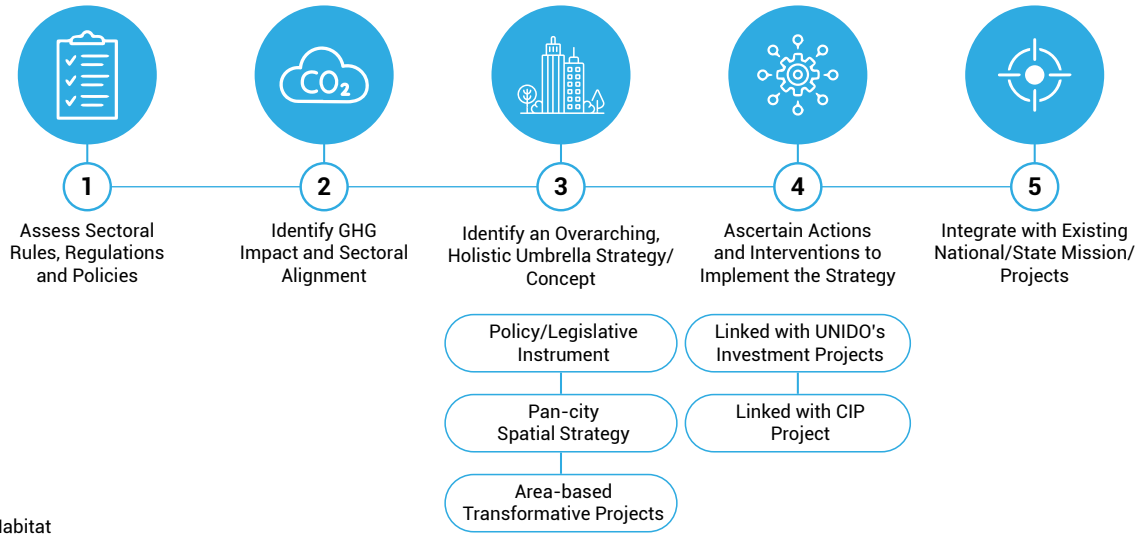
The foundation of the SCS is in the New Urban Agenda (NUA) with the following five pillars (except Pillar 1, since it is beyond the scope of SCIAP) of the NUA has been the guiding document in framing the SCS.

i) National Urban Policies (NUPs)
ii) Rules and Regulations
iii) Urban Planning and Design
iv) Financing Urbanization
v) Local Implementation

A detailed guidance note on the development of the SCS has been given in Annex 1. The strategies could take the form of pan-city, inter-sectoral, spatial interventions; area-based projects; and even legislative/policy based instruments. Emphasis was given to the carbon footprint profile of sectors and the relationship with the intended strategic interventions to ensure that maximum carbon capturing is achieved. Significant effort has been made to ensure convergence with projects and sectors covered by the national missions and state schemes/policies with the recommended interventions.

The overarching steps followed for the development of the SCS have been illustrated in Figure 1.1.

FIGURE 1.1 Sustainable city strategy development process



Source: UN-Habitat

1 The Urban Sustainability Assessment Framework was developed by UN-Habitat India as a part of the SCIAP project. Further details are available in the Urban Sustainability Assessment Framework Report.

1.3 Scope and Limitations

The SCS is intended to be very targeted and caters to specifically identified issues in the previous stage of the project. Unlike a master plan with a longer project horizon of ten to twenty years, this strategic plan has a timeframe of five years. It does not intend to be a master plan and look at all development sectors and resolve all challenges of a city. However, the SCS does base its recommendations considering their impact on various sectors from the USAF and their interrelatedness.

This SCS will help the municipal corporations to identify the following:[2]

1. Where are the areas of growth and what type of growth?
2. Where should investments from various national and state missions/schemes be located to maximize their impact on vulnerable social sections?
3. How can the existing natural and economic assets of the city be preserved and enhanced?
4. How can quality of life and equitable provision of urban amenities be enhanced?
5. How may interventions be prioritized to ensure practicality and maximum impact?

The following limitations need to be considered while assessing the strategic interventions:

1. The cost estimates have been calculated on block cost thumb rules derived from industry standards adopted in the national missions of India. All assumptions have been included in detail for context-building and understanding.
2. The concept designs and spatial location of proposed interventions are shown for approach demonstration purpose only, the interventions would require detailed planning and engineering studies to arrive at accurate costing and spatial design.
3. The greenhouse gas (GHG) savings given for the strategic interventions are based on very high-level standards and metrics since these must be calculated at the detailed design stage with site specific inputs.
4. The analysis of legislations and policies is limited to its high-level implication of diagnostics issues. The SCS does not intend to provide detailed assessment of legislative framework, nor is it intended as an amendment to existing policy and legislative frameworks.
5. The SCS are based on secondary data sources available within the public domain, which may be limited. Primary data involves the data collected through site visits and stakeholder consultations by the UN-Habitat team.
6. In some aspects of issue assessment and strategy-building, certain assumptions have been made where the latest spatial data, such as land use and population densities of Bhopal, was unavailable from the Urban Local Bodies (ULBs).

2 https://unhabitat.org/sites/default/files/2014/07/A-guide-for-Municipalities-Inclusive-and-Sustainable-Urban-Development-Planning-Volume-1.pdf.

Taj-ul-Masajad and Motia Talab

2 CITY DIAGNOSTICS

2.1 Climate Context and GHG Emission Profile

2.1.1 Climate profile and projections

Bhopal has a sub-tropical hot summer, dry winter, and well distributed rainfall during the southwest monsoon season (June–September). The mean monsoon rainfall over the district is around 1,015 mm and maximum rainfall is received during the months of July and August. The district receives more than 53 days of good rainfall during the summer and monsoon months. The mean monthly maximum temperature ranges from 34°C to 41°C during summer, which also is the driest period of the year.

The Draft Climate Change and Environment Action Plan of Bhopal District, 2022, was prepared by the Environment Planning and Coordination Organisation (EPCO). The key highlights on climate predictions are summarized below.

Warm days have gone up by 10 per cent: The daily maximum temperature in May goes up to 42°C. The maximum temperatures show an increasing trend during April and May with an accelerated rise from 1990s onwards. The maximum temperature shows a significant increasing trend in April and May. This trend has accelerated over the last two decades. Bhopal district is projected to experience a warming of 2°C to 3°C under RCP4.5[3] and a warming of 2°C to 5°C under RCP8.5. The percentage of warm days is also projected to increase by more than 35 per cent in forthcoming years.

Cold days are decreasing: The minimum temperatures during winters (December, January, and February) range from 9°C to 10°C, with January being the coldest month in the district. The year-on-year variability of minimum temperature shows an increasing trend for all three months, particularly during January. The number of cold days (in percentage) may decrease in all the epochs with changing climate conditions.

Rainy days are projected to increase in the coming decades: The monsoon rainfall does not show any significant trend. July and August are the principle monsoon months for the district. The variability in rainy days has been high, showing a slight decreasing trend in the monsoon months for the period 1951-2018. The seasonal rainfall of the district is projected to increase by 5–21 per cent under RCP4.5 and by 17–39 per cent under RCP8.5 emission scenarios. The number of rainy days is also projected to increase during the monsoons, particularly during July and August.

2.1.2 GHG emissions profile

In 2015-16, Bhopal emitted a total of 36,60,161 Mt CO_2-eq from seven sectors, including, stationary energy, transportation, waste, Industrial Processes and Product Use (IPPU), and agriculture, forestry and other land use (AFOLU). The total CO_2, CH_4, and N_2O emitted were 27,67,923 Mt, 27,286 Mt, and 484 Mt, respectively.

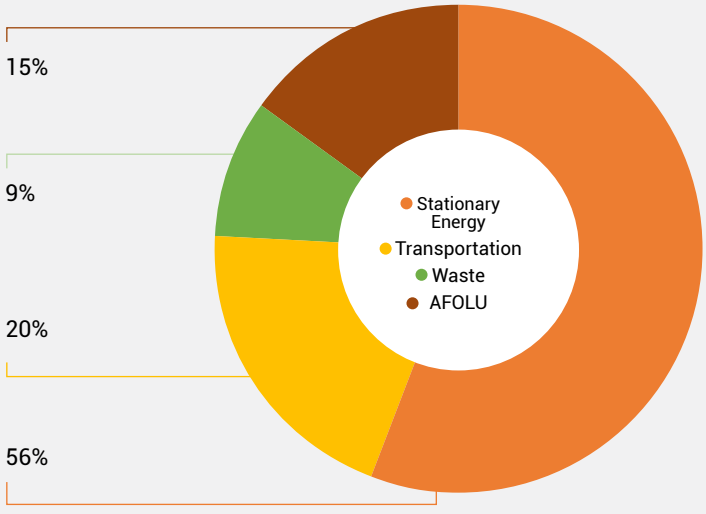
The city's emissions trend is summarized in Figure 2.1. Emissions from stationary energy were the highest generators of GHGs (56 per cent), followed by the transportation sector (20 per cent), and the AFOLU (15 per cent), in Bhopal city during 2015-16.

The key highlights of GHG emissions in Bhopal district as per the draft District Climate Change Action Plan, 2022, are:

- **GHGs have increased three-fold since 2005:** Between 2005 and 2019, the total GHG emissions of Bhopal district increased by 291.80 per cent from 0.57 million tonnes (MT) of CO_2-eq in 2005 to 2.21 MT CO_2-eq in 2019 at a compounded annual growth rate (CAGR) of 10.25 per cent.
- **Energy sector is the highest contributor of emissions:** The energy sector (direct fuel combustion in transport, agricultural, and residential categories, etc.) emits the highest volume of GHGs. Although energy emissions of Bhopal district increased at a CAGR of 5.31 per cent, its share has decreased from 84 per cent in 2005 to 52 per cent in 2019 due to increase in AFOLU emissions.
- **From a net sink in 2011, AFOLU is now leading high GHG emissions:** The AFOLU sector has generated very high GHG emissions due to constant reduction of forest cover. It may be noted that the sector was a net sink until 2011. Between 2012 and 2015, however, emissions from the sector grew at a CAGR of 9.66 per cent (see Figure 2.2).

3 Representative concentration pathways (RCPs) are concentration pathways used by the IPCC. They are prescribed pathways for greenhouse gas and aerosol concentrations, together with land use change, that are consistent with a set of broad climates outcomes used by the climate modelling community. The pathways are characterized by the radiative forcing produced by the end of the 21st century. Radiative forcing is the extra heat the lower atmosphere will retain as a result of additional greenhouse gases measured in Watts per square metre (W/m²). There are four RCPs, RCP2.5 (low pathway, where radiative forcing peaks at approximately 3 W m-2 before 2100), RCP4.5 and RCP6.0 (two intermediate stabilization pathways in which radiative forcing is stabilized at approximately 4.5 W m-2 and 6.0 W m-2 after 2100) and RCP8.5 (high pathway for which radiative forcing reaches greater than 8.5 W m-2 by 2100).

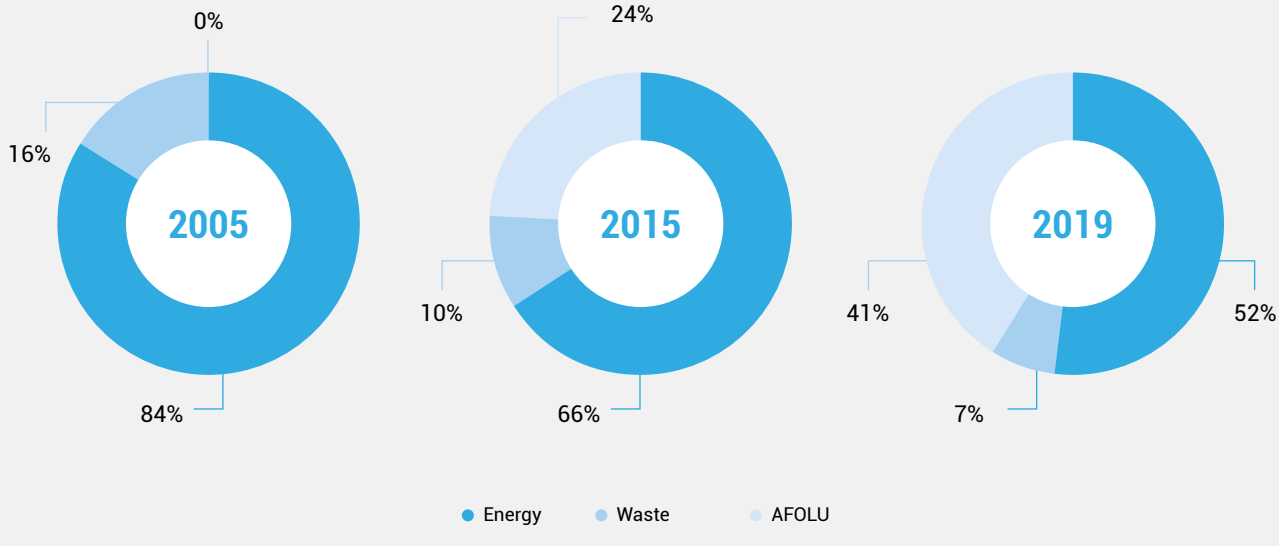
FIGURE 2.1 GHG emission profile of Bhopal for 2015-16



Source: GHG Accounting and Capacity Building for the Cities of Jaipur, Bhopal, Mysore, Vijayawada and Guntur as a first step under the GEF-UNIDO-MoUD Project (2017)

- **Waste sector's GHG emission share is decreasing:** Emissions from the waste sector slowed down to a CAGR of 2.89 per cent, with its share of total GHG emissions in Bhopal dropping from 16 per cent in 2005 to seven per cent in 2019.
- **Business-as-usual scenario is not an option:** If no action is taken and/or relevant policies put in place to mitigate this scenario, total GHG emissions in Bhopal are likely to increase by 342 per cent by 2030, over 2015 levels.

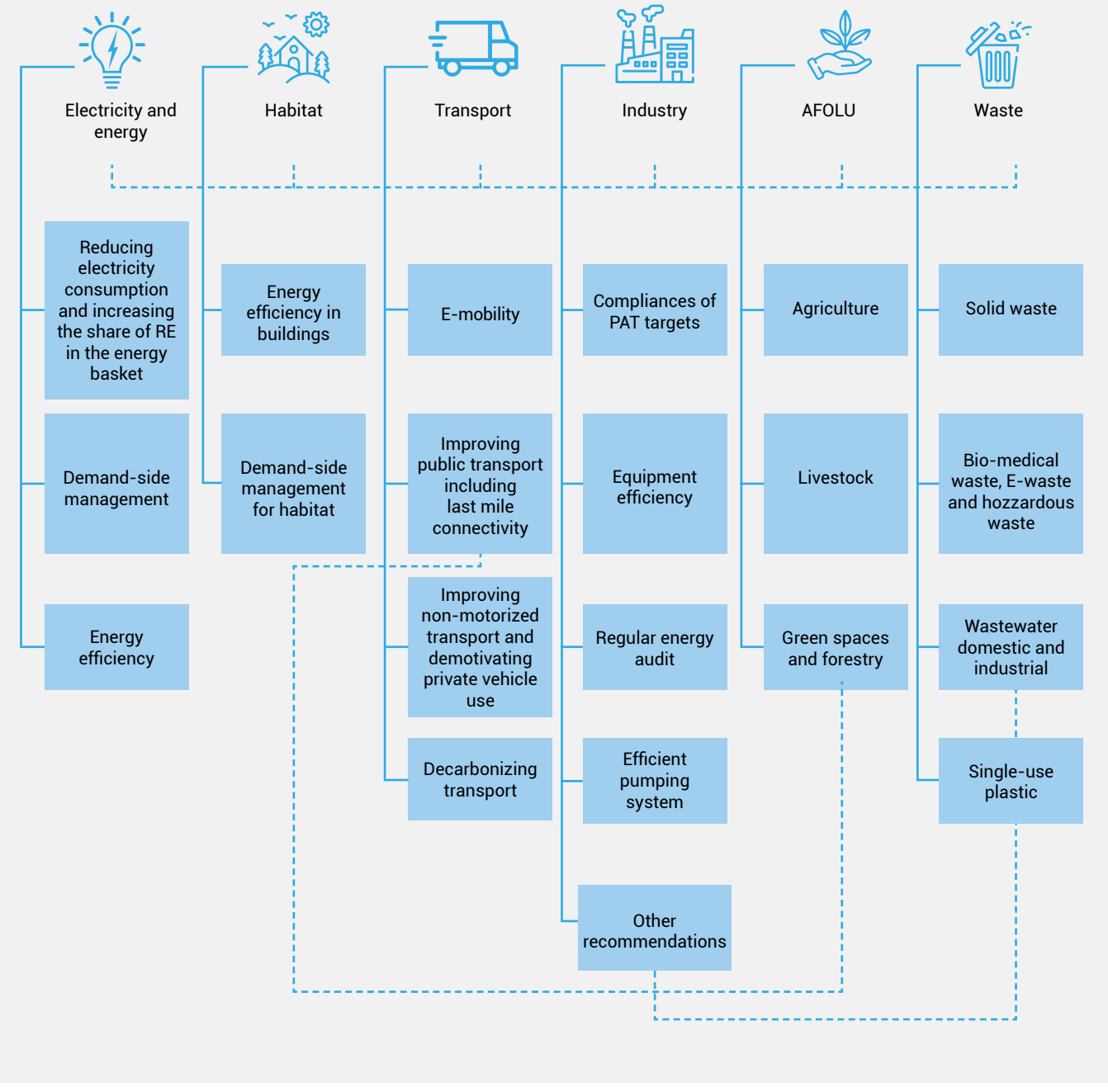
FIGURE 2.2 Contribution of GHG emissions in Bhopal from different sectors in 2005, 2015 and 2019



Source: Draft Climate Change Action Plan for Bhopal District, 2022

The key sectoral recommendations from the draft Climate Change Action Plan for Bhopal District are summarized in Figure 2.3. These recommendations, especially for the habitat and transport sectors, act as guidelines for formulating sustainable city strategies for Bhopal.

FIGURE 2.3 Key sectoral recommendations from Bhopal District Climate Change Action Plan 2022



Source: Draft Climate Change Action Plan for Bhopal District, 2022

2.1.3 Natural hazard vulnerability

The State Disaster Management Plan for Madhya Pradesh, 2014, classifies Bhopal District as 'moderately vulnerable', mainly due to its abundant natural resources, progress in socio-economic development, and infrastructure development in recent years.[4]

Bhopal is moderately vulnerable to flooding and waterlogging during the monsoons. The topography of the city drains most of the rainwater into its lakes; however, factors like encroachment along waterbodies, blockage of storm drains and decrease in permeable surfaces have led to increasing cases of waterlogging in recent years. Similarly, the city is moderately prone to drought due to scanty rainfall conditions. The region largely practices rain-fed agriculture and, hence, any variation in the monsoons can push it towards drought.

Yes

Prepared after 2016

Presence of City Disaster Management Plan prepared/ updated in last five years (DRM 10.1)

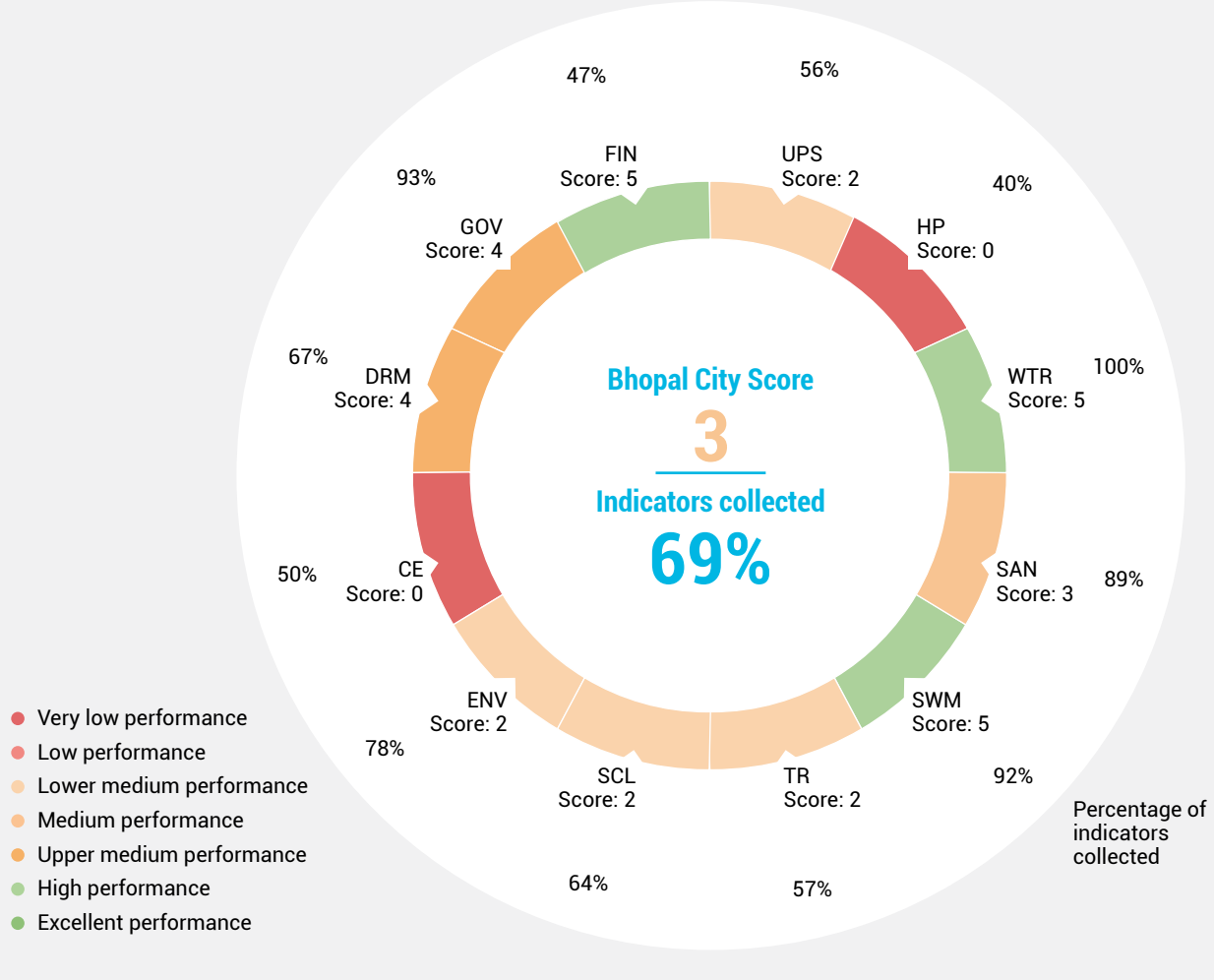
No

Existence of hazard vulnerability maps (at city level) prepared/ updated in the last five years for the main hazards threatening the city (DRM 10.2)

2.2 Sectoral Assessment

Bhopal was assessed over the 12 sectors under the Urban Sustainability Assessment Framework (USAF), namely, public space, urban form and safety, housing and property, water, sanitation, solid waste management, clean energy, disaster management, environment, transport, social facilities and services, governance and data management, finance, and economy.

FIGURE 2.4 Sectoral performance of Bhopal in 2019-20 using USAF



Source: UN-Habitat

4 "District-wise Hazard Analysis Summary of Madhya Pradesh," in The State Disaster Management Plan 2014, p. 30. http://www.mpsdma.mp.gov.in/uploads/media/MP-SDMP-2307141.pdf.

Based on the USAF assessment, the city scored an overall 3 points, denoting a medium performance. The scoring for each sector is shown in Figure 2.4, with water, solid waste management, and finance and economy leading as the top performing sectors in the city; while urban form, public space and safety, housing and property, clean energy, environment and ecology, and transportation scored the lowest.

For a sector-wise indicator performance, please refer to the Bhopal Urban Sustainability Indicators Report and for sector-wise detailed inferences, see the section, Sectoral Context (Chapter 4.4) of the ***Bhopal City Profile and Diagnostic Report.***

2.3 Key Issues Diagnosed

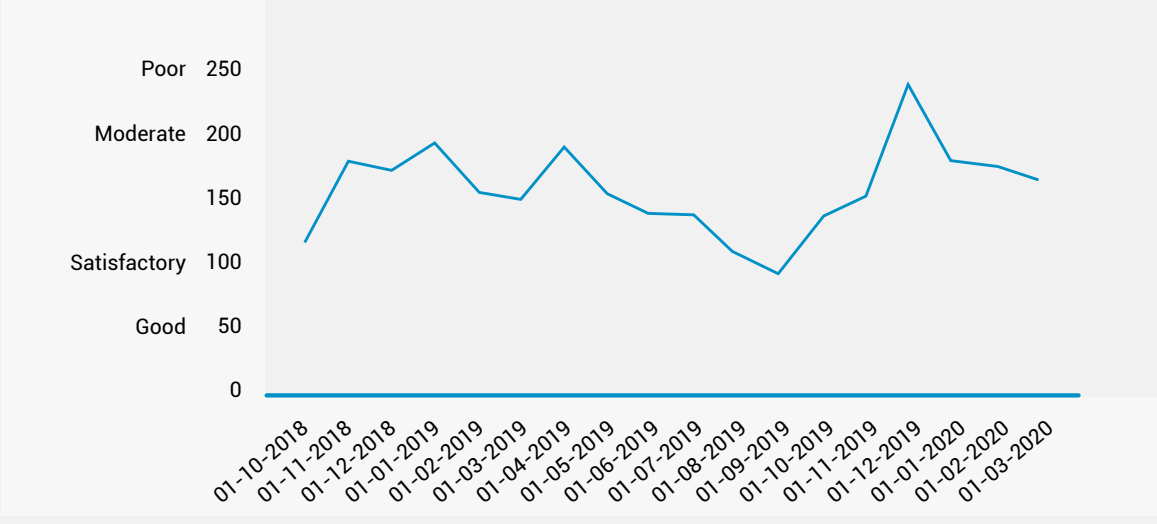
The city diagnostic study of Bhopal has identified a combination of policy, environmental and spatial factors as being the key issues facing the city. These factors are not only significant for identifying a city's strategic issues but also for developing sustainable city strategies.

Delay in revision of the Development Plan: The Bhopal Development Plan 2005, which was prepared in 1999 for 240 sq. km., is still used as a guideline for the city's spatial development. The revision of the plan was initiated in 2016 and a draft Bhopal Development Plan (BDP) – 2031 was prepared in 2018. The draft plan will be in effect after the approval from the state government, which is still pending. According to the diagnostic study, the past two decades show an unchecked trend of low density–low rise development and reduced coherence with Bhopal's urban environment.

Low density development: The net population density of the Bhopal Municipal Corporation (BMC) in 2020 was 56.8 persons per hectare (PPH). By 2005, BMC's jurisdiction increased four times to 285 sq. km. from 71.23 sq. km., to accommodate the predicted additional population growth, which did not occur. In 2014, the city's boundary was again increased to 417 sq. km. to include Kolar Census town within BMC's administrative area. The draft BDP 2031 has considered a target density of 100 PPH for future development, which may further promote low density development, resulting in low utilization of urban land.

Increasing air pollution: The pollution in the city is increasing[5] due to the use of fossil fuels, felling of trees[6] and dust from development activities. As per Figure 2.5, the city's AQI in 2018-2020 was in the range of 'moderate to poor'. The AQI in Bhopal varies seasonally and the poorest air quality is typically seen during the winters (November to February). The AQI during the monsoons (June–September) is comparatively lower than the winters.

FIGURE 2.5 Monthly average AQI from October 2018 to March 2020 in Bhopal



Source: Madhya Pradesh Pollution Control Board

5 https://timesofindia.indiatimes.com/city/bhopal/bhopal-chokes-with-poor-air-quality-index/articleshow/72282917.cms
6 https://timesofindia.indiatimes.com/city/bhopal/toxic-times-air-in-major-mp-cities-not-fit-for-breathing/articleshow/80657174.cms

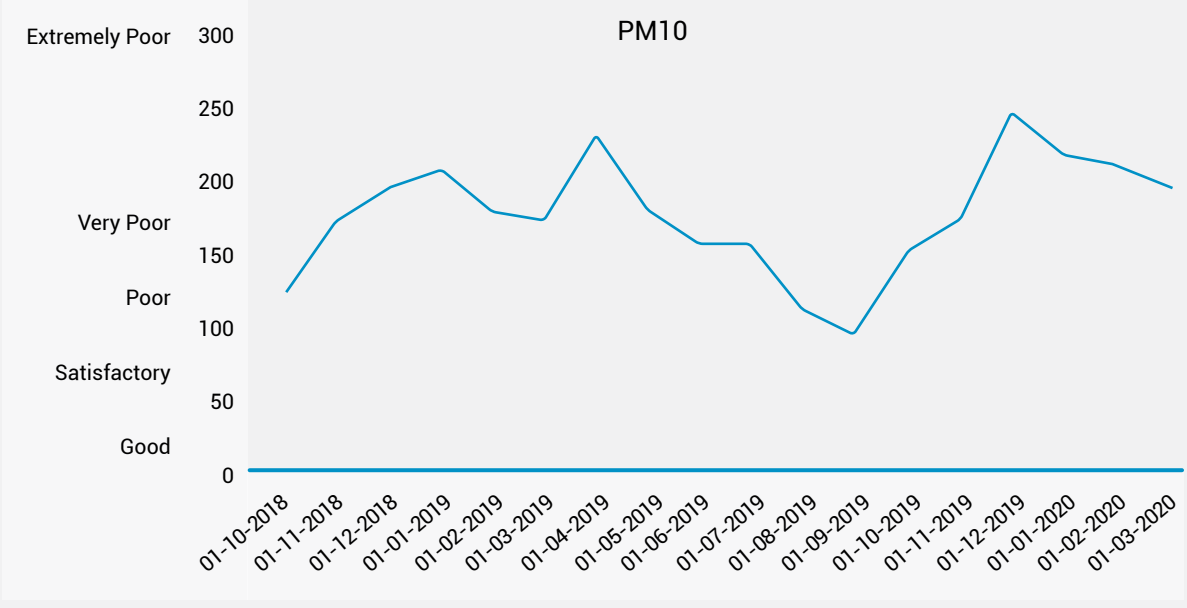
Residual particulate matter of size 10 microns (PM10) is produced by burning fossil fuel and dust from development activities.[7] As per Figure 2.5, during 2018-2020, PM10 in Bhopal ranged from 'poor' to 'extremely poor', which can cause breathing discomfort and respiratory ailments among residents.

The under-performing sectors and identified key issues in Bhopal are the opportunity areas where significant improvement is warranted. These include improvements in public space, mobility infrastructure and compact development, which have a direct impact on pollution and air quality. Further, the city needs more focussed attention in protecting its immediate ecosystem by preserving the existing biodiversity.

These multi-sectoral issues were deduced after careful analysis of data. Specific thematic issues were identified for Bhopal after USAF inter-sectoral linkages, which were reiterated by consultations with city officials (see Chapter 4.4, Bhopal City Profile and Diagnostic Report). These issues are:

1. Sprawling urban development pattern
2. Endangered natural assets
3. High dependence on fossil fuel and sub-optimal use of non-motorized transport (NMT)
4. Vulnerability in informal settlements

FIGURE 2.6 Variation of PM10 concentration from 2018 to 2020



Source: Madhya Pradesh Pollution Control Board

2.3.1 Strategic issues diagnosed using USAF

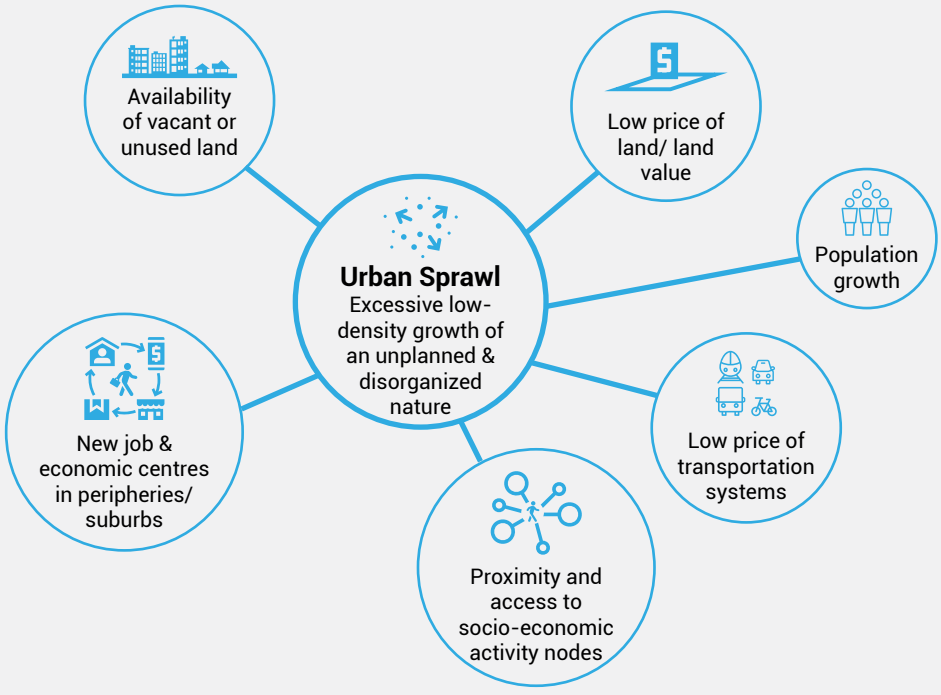
The four most critical issues affecting Bhopal threaten the equilibrium of its natural ecosystems, contribute significantly to GHG emissions and the carbon footprint of the city. For an in-depth analysis of these strategic issues, refer to Chapter 5, ***Strategic Diagnosis of the Bhopal City Profile and Diagnostic Report***.

Sprawling Urban Development Pattern

Bhopal experiences sprawling urban development, characterized by low-rise, low-density habitation, with loss of agricultural land along the fringes, and a high dependency on automobiles.

7 National Ambient Air Quality Standards, Central Pollution Control Board, https://cpcb.nic.in/uploads/National_Ambient_Air_Quality_Standards.pdf

FIGURE 2.7 Potential causes of urban sprawl in Bhopal

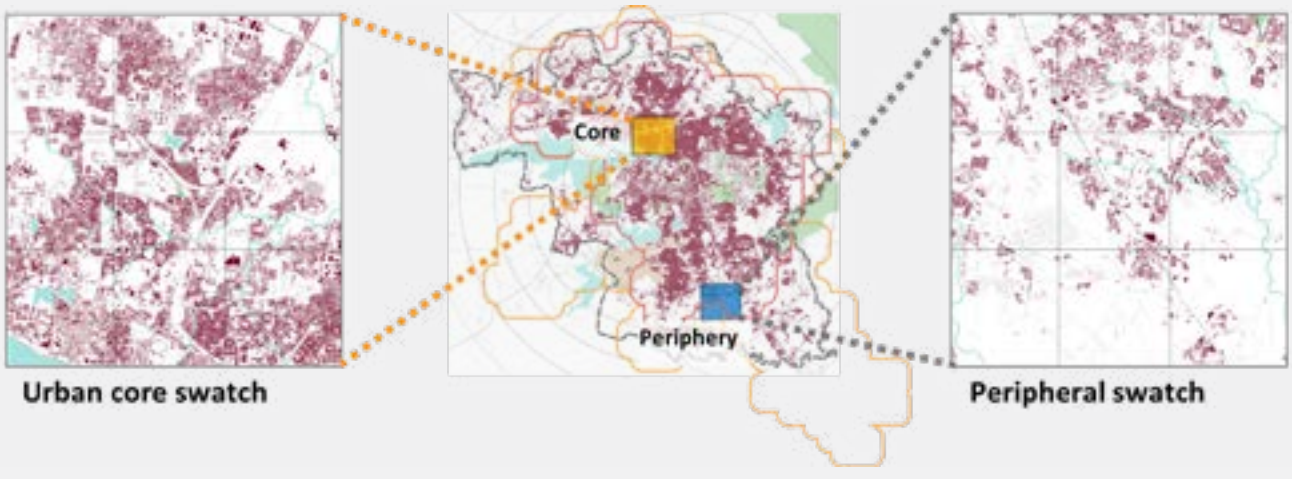


Source: UN-Habitat

The population growth rate of Bhopal during 2001–2011 reduced by 14 percentage points from 37 per cent in 2001 to 23 per cent in 2011; while the total built-up area (BuA) of the city increased by 26 per cent from 68.6 sq. km. in 2001 to 86.7 sq. km. in 2011. Additionally, the city saw two per cent increase in built-up area per capita between 2000 and 2014 (UPS 1.2). There was high variation in density within the city, with a very dense urban core as high as 600 PPH contrasting with large peripheral areas with density lower than 75 PPH. During the same period, around 25.74 sq. km. of agricultural land was converted into different uses like residential (86 per cent), industrial, commercial and public/ semi-public use (9.45 per cent), with the remaining used as forest land (4.3 per cent).[8]

Of the total 85 wards in the city, 52 (60 per cent) have a

FIGURE 2.8 Swatch analysis of urban core and periphery



Source: UN-Habitat

8 As per the Bhopal City Operation Report by Earth Observation for Sustainable Development.

TABLE 2.1 Density assessment in urban core and periphery using swatch analysis

Urban Core Swatch	Cha Racteristics	Peripheral Swatch
9	Area (sq. km.)	9
257	Road Length (km)	116
28.5	Road Density (km/sq. km.)	12.9
3.8	Built Footprint (sq. km.)	0.8
42.2%	Built Footprint Ratio	8.8%

Source: UN-Habitat

population density of less than 150 PPH, which is the recommended global practice for optimum population density for cities.[9]

As per BDP 2005, the net available land area for development was 225 sq. km.; and in 2019-20, the city's population was 23.71 lakh. Bhopal city can accommodate an additional population of **10.04 lakh** based on the net density and available land to achieve the global recommended density of 150 PPH.

The assessment of the city's coverage of urban services as part of the spatial analysis reveal that these services are concentrated in the city centre and gradually thin out towards the periphery. With less population density along the periphery, the per capita cost of providing services also increases. For instance, the city's newly developed areas have low or no access to public transportation.[10] Furthermore, according to the draft BDP 2031, the land value at the city centre is at least 2.5 times higher than the peripheral areas, thus propelling the city to spread outwards in search of affordable housing by compromising on better access to services that are available near the city core.

TABLE 2.2 Land carrying capacity of Bhopal

Population of the city in 2019-20	23,71,000
Area of the city in sq. km.	417
Current gross population density (PPH)	56.8
Area of protected land as per BDP 2005 (sq. km.)	192
Net land available for development (sq. km.)	225
Current net population density (PPH)	105.37
Additional population required to reach 150 PPH	**10,04,175**

Source: UN-Habitat

Endangered Natural Assets

Bhopal is endowed with diverse natural assets like lakes, rivulets, forest reserves, and wetlands. The city's increasing urbanization poses challenges to the delicate balance of its eco-sensitive natural assets. Factors like urban sprawl, lack of formalization of forest typology, and lack of enforcement of preservation zones have resulted in seriously endangering its natural assets.

The USAF sectoral analysis, stakeholder consultations and site visits have revealed that the implementation rate of these proposed preservation zones as per BDP 2005 is limited. The buffer zones and plantations are not developed uniformly, exposing the city's natural assets to the adverse effects of urbanization. The study of the Bhoj

9 A New Strategy of Sustainable Neighbourhood Planning: Five principles, UN-Habitat; https://unhabitat.org/a-new-strategy-of-sustainable-neighbourhood-planning-five-principles-0

10 See Section 5.2.1 – Strategic issue 1: Sprawling urban development pattern, Bhopal City Profile and Diagnostics Report.

Wetland[11] reveals that the preservation zones proposed by BDP 2005 were not implemented completely, with the extent of land use disclosing incompatibility (presence of Chirayu Hospital, a biomedical waste generator, and the BCLL bus workshop, an industrial waste generator, along the Upper Lake are not compatible with the water body) and encroachment on preservation zones. Similar conditions prevail along several water bodies in the city.

15 Years

Years since enforced master plan/ development plan was last reviewed and updated.
(Gov 11.2)

No

Is there a land use plan that includes zoning with environmental protection and preservation zones?
(ENV 8.12)

10%

Share of recreational & open green space in total developable area
(USAF UPS 1.7)

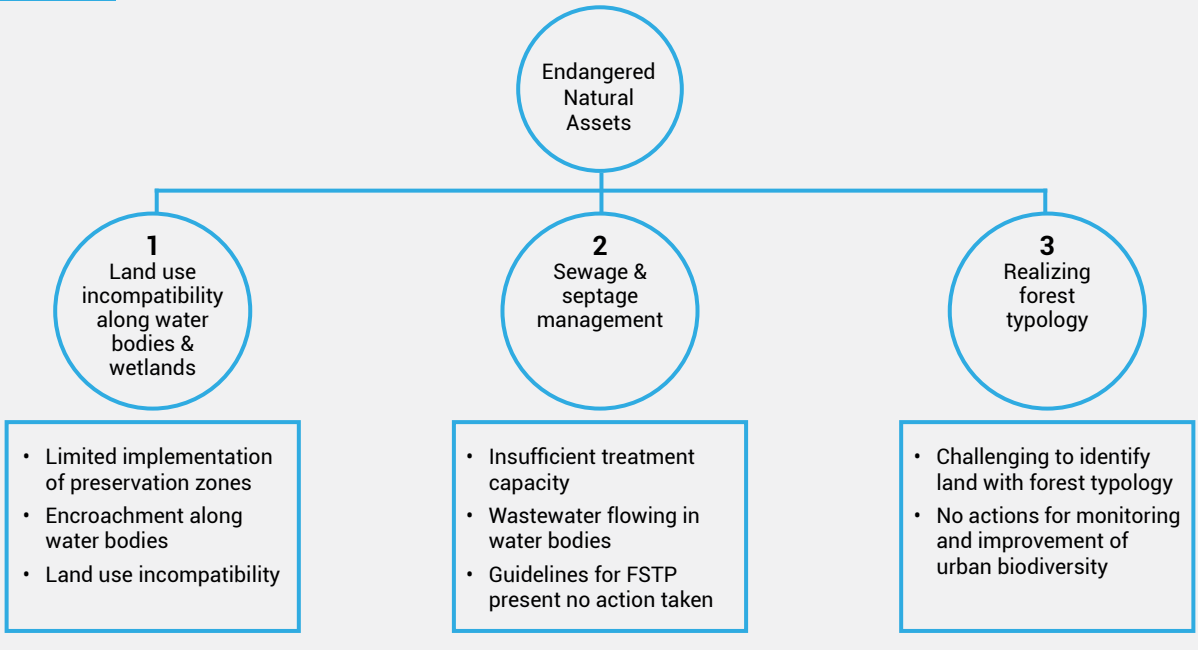
Bhopal district is surrounded by the Ratapani Forest Reserve on the East and South, an d by the forest reserves of the Betwa River Valley to the North. The 4.45-sq. km. Van Vihar National Park is a major forest area and tourist destination on the southern banks of Upper Lake. Similarly, as per the LULC analysis, around 40 sq. km. of forests and shrublands are present within Bhopal Municipal Corporation (BMC) limits.

Vulnerable Natural Asset: Kerwa–Kaliasot Area

The ridge between Kerwa Dam and Kaliasot Dam has characteristics of a tropical dry deciduous forest. According to a National Green Tribunal (NGT) order in February 2020,[12] the area should be recognized and mapped out as forest land. However, the draft BDP 2031 does not recognize the forest resources of the Kaliasot–Kerwa region and, consequently, has not proposed any preservation measures for the area. In fact, the BDP 2031 proposes the Kerwa–Kaliasot area to have public/ semi-public land use, which may encourage the undesirable development of large-scale institutional, administrative, educational, health, and social-cultural activities in the region.[13]

The issue of endangered natural assets is further compounded by sub-issues, which are illustrated in Figure 2.9.

FIGURE 2.9 Sub-issue categorization of Endangered Natural Assets strategic issue



Source: UN-Habitat

11 See Section 5.2.2, Bhopal City Profile and Diagnostic Report and Bhoj Wetland Experience and Lessons Learned Brief, 2006 (Kodarkar & Mukerjee, 2006).

12 Rashid Noor Khan vs State of Madhya Pradesh, Original application No. 159 of 2014, appeal to Central Bench of National Green Tribunal. https://timesofindia.indiatimes.com/city/bhopal/ngt-orders-fresh-mapping-of-kaliasot-kerwa-stretch/articleshow/73993202.cms.

13 Permissible uses under Public-Semi Public Land classification as per Draft BDP 2031

High dependence on Fossil Fuels & Sub-optimal Use of NMT

The transportation sector is a major generator of GHG emissions in Bhopal city. In 2015-16, emissions from the transportation sector stood at 7,10,271 Mt CO_2-eq, which was 19 per cent of the total emissions of the city.[14] Moreover, vehicular traffic in Bhopal is increasing at a rate of 10 per cent each year. Pollution in the city, as discussed earlier, is increasing[15] with the use of fossil fuel, felling of trees[16] and dust from development activities.

Of particular concern is the apparent, increasing preference for private modes of transportation—a trend which may pose serious hurdles to the viability of the city's upcoming metro rail.[17] Additionally, road safety conditions in the city are precarious, with a high number of fatalities from annual road accidents, especially among pedestrians, cyclists and motorized two-wheelers. In 2019, Bhopal ranked eighth among India's million-plus cities, with respect to the number of road accidents, according to the Ministry of Road Transport and Highways (MoRTH), Government of India.[18]

Furthermore, the sprawling urban development in the city demands integrated mobility. **Households in the northern and south-eastern parts of the city have poor access to transit stops as there is low coverage of public transportation in the newly developed neighbourhoods.** Moreover, shared vehicles are a major mode of preferred transport over public transportation. **The increase in urban sprawl and the number of vehicles have led to an increase in traffic problems, such as air pollution, increase in on-street parking, frequent traffic congestions, and increase in travel time.**

IMAGE 2.1 Under construction elevated metro corridor near DB Mall, an important commercial area in the city.

Source: UN-Habitat

14 According to GHG Accounting and Capacity Building for the Cities of Jaipur, Bhopal, Mysore, Vijayawada and Guntur as a first step under the GEF-UNIDO-MoUD Project (2017).
15 https://timesofindia.indiatimes.com/city/bhopal/bhopal-chokes-with-poor-air-quality-index/articleshow/72282917.cms
16 https://timesofindia.indiatimes.com/city/bhopal/toxic-times-air-in-major-mp-cities-not-fit-for-breathing/articleshow/80657174.cms
17 Centre for Science and Environment 2019. 'The Cost of Urban Commute: Balancing Affordability and Sustainability', New Delhi, https://www.cseindia.org/the-cost-of-urban-commute-9664.
18 Road Accidents Report 2019, among million-plus cities, by the Ministry of Road Transport and Highways (MoRTH), https://morth.nic.in/sites/default/files/RA_Uploading.pdf (accessed on 4 February 2022).

Intermediate public transportation (IPT) will remain an essential mode of transport to augment the gaps in public transportation at the neighbourhood level. Popular IPT modes in Bhopal include diesel-operated, 'magic' autos and minivans.

The spatial coverage of public cycle sharing, or 'chartered' docking stations, reveals that these facilities are concentrated in the heart of the city, where access to public transportation is high. The peripheral zones of the city are deprived of access to such bicycle docking stations and cycle tracks. Only 54 per cent of the city's roads are flanked by footpaths wider than 1.2 m., which is a 'low' performance as per USAF. Haphazard on-street parking, increasing encroachment by street vendors, and undeveloped footpaths have created despair for pedestrians in Bhopal city.

0.93%

Kilometres of bicycle paths per 100,000 population
(TR 6.2)

54%

Percentage of major roads covered by footpaths (wider than 1.2 metres) in the city
(TR 6.3)

47%

Percentage share of NMT in commuting (cycling & walking)
(TR 6.8)

Source: UN-Habitat

The local government can leverage this situation to promote cleaner modes of IPT like electric and CNG auto rickshaws, as well as build a city-wide infrastructure that is necessary for a seamless transition to cleaner fuel and power consumption.

The development of the metro rail in Bhopal could bring about new opportunities for densification under transit-oriented development (TOD), scale of options of buses, pricing in public transport fleet, and cleaner modes of IPT.

Furthermore, Bhopal has become a lighthouse city for promoting cycling in India under the flagship Smart City Mission. The city's public transportation includes a dedicated bus rapid transit system (BRTS) lane established along 24 km, and a fleet of 115 buses operating on routes spanning 400 km. Bhopal City Link Limited (BCLL) will soon add 300 buses to its fleet, to be procured under the Atal Mission for Rejuvenation and Urban Transformation (AMRUT). Additionally, the advent of the COVID-19 pandemic resulted in city-wide protocols to maintain social distancing, reduce public gatherings, and incentivize active transportation. These new situations further highlight the need for developing a robust and sustainable transportation network, which encourages more walking, cycling and other NMT.

Vulnerability in Informal Settlements

Urban growth in Bhopal has outpaced the development of appropriate housing, giving rise to overcrowded informal settlements. Informal settlements have mushroomed all over Bhopal in the past 20 years, many of which are situated on the ecologically vulnerable or infrastructure deficient pockets of the city.

The 388 informal settlements that exist in Bhopal, as identified by BMC, are home to around 36 per cent of its total households, which are located on just eight per cent of the total city area.

As shown in Map 2.1, around 90 informal settlements (23 per cent of total slums in the city) are located on eco-sensitive buffer zones. Households in the areas with a slope greater than eight degrees are prone to landslides. Informal settlements along the streams and wetlands, viz., the Kaliasot River slum cluster and the Harshvardhan Colony slum cluster, are prone to flooding and water-borne diseases.

The assessment of informal settlements based on their accessibility to six basic urban services and amenities, has revealed that around 300 households in three settlements do not have access to any of the six services. Around 194 settlements (50 per cent of total slums) have access to three or fewer urban services (see Table 2.3).

36%

Percentage of urban households living in slum/squatter settlements
(HP 2.1)

8%

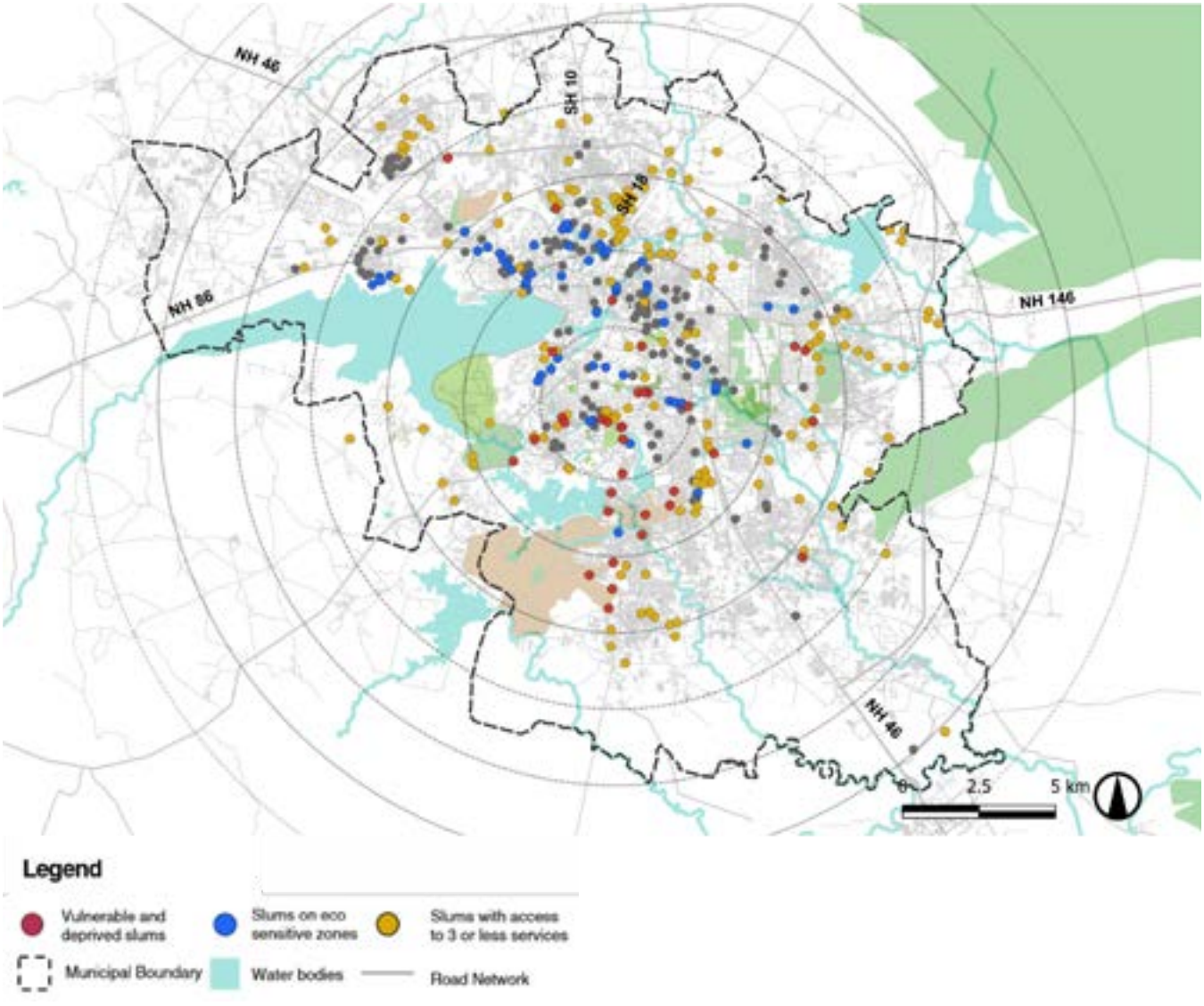
Percentage of city area under slum/ squatter settlements
(HP 2.2)

Source: UN-Habitat

TABLE 2.3 Classification of slums based on topographical vulnerability and deprivation of access to urban services

Slum Classification	Number of slums	Population	Households
Critical (Both vulnerable and deprived)	34	41,397	10,966
Vulnerable (Slums on eco-sensitive and non-buildable zones)	56	1,22,632	33,157
Deprived (Slums with access to 3 or less amenities)	160	2,30,494	63,255

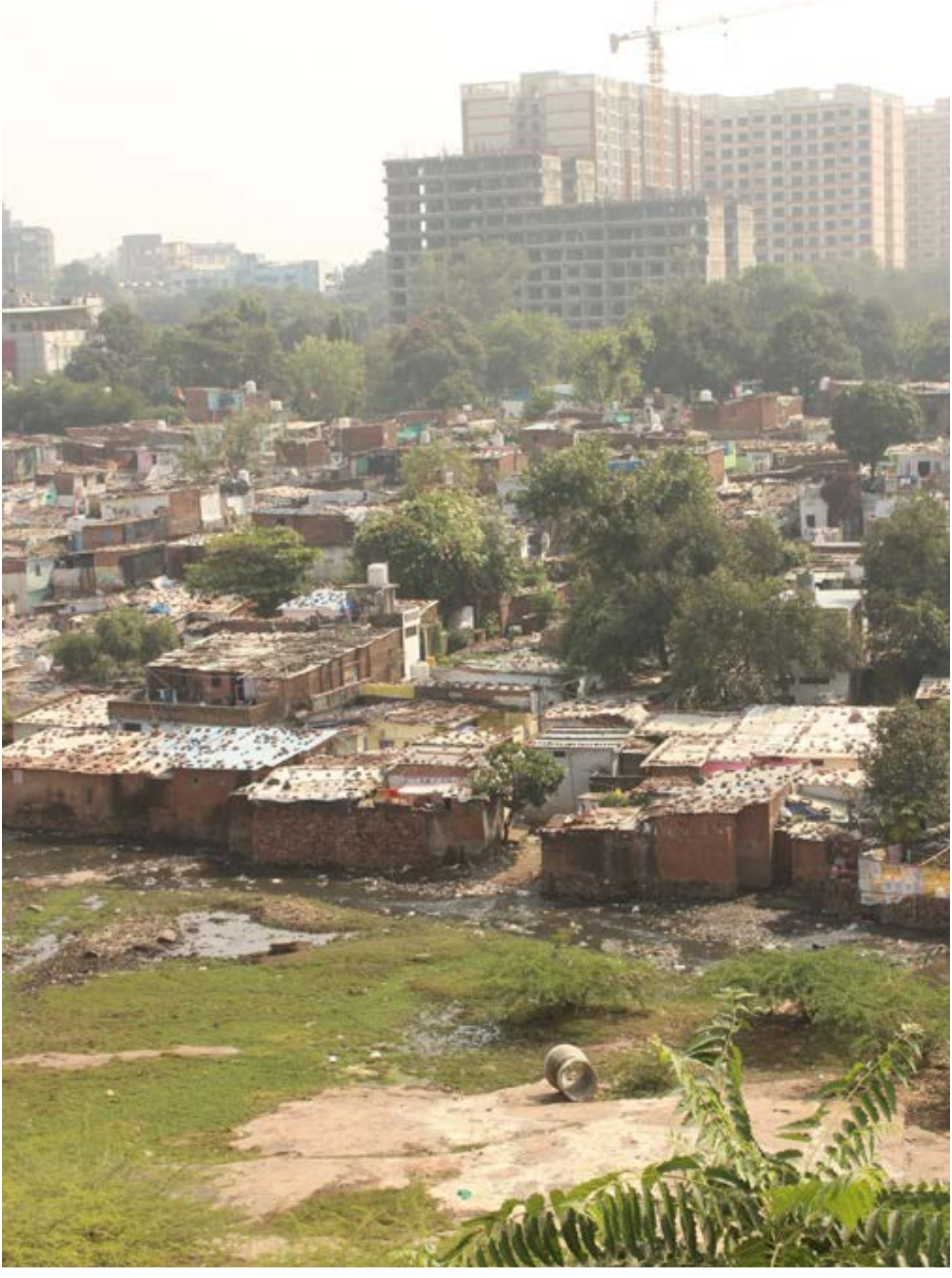
Source: UN-Habitat



Map 2.1: Classification of slums based on vulnerability and deprivation

Source: UN-Habitat

IMAGE 2.2 Banganga slums in the valley between Upper Lake and Lower Lake



Source: UN-Habitat

Chartered Cycle docking station, a public bicycle sharing initiative, along the Boat Club Road

3

STRATEGIC RESPONSES

3.1 Core Planning Principles

Four urban planning principles form the pillars for achieving a cohesive, low carbon and sustainable future for Bhopal. These planning principles anchor the resultant strategic responses to the issues outlined in Section 3.[19]

3.1.1 Principle 1: Compact cities

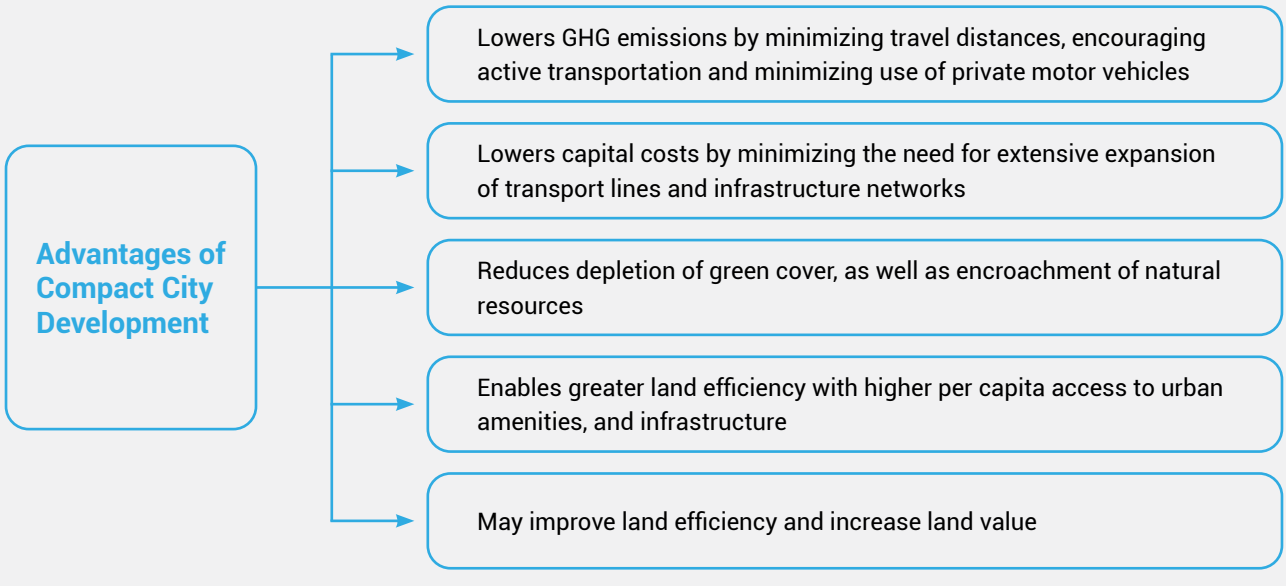
Compact cities are dense urban settlements that facilitate proximate development and low carbon growth, encouraging high per capita access to existing urban amenities and jobs.[20] The compact organization also minimizes disruption of the local ecology, enabling land use to be more diverse, while creating services and work opportunities within shorter distances. Thus, as the city becomes more compact, GHG emissions may reduce significantly[21] and the quality of life may become significantly better. The benefits of compact city development are summarized in Figure 3.1.

3.1.2 Principle II: Ecosystem restoration and enhancement

Ecosystem restoration and enhancement focuses on maintaining the critical balance between the built and natural environments. A shared vision of ecosystem restoration has been developed and defined by the UN General Assembly, in its declaration of 2021–2030 as the United Nations Decade on Ecosystem Restoration (hereafter referred as the "UN Decade"), to address the critical need to globally halt, prevent and reverse ecosystem degradation, and restore degraded ecosystems. This restorative process encompasses a wide continuum of practices, depending on local conditions and "societal choice". [22]

Through the ***Principles for Ecosystem Restoration to Guide the United Nations Decade 2021–2030,*** UNEP and the Food and Agriculture Organization of the United Nations (FAO), advise that ecosystem restoration and other nature-based solutions are essential for issues such as climate change mitigation and biodiversity protection.

FIGURE 3.1 Advantages of compact city development



Source: UN-Habitat

19 See Bhopal City Profile and Diagnostic Report for detailed information on identified strategic issues.

20 Compact City Policies: A Comparative Assessment (OECD Green Growth Studies). Organisation for Economic Co-operation and Development, 2012, https://www.oecd.org/cfe/regionaldevelopment/50524895.pdf (accessed on 10 January 2021).

21 https://newclimateeconomy.report/workingpapers/wp-content/uploads/sites/5/2018/02/Building-Thriving-Low-Carbon-Cities-An-Overview-Full-Paper-1.pdf

22 Principles for Ecosystem Restoration to Guide the United Nations Decade 2021–2030, Food and Agriculture Organization of the UN, 2021, https://www.fao.org/3/cb6591en/cb6591en.pdf (accessed on 10 January 2022).

3.1.3 Principle III: Adequate housing for all

"Access to adequate housing can be a precondition for the enjoyment of several human rights, including the rights to work, health, social security, vote, privacy or education."[23] Therefore, an impact focus on the housing sector has the potential for a comprehensive improvement to the "standard of living" and "well-being" of communities by addressing poverty reduction, inclusion, safety, economic growth and prosperity, sustainability, climate mitigation and adaptation.

The Universal Declaration of Human Rights (UDHR), 1948, under Article 25 (1), clearly states that, "Everyone has the right to a standard of living adequate for the health and well being of himself and his family, including food, clothing, housing, medical care and necessary social services, and the right to security in the event of unemployment, sickness, disability, widowhood, old age or other lack of livelihood in circumstances beyond his control."[24]

3.1.4 Principle IV: Complete streets

Complete streets should enable the safe, comfortable, and unobstructed mobility for all road users, inclusive of all ages, abilities, incomes, and ethnicities. Complete streets prioritize public transportation and NMT needs over personal motorized transport in the design, planning, operations, and maintenance of urban streets, which includes the equitable allocation of road space and development of universally accessible streets.[25]

Complete streets also help create liveable communities by enabling high-performing sustainable transportation networks and activating public spaces that may benefit the urban poor and other marginalized groups. This may lead to long-term benefits for public health, safety, land value, and the environment. In India, the Complete Streets principle is reflected in the National Urban Transport Policy (NUTP).

IMAGE 3.1 Dense built form in old city of Shahjahanabad

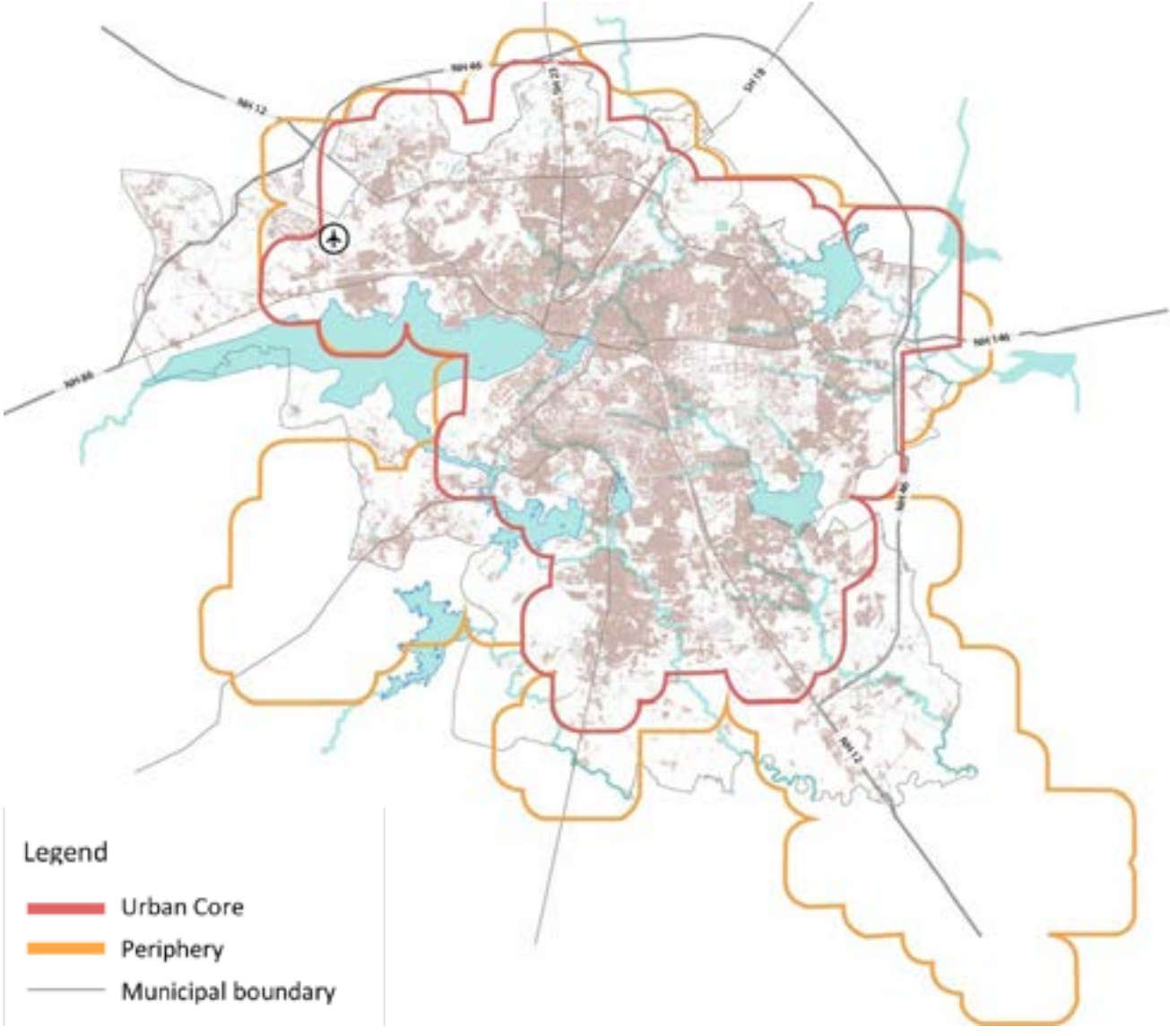
Source: UN-Habitat

24 "Right to Adequate Housing" Fact Sheet No 21. Office of the United Nations High Commissioner for Human Rights, UN-Habitat. https://www.ohchr.org/documents/publications/fs21_rev_1_housing_en.pdf.

25 National Urban Transport Policy, MoHUA, Government of India, https://www.mohua.gov.in/upload/uploadfiles/files/TransportPolicy.pdf, (accessed 6 January 2022).

3.2 Strategic Response 1: Urban Core Revitalization

The first strategic response identified for Bhopal under the SCIAP project tackles the critical issue of **sprawling urban development**.[26] This strategy outlines **urban core revitalization** that enables compact urban development and mitigates sprawl. It rests on the core planning principles[27] of Compact Cities (3.1.1), Ecosystem Restoration and Enhancement (3.1.2), and Adequate Housing for All (3.1.3). To assess the existing condition of sprawl in Bhopal, the city's urban core[28] and periphery[29] are outlined below (see Map 3.1).



Map 3.1: Representation of urban core and periphery of Bhopal
Source: EO4SD-Urban Project: Bhopal City Report by Earth Observation for Sustainable Development

26 See Section 2.3.1: Strategic Issues Diagnosed using USAF under City Diagnostics for a detailed assessment of Issue 1 - Sprawling urban development.

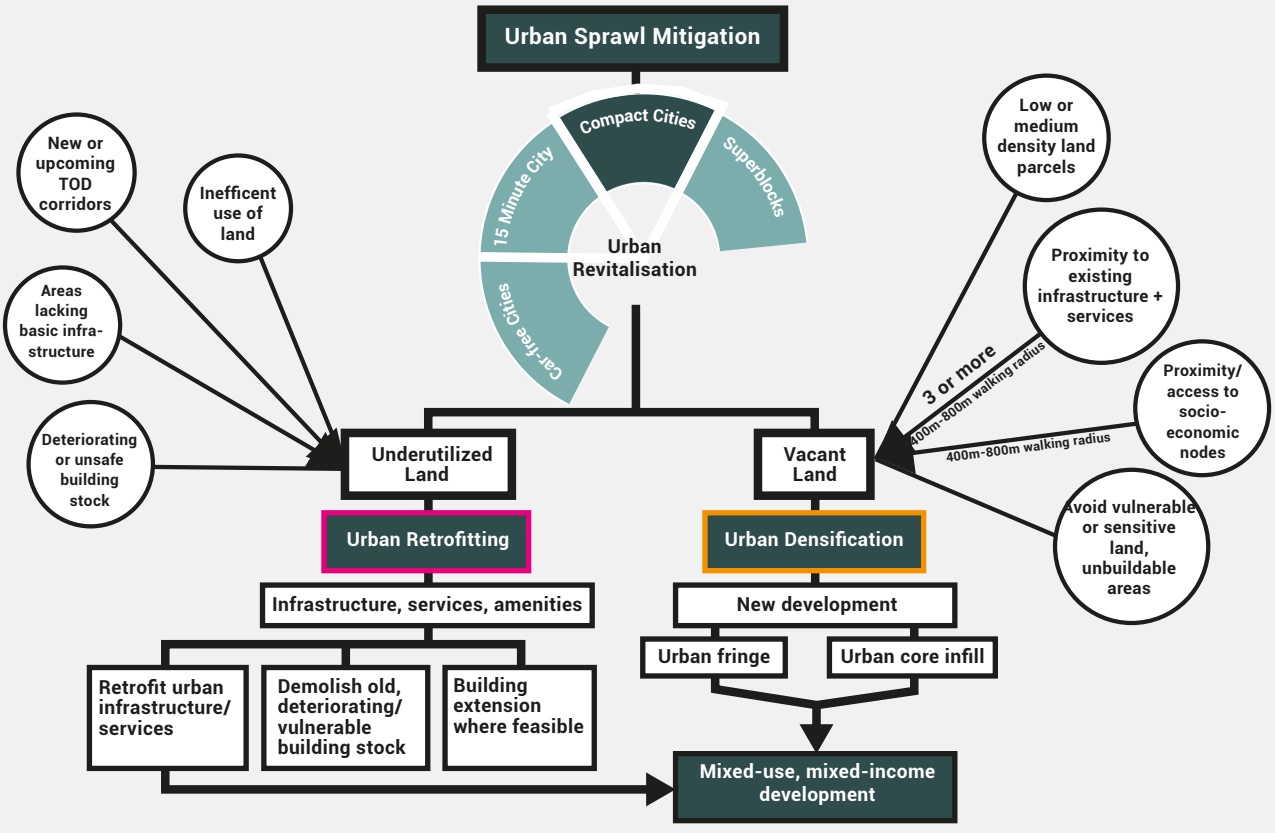
27 See Section 3.1: Strategic Responses – Core Planning Principles.

28 The urban core is defined as a high-density area having contiguous grid cells of 1 sq. km with a density of at least 1,500 inhabitants per sq. km., and a minimum population of 50,000. The contiguity is only allowed via a vertical or horizontal connection. This classification is based on the European Union's Directorate-General for Regional and Urban Policy (DG REGIO) method and follows the Global Human Settlement Population Grid, having a spatial resolution of 1 km. It Incorporates data for 1975, 1990, 2000 and 2015. (Source: EO4SD-Urban Project: Bhopal City Report by Earth Observation for Sustainable Development).

29 The periphery or peri-urban area is defined as clusters of contiguous grid cells of 1 sq. km. with a minimum density of 300 inhabitants per sq. km., and a minimum population of 500. To smoothen the border of the areas, a buffer of 1 km. is calculated around both zones. (Source: EO4SD-Urban Project: Bhopal City Report by Earth Observation for Sustainable Development).

The different methods of urban core revitalization, along with its process flow, are explained in Figure 3.2.

FIGURE 3.2 Urban revitalization process flow



Source: UN-Habitat

3.2.1 Proposed interventions within the strategic response

The strategic response of urban core revitalization involves two key interventions. These are:

Intervention 1.1: Revitalize Urban Core through Densification

a. Infill development or redevelopment
b. Promote and generate affordable housing stock

Intervention 1.2: Revitalize Urban Core via Urban Retrofitting

a. Enable seamless integration of multi-modal transport systems
b. Improve the coverage of urban amenities

Intervention 1.1: Revitalize Urban Core through Densification

As depicted in Figure 3.3, the vacant and underutilized land parcels of the urban core may be opportune sites for infill development. To enable compact development, infill sites should be low density (0-75 PPH) land parcels satisfying certain ecological and infrastructural criteria, some of which have been depicted in Figure 3.3. Vacant land parcels within the site or in the vicinity become an added advantage. Additionally, these areas should already have access to urban infrastructure and amenities within a prescribed raduis (as per the USAF, as indicated in Chapter 2) or may require minor improvements to these infrastructure networks. However, in-fill housing densification should be avoided in eco-sensitive, vulnerable, ecologically protected zones, and/or historically preserved

FIGURE 3.3 Key opportunities and constraints for urban revitalization in Bhopal

OPPORTUNITY

Vacant Land

- Identify wards with unutilized/ vacant land parcels or land without any identified purpose, irrespective of public or privately ownership.

OPPORTUNITY

Population Density

- Identify 'unsaturated' wards having low and medium density land parcels of population density 75 PPH or less for re-densification.
- Identify 'saturated' wards having high density land parcels of population density exceeding 75 PPH for re-urbanisation .
- Also identify informal settlements as these are high density areas with minimal services and amenities.

CONSTRAINT

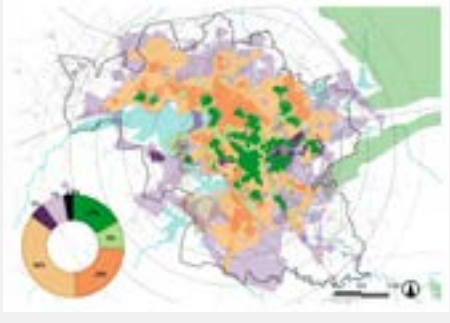
Ecologically Vulnerable/ High-risk Areas

- Exclude conservation zones around natural assets and ecologically sensitive areas.
- Introduce a minimum buffer from these resources based on their typology.
  Upper Lake: 50m
  Other water bodies: 33m
  Rivers & major streams: 50m
  Minor streams: 9m
- Topography – avoid hilly terrain with steep slopes, of 8 degrees or more.

OPPORTUNITY

Access to Public Transportation & NMT

- Consider areas within a 500m walking radius of one or more public transit stations (bus, metro, etc).
- Consider existing or upcoming TOD corridors of Bhopal Metro or BRTS, for higher FAR opportunities for building developments.



OPPORTUNITY

Access to Services and Amenities

- Consider areas within a 500m / 800m walking radius of 3 or more public services and/ or amenities, such as schools, medical centers, Schools, hospitals, fire emergency services, parks and open space, public transportation, and NMT.

Source: UN-Habitat

areas. Compact development through densification can create diversified housing options like mixed-income development and innovative housing typologies. It may also assist in integrating urban populations, especially marginalized groups.[30]

1.1.a. Infill development or redevelopment

Redeveloping underutilized sites provide an opportunity to adapt and reuse existing land and infrastructure, including roads, underground utilities, and street lighting. According to the population density assessment of Bhopal, almost 60 per cent of the total 85 wards have a density of less than 150 PPH.[31] Through this approach, areas of higher residential density may improve their land efficiency, and access to urban services and amenities like employment centres, commercial centres, and recreational centres within shorter walking and cycling distances. Government housing colonies, sector markets, and gated residential colonies are some of the underutilized land parcels that may undergo redevelopment in the near future, after due assessment.

1.1.b. Promote and generate affordable housing stock

Currently, the government is the only provider of low-income affordable housing in the city. The better access to basic amenities and public transportation in the urban core may act as a catalyst to promote the redevelopment of older developments, which were built during 1990–2000, or earlier.[32] Appropriate financial and procedural incentives may attract private builders to construct more affordable housing. Some of these incentives are listed in Table 3.1, which lists proposed revisions to zoning guidelines of the draft BDP 2031, to incentivize compact development. These procedural, financial, and regulatory incentives have been further described under Intervention 3 of this strategic response.

Intervention 1.2: Revitalize Urban Core via Urban Retrofitting

Certain settlements and areas in the urban core qualify for urban retrofitting instead of densification. These include high-density (>150 PPH), or medium-density (75-100 PPH) land parcels that are under-serviced by basic urban amenities or infrastructure (within walking distance of only three or less urban amenities, as defined under the USAF in Chapter 2), or exist in a condition of deterioration. Special emphasis should be given to applicable sites that contain one or more informal settlement(s) and/ or affordable housing developments that are in a state of deterioration. The urban retrofitting process, particularly for informal settlements, has been defined in elaborate detail in Section 3.5: Strategic Response 4 – Urban Retrofitting of Informal Settlements.

In these cases, urban retrofitting may include in-situ improvements or upgrades to urban infrastructure, and services to improve walkability, sanitation, and safety of the area, such as pedestrian infrastructure and intermodal connectivity, or the addition of public, green and open spaces. Proposed interventions may also include improvements to housing or building structure or finishes. However, these sites should not lie on eco-sensitive, vulnerable and/or ecologically protected areas or historically preserved areas of the city.

1.2.a. Enable seamless integration of multi-modal transport systems

The northern, western, and south-eastern areas of Bhopal currently have limited access to public transportation connectivity.[33] Low population density in these areas may be one of the reasons for the low public transportation connectivity. The proposed multi-modal transportation (MMT) systems, including metro, public transport, BRTS and NMT, etc., need integration to provide seamless first and last mile connectivity. Strategic Response 3 – Eco-Arterial Complete Streets Network addresses the integration of these MMT systems in further detail.

1.2.b. Improve the coverage of urban amenities

Only 25 per cent of the urban population in Bhpoal city has access to a publicly managed park within a walking distance of 500 m.[34]

Parks and public open spaces are crucial for maintaining public health and well-being, and should be expanded throughout the city, particularly in areas with low coverage, following a detailed open space assessment study for the city. The process of determining the type, scale, function, and amenities within the public open spaces should be ascertained through community-participation to create safe and diverse neighbourhoods. Representative engagement activities are discussed in detail in Section 3.3 – Strategic Response 2: Ecological Restoration through Bhopal Eco-Living Lab.

30 Planning compact cities: exploring the possibilities and limits of densification, UN-Habitat, 2017 https://unhabitat.org/sites/default/files/documents/2019-06/planning_compact_cities_exploring_the_possibilities_and_limits_of_densification.pdf.

31 150pph is recommended as optimum density for the provision of high-cost public infrastructure such as public transit, and to ensure a vibrant, economically thriving community. P 28 Urban Patterns for A Green Economy- Leveraging Density, UN-Habitat 2012 (https://unhabitat.org/leveraging-density-urban-patterns-for-a-green-economy.

32 Identified as Residential General (RG) – 1 zone in draft BDP 2031

33 See Chapter 4 – Existing Urban Analysis, Bhopal City Profile and Diagnostic Report.

34 As per USAF (UPF 1.4). See Chapter 4 – Existing Urban Analysis, Bhopal City Profile and Diagnostic Report.

25%

Percentage of population within 500m distance to public parks / open space (UPF 1.4)

25%

Percentage of properties in the ULB connected to sewerage network (SAN 4.1)

72%

Percentage of population within 500m of public transport stops (TR 6.1)

Densification vis-à-vis Urban Retrofitting

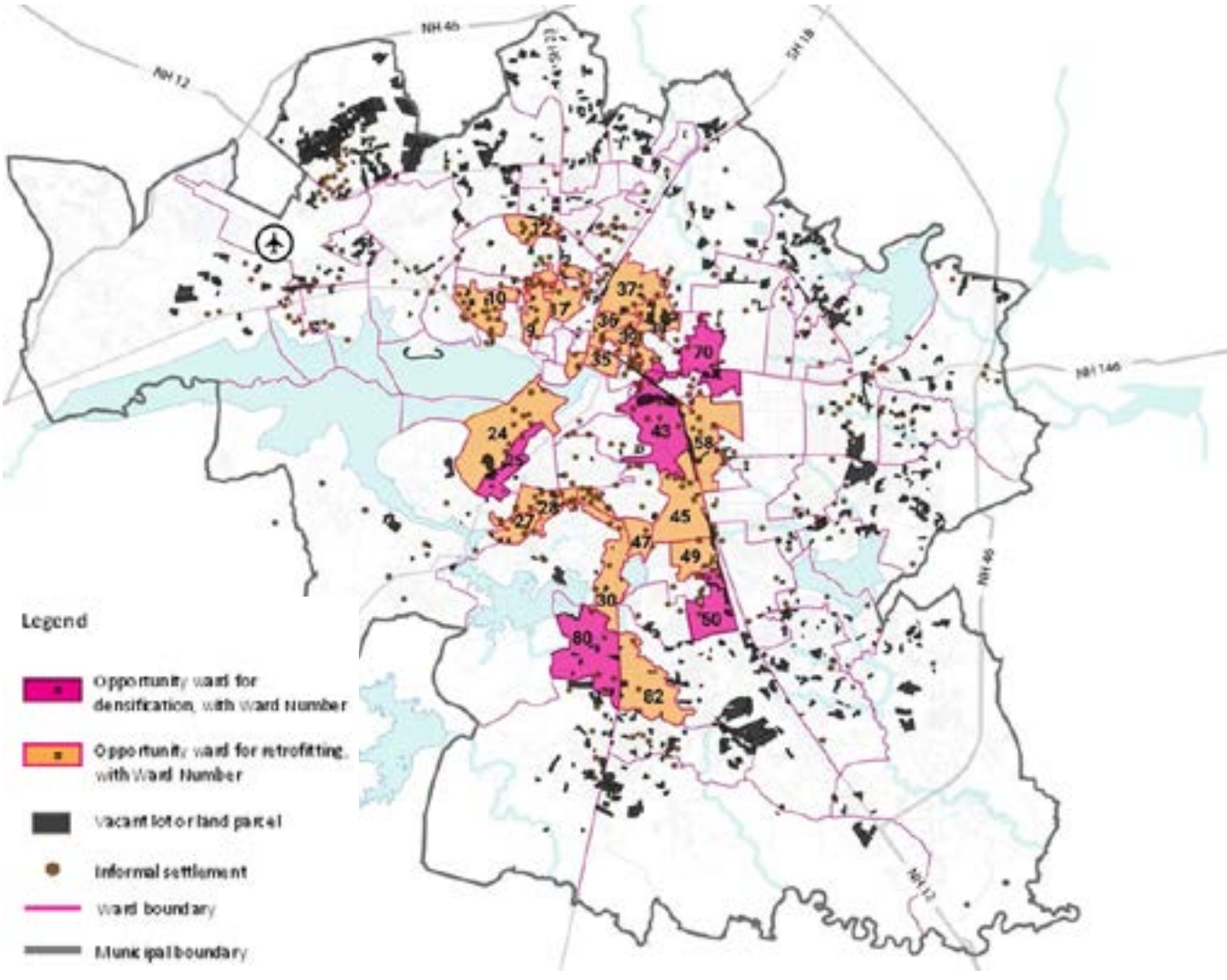
To summarize the criteria discussed above, a site or settlement within the urban core can be assessed to see if it qualifies for urban revitalization; while an assessment of the condition of its housing, amenities and services, can help decide the applicable method to be used. Combined with the contextual opportunities and constraints, this forms a checklist, as indicated below, in Figure 3.4.

FIGURE 3.4 Densification versus urban retrofitting checklist

Condition	Re-densification	Urban Retrofitting
 Location (Urban Core or Periphery)	Within the Urban Core	Within the Urban Core
 Urban Density	Contains low and medium density land parcels (unsaturated wards of 0-100 PPH)	Contains high-density land parcels (saturated wards of over 100 PPH)
 Presence of Informal Settlements	Optional	1 or more
 Vacant Lots	1 or more	1 or more (preferably)
 Access to Urban Services and Amenities (within 500m walking distance of 3 or more)	Yes	No
 Access to Public Transportation (within 500m walking distance of bus/ metro station)	Yes	No/ Yes
 On Ecologically Vulnerable Land (flood plain, steep topography of 8 degree slope or more, or a conservation zone)	No	Yes

Source: UN-Habitat

Spatial Opportunities for Densification over Urban Retrofitting



Map 3.2: Spatial opportunities for densification versus urban retrofitting

Source: UN-Habitat

Wards identified for retrofitting (low amenities coverage and high density) – 12, 24, 27, 28, 29, 37, 47, 54, 56, 57, 58, 63, 65, 73, 76

Wards identified for densification (high amenities coverage and low density) – 25, 43, 50, 70, 80

Spatial incentives and revision in development controls: Zoning guidelines and developmental controls may incentivize the densification of housing and mixed-use development in the identified opportunity sites. The following proposed zoning recommendations are part of sustainable city strategies:

Incentivize redevelopment: The draft BDP 2031 has identified the Residential General 1 (RG1) zone for redevelopment. Currently, the zone allows a total floor area ratio (FAR) of 2, of which the base FAR of 1.25 is free, and permissible FAR of 0.75[35] is chargeable. Increasing the base FAR to 1.5 may provide additional built-up area for developers, which could make redevelopment projects in the urban core more lucrative and profitable.

Incentivize affordable housing: Currently, affordable housing development does not attract private sector investment. The draft BDP 2031 may include incentives for private sector involvement in affordable housing projects.

35 As per the draft BDP 2031, permissible FAR is chargeable at the rate of 20 per cent of circle rate, or as determined by the regulating authority.

Any redevelopment or greenfield project, which includes affordable housing units may generate a Transferable Development Right (TDR) of 0.25. The TDR certificate can be utilised by the developer or may be sold to generate more revenue. Innovative affordable rental housing schemes may avail credit linked subsidies as recommended by PMAY affordable housing schemes. Affordable housing projects may be constructed in RG-1, RG-2 and RG-4 zones, which may classify all these zones as TDR generating zones.

The proposed amendments to zoning regulations in the draft BDP 2031 include the revision of the base FAR for RG-1, and incentives for constructing affordable housing projects, as summarized in Table 3.1.

The recommendations under Climate Smart Cities Assessment (CSCAF 1.0) for Bhopal lists the following actions for promoting green buildings in the city:

1. Immediately develop and adapt to new NBC 2016 and ECBC 2017 codes (NBC 2016 and ECBC 2017) in the local building byelaws.
2. Develop green building incentives (such as rebates on property tax and increase in FSR) and promote construction of green buildings in the city.
3. Act on strengthening the green building team within ULBs, and the functioning of green building committees of external stakeholders, to put the recommendations into action.

Source: Climate Smart Cities Assessment Framework City Report for Bhopal by MOHUA

TABLE 3.1 Revision in zoning recommendations of draft BDP 2031 to promote urban revitalization

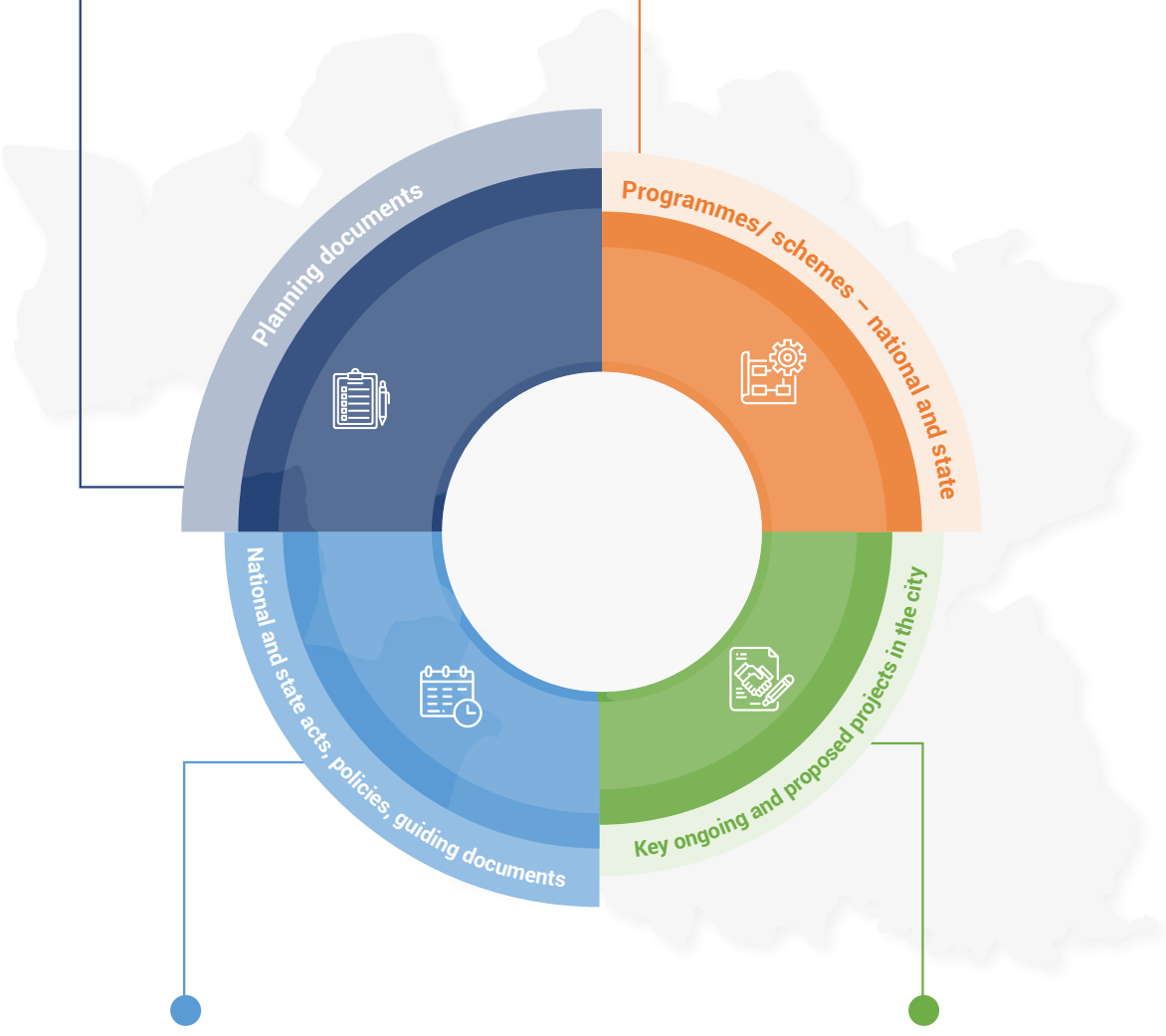
Zone Name	Proposed under draft BDP 2031						Revision of zoning proposed as part of sustainable city strategies					
	Features	FAR		TDR		Total	Features	FAR		TDR		Total
		Base	Permissible	Generate	Receive			Base	Permissible	Generate	Receive	
RG - 1	Old areas, provision for redevelopment	1.25	0.75	-	-	2	Incentivize affordable housing units to generate more stock in redevelopment projects	1.5	-	0.25*	0.5	2
RG - 2	Proposed under BDP 2005. Limited mixed-use. Sector development	1.25	0.75	-	-	2	Incentivize rental housing and affordable housing units for redevelopment. Allow further densification of land to monetize infrastructure improvement	1.25	0.75	0.25*	0.5	2.5
RG - 4	Proposed under BDP 2031. Agriculture to residential use. Low density	1.25	0.75	-	-	2	Include RG-5 as buffer near Laharpur Dam and introduce green belt near proposed industrial estates. Trim the zone to include eco-sensitivity.	1.25	0.75	0.25##	-	2
TOZ	Transit oriented development (TOD)	1.25	1.25	-	0.5	3	Incentivize and regulate rental housing or PG segment	1.5	1.25	-	0.5	3

Note*: Adhere to PMAY guidelines of required minimum affordable housing units to be considered for incentivization.
Source: Draft BDP 2031

3.2.2 Alignment with national, state policies, programmes and ongoing, proposed capital projects in the city

- Bhopal Development Plan 2005
- Bhopal Smart City Plan

- AMRUT
- AMRUT 2.0/ Jal Jeevan Mission (Urban)
- Smart City Mission
- Swachh Bharat Mission (Urban) 2.0
- Pradhan Mantri Awas Yojana - Urban



- National Urban Policy Framework, 2018
- National Urban Transport Policy, 2014
- National Mission on Sustainable Habitat 2021-2030
- Affordable Housing in Partnership Guidelines, PMAY
- Urban and Regional Development Plans Formulation and Implementation Guidelines, 2014
- Madhya Pradesh Nagar Tatha Gram Nivesh Adhiniyam, 1973
- Madhya Pradesh Bhumi Vikas Niyam, 1984

- Draft Bhopal Development Plan 2031 (approval from state government pending)
- Draft Bhopal District Climate Change Action Plan (approval from state government pending)

The detailed alignment with programmes, national missions and key projects are summarized in Annex 2.

3.2.3 Gender and inclusion

The urban core revitalization offers opportunities to address the inequity and challenges faced by women and marginalized groups. Urban retrofitting, specifically with seamless integration of MMT systems and improving coverage of urban amenities, could aid in gender equitable development.[36]

Improved services encourage more women to access amenities like public transport and green spaces. The proposed pedestrian infrastructure and intermodal connectivity could improve the participation of women in the workforce. The new compact, mixed-use nodes and employment centres proposed as part of Section 3.2.1, Intervention 1.1: Revitalize urban core through densification can address the time poverty women face. As part of the strategic response, additional social infrastructure is recommended (on assessment of existing shortage) for marginalized groups. Densification and urban retrofitting hold the potential to strategically include such amenities to support and provide safe stay for survivors of gender-based violence in Bhopal.

Homeless shelters (men, women, families, gender minorities), creches, primary education facilities, primary healthcare centres (PHCs), along with skill development and information sharing, working women's hostels and living facilities for the elderly are some of the suggested social infrastructures. Gender-inclusive urban design guidelines can be adopted to create safer neighbourhoods, as presented in Annex 5.

3.2.4 Climate convergence

Although there are no specif ic metrics to be applie d to these two interventions due to their scale and basis in policy level changes, compact development can help to reduce emissions from sprawling developments and their corresponding reduced transport demand.

As per the density and population analysis (see Table 2.2), around 10 lakh people can be accommodated within the urban area using the densification strategy. The combination of green and sustainable building materials can mitigate carbon emissions and store carbon in the form of housing units, as opposed to using regular construction materials.

The comparison of potential GHG emissions and savings in the business-as-usual scenario and alternative scenario where sustainable building materials are used for construction of housing units for the economically weak sections (EWS) and lower income groups (LIG) is summarized in Table 3.2.

TABLE 3.2 Carbon storage potential of affordable housing units by using green and sustainable building materials

'Business-as-usual' scenario				Alternative, low-carbon scenario			
Affordable Housing – EWS (sq. m.)	**30**	**Affordable Housing – LIG (sq. m.)**	**40**	**Sustainable construction Affordable Housing – EWS (sq. m.)**	**30**	**Sustainable construction Affordable Housing – LIG (sq. m.)**	**40**
Materials – Regular	Carbon Emission (tCO2e)	Material – Regular	Carbon Emission (tCO2e)	Material – combination of green and regular	Carbon Emission (tCO2e)	Material – combination of green and regular	Carbon Emission (tCO2e)
Concrete, Cement Bricks, Clay Bricks, Clay Tiling, Steel, Metal Studs, Paint	4.11	Concrete, Cement Bricks, Clay Bricks, Clay Tiling, Steel, Metal Studs, Paint	5.48	Straw Bale, ICF, SIPS, Wood, Fiberglass, Steel, Fibre Cement, Natural Clay, Bamboo, Fly ash, Clay Plaster	-20.03	Straw Bale, ICF, SIPS, Wood, Fiberglass, Steel, Fibre Cement, Natural Clay, Bamboo, Fly ash, Clay Plaster	-26.71
Potential carbon emissions							
4.11		5.48		-24.14*		-32.19*	

Note*: Negative sign indicates carbon storage potential

Source: Kurian, R., Kulkarni, K. S., Ramani, P. V., Meena, C. S., Kumar, A., & Cozzolino, R. (2021). "Estimation of carbon footprint of residential building in warm humid climate of India through BIM". Energies, 14(14), 4237.

36 ADB. (2013). Gender Tool Kit: Maximizing the Benefits of Improved Mobility for All. Asian Development Bank.
UN Women. (2014). World Survey on the Role of Women in Development, 2014: Gender Equality and Sustainable Development. UN Women.

IMAGE 3.2 Low-rise, low-density built form along Kolar Road in southern Bhopal

Source: UN-Habitat

3.3 Strategic Response 2: Ecological Restoration through the Bhopal Eco Living Lab

The second critical issue of **endangered natural assets**[37] in Bhopal is addressed by the strategic response of **ecological restoration through the Bhopal Eco Living Lab (BELL)**. This strategy is guided by the two core planning principles[38] of Ecosystem Restoration and Enhancement (Principle 3.1.2), and Compact Cities (Principle 3.1.1).

Under this strategy, the city is re-imagined as an **Ecological Living Lab ('Eco Living Lab')** or a living laboratory. Here, the city becomes **a dynamic testing ground for collaboration, research, innovation and testing interventions for mitigating climate change and urbanization impacts on the urban ecology.**

By collaborating with academia, community organizations and the local communities themselves, the Eco Living Lab fosters long-term, tailored solutions for preserving the balance between built and natural environments. It leverages the knowledge resource from numerous reputed educational and research institutes in Bhopal[39], particularly in the fields of environmental sciences, forest management, urban planning, and design, etc. It also involves the community in the process of testing, implementation and management of proposed solutions, particularly nature-based solutions (NbS)[40], at critical and vulnerable ecological zones in the city. As a result, the city of Bhopal has the potential to become a regional hub for ecological conservation, innovative and sustainability, while also spurring a green economy.

3.3.1 Proposed interventions within the strategic response

There are four interventions proposed under Strategic Response 2:

Intervention 2.1: Establish the Bhopal Eco Living Lab (BELL)
Intervention 2.2: Urban Biodiversity Assessment and Conservation by BELL
Intervention 2.3: Enable Ecologically Sensitive Public Spaces
Intervention 2.4: Establish City-level Guidelines for Urban Forestry and Public Space

37 See Section 2.3.1, Issue 2 – Endangered Natural Assets, and the Bhopal City Profile and Diagnostic Report for a detailed assessment.

38 See Section 3.1: Strategic Responses – Core Planning Principles.

39 Bhopal houses numerous institutions of national and regional importance, such as the Indian Institute of Forest Management (IIFM), Indian Institute for Science Education and Research (IISER), and the School of Planning and Architecture (SPA Bhopal), Maulana Azad National Institute of Technology (MANIT), amongst others.

40 Lupp, G.; Zingraff-Hamed, A.; Huang, J.J.; Oen, A.; Pauleit, S. Living Labs—A Concept for Co-Designing Nature-Based Solutions. Sustainability 2021, 13, 188. https://dx.doi.org/10.3390/su13010188. As determined by the USAF indicators, and detailed in Section 3.2.1: City Diagnostics - Strategic Issues.

Intervention 2.1: Establish the Bhopal Eco Living Lab (BELL)

BELL is envisioned as a common platform or body led by the city government. It is intended to become a nodal point for matters pertaining to ecological conservation and to guide urban development in harmony with the local biodiversity. BELL also enables a multi-stakeholder approach in natural resource management.

In 2019, under the Smart Cities Mission and Atal Innovation Mission (AIM), the Bhopal Smart City Development Corporation Limited (BSCDCL) formulated the Bhopal Living Lab (BLL). The BLL is a start-up incubator focusing on the Internet of Things (IoT) and Sensor Technologies pertaining to urban issues.[41] The proposed BELL may be incorporated within the BLL or function in partnership with it, to foster innovative ecological restoration and conservation solutions for the city.

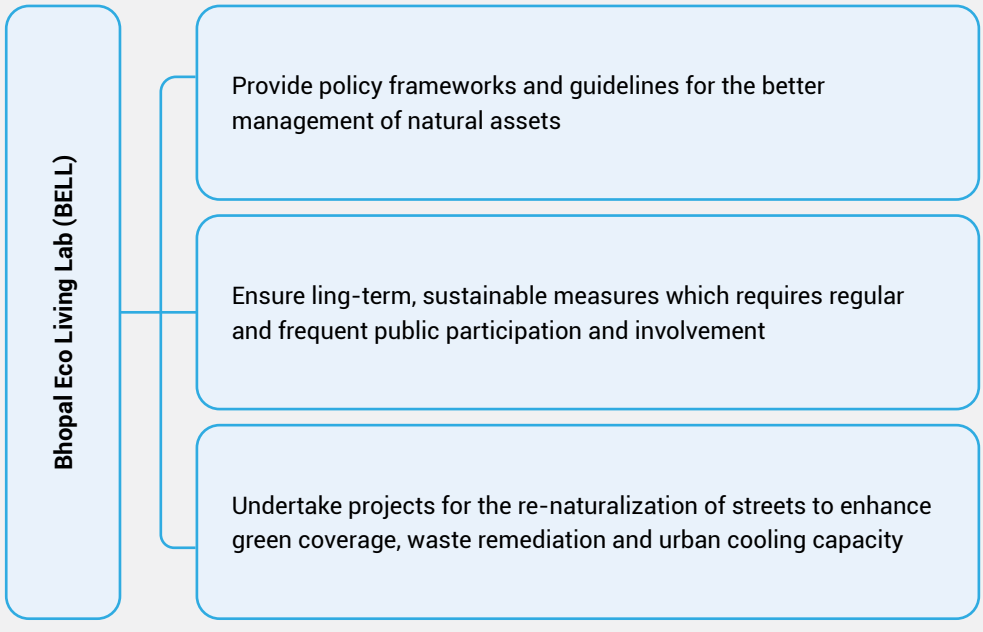
The structural and operational features of BELL are summarized in Figure 3.5.

Additional features of BELL

1. **Potential to pioneer green economy:** Growth in employment and income are driven by public and private investment into economic activities that reduce carbon emissions, enhance energy and resource efficiency, and prevent the loss of biodiversity. This collaboration can strengthen market-based tools like the Green TDR proposed under the draft BDP 2031 to incentivize the conservation of water bodies and buffer zones.

2. The collaboration may also guide ULBs to fulfil their mandates, such as establishing a **City Level Biodiversity Management Committee**, developing **Peoples' Biodiversity Register**, and calculating a **City Biodiversity Index** as per the Biological Diversity Act, 2002.[42]

FIGURE 3.5 Key operational features proposed for BELL

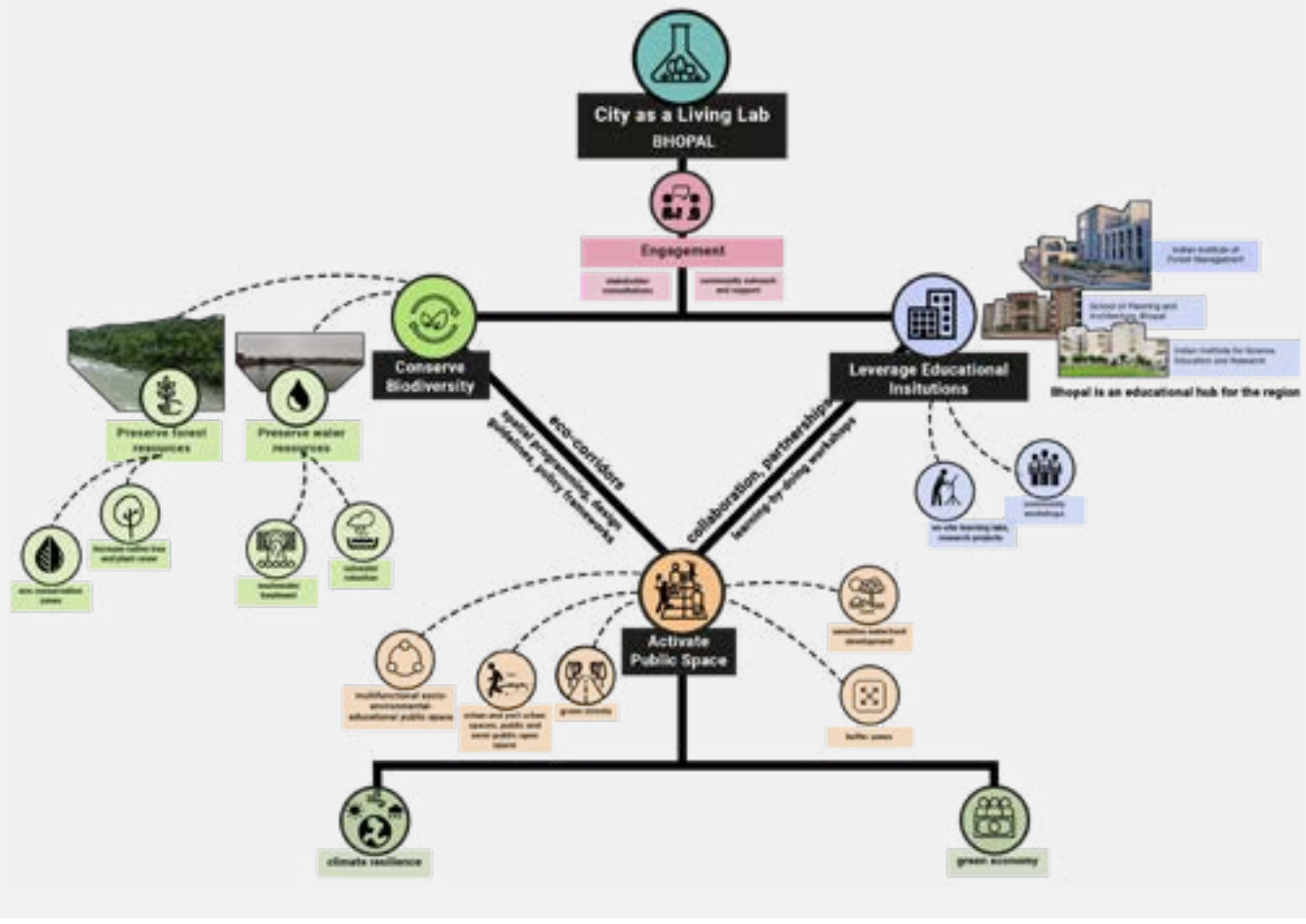


Source: UN-Habitat

41 Bhopal Living Labs (as Atal Incubation Centre) Proposal To Niti Ayog; NIUA; https://smartnet.niua.org/sites/default/files/webform/Bhopal%20Living%20Labs%20(as%20Atal%20Incubation%20Centre).pdf.

42 The Biological Diversity Act, 2002, Ministry of Law and Justice, Government of India, https://legislative.gov.in/sites/default/files/A2003-18.pdf (accessed on 1 February 2022).

FIGURE 3.6 Armature of the Bhopal Ecological Living Lab



Source: UN-Habitat

Intervention 2.2: Urban Biodiversity Assessment and Conservation via BELL

2.2.a. Mapping and data repository

BELL should develop a data repository of the local biodiversity and natural assets of the city, which include wetlands, preservation zones, buffer zones, eco-corridors, etc. This repository may serve as a valuable resource for future urban planning and design initiatives. The Madhya Pradesh Biodiversity Board, EPCO and the Madhya Pradesh Forest Department have been collating data on the eco-sensitive areas of the city. The BELL may pool data from these agencies and other relevant organizations to create a comprehensive database of the natural and eco-sensitive areas in the region.

The city diagnostics identified certain eco-sensitive areas as critical, which require immediate conservation efforts. These areas are listed in Table 3.3:

The critical eco-sensitive areas identified during the SCIAP project assessment are illustrated in Map 3.3. As per an order from the NGT[43] in 2020, the Kerwa–Kaliasot area in Bhopal must be recognized as a protected forest, which must be studied and documented by detailed mapping. However, the draft BDP 2031 has assigned this area under public/ semi-public use, which will permit the development of social, cultural, administrative, educational and health facilities in the area.[44]

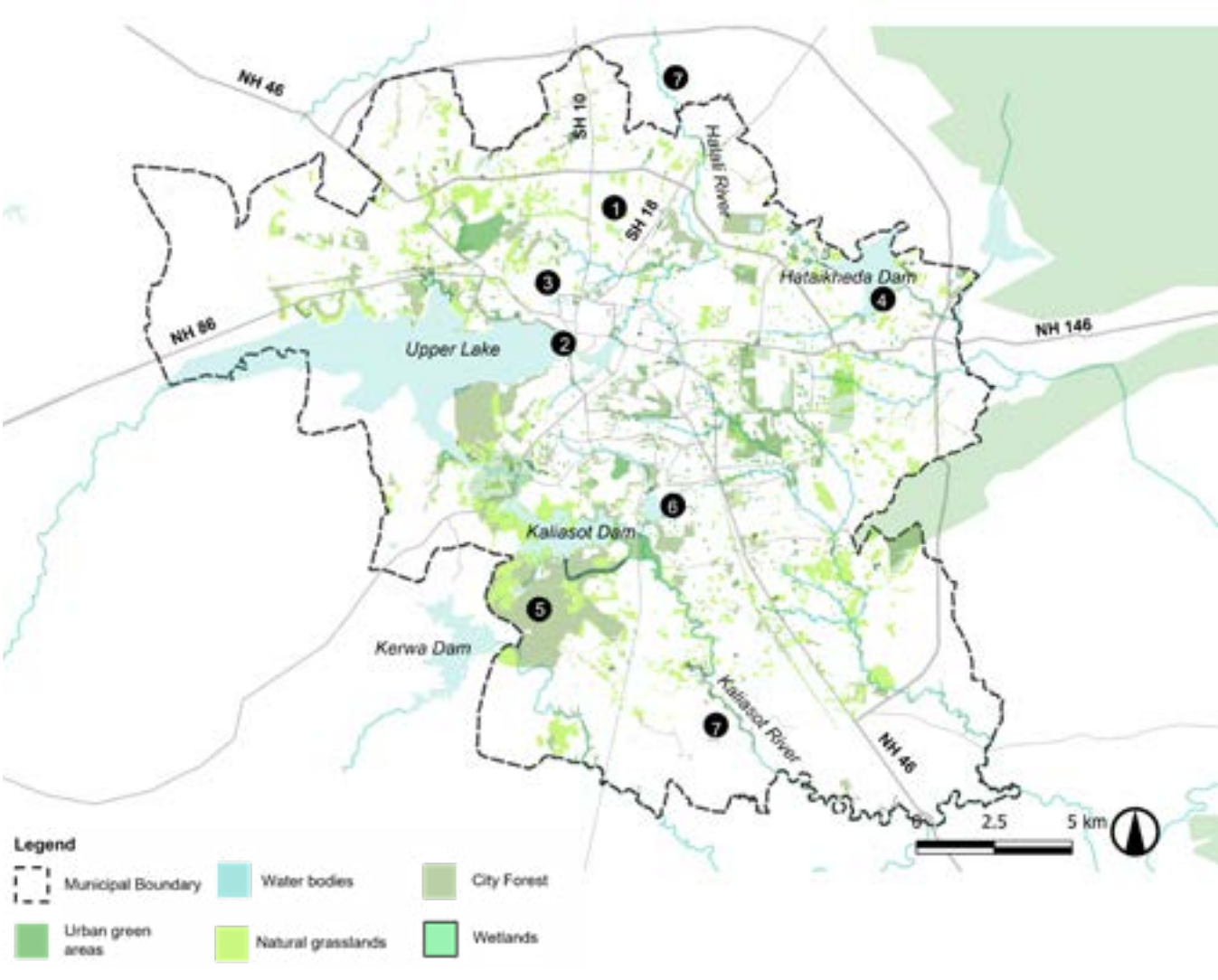
43 Rashid Noor Khan vs State of Madhya Pradesh, Original application No. 159 of 2014, appeal to central bench of National Green Tribunal; https://timesofindia.indiatimes.com/city/bhopal/ngt-orders-fresh-mapping-of-kaliasot-kerwa-stretch/articleshow/73993202.cms.

44 Planning Proposal & Recommendations, Draft Bhopal Development Plan 2031, Volume II, p. 20.

TABLE 3.3 Indicative list of critical eco-sensitive areas identified during SCIAP project assessment

#	Name of critical eco-sensitive region/ lake/ waterbody	Key concerns
1	Union Carbide Pond	Polluted by poisonous gas leakage during Bhopal gas tragedy.
2	Upper Lake and Lower Lake system	Pollution by sewage and encroachment main concerns. Pollution of numerous inlet channels of lakes is a major threat
3	Cascading Lakes – Motia Talab, Noor Mahal Talab and Munshi Hussaini Talab	Highly encroached and polluted. The hospitals constructed on the banks of the lakes may expose them to bio-medical waste
4	Hataikheda Dam	Development along inlet channels and wetlands. Lack of sanitation facilities
5	Forest between Kerwa Dam and Kaliasot Dam	Encroachment and land use incompatibility with forest land. High biodiversity and eco-sensitivity.
6	Shahpura Lake	Pollution by sewage water and encroachment. A hospital along the lake increases the exposure to bio-medical waste
7	Kaliasot River and Halali River	Encroachment and pollution by untreated wastewater from tributaries of Betwa River

Source: Draft BDP 2031



Map 3.3: Mapping of critical eco-sensitive areas in Bhopal

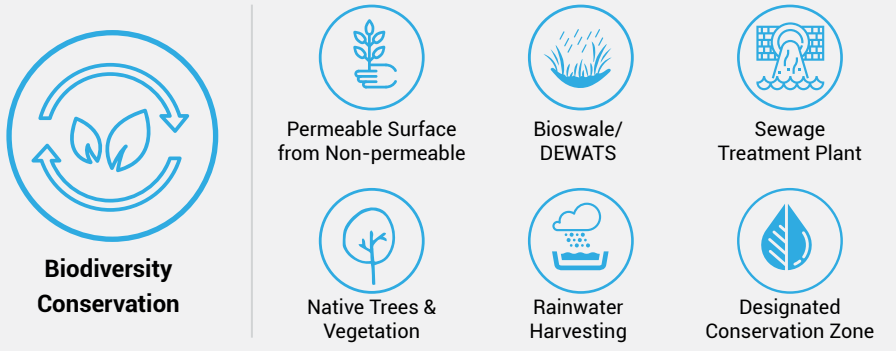
Source: UN-Habitat

2.2.b. Employing nature-based solutions to restore the ecosystem

Urban conservation zones[45] may employ both active and passive measures, especially by using **nature-based solutions (NbS).** Some of these NbS include bioswales and decentralized wastewater treatment systems for treating wastewater and grey water; designated buffer zones; rainwater harvesting troughs for replenishing the ground water table; permeable and semi-permeable ground surface materials rather than non-permeable or paved surfaces, to improve rainwater percolation; and planting native trees and plants for carbon sequestration and improved soil health, where appropriate. These nature-based measures, and their benefits, are illustrated in Figure 3.7.

Alignment with Swachh Bharat Mission 2.0: SBM 2.0 aims to create a sustainable ecosystem of sanitation services by ensuring that no untreated wastewater is discharged into the open environment for already ODF++ cities. SBM's Water Plus Protocol Toolkit provides design guidelines for implementing nature-based solutions.

FIGURE 3.7 Proposed nature-based solutions for biodiversity conservation



Source: UN-Habitat

Intervention 2.3: Enable Ecologically Sensitive Public Spaces

The BELL may facilitate the creation of ecologically sensitive, public open spaces in diverse forms, functions, and scales. This includes urban, peri-urban, public, semi-public, neighbourhood-level, district-level or city-level spaces.

These public spaces may take the form of adaptive green spaces such as green streets, recreational parks or ecologically sensitive waterfront redevelopment. Some such examples are highlighted in the case studies of urban ecological restoration projects like Bishan-Ang Mo Kio Park along the Kallang River in Singapore, and in Xuzhou City in China. Wilderness parks, natural waterfront development and waterfront trails are some examples of public space programming, which may encourage lighter public activity without disturbing the natural balance or disrupting the local flora and fauna.

Detailed gender inclusive urban design guidelines for these public spaces are listed in Annex 5.

Women can be employed under the initiative for ecological restoration and conservation in Bhopal through green buffers. Existing civil society organizations and women self-help groups (SHGs) should be identified for potential partnerships. Such women's SHGs may take up the responsibilities of water-sensitive planting, maintenance, and management of water bodies as public spaces.

Potential Examples of Collaboration among Educational Institutions and Communities

An example of such an initiative could involve on-site, outdoor ecological labs at research facilities with a public workshop component. The local community could be invited to learn about scientific and environmental interventions being carried out in the city to maintain and improve the equilibrium of various ecosystems. A wastewater treatment facility on the banks of a river or lake may incorporate a 'Learning Garden', enabling school children, residents and the general public to participate in workshops to learn and even test certain nature-based solutions or other technological advancements for ecological remediation, either at the facility or at different intervention sites.

45 The draft BDP 2031 proposes such conservation zones and regulates development along water bodies, catchment areas and forests. Around 27 per cent of the total planning area (1,016 sq. km.) falls under conservation zones.

FIGURE 3.8 Actions and elements for public space activation

Public Space Generation

Greenway/ Native tree-lined street

Semi-permeable pedestrian pathway

Active open space

Waterfront development

Buffer zone

Urban and peri-urban open space

- Provides shade to NMT users
- A variety of open space typologies enables inclusion from diverse demographics and age groups
- Protects sensitive ecological zones from built encroachment
- Buffer zones mitigate flood risk and risk of loss or life and damage to property

Source: UN-Habitat

IMAGE 3.3 Development by Builtform along northern banks of Lower Lake

Source: UN-Habitat

CASE STUDY : BISHAN-ANG MO KIO PARK, SINGAPORE

Effective improvement in environmental quality: The Bishan Ang Mo Kio Park project transformed 3km of Singapore's longest river, Kallang River, from a concrete canal into a natural river with bioengineered slopes and landscaped banks, across 64 hectares. In 2006, Singapore's national water agency, PUB, initiated the Active, Beautiful and Clean Waters Programme, a long-term initiative to transform the functionality of the nation's water bodies beyond just drainage and water supply, into vibrant, new spaces for community bonding and recreation.

Ecological regeneration: The new river showed a 30 per cent increase in biodiversity even before construction was complete. Soil bioengineering techniques have since stabilized the river banks, which can withstand strong flood flows and also provide habitats for local wildlife. The flood plains provide generous open space for recreational activities and, in case of a heavy storm, the park functions like a real river plain, allowing the river water to spread and slow down through friction.

Image source (left) – National Parks, Government of Singapore (https://www.nparks.gov.sg/gardens-parks-and-nature/parks-and-nature-reserves/bishan---ang-mo-kio-park) (right) – American Society of Landscape Architects (ASLA) (https://www.asla.org/2016awards/169669.html)

Ecologically sensitive public space design: Designed along the concept of a floodplain, people can get closer to the water and enjoy recreational activities along the river banks when the water level is low. During heavy rains, the park land by the river doubles up as a conveyance channel, enabling multiple land uses and creating more spaces for communal activities. The design of the floodplain also adopts a new typology and quality of urban public space in Singapore with three new bridges, a terraced riverside gallery, river platforms, stepping stones across the river and a water playground. These features help to bring the public close to the water and transform their sense of responsibility towards their environment.

Innovative infrastructure and iterative process: A new model of landscape infrastructure was developed for tropical urban hydrology, enabling water supply independence, and proper flash flood management for Singapore. Prior to redevelopment, Kallang River was a clear concrete divider between the park and the community. Results proved healthy vegetation growth and, in a reiterative process, soil conditions, slope and plant root strength were examples of adjustments made to the models. The new approach maximizes land, financial and human resources. Simple, yet highly engineered, the river park blurs the divide between infrastructure and recreation, and has transformed the community's pragmatic perception of urban water systems.

Source: ASLA, https://www.asla.org/2016awards/169669.html (accessed on 4 February 2022).

CASE STUDY OF URBAN ECOLOGICAL RESTORATION WITH NATURE-BASED SOLUTIONS IN XUZHOU CITY, CHINA

Effective improvement in environmental quality: The Ecological Restoration Landscape Enhancement Project of Xuzhou City, a coal-rich city in eastern China, is a key municipal project. It optimized the plant configuration and landscape design, and improved the greening quality and convenience facilities, effectively improving environmental quality in its neighbouring areas.

Promotion of social and cultural development: This ecological restoration has created a fresh and beautiful living atmosphere for its citizens and expanded the urban green space, thus playing a positive role in maintaining social harmony and stability.

Growth of tourism and regional economy: Taking the Wetland Park in the mining subsidence area of Pan'an Lake as an example, ecological restoration augmented the development of gardening, ecological tourism, folk culture and other industries, creating more than 2,000 jobs for local villagers. In 2018, the site attracted five million tourists, with a comprehensive revenue of 1 billion Yuan.

Image source (all) – NBS Good Practices from Chinese government: Ecological restoration in Xuzhou City, Jiangsu Province, 2019

Source: UNEP Compendium of Contributions: Nature-Based Solutions, https://wedocs.unep.org/ bitstream/handle/20.500.11822/29988/Compendium_NBS.pdf?sequence=1&isAllowed=y (pp 157), (accessed on 4 February 2022)

NBS Good Practices from Chinese government: Ecological restoration in Xuzhou City, Jiangsu Province, 2019, https://wedocs.unep.org/bitstream/handle/20.500.11822/29441/Xuzhou.pdf?sequence=1&isAllowed= y, (accessed on 4 February 2022)

Intervention 2.4: Establish City-level Guidelines for Urban Forestry and Public Space

This intervention provides a common vision for the urban green infrastructure in and around the city. It also protects and conserves the urban forests and greenery of the city through citywide guidelines regarding any activity affecting these areas. Policies on urban forests are often developed in silos, leading to conflict with other policies by urban sectors regarding the use of green spaces. An effective urban forest policy, therefore, requires intersectoral dialogue to harmonize the range of interests. The objectives of the city-level guidelines are in tandem with the Urban Greening Guidelines[46] of 2014, published by the Ministry of Housing and Urban Affairs (MoHUA), Government of India.

The city-level guidelines on urban forestry and public spaces (UFPS) aim to:

1. Establish and enforce conservation zones, and also incorporate participatory approaches in re-greening these zones;
2. Provide a framework to mainstream regular mapping and monitoring of eco-sensitive areas in the city;
3. Propose methods for implementing the Green TDR described in the draft BDP 2031;
4. Provide an indicative list of scalable NbS or specifications, for reference;
5. Convene several stakeholders (such as BMC, Capital Project Administration Department (CPA), Bhopal Development Authority (BDA), Town and Country Planning Department (TNCP) and Bhopal Smart City Development Corporation Limited (BSDCL) for developing public spaces, such as for channelizing resour ces towards improving urban green spaces;
6. Highlight how to achieve convergence of national and state missions; and
7. Classify urban green areas as per URDPFI guidelines, as shown in Table 3.4.

TABLE 3.4 Classification of urban green areas in Bhopal under UFPS

Sl No	Category of green space	Population served per unit	Area (Ha)
1	Housing Area Park	5,000	0.5
2	Neighbourhood Park	15,000	1.0
3	Community Park	1,00,000	5.0
4	Botanical Garden	City level	10.0 to 20
5	City/ Urban Forest	City level	As identified by the city
6	Reserved Forest	City level	As identified by the city

Source: Urban and Regional Development Plans Formulation and Implementation (URDPFI) Guidelines, 2015

46 Urban Greening Guidelines 2014 is a model for states and cities to manage and safeguard their green spaces; https://mohua.gov.in/upload/uploadfiles/files/G%20G%202014(2).pdf.

3.3.2 Alignment with national, state policies, programmes and ongoing, proposed capital projects in the city

- Bhopal Development Plan 2005
- Draft Bhopal Development Plan 2031 (approval from state government pending)
- Bhopal Smart City Plan
- Clean Air Action Plan 2019

- AMRUT
- AMRUT 2.0 / Jal Jeevan Mission (Urban)
- Smart City Mission
- Swachh Bharat Mission (Urban) 2.0 AMRUT
- AMRUT 2.0 / Jal Jeevan Mission (Urban)
- Smart City Mission
- Swachh Bharat Mission (Urban) 2.0

- The National Forest Policy, 1988
- The Biological Diversity Act, 2002
- Urban and Regional Development Plans Formulation and Implementation Guidelines, 2014
- Urban Greening Guidelines, 2014
- Madhya Pradesh Nagar Tatha Gram Nivesh Adhiniyam, 1973
- Madhya Pradesh Bhumi Vikas Niyam, 1984
- Madhya Pradesh State Environment Policy, 1999
- The Environmental Status Report for Bhopal, 2015

- Expansion of sewerage network under Urban Water Supply and Environmental Improvement in Madhya Pradesh Project, funded by Asian Development Bank
- Construction of STP and Upgradation of the sewerage network under AMRUT
- Development of 70 parks under AMRUT
- Development of Smart Parks under Smart City Mission

The detailed alignment with programmes, national missions and key projects are summarized in Annex 2.

3.3.3 Gender and inclusion

BELL enables the creati on of safe and secure public spaces for women and marginalized groups, where they may participate, interact and contribute to developing their community. This strategic response offers the scope for a gender-transformative approach through all its interventions. Institutional recommendations have been especially made for BELL to ensure equal participation of marginalized communities, particularly women. Intervention 2.2 can utilize women and gender minority SHGs for executing biodiversity conservation initiatives throughout the city. Under Intervention 2.3, developing ecologically sensitive public spaces in diverse forms, scales and functions, would help in creating gender inclusive socio-recreational spaces. BELL also provides the opportunity to create a women-led green economy in Bhopal. By leveraging its rich natural resources, the city can pioneer women-led urban agriculture and agro-forestry. Application of NbS along with their function in public spaces is further explained in later sections (see Transformative Projects 1, 2 and 3). Further details and specific guidelines for gender-inclusive amenities are listed in Annex 5.

3.3.4 Climate convergence

The holistic approach of the BELL, through research, consultation, experimentation, on-ground trial, and sustainable maintenance aims to mitigate GHG emissions, build climate resiliency, and spur the city's green economy. The unit potential savings in GHG emissions that can be achieved by adapting NbS and ecological elements like bioswales, plantations and tree lined streets is summarized in Table 3.5.

The city can potentially store up to 65,360 tCO2-eq/ annum by implementing preservation zones and existing natural blue–green areas that include city forests, water bodies and urban green spaces[48] as proposed under the draft BDP 2031.

The inventory of carbon savings from vegetation and ecological conservation activities proposed in the strategic response interventions are detailed in Section 3.6.4: Transformative Project 2 (see Table 3.15).

TABLE 3.5 Potential savings of GHG emissions – Nature-based solutions and ecological elements

Classification	Category	Potential savings in GHG emissions (in tCO_2e)	Unit of Measurement	Source
Area Basis	Trees	8.00	tCO_2/ ha/ annum	Chen (2015), Velasco et al. (2014), Nowak et al. (2013)
Area Basis	Lawns	2.05	tCO_2/ ha/ annum	Raciti et al. (2011), Smith et al. (2018)
Area Basis	Bioswales (trench with planting)[47]	3.75	tSO_2/ ha/ annum	FAO (2021)
Unit Basis	Tree (neem)	0.07	tCO_2/ tree/ annum	Sharma, Pradhan, Others (2020)

3.4 Strategic Response 3 Eco-arterial Complete Streets Network

The third diagnostic issue for Bhopal determined by the USAF[49] and on-ground assessment is the city's **high dependency on fossil fuels and sub-optimal use of NMT.** The corresponding strategic response proposes to establish an **Eco-arterial Complete Streets Network (or 'Eco-arterial Network'),** which is defined in detail in this section. This strategy rests on the core planning principles[50] of Complete Streets (3.1.3), Ecosystem Restoration and Enhancement (3.1.2), and Compact Cities (3.1.1).

The eco-arterial network aims to establish a comprehensive, integrated, and ecologically beneficial NMT system in Bhopal, incorporating **seamless multi-modal integration while preserving the urban green assets and minimizing the total GHG footprint of the city.** It is guided by the concepts and goals described in Figure 3.8.

47 This Co_2 potential for bioswales uses a bracket of 1.5-9 ha. An average of 4.75 has been taken to scale up/down and contextualize the Co_2 storage potential.

48 The forest and natural green spaces combined form around 19.6 per cent of total city area, which is 81.7 sq. km. See Table 5.3, Bhopal City Profile and Diagnostic Report.

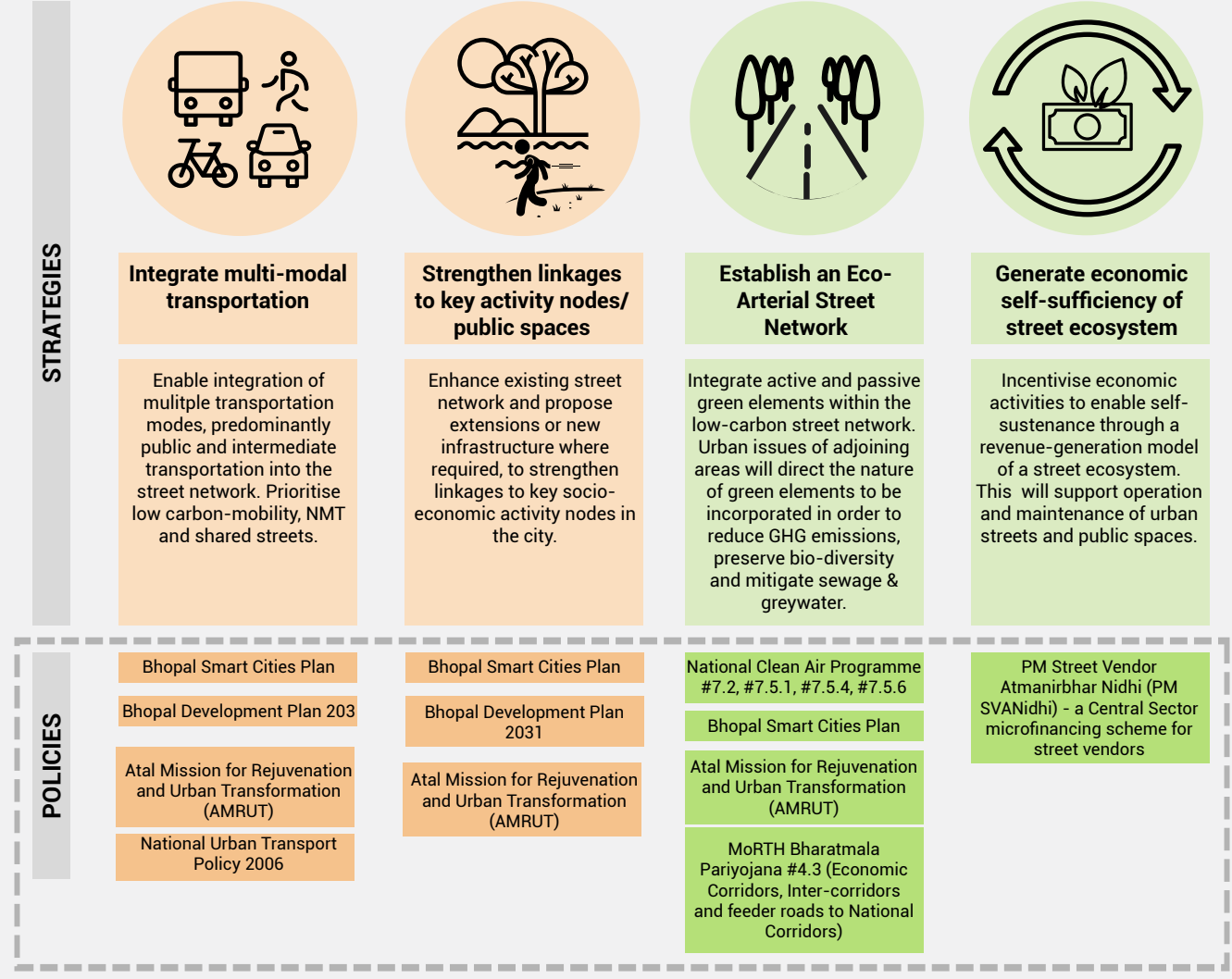
49 See Section 5.2.4 – High dependence of fossil fuels and sub-optimal use of NMT, Bhopal City Profile and Diagnostic Report.

50 See Section 3.1: Strategic Responses – Core Planning Principles.

Currently, Bhopal lacks an updated Comprehensive Mobility Plan (CMP).[51] The last Mobility Plan for the city was developed in 2012, following which there has been significant population growth, BMC area expansion, and heightened economic activity. The United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP), in partnership with Bhopal City Link Limited (BCLL), prepared a Sustainable Urban Transport Index for Bhopal in 2019. However, the index covers a limited assessment of the on-ground traffic in the city.

There has been considerable increase in traffic, along with a proposed metro rail and urban expansion and, therefore, a comprehensive and updated traffic study is vital to support the eco-arterial network, develop a holistic vision of seamless multi-modal integration and prioritize low-carbon mobility in the city.

FIGURE 3.9 Concepts of the eco arterial complete streets network strategic response



Source: UN-Habitat

51 A CMP is a vision statement of the direction in which urban transport in a city should grow. It should cover all elements of urban transport under an integrated planning process. The CMP is a long-term vision for desirable accessibility and mobility pattern for people and goods in the city to provide, safe, secure, efficient, reliable and seamless connectivity that supports and enhances economic, social and environmental sustainability (Toolkit for Comprehensive Mobility Plan (CMP) Revised (2014), Ministry of Urban Development, Government of India; https://mohua.gov.in/upload/uploadfiles/files/CMP%20Report%20Revised.pdf).

1. **Multi-modal integration**
   - Designing streets to provide a continuous and safe city-wide NMT infrastructural network, especially servicing high-density areas. This network should prioritize the safety, universal accessibility, comfort, and convenience of NMT operators, users, pedestrians, and cyclists.
   - Creating seamless links between the public transit system and affordable, low carbon first/ last mile mobility options, thereby encouraging their increased modal share in the city.

2. **Strengthen linkages to key activity nodes and public spaces**
   - Incorporate complete streets infrastructure and services on major urban streets
   - Activate streets as multi-functional public spaces

3. **Establish an eco-arterial street network**
   - Incorporate green streets NbS in public spaces
   - Re-imagine streets as important carbon sequesters through increased green cover and NbS

4. **Economic self-sufficiency of the street ecosystem**
   - Enable urban streets to become self-sustaining systems through innovative financing and revenue generation, which will help in expanding the complete streets network in Bhopal.

3.4.1 Proposed interventions under the strategic response

This strategic response proposes **three key interventions** to attain the ecological goals described in the previous section (3.4), which are:

Intervention 3.1: Eco-Arterial Complete Streets Assessment Toolkit for the Development of NMT
Intervention 3.2: Reorganize the Regional and City Transportation Networks
a. Prioritize the improvement of public transportation
b. Reorganize regional transportation network through transit hubs
Intervention 3.3: Prepare a Low-carbon Comprehensive Mobility Plan for Bhopal

Intervention 3.1: Eco-Arterial Complete Streets Assessment Toolkit for the Development of NMT

UN-Habitat has developed an Eco-Arterial Complete Streets Assessment Toolkit (or 'Toolkit') for the following purposes:

1. To simplify the assessment of urban streets in the city, for ascertaining the NMT infrastructural opportunities on them; and

2. To provide an indicative list of NMT and ecologically beneficial design, infrastructure and service interventions along urban streets in the city that can help realize an eco-arterial complete streets network for Bhopal.

The Toolkit provides guidance to assess any urban street in the city to determine the applicable NMT infrastructure; design elements; NbS; and other facilities for developing an Eco-Arterial Complete Streets Network. It is intended as a starting point in the redevelopment process of urban streets into eco-arterial complete streets.

The Toolkit describes four assessment categories, as indicated in Table 3.6, which are: street profile, adjacencies and context (including adjacent land use, adjoining ecological assets, if any, ecological; and site vulnerabilities), predominant modal use; and street geometry. The elements illustrated in the Toolkit are design and infrastructural elements that facilitate the development of safe and equitable streets and public spaces, including safe and convenient streets for cycling, walking, shared mobility, economic activity, programming, etc. These can also help identify the opportunities for revenue generation to sustain the ecologically sensitive complete streets network in Bhopal. The full Toolkit is represented in Table 3.7.

Based on these conditions, the Toolkit lists possible interventions, which are either **mobility elements or ecological elements.**

1. **Mobility elements:** These include infrastructural and design features, as illustrated in Figure 3.10, to enable safe, seamless, comfortable mobility, and universally access throughout the city, especially for pedestrians, cyclists, and other vulnerable road users. These mobility elements of the Toolkit are proposed with the following **goals and features:**

TABLE 3.6 Complete Streets Assessment Toolkit Categories

STREET PROFILE	ADJACENCIES AND CONTEXT	PREDOMINANT ROAD USERS	GEOMETRY
1. RIGHT OF WAY (IN METERS)	1. ADJACENT LANDUSE (RESIDENTIAL, COMMERCIAL, INDUSTRIAL MIXED USE RECREATIONAL ETC.)	PRIMARY MODAL USE BUS, METRO, PMV/LMV, HMV, BICYCLE, PESESTRIANS, IPT, ETC	SPATIAL CONFIGURATION (LINEAR, T-JUNCTION, 4 WAY INTERSECTION, ROUNDABOUT, CUL-DE-SAC, ETC.)
2. FUNCTION	2. ADJOINING ECOLOGICAL ASSETS IF ANY (LAKE, RIVER, WETLAND, FOREST, ETC)		
	3. VULNERABILITIES IF ANY (LANDLSIDES, WETLAND ECOLOGICAL ZONE, FLOODPLAIN, INFORMAL SETTLEMENTS, ETC)		

Source: UN-Habitat

a) Establish convenient, uninterrupted, and universally accessible streets for pedestrian, cyclist and other NMT users through the provision of a pan city complete streets network.
Suggested actions: This can be achieved by establishing sufficiently wide and unobstructed pedestrian sidewalks; continuity of NMT lanes and infrastructure; universally accessible ramps, flooring material, tactile edges and infrastructure dimensions; public plazas in socio-economic nodes and hubs, and shared streets, where applicable.

b) Improve road safety for vulnerable road users by reducing road accidents, conflicts, and severity of crashes, particularly in high-conflict zones, black spots[52], and school zones.
Suggested actions: This can be achieved by implementing protected bicycle tracks; unobstructed sidewalks and plazas in areas of large pedestrian movement; and speed calming design features.

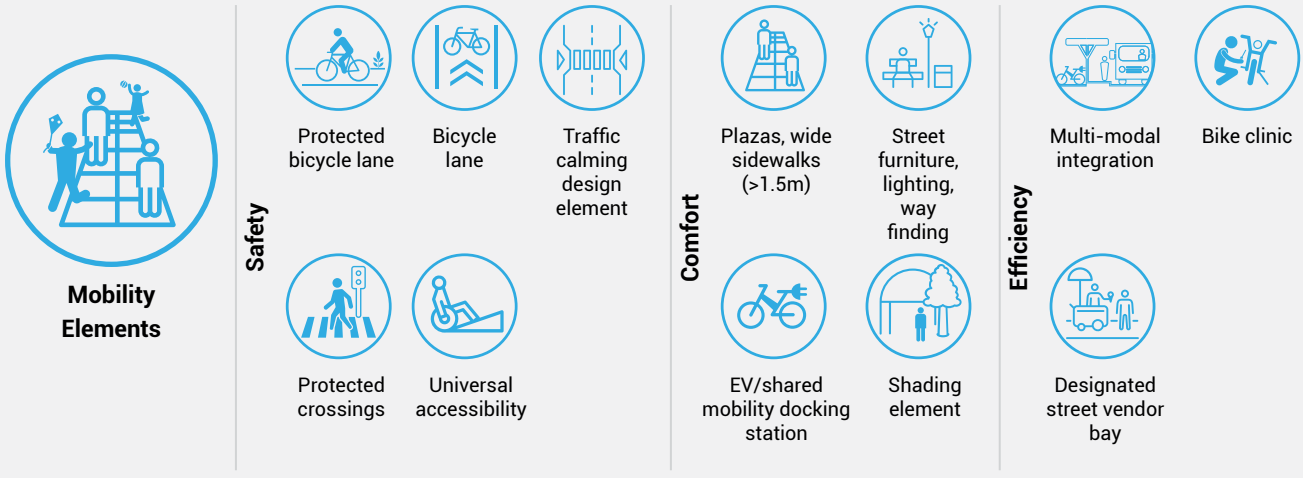
c) Seamless first/ last mile connectivity and multi-modal integration at transport hubs.
Suggested actions: Provision of low-carbon and shared mobility options at important transit nodes and areas with high pedestrian volumes. First/ last-mile services can include Public Bicycle Sharing (PBS), cycle-rental, shared tempos, autorickshaws, e-rickshaws, or a combination of these.

52 Areas of a city within a 500-m radius catchment, having among the 10 highest number of annual road accident fatalities, according to the Ministry of Road, Transport and Highways (MoRTH), Government of India. The draft BDP 2031 identifies several black spots and high conflict zones in Bhopal. Areas of a city within a 500-m radius catchment, having among the 10 highest number of annual road accident fatalities, according to the Ministry of Road, Transport and Highways (MoRTH), Government of India. The draft BDP 2031 identifies several black spots and high conflict zones in Bhopal.

d) Enhance NMT user comfort
Suggested actions: Incorporating street furniture, a variety of public seating, street lighting, shelters and shading devices and wayfinding along streets and public spaces.

e) Accommodate equitable and shared streets for street vendors and promote their roles in the informal economy as well as for improving public safety.
Suggested actions: Designated hawker zones fitted with basic infrastructure and services, such as lighting, protected vending bays or areas, etc. No-tolerance zones should also be implemented to prevent encroachment and obstruction to traffic. Adequate spaces should be created for shared mobility infrastructure, charging facilities and basic amenities.

FIGURE 3.10 Mobility elements under the Eco Arterial Complete Streets Network strategy



Source: UN-Habitat

2. **Ecological Elements:** These targeted interventions aim to leverage the public space of urban streets to preserve and enhance an area's ecological balance and biodiversity. The ecological elements of the Toolkit consist of NbS, as illustrated in Figure 3.11. The proposed ecological elements of the Toolkit are proposed with the following **goals and features:**

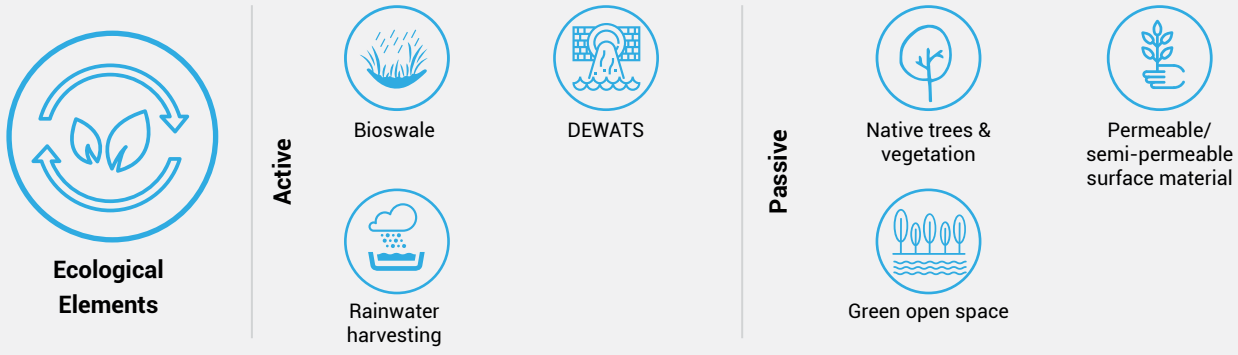
a) Improve the carbon sequestration capacity of urban streets in the city.
Suggested actions: Carbon sinks can line street edges with native trees, plants, bioswales and other forms of green cover. Along with being excellent carbon absorbers, appropriate natural vegetation may also improve soil health.

b) Increase the wastewater treatment capacity of the city through multifunctional public spaces and urban streets.
Suggested actions: Public spaces and streets can be utilized for passive treatment interventions that help treat the city's wastewater volume. These can include decentralized, low-cost, nature-based measures for greywater and blackwater treatment along streets, such as bioswales and Decentralized Wastewater Treatment Systems (DEWATS).

c) Mitigate the urban heat island effect and maintain recommended levels of the groundwater table.
Suggested actions: This can be achieved by reducing the paved surface area and increasing the permeable surface area in the city, where applicable.

d) Enhance pedestrian comfort and respite.
Suggested actions: This can be achieved by providing street shading via natural and artificial structures like trees and plants.

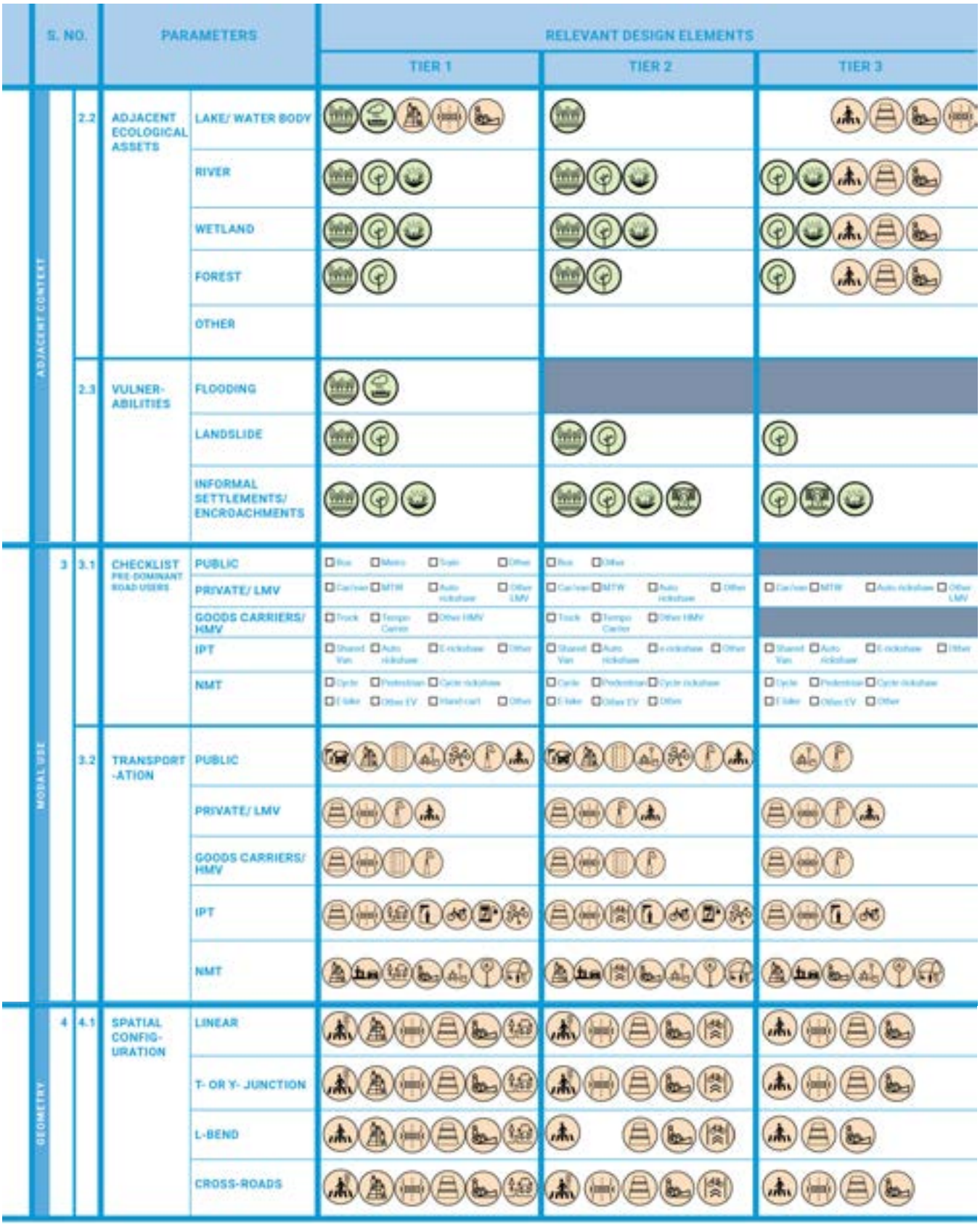
FIGURE 3.11 Ecological elements under the eco arterial complete streets network strategy



Source: UN-Habitat

TABLE 3.7 The Complete Streets Assessment Toolkit for Bhopal

	S. NO.		PARAMETERS		RELEVANT DESIGN ELEMENTS		
					TIER 1	TIER 2	TIER 3
STREET PROFILE	1	1.1	RIGHT OF WAY (IN METERS)		40-60m	20-40m	20m or less
		1.2	FUNCTION		Expressways, arterial streets (serving as major transit corridors)	Sub-arterial streets (connecting to ecological-socio-cultural-economic hubs)	Collector and local Streets (feeding sub-arterial streets) and sub-arterial streets not connecting to hubs
ADJACENT CONTENT	2	2.1	ADJACENT LANDUSE	RESIDENTIAL			
				COMMERCIAL			
				INDUSTRIAL			
				MIXED-USE			
				RECREATIONAL			



Source: UN-Habitat

Implementing the Toolkit

The street interventions described in this section require innovative revenue streams to fund and finance their development. Land value capture financing using Town Planning (TP) schemes, betterment levies, advertisement taxes, and strategic premiums on street parking fares are a few instruments that may allow the replication and sustenance of eco-arterial complete streets. Some key areas for implementing the Toolkit in Bhopal city are shown in Figure 3.12.

FIGURE 3.12 Key areas for the application of the Complete Streets Assessment Toolkit

Source: UN-Habitat

IMAGE 3.4 VIP Road along the northern banks of Upper Lake

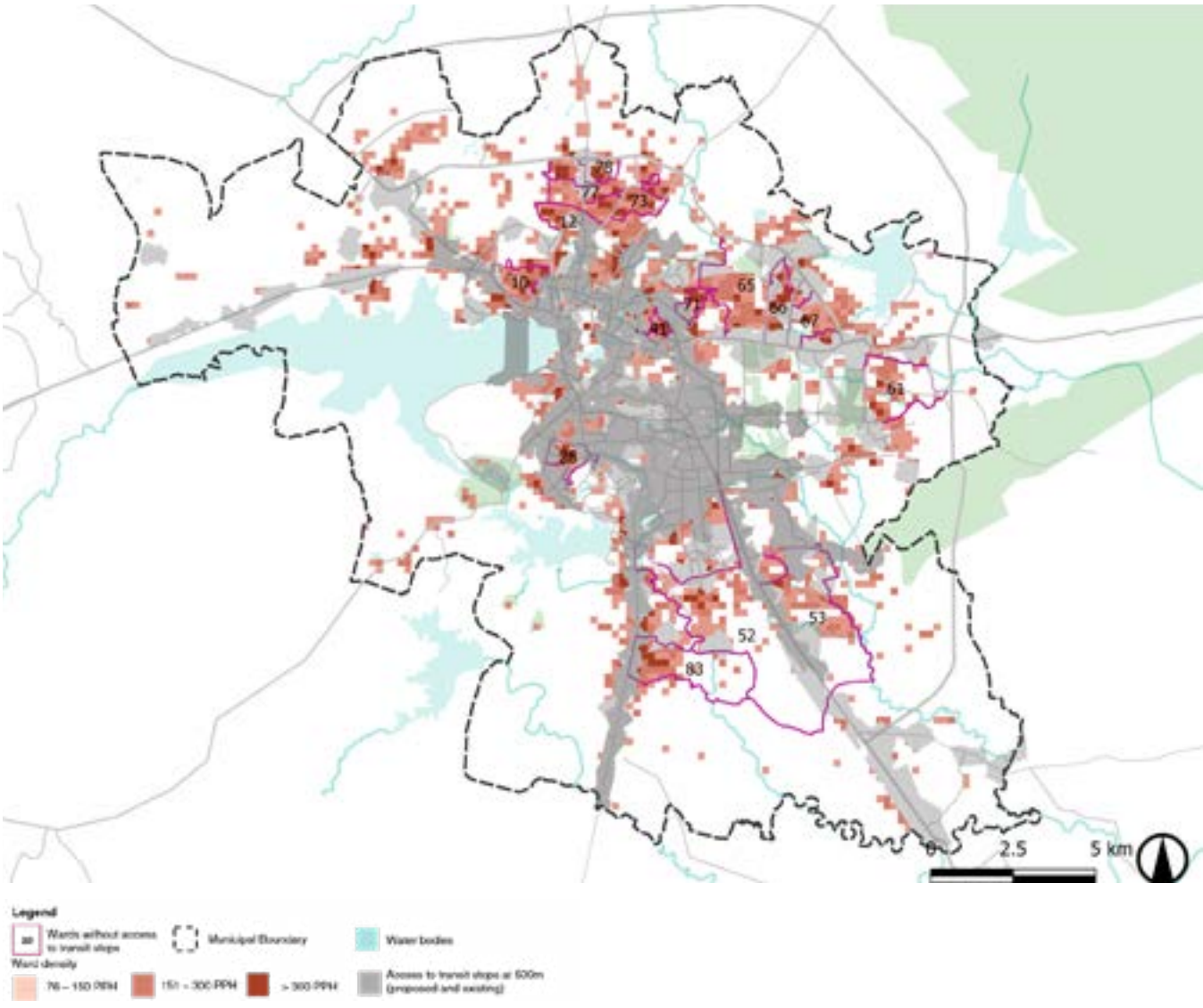
Source: UN-Habitat

Intervention 3.2: Reorganize the Regional and City Transportation Networks

Intervention 3.2.a: Prioritize the improvement of public transportation coverage

The spatial analysis of population density[53] within a transportation network coverage of a 500-m radius (USAF TR 6.1) revealed that several wards with high population densities (over 100 PPH) are still not serviced with any existing or upcoming transportation systems. As illustrated in Map 3.4, **wards 10, 12, 28, 41, 52, 53, 61, 65, 66, 67, 71, 73, and 78** do not have proper access to existing or proposed transit facilities (under AMRUT) within a 500-m radius.

After completion of Phase 1 of the Bhopal Metro, the existing public transportation of the city should be reorganized to incorporate feeder transportation to the metro stations. This is especially important to improve neighbourhood connectivity in the peripheries, as shown in Map 3.4. BMC is advised to prioritize the expansion of transit facilities in the identifi ed wards in subsequent proposals, under AMRUT 2.0, Smart City Mission and/or the FAME India Scheme[54] for the improvement of public transportation. The Toolkit may be utilized to ascertain the design elements to encourage low-carbon mobility while conserving the natural local ecology.



Map 3.4: Map showing land parcels with greater than 75 PPH and wards without access to proposed and existing transit stops within 500m radius

Source: UN-Habitat

53 Using population density in residential population density estimates, 2018 (250x250m pixels) from Worldpop https://www.worldpop.org.

54 Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India (FAME India) scheme launched in 2015, https://pib.gov.in/newsite/PrintRelease.aspx?relid=191377.

Intervention 3.2.b: Reorganize regional transportation network through transit hubs

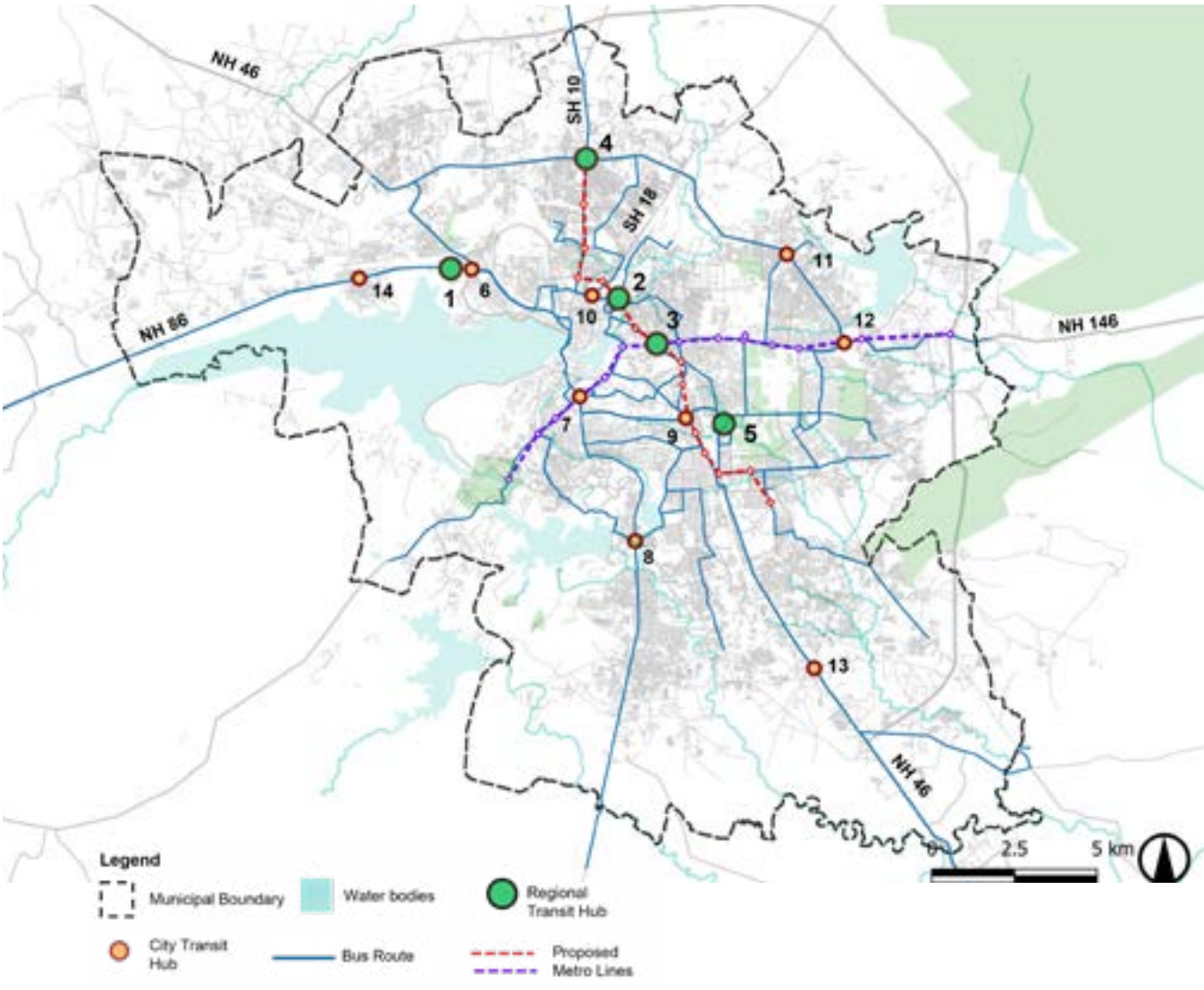
The integration of MMT systems provides an opportunity to **reorganize the regional transportation network while restricting the movement of inter-city buses** in the BMC area. Restricting thoroughfare in the urban core may ease traffic congestion and reduce air and noise pollution in the city. Possible transit hubs at the regional or city-level are described below:

1. **Regional transit hubs** are existing intersections or nodes with regional transit terminals for railways or buses, city transit stops, IPT, and/or proposed metro stations. These should restrict the movement of inter-city buses and prevent them from entering the city to reach an Inter-State Bus Terminal (ISBT). These hubs can be developed as gateways to the city with integrated access to diverse modes of public transportation. The Toolkit can be used to assess the existing condition of these nodes, as well as determining the long-term and tactical interventions that may be employed at these hubs (see Table 3.10).

The regional transit hubs are mapped in Map 3.5:

City transit hubs are public transit stops connecting important work centres, commercial and retail clusters, institutional centres, social/ recreational nodes, and industrial centres (see Map 3.5). These nodes witness traffic surges and congestion during peak hours.[55]

The Toolkit can be adopted to determine the relevant tactical as well as long-term interventions to promote active transportation in and around these hubs. The regional and city transit hubs that require priority development are listed in Table 3.8 .One such hub development, Chunabhatti Chowk, is described in detail in the Transformative Project (ABD), under Section 3.1.25 of this report.



Map 3.5: Development of regional transit hubs and city transit hubs

Source: UN-Habitat

55 As per traffic analysis in Chapter 8: Transportation and Mobility, draft BDP 2031.

TABLE 3.8 List of regional and city transit hubs

#	Name of the node	Type	Features
1	Halalpura	Regional Transit	Existing regional bus terminal along NH 86. Proposed regional hub to the West.
2	Bhopal Railway Station	Regional Transit	Railway terminal, BRTS corridor, IPT, and proposed Metro station. Dense built form and proposed central regional transit hub.
3	Pul Bogda	Regional Transit	Proposed Metro Phase 1 interchange. Major commercial node. Proposed eastern regional hub.
4	Karond Circle	Regional Transit	Integration of national highway and metro rail; can act as regional transit node to the North.
5	Habibganj Railway Station and ISBT	Regional Transit	Integration of railway, inter-city bus, BRTS, metro rail and IPT. Southern regional hub.
6	Lalghati	City Transit	Key transit hub and key integration with IPT and public transport. Leverage to improve access to Bhopal Airport.
7	New Market	City Transit	Central business district. Integration with market, smart parking, subway and NMT.
8	Chunabhatti	City Transit	Commercial, institutional and residential node. Integration with natural assets and NMT.
9	Board Office	City Transit	Administrative area with offices, government housing and commercial
10	Nadra Bus Stand	City Transit	Regional transport hub, integration with dense built form and commercial development in city core.
11	Ayodhya Bye Pass Junction	City Transit	Industrial suburb with new LIG and MIG housing units.
12	Piplani	City Transit	Potential regional transit node to the West. Integration of movement of goods and people.
13	Misrod	City Transit	Industrial and LIG housing. Integration with public transport and NMT.
14	Chanchal Chouraha	City Transit	Commercial node. Integration with St Hirdaram Railway Station and public transport.

Source: UN-Habitat

Intervention 3.3: Prepare a Low-carbon Comprehensive Mobility Plan for Bhopal

Preparing a Low Carbon Comprehensive Mobility Plan (LCCMP) for Bhopal is crucial for developing a long-term vision for desirable accessibility and mobility patterns for people and goods in the city. It is also important for facilitating proper integration of multimodal transit systems and reorganizing regional traffic.

The LCCMP for Bhopal should follow these steps:

- Assess the present travel behaviour and patterns in the city and forecast future travel demand.
- Estimate emissions from urban transport based on future travel demand.
- Assess the impacts of transport on local air quality, emissions, safety, and social aspects.
- Provide a centralized, effective platform for integrating land use and transport planning.
- Reorganize regional and city traffic to provide a seamless experience between different modes.
- Provide spatial, economic, and regulatory plans and interventions based on
  i. urban structure (land use);
  ii. public transport strategies (city-wide and urban design); and
  iii. NMT (complete streets Toolkit).
- Integrate the recommendations of relevant plans and policies like Bhopal Clean Air Action Plan (2019), draft BDP 2031, ongoing Bhopal Metro Rail projects and Bhopal Smart City Plan.

Refer to Annex 8 for the list of activities to be included in the scope of work for the LCCMP.

To encourage use of public transportation, transit hubs and public transport facilities should cater to all user groups, especially women, children, and the elderly. Specific assessment and data are required to inform and develop a gender-sensitive CMP. The recommended datapoints are provided in Section 3.4.3.

3.4.2 Alignment with national, state policies, programmes and ongoing, proposed capital projects in the city

- Bhopal Development Plan 2005
- Draft Bhopal Development Plan 2031 (approval from state government pending)
- Bhopal Smart City Plan
- Clean Air Action Plan 2019

- AMRUT
- AMRUT 2.0 / Jal Jeevan Mission (Urban)
- Smart City Mission
- Swachh Bharat Mission (Urban) 2.0
- Pradhan Mantri Awas Yojana - Urban

- National Urban Policy Framework 2018
- National Urban Transport Policy, 2014
- National Mission on Sustainable Habitat 2021-2030
- Non-Motorized Transport Guidance Document 2016
- Madhya Pradesh Transport Policy 2010
- Madhya Pradesh Draft Transit Oriented Development (TOD) Policy 2018
- Sustainable Urban Transport Index (SUTI) for Bhopal 2017

- Procurement of 300 hybrid buses under AMRUT
- Development of smart road with dedicated cycle lanes under Smart City Mission
- Construction of Bhopal Metro Phase -1

The detailed alignment with programmes, national missions and key projects are summarized in Annex 2.

3.4.3 Gender and inclusion

This intervention offers an affordable, equitable and efficient transportation system by prioritizing the improvement of NMT and public transportation networks in the city. Improving the safety and comfort of pedestrian mobility with key infrastructure like lighting, street furniture and shading elements can encourage more pedestrians on the street. It can also facilitate safer streets for women, children, the differently abled, the elderly, and other vulnerable groups.

The Toolkit should be accompanied by an understanding of the needs of mobility care, universal accessibility, safety of marginalized groups, specifically women and gender minorities. It is recommended that the CMP collect and report travel behaviour data, as defined in Intervention 3.3. Recommended datapoints include travel behaviour, perceptions and experiences of safety and sexual harassment disaggregated by gender, age, income (and religion, where relevant). Specifically, perceptions and experiences of safety and sexual harassment should cover the experiences of people not only during in-vehicle public transport use, but also while travelling to and waiting for public transport and paratransit.

Intervention 3.2: Reorganizing the regional and city transportation network offers the opportunity for gender mainstreaming in each of its sub-interventions (2a and 2b). To encourage use of public transportation, transit hubs should cater to all user groups, especially women, children, and the elderly. Provision of gender inclusive amenities should include nursing stations, public toilets, drinking water facilities, waiting rooms.

Incorporating gender-inclusive amenities in public transportation and transit hubs should also be accompanied by safer 'Travel at Night' programmes, which aim to improve women's safety while travelling after dark. Some components of these programmes include ensuring women-led police patrols, night accommodation for women, choosing certain street vendors as street marshals, requesting stop service on public transport, etc. Further details and guidelines for such programmes are listed in Annex 5.

3.4.4 Climate convergence

This strategic response includes the redesign of major streets into complete streets with improved NMT facilities. The objective of this strategic response is to promote a modal shift of transport from private vehicles to public transport, NMT or shared vehicles. This can aid in the reduction of overall GHG emissions from the transportation sector. Additional interventions like tree lining, shift towards green fuel (CNG/ electric) and promoting shared mobility may reduce the overall emissions in the long-term.

The potential GHG emission savings by integrating green spaces with Kolar Road and developing it as an eco-arterial corridor is summarized in detail in Transformative Projects 3 (see Section 3.6.5).

3.5 Strategic Response 4: Urban Retrofitting of Informal Settlements

The fourth critical issue for Bhopal, highlighted by the USAF, is that of the **vulnerability of informal settlements**.[56] The strategic response to this is **urban retrofitting**, which is guided by the core planning principles[57] of – Adequate Housing for All (3.1.3), Compact Cities (3.1.1), and Ecosystem Restoration and Enhancement (3.1.2).

Urban retrofitting is the adaptation or re-engineering of the fabric, form or systems of existing urban environments, such as social and technological infrastructure, to improve energy, water and waste efficiencies, and mitigate climate change impacts.[58,59,60] This approach encourages in-situ upgrading of housing, infrastructure, or both, over relocation and resettlement of informal settlements, where possible.

In-situ urban retrofitting enables city governments to improve the standard of living and quality of life of its citizens through adequate housing for all, including for informal settlement dwellers living in deteriorating or vulnerable habitats. This strategic response allows informal settlement dwellers, who are often part of the informal economy, the opportunity to stay close to their workplaces, while also preserving their social and personal support networks.

56 As per the USAF. See Section 2.3.1: City Diagnostics – Strategic Issues.

57 See Section 3.1: Strategic Responses – Core Planning Principles.

58 Scaling up: the challenges of urban retrofit, Building Research & Information, Tim Dixon & Malcolm Eames (2013), 41:5, 499-503, DOI: 10.1080/09613218.2013.812432, paper accessed on 02/03/2022.

59 Retrofitting Suburbia: Urban Design Solutions for Redesigning Suburbs, (Wiley 2009, 2011, Mandarin 2013).

60 Urban Retrofitting: Because Starting from Scratch Is Not Always A Good Idea, Jaime Ramos, 2021, https://tomorrow.city/a/urban-retrofitting-because-starting-from-scratch-is-not-always-a-good-idea, accessed on 20 December 2021.

The primary policy addressing affordable housing for marginalized urban communities by the central government is the Pradhan Mantri Awas Yojana – Urban (PMAY-U) or the Housing for All Mission, a scheme initiated in 2015. The urban retrofitting strategic response supplements the PMAY-U with suggested additions and modifications to fortify rehabilitation efforts for informal settlements through the context of Bhopal.

The Urban Retrofitting Process

Informal settlements may qualify for urban retrofitting in the form of **in-situ infrastructure, and/or housing upgrades**, as illustrated in Figure 3.13. This depends on multiple factors, including the inherent vulnerabilities and ecological threats to such settlements, and contextual, site-specific opportunities and constraints like availability of vacant land, population density, ecological vulnerability and risks, access to public transportation, and access or deprivation to basic urban amenities and services, among others. These determining criteria have been illustrated in Figure 3.15.

However, if an informal settlement faces inherent risks or vulnerabilities, such as risk to life or building stock, or lies on protected land, **relocation of settlement dwellers to infill sites may be recommended instead of in-situ urban retrofitting.** These receiving infill sites are optimal for affordable housing based on the assessment described in **Section 3.2.1, Proposed Intervention 1: Revitalize urban core through re-densification,** for Strategic Response 1: Urban Revitalization.

The urban retrofitting process flow diagram (see Figure 3.14) illustrates the various components and detailed steps of urban retrofitting for Bhopal.

The main objectives of this strategy are:

1. To protect informal settlement dwellers from ecological risks, climate related disasters and vulnerabilities based on their dwelling location.
2. To improve the quality of life of informal settlement dwellers by improving their access to urban services and amenities, including education, public transport, open space and healthcare.
3. To maintain existing linkages to socio-cultural-economic networks and livelihood opportunities.

Based on the USAF, the 388 informal settlements of Bhopal were assessed in terms of their ecological risks and access to basic amenities. Accordingly, the settlements were categorized into three main groups, as shown in Table 3.9.

TABLE 3.9 Classification of informal settlements based on ecological risks, vulnerabilities and access to amenities

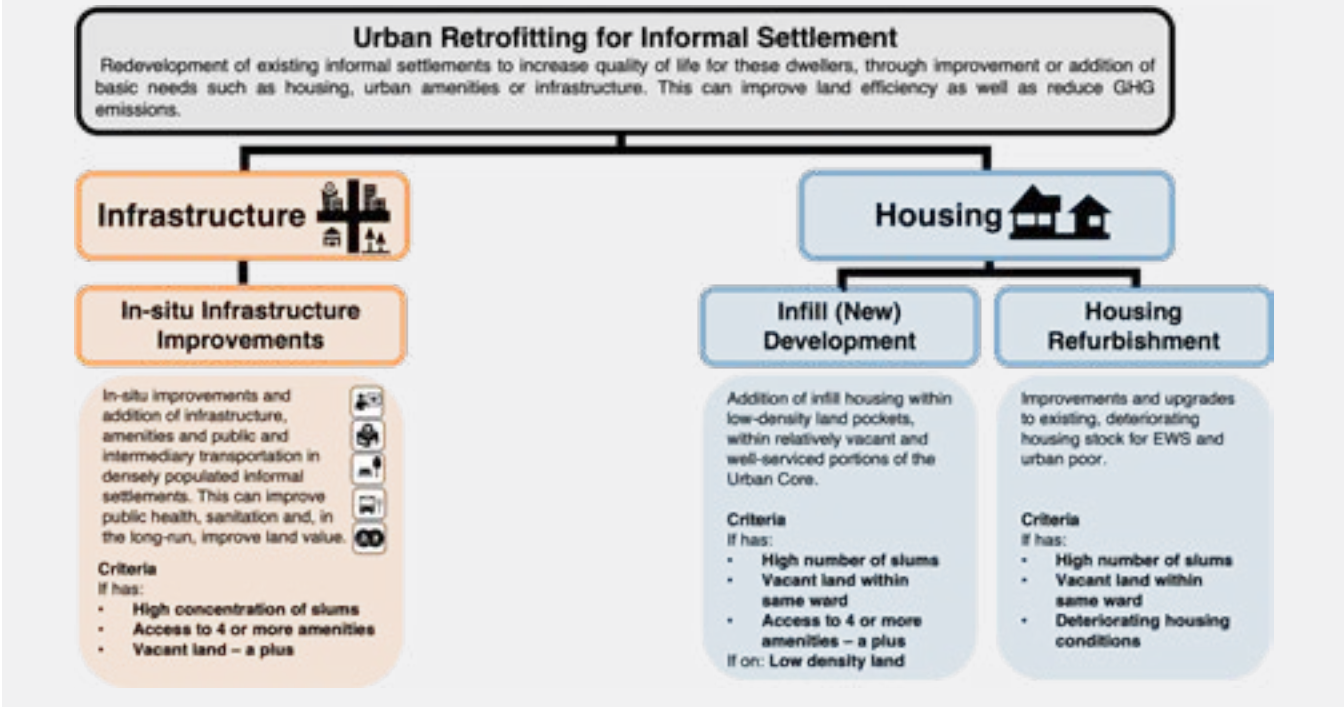
Slum Classification	Number of slums	Population	Households
Critical (Both vulnerable and deprived)	34	41,397	10,966
Vulnerable (Slums on eco-sensitive and non-buildable zones)	56	1,22,632	33,157
Deprived (Slums with access to 3 or less amenities)	160	2,30,494	63,255

Source: UN-Habitat

IMAGE 3.5 Dhamkheda slum settlement situated on eco-sensitive land along the Kaliasot River

Source: UN-Habitat

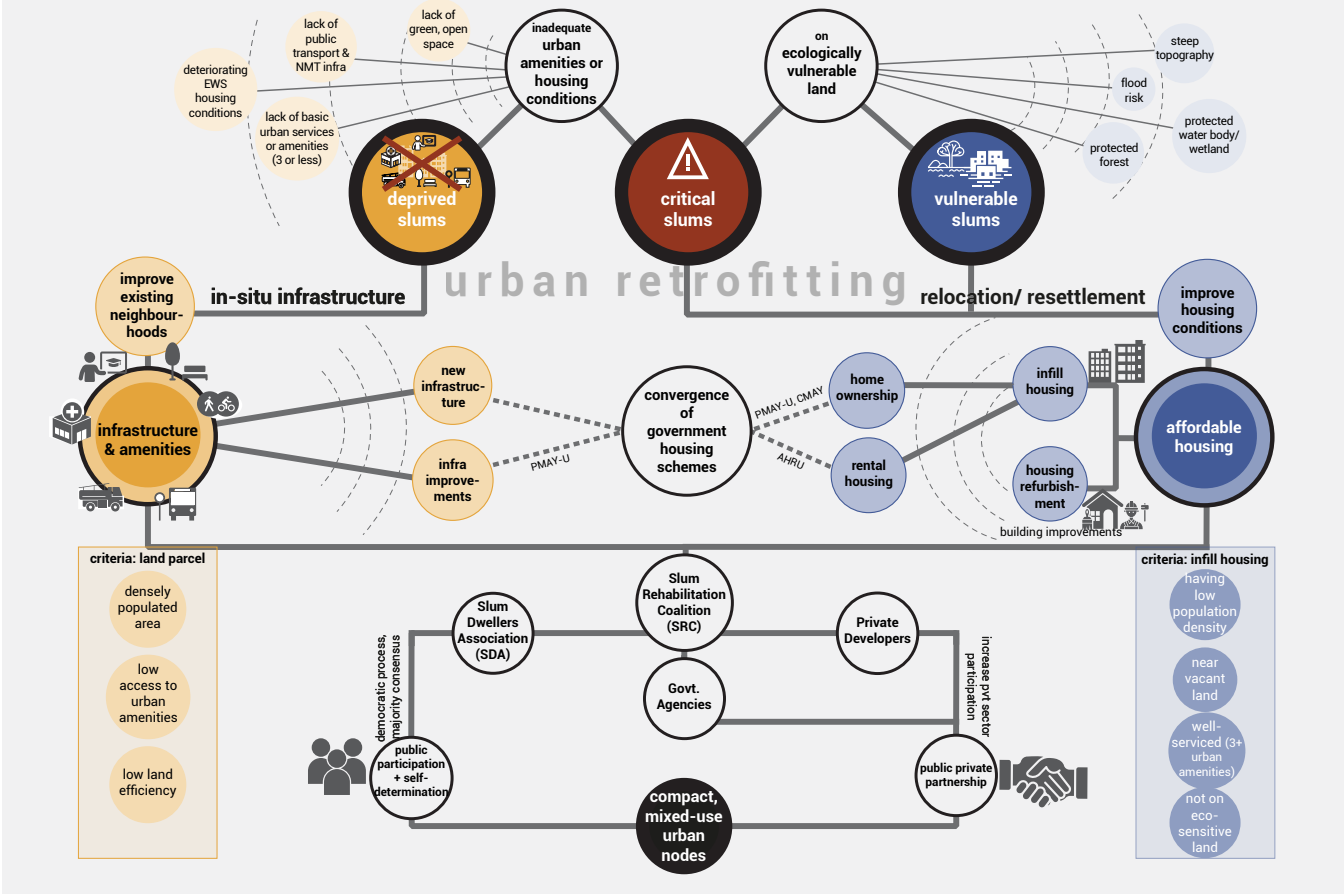
FIGURE 3.13 Types of urban retrofitting for informal settlements



Source: UN-Habitat

Process Flow Diagram: Urban Retrofitting for Informal Settlements in the Urban Core

FIGURE 3.14 Process flow diagram for urban retrofitting of informal settlements



Source: UN-Habitat

FIGURE 3.15 Key criteria for urban retrofitting of informal settlements: Opportunities and constraints

OPPORTUNITY

Vacant Land

- Identify wards with unutilized/ vacant land parcels or land without any identified purpose, irrespective of public or privately ownership.

OPPORTUNITY

Population Density

- Identify 'saturated' wards having high density land parcels of population density exceeding 75 PPH for re-urbanisation.

CONSTRAINT

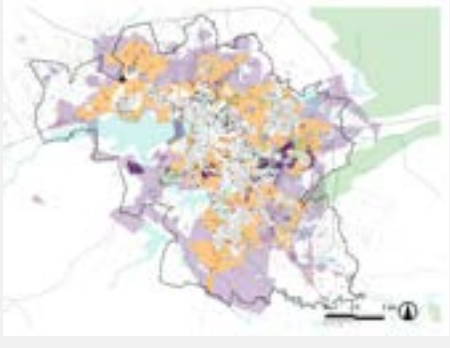
Ecologically Vulnerable/ High-risk Areas

- Identify ecological conservation zones around natural assets and ecologically sensitive sites.
- Introduce a minimum buffer from these resources: Upper Lake: 50mOther water bodies: 33mRivers & major streams: 50mMinor streams: 9m
- Identify settlements on hilly terrain with a steep slope of 8 degrees or more.

OPPORTUNITY

Access To Public Transportation & NMT

- Identify areas within a 500m walking radius of one or more public transit stations (bus, metro, etc).
- Identify existing or upcoming TOD corridors of Bhopal Metro or BRTS, for higher FAR opportunities for building developments. This is an added opportunity.



OPPORTUNITY

Access To Services And Amenities

- Identify informal settlements in areas within a 500m walking radius of less than 3 public services and/ or amenities, out of the 6 identified.

Source: UN-Habitat

3.5.1 Proposed interventions under the strategic response

The strategic response includes **five key interventions** to effectively and comprehensively implement urban retrofitting in the city. These are:

Intervention 4.1: City-wide Survey of Informal Settlements
Intervention 4.2: Development of a Slum Rehabilitation Coalition (SRC)
Intervention 4.3: In-situ Development of Infrastructure and Urban Amenities
Intervention 4.4: Housing Development – Increase Affordable Housing Stock
a. Spatial opportunities for resettlement or relocation of critical and vulnerable slums
b. Spatial opportunities for in-fill affordable housing
Intervention 4.5: Housing Refurbishment

Intervention 4.1: City-wide Survey of Informal Settlements

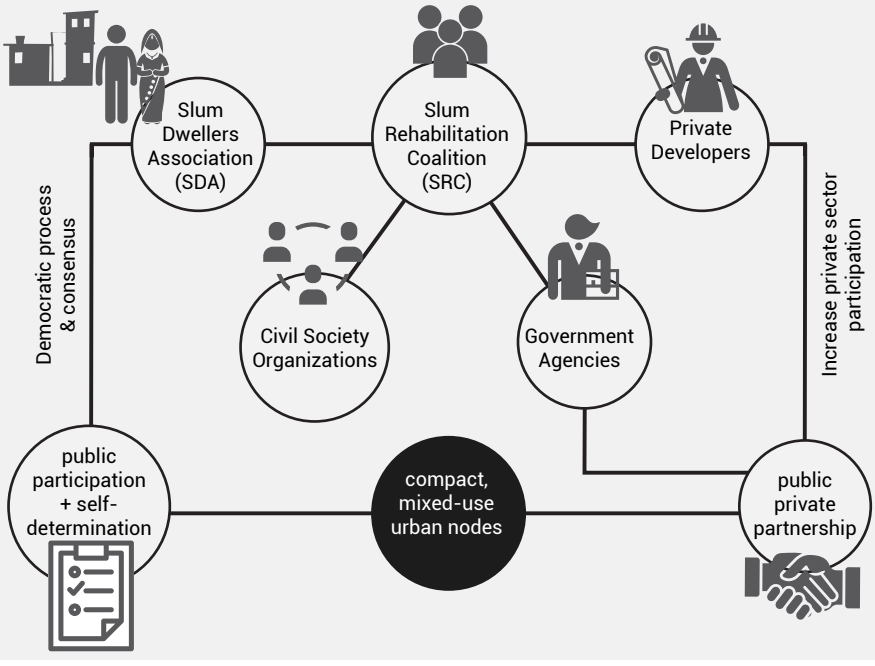
In the absence of any current comprehensive assessment of the existing informal settlements in Bhopal, a pan city survey is recommended by the BMC to ascertain the socio-economic demographics, activity patterns and existing infrastructure and housing conditions of these informal settlement populations. Stakeholder consultations in Bhopal have further corroborated this need.

Such a data repository is the first step in identifying the socio-economic-infrastructural-cultural needs of these vulnerable populations. The survey should encompass, inter alia, land ownership, household-level data for household size, gender-based composition, education levels, head of household segregated by gender, tenure of residence, household income, places of income and livelihood, daily mobility and travel modes, condition of housing, personal water supply, electricity, waste management and sewage treatment methods, if any, etc. It should also document community-level urban infrastructure, amenities, and services in the informal settlement, if any.

Intervention 4.2: Development of a Slum Rehabilitation Coalition (SRC)

In addition to the infrastructural and contextual conditions, urban retrofitting is also centered on active participation from all stakeholders, including the informal settlement communities, civil society organizations, private real estate developers, and relevant government department(s) and agency(ies). This collaborative participation is envisaged via the formation of an **SRC**, as illustrated in Figure 3.16.

FIGURE 3.16 Slum Rehabilitation Coalition composition



Source: UN-Habitat

Slum Dwellers Association (SDA)	Civil Society Organizations	Government and Affiliated Agencies	Private Developers
• Representatives of 388 informal settlements • Occupational associations	• Residents Welfare Associations (RWA) • Self Help Groups (SHG) • Non-profit organizations like CURE, Housing and Land Rights Network, Centre for Advocacy and Research, Campaign for Judicial Accountability and Reform, Delhi Rozi Roti Abhiyan.	• BMC, BSDCL, BDA • TNCP, MPHB • MoHUA	• Builders' Association • Real Estate Developers • Banks

Features of the SRC: The creation of an **SRC** is recommended to catalyse inclusive, collaborative and integrated informal settlement rehabilitation in Bhopal. The components of the SRC are listed below, and illustrated in Figure 3.16:

1. The **SRC** is envisioned as a **diverse and representative body**, bringing government, informal settlement populations, civil society organizations, and the private housing sector together to streamline and expedite affordable housing development, community-driven housing, and infrastructure improvements in informal settlements. It should include representatives of the affected informal communities, municipal leaders, and experts from the housing, planning, real estate, and financing sectors.

2. **Collaborations between the government and the private sector** may include financial institutions, banks, lending institutions and real estate developers, to create innovative public-private partnerships, financing models, and operating procedures, for self-sustaining, affordable housing developments in the city.

3. To **ensure self-determined priorities and needs, of and by the community,** dwellers of each informal settlement should be represented by an individual Slum Dwellers Association (SDA), whose features are defined below:
   a. The SDA must feature one female and one male member from each household, if available.
   b. Decisions made by the SDA represent the entire local community and must be passed by a simple majority vote for consensus.
   c. The SDA should be represented in the SRC by community-selected leaders, of which 50 per cent should be females.
   d. BELL should guide and facilitate the SDA for efficient participation in the SRC.

4. BELL should leverage the strengths of civil society organizations and educational institutions for community capacity building, knowledge sharing and public awareness, as well as sensitization to local ecological threats and land issues.

5. The SRC builds a greater sense of ownership over community-driven projects through frequent participation and representation during the planning process and may enable opportunities for community-led maintenance. Community members can become valuable contributors to finding localized solutions to inherent roadblocks and challenges. This process may also facilitate new community leaders, advocates, and increase participation by women and other marginalized groups within the communities.

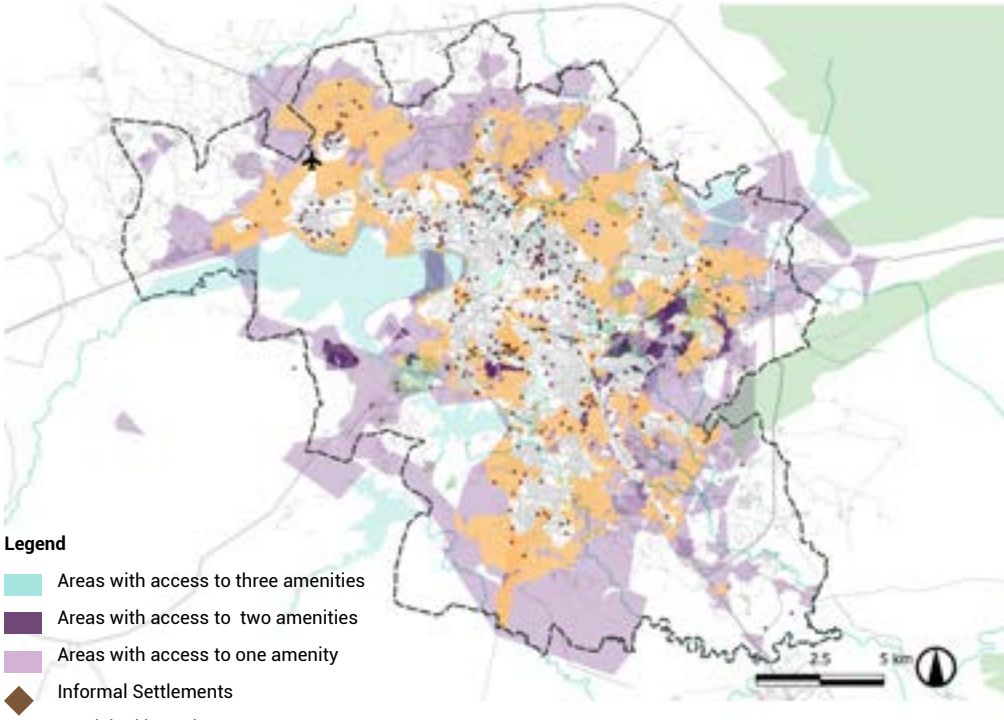
Intervention 4.3: In-situ Development of Infrastructure and Urban Amenities

Informal settlements in the urban core, which are deprived of basic urban amenities[61] (with access[62] to only three or less services); are devoid of any ecological risk; and require infrastructure improvements, may qualify for urban retrofitting through in-situ development of infrastructure and basic urban amenities. The locations and opportunities for infrastructural urban retrofitting within the BMC area were identified by analysing the slum locations, population density and their access to urban amenities (coverage of urban amenities as per USAF). The identified wards with land parcels that require in-situ infrastructure development are illustrated in Map 3.6.

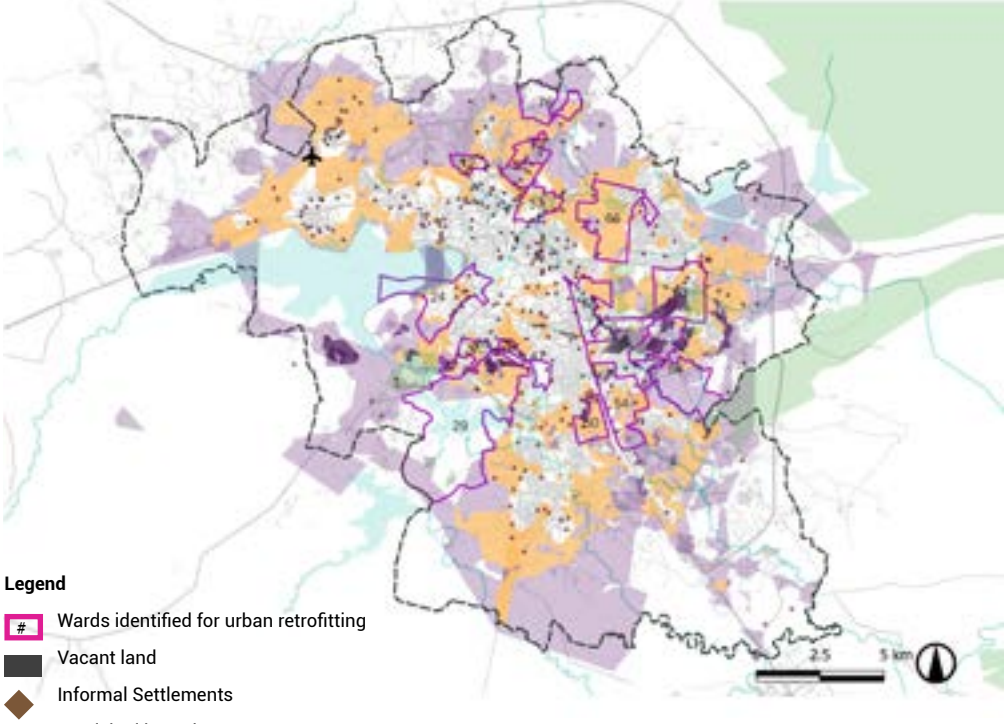
61 Six urban amenities are considered by the USAF, including a school, hospital, fire emergency service, park or public open space, public transportation, and NMT service/ amenity.
62 Maximum permissible walking distance to these amenities, as defined in the USAF (see Section 2).

Spatial Opportunities for In-situ Infrastructure Development

Slums having access to 3 or less amenities



Opportunity wards for urban infra retrofitting



Schools

Hospitals

Fire Emergency Services

Parks and Open Spaces

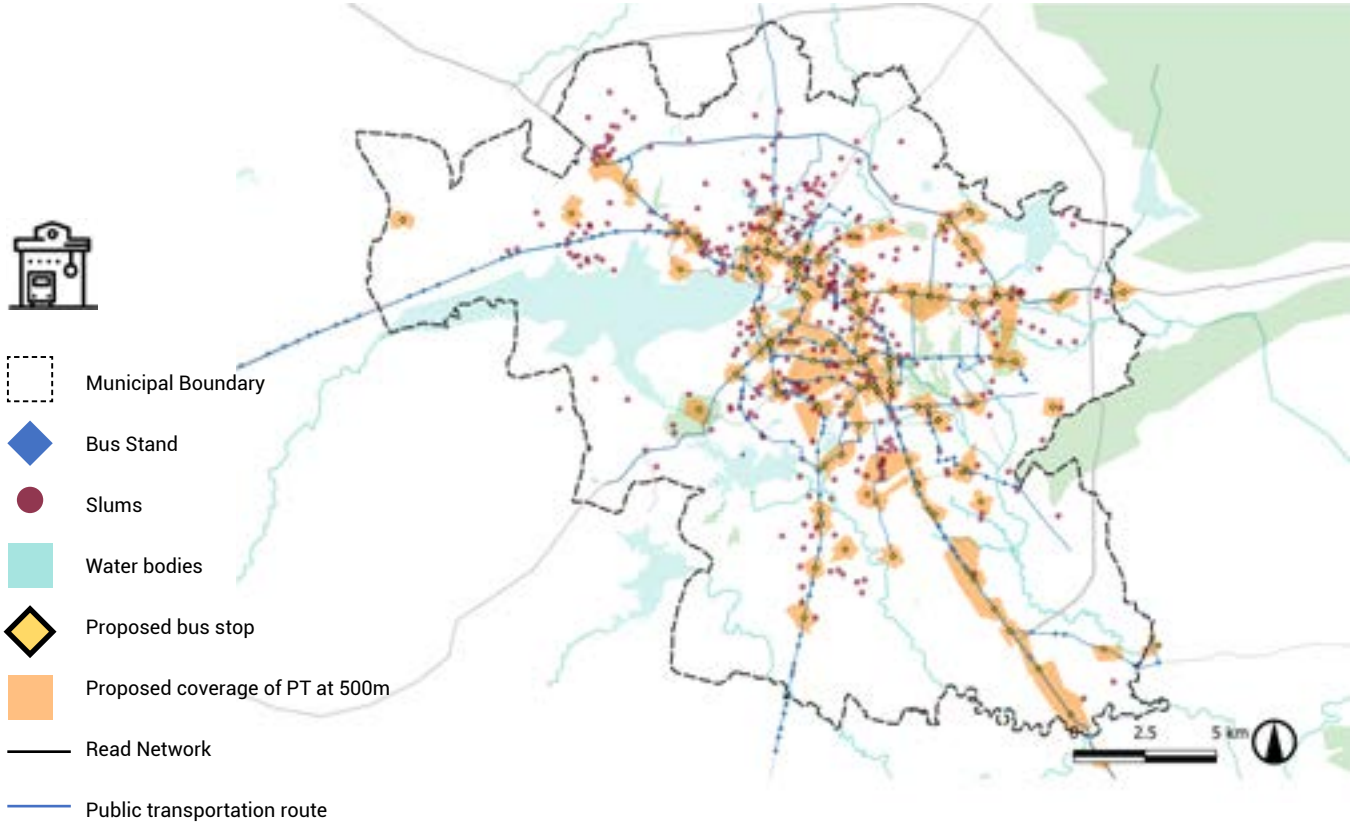
Public Transportation

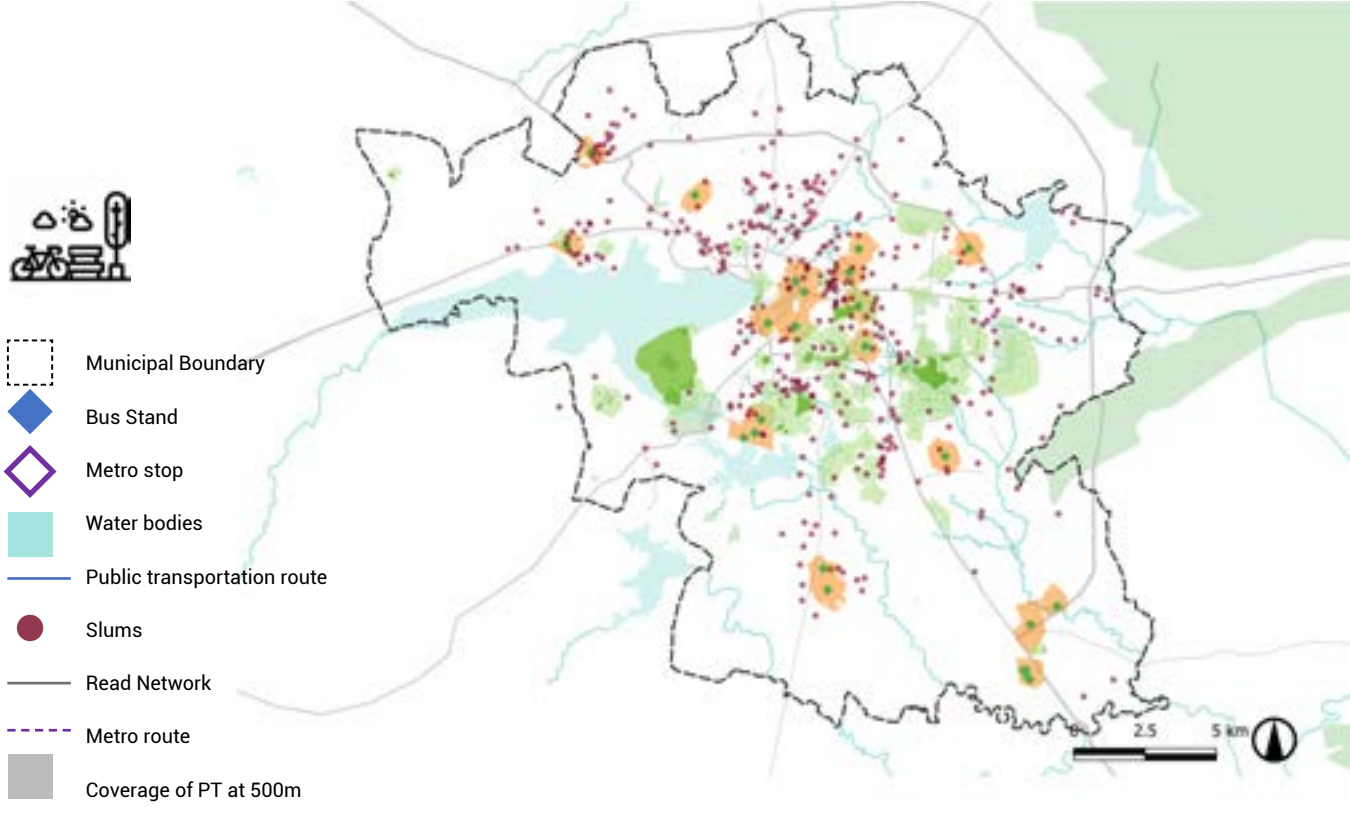
NMT

Map 3.6: a. Slum distribution and coverage of three amenities or less
b. Optimal wards for in-situ infrastructure retrofitting

Source: UN-Habitat

Mapping city wards with slums situated on eco-sensitive land and proposed for densification





Map 3.7: a. Coverage of existing and upcoming bus networks under various schemes for slum distribution in Bhopal
b. Coverage of existing and upcoming parks under various schemes for slum distribution in Bhopal

Source: UN-Habitat

Improved amenities through the convergence of National Missions

In Bhopal, several national policies and schemes are already being implemented to facilitate urban infrastructure improvements. One such scheme is AMRUT, under which 300 new buses will be procured for Bhopal city to improve the network coverage of its bus system, and upgrade its underground sewerage network. Additionally, parks and open spaces will be developed across the city.

Another national scheme, the Smart City Mission, has been underway in Bhopal since 2015. It includes the development of NMT infrastructure, parks and open spaces, and smart street infrastructure using the Internet of Things (IoT) for the monitoring and administration of civic utilities and citizen services. Under the mission, a pilot Area Based Development project is being implemented in TT Nagar. This project has developed smart roads, smart parking surveillance, and Intelligent Transport Management System (ITMS) in the area.

Finally, the National Urban Livelihoods Mission (NULM) encompasses livelihood schemes and incentives for the urban poor, including financial aid to street vendors and other marginalized communities in the city.

To supplement the efforts under the existing national schemes and projects in the city, two additional interventions can expand and fortify the pan city sustainable transportation network to mitigate GHG emissions. These include Strategic Responses 3 and 4 of this report, namely "incorporating nature-based solutions for preserving urban ecology through the Bhopal Eco Living Lab", and "applying the assessment toolkit and corresponding interventions under the Complete Streets Assessment Toolkit".

Intervention 4.4: Housing Development – Increase Affordable Housing Stock

Affordable housing development may be required either due to the resettlement needs of vulnerable informal settlements, or from infill housing opportunities to realize compact development in the urban core. This intervention identifies clusters of informal settlements and the spatial opportunities in the BMC core, which fulfill the requisite criteria of low-density and high access to urban amenities for new housing development.

Intervention 4.4a: Spatial opportunities for resettlement or relocation of critical & vulnerable slums

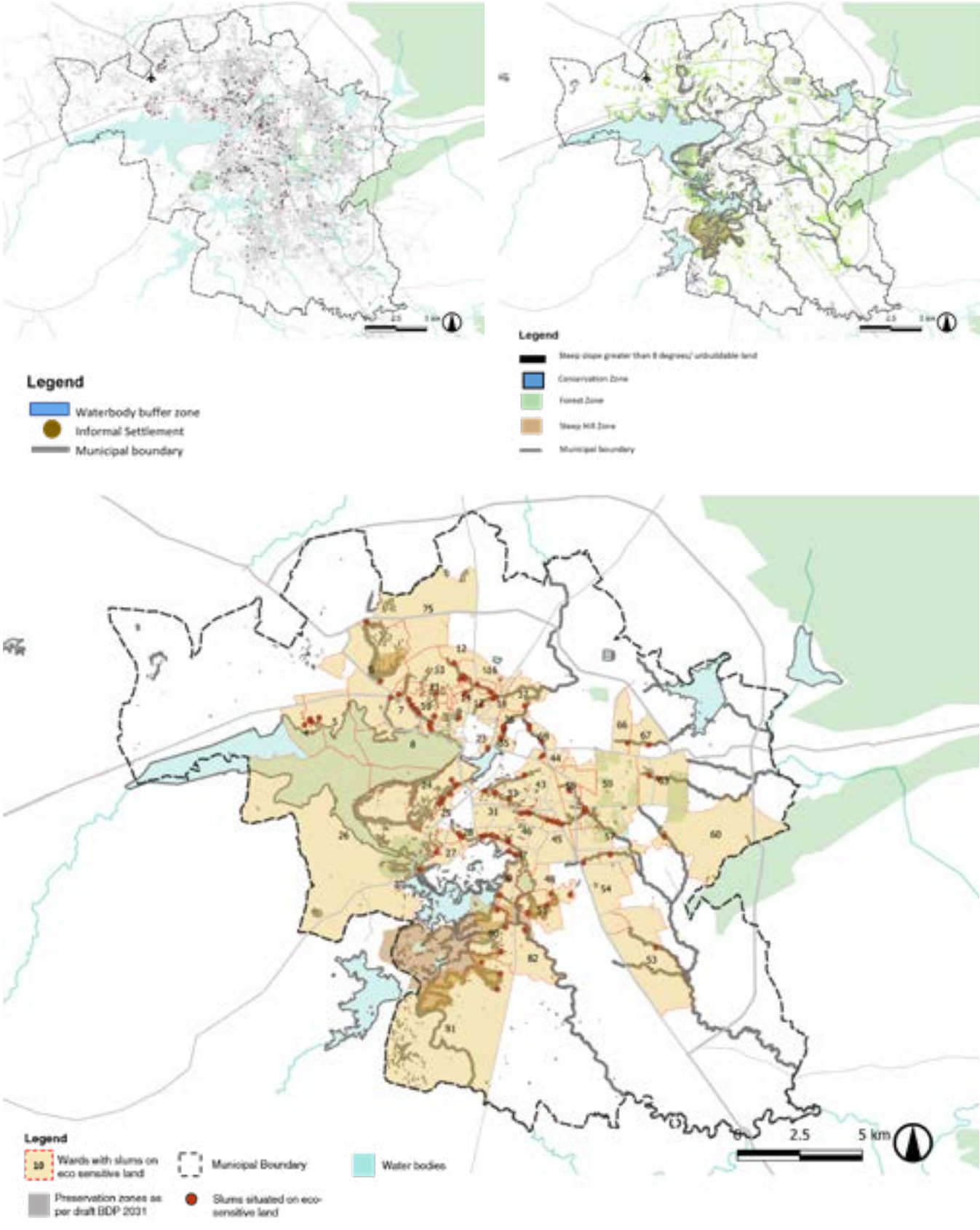
Informal settlements in ecologically protected or vulnerable areas of the city have been identified through GIS data mapping. The following maps highlight these protected and vulnerable zones and the informal settlements they contain, along with their municipal wards. These form part of 90 vulnerable or critical informal settlements (see Annex 6 for the list of informal settlements on eco-sensitive land), which require priority and urgent attention for resettlement.

The resettlement of the informal settlements located on eco-sensitive land may be carried out within the ward, or nearby ward/s, by identifying low density sites with good access to amenities and livelihood opportunities. (see Map 3.8)

Intervention 4.4b: Spatial opportunities for in-fill affordable housing

Certain sites within the BMC area have been identified as optimal for infill affordable housing. These sites satisfy multiple criteria, such as low population density (less than 150 PPH), access to four or more urban amenities and absence of ecological vulnerabilities. As a result, they may qualify for infill housing development, as illustrated in Map 3.9(a), (b) and (c). The resultant sites for infill development are represented as 250-sq. m. land parcels, as shown in Map 3.9(d). The sites highlighted in red are the most suitable for infill affordable housing as they are without any current land use and enjoy access to more than four urban amenities.[63]

63 Includes schools, hospitals, fire emergency services, parks and public open space, public transportation, and NMT infrastructure. Access means maximum walking distance to these amenities, as defined in the USAF (see Section 2).

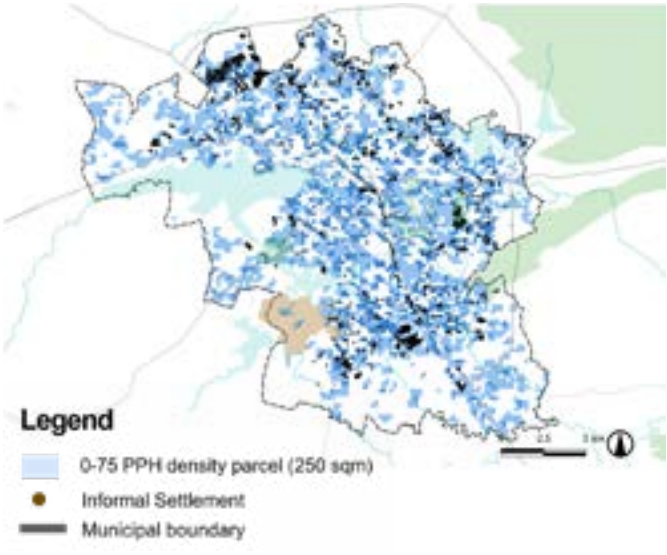


Map 3.8: a. Water bodies and their buffer zones in Bhopal, with respect to slum distribution
b. Ecologically vulnerable and non-buildable land, with respect to slum distribution
c. Wards with slums situated on eco-sensitive land

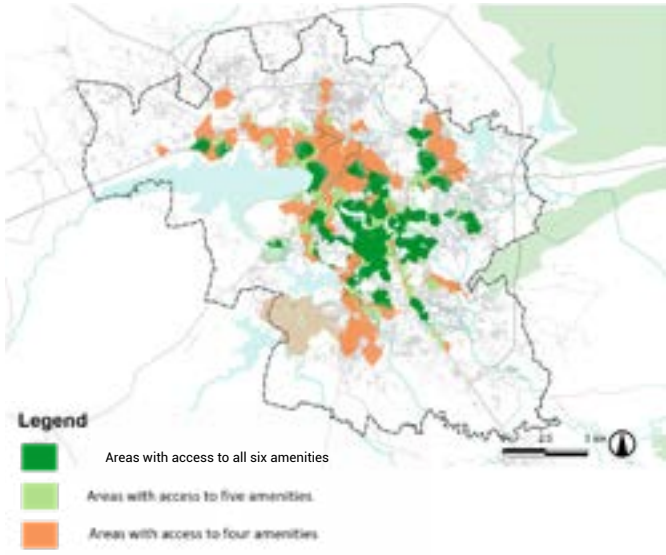
Source: UN-Habitat

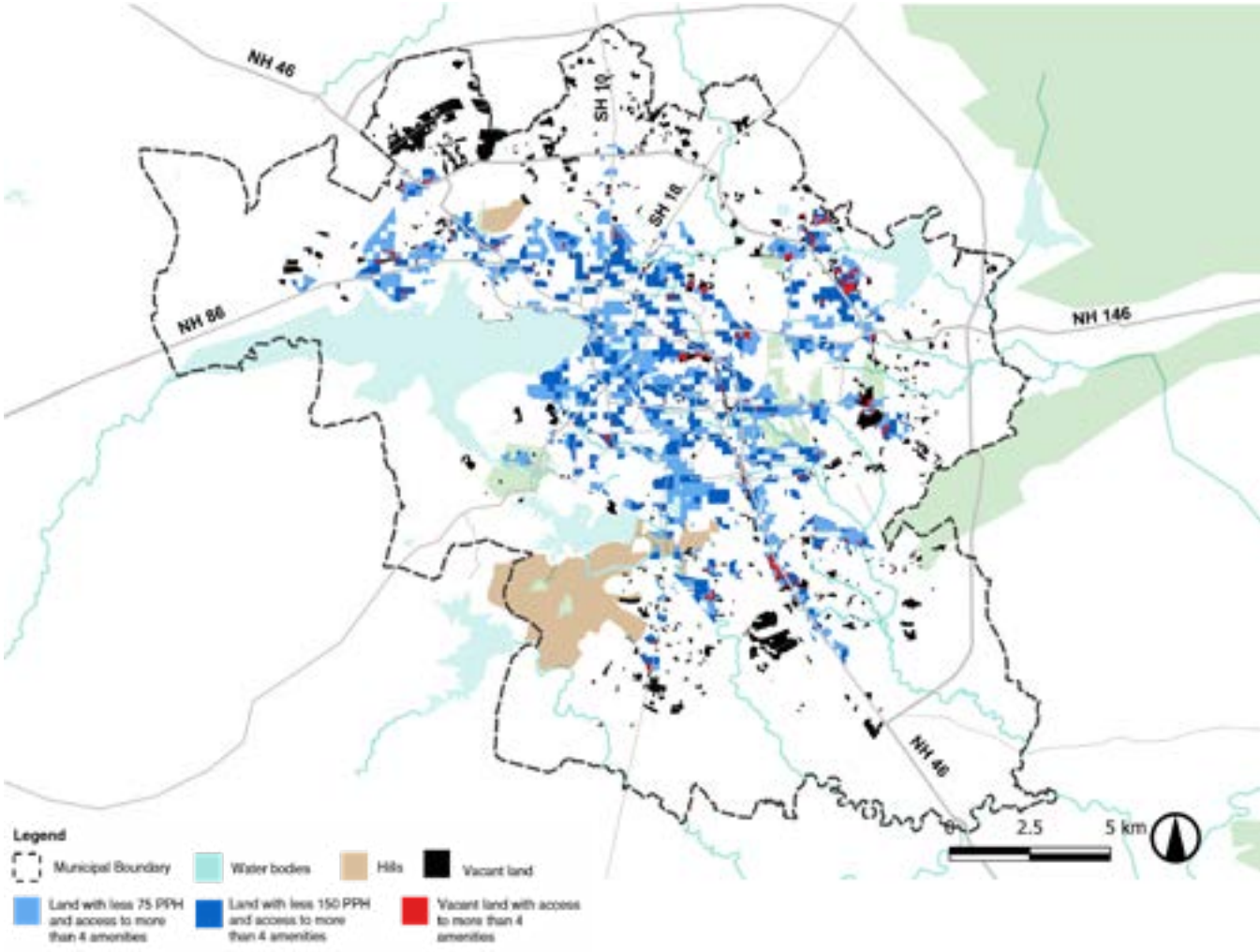
Spatial Opportunities for In-fill Affordable Housing

Slums having access to 3 or less amenities



Opportunity wards for urban infra retrofitting





Map 3.9: a. Low density (0-100 pph) land and vacant land parcel
b. Areas with access to four or more amenities
c. Map showing low density land parcels as opportunity for redevelopment

Source: UN-Habitat

A joint effort by the private and public sector provides sustainable affordable housing opportunities for the urban poor. To attract private developers for this purpose, the MoHUA has drafted a policy on 'Public Private Partnerships for Affordable Housing',[64] which will guide the affordable housing strategy for Bhopal and encourage private sector participation.

Intervention 4.5: Housing Refurbishment

This intervention caters to those existing informal settlements and affordable housing developments, which suffer from deteriorating building or structural conditions, but lie in well-serviced urban areas with access[65] to at least three core basic urban amenities.[66]

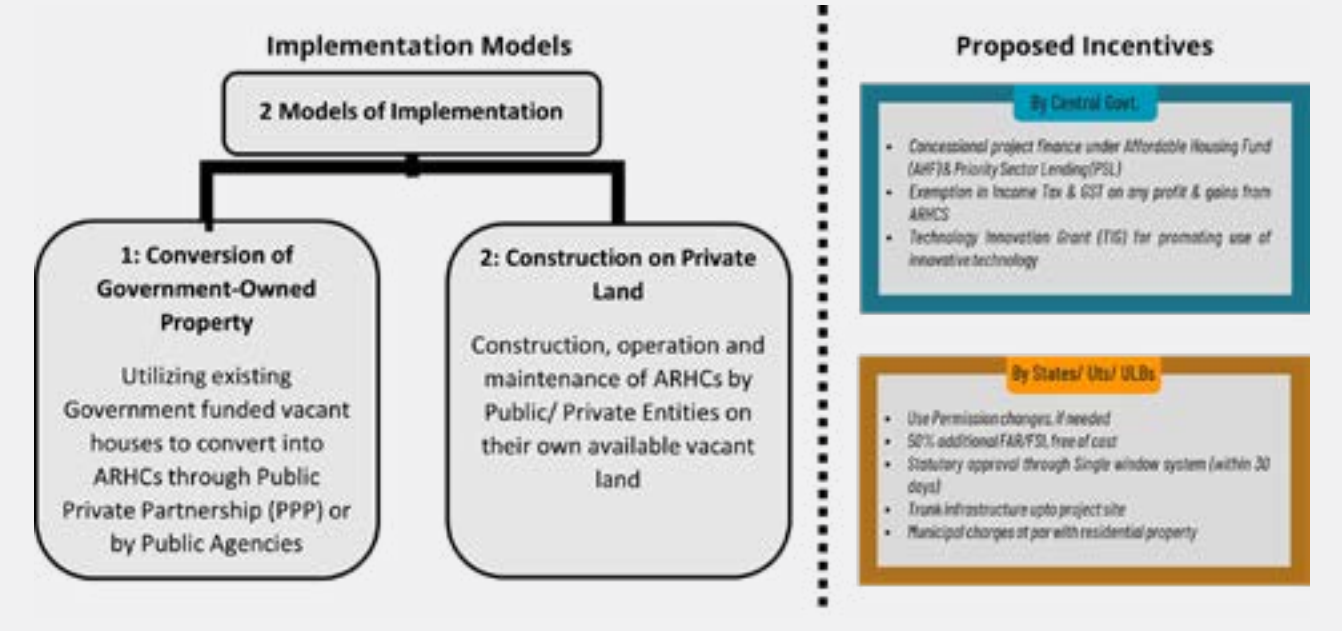
These informal settlements should not lie in ecologically protected zones, and may qualify for urban retrofitting in the form of housing refurbishment and/or extension, which may allow otherwise neglected developments to become revitalized. This can lead to greater cost-efficiency over demolition and construction of replacement affordable housing. It can also enable previously underutilized or unutilized building stock to be repurposed for the much-needed housing requirements in the city.

Through collaborative financing and public-private partnered development models, such refurbished developments can prove to be valuable **affordable rental housing or shared housing stock.** The **Affordable Rental Housing Complex (ARHC)** sub-scheme under the PMAY-U policy may be utilized to develop and incentivize affordable rental housing stock in the city, as indicated in Figure 2.28. Such housing may be used to generate mixed-use social housing projects for short-term dwellers, migrant workers, single parent families, the youth, elderly, disabled, or transitionary housing, rehabilitation centres, etc. Other applicable central and state government incentives are:

- concessional financing for affordable housing;
- tax and GST exemptions;
- grants for innovation in green building technology; and
- additional FAR.

Ultimately, all the localized, market-driven strategic solutions described in this chapter aim to achieve adequate housing for all, mitigate the carbon footprint and GHG emissions of the city, build urban and ecological resiliency among informal settlements, while establishing a framework for incentivizing walkable, mixed-used, affordable housing development in Bhopal.

FIGURE 3.17 Opportunities and incentives for housing refurbishment under the ARHC sub-scheme of PMAY-U



Source: Affordable Rental Housing Complex Guidelines, PMAY

64 PPP Models for Affordable Housing, MoHUA, 2017; https://mohua.gov.in/upload/uploadfiles/files/PPP%20Models%20for%20Affordable%20Housing.pdf.

65 Maximum permissible walking distance to these amenities, as defined in the USAF (see Section 2).

66 Six core urban amenities are considered by the USAF, including a school, hospital, fire emergency service, park or public open space, public transportation, and NMT service/ amenity.

3.5.2 Alignment with national, state policies, programmes and ongoing, proposed capital projects in the city

- Bhopal Development Plan 2005
- Draft Bhopal Development Plan 2031 (approval from state government pending)
- Bhopal Smart City Plan

- Pradhan Mantri Awas Yojana – Urban (PMAY-U)
- Affordable Rental Housing Complexes Sub-scheme
- National Urban Livelihood Mission (NULM)
- Madhya Pradesh Chief Minister Awas Yojana

- National Urban Policy Framework, 2018
- National Urban Housing Policy, 2007
- Madhya Pradesh Housing and Habitat Policy, 2007
- Madhya Pradesh Real Estate Policy, 2019

- Construction of EWS Housing Complexes under PMAY
- Credit Link Subsidy Scheme for Construction of Self-owned Houses

The detailed alignment with programmes, national missions and key projects are summarized in Annex 2.

3.5.3 Gender and inclusion

The mixed-use, mixed income housing envisioned as part of the urb an retrofitting strategy provides an opportunity for equitable amenities for all. In-situ infrastructure improvements can address the deprivation faced by vulnerable communities. This intervention could significantly benefit the time poverty[67] faced by women and children. Accessible amenities could reduce additional time spent on travel for safe access to basic services, water supply, sanitation, while improving the leisure activity rate of women.

The participatory approach of the SRC, with a capacity building cell constituting civil society organizations and educational institutions to guide SDA, may enable community sensitive relocation of informal settlement dwellers. In its structure, SRC should ensure the adequate representation and involvement of women, girls and gender minorities. With feedback from the SDA, the planning and design of the integrated living-and-working scheme can follow a gender transformative approach.

The relocation process and programme should assess the use of existing housing, street networks, and public spaces. It should also analyse how women, girls and gender minorities use these amenities and infrastructure. Relocation could also disrupt the existing livelihood and mobility pattern of residents, especially employment for women. A mobility subsidy is recommended to compensate for the increase in transportation cost to beneficiaries, if applicable, based on the impact study of relocation for livelihood.

The rental/ shared housing intervention, part of Intervention 4.4: Housing Refurbishment, provides single women, or those with a single household income, security, and opportunities to avail better amenities. It also offers housing opportunities and shelter for short-term dwellers, migrant workers, and the elderly.

All housing development via in-situ infrastructure development, housing refurbishment, relocation or infill and re-densification housing should follow the gender-inclusive urban development guidelines and principles, which have been listed in Annex 5 (gender-inclusive guidelines for the proposed strategic responses).

3.5.4 Climate convergence

Urban retrofitting of informal settlements proposes new construction or redevelopment of housing complexes for the housing needs of the urban poor. These activities may significantly contribute to increasing GHG emissions. However, the adoption and incorporation of green construction technology, locally sourced construction materials and environmentally sensitive design and construction methods may reduce the impact of GHG emissions due to housing development and related activities.

Each new affordable housing unit constructed for EWS (30 sq. m.) under affordable housing schemes may emit up to 4.1 tCO_2e per annum, and each unit of a lower income housing (LIH) (60 sq. m.) development may emit 5.48 tCO_2e per annum.

Under the urban retrofitting, housing refurbishment strategy, the identification and upgradation of private or government rental units using existing recycled/ upcycled construction materials could emit the least amount of GHGs and further reduce the carbon footprint through improvements such as energy-efficient building insulation, ventilation and building operations in the long run. The detailed GHG estimations for proposed redevelopment projects are summarized in Section 3.6.7: Transformative Project 5 – Redevelopment of Manisha Market. The section illustrates the potential carbon storage that can be achieved by using local and sustainable construction material for the redevelopment project.

3.6 Transformative Projects (ABD)

3.6.1 Scope of the area-based project

The transformative projects of this section showcase the practical application of the strategic interventions described in the preceding sections of this report. The region selected to demonstrate these projects is called the Area Based Development (ABD) area. This ABD area lies to the south of the precinct between the Kerwa–Kaliasot forest area (proposed) and Shahpura Lake. It includes BMC wards 30, 48, 51, 80, and parts of 52, as shown in Map 3.10.

The ABD area exhibits several diagnostic issues identified in the City Profile and Diagnostic Report for Bhopal, such as the encroachment of urban forest hinterlands, pollution of natural assets, human-animal conflicts, traffic congestion, and presence of vulnerable informal settlements.

The transformative projects of the ABD area may, thus, reduce the stress of urbanization on the natural resources,

67 Time poverty is shortage of time available to devote to personal requirements, including leisure and recreational activities, mostly faced by women due to caregiving and unpaid domestic work.

reduce human-animal conflict, improve NMT facilities, and create compact neighbourhoods. These projects will also demonstrate how the UN-Habitat principles for sustainable neighbourhood planning[68] can be tailored and applied for Bhopal. One goal is to demonstrate solutions for mitigating conflict between human settlements and the environment caused by urbanization.

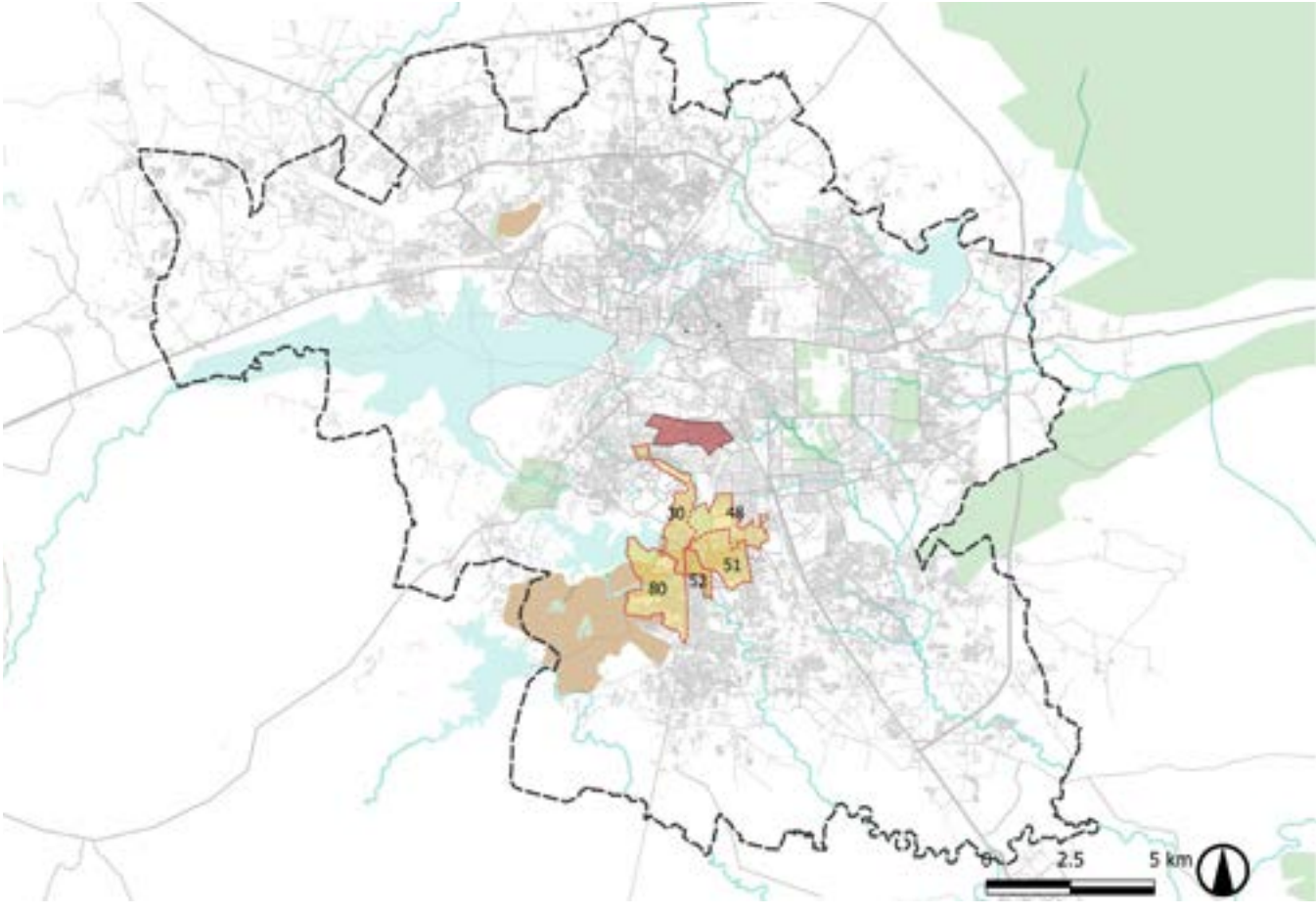
3.6.2 Strategic interventions proposed in ABD

The ABD transformative projects include design interventions across varying scales, as detailed in Table 3.10.

TABLE 3.10 Summary of diagnostic issue, strategic interventions, and transformative projects in ABD

Diagnostic Issue	Strategic intervention	Transformative projects
Endangered natural assets Pollution of water bodies, encroachment of green spaces, and depleting green cover	Intervention 2.1 – Urban bio-diversity conservation by eco-living lab	1 NbS for preservation of ecology
	Intervention 2.2 – Public space activation via community participation	2 Preserve and activate public spaces near Shahpura Lake
High dependence on fossil fuels and sub-optimal use of NMT Increasing private vehicles and low neighbourhood-level access to NMT facilities	Intervention 3.1 - Complete Streets Toolkit for self-assessment and development of NMT	3 Eco-arterial, shared mobility corridor – Kolar Road
		4 Pedestrian street – Campion School Road
Sprawling urban development and vulnerable informal settlements Low-rise, low-density development and high vulnerability in informal settlements	Intervention 1.1 - Revitalize urban core through densification	5 Redevelopment of Manisha Market in Shahpura, to promote PPP in affordable housing
	Intervention 4.2 – Housing development (infill development or refurbishment)	

Source: UN-Habitat



Map 3.10: Delineation of area for demonstration of sustainable city strategies

Source: UN-Habitat

68 A New Strategy of Sustainable Neighbourhood Planning: Five principles. 2014. Discussion notes 3, UN-Habitat. https://unhabitat.org/sites/default/files/documents/2019-05/five_principles_of_sustainable_neighborhood_planning.pdf.

Existing Context

The ABD area includes numerous landmarks, the most prominent of which are Shahpura Lake, Swarna Jayanti Park, Kaliasot Dam, and Kerwa Dam. Some major mixed-use neighbourhoods here include Shahpura, Chunabhatti, Sarvdharam, and parts of Kolar. In addition, the area houses several public offices, hospitals like Bansal Hospital and Manoria Hospital, educational institutions like Madhya Pradesh Bhoj Open University and Maulana Azad National Institute of Technology (MANIT), and numerous natural resources (see Map 3.11).

Population (2018)
98,124

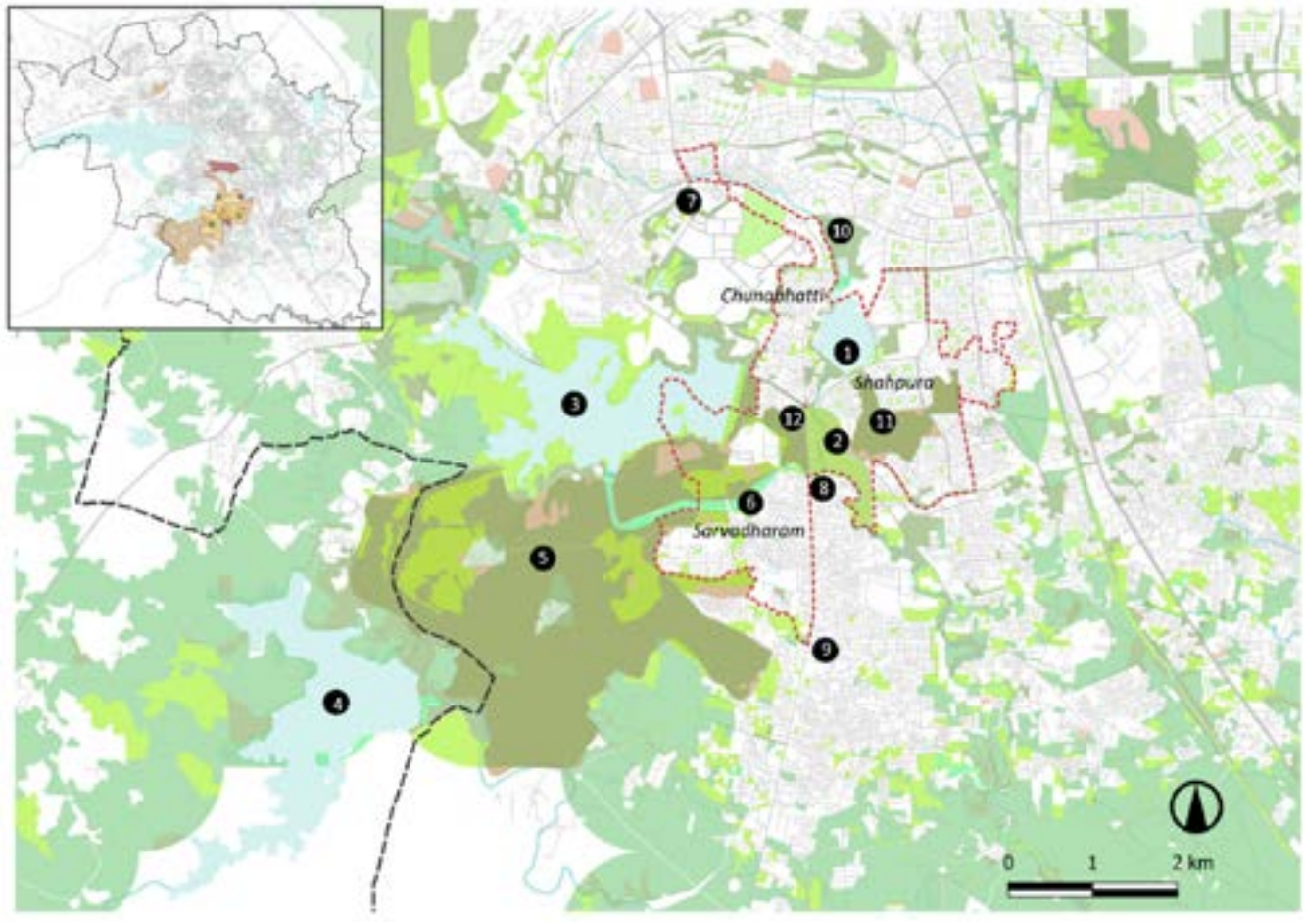
Area (sq. km.)
9.72

Wards
30, 48, 51, 80 and parts of 52

Water bodies
Shahpura Lake and Kaliasot River

Number of informal settlements
22
Slum population: 34,200 (35 per cent of population residing in ABD)
Slum HH - 8418

Forest areas
Swarna Jayanti Park, proposed forest area between Kerwa–Kaliasot Dam



1. Shahpura Lake
2. Swarna Jayanti Park
3. Kaliasot Dam
4. Kerwa Dam
5. Proposed City Forest
6. Kaliasot River
7. Manit
8. Sarvdharam
9. Nayapura Bus Stand
11. Pahadi Mandir Park
12. Madhya Pradesh Bhoj Open University

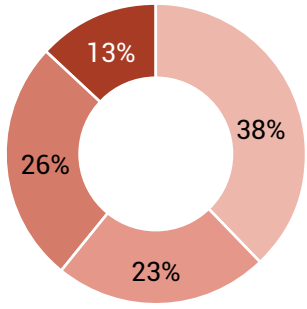
Legend

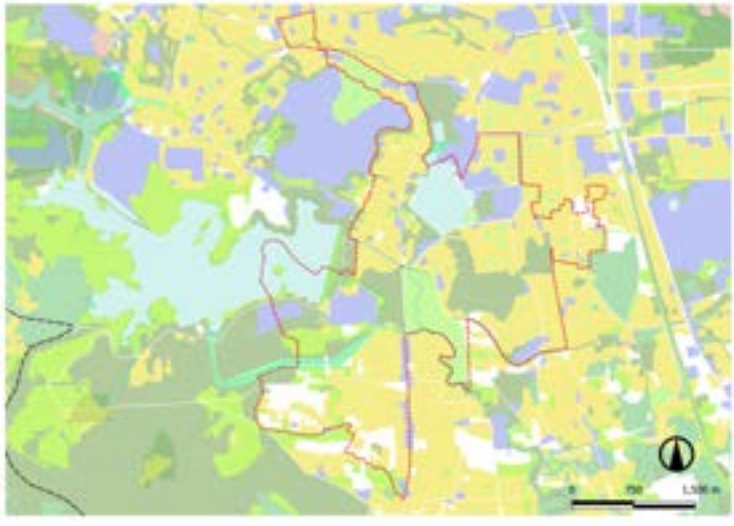
Municipal Boundary | SCS ABD boundary | Water bodies | City Forest
Urban green areas | Agricultural land | Natural grasslands

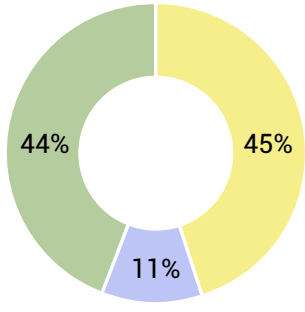
Map 3.11: Key landmarks in SCS ABD area

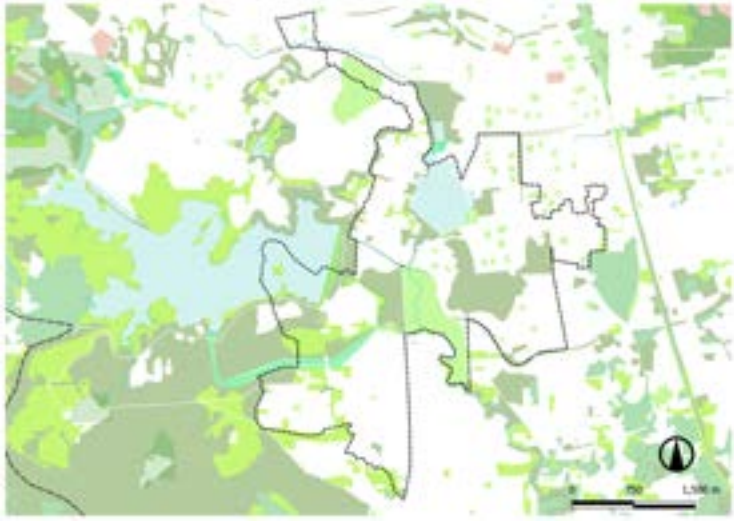
Source: UN-Habitat

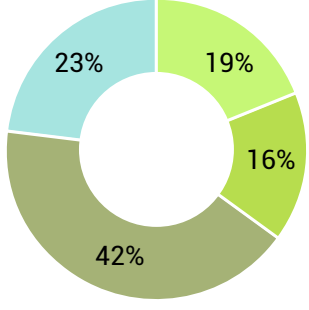
Aerial view of the ABD area, highlighting Shahpura Lake and Swarna Jayanti Park











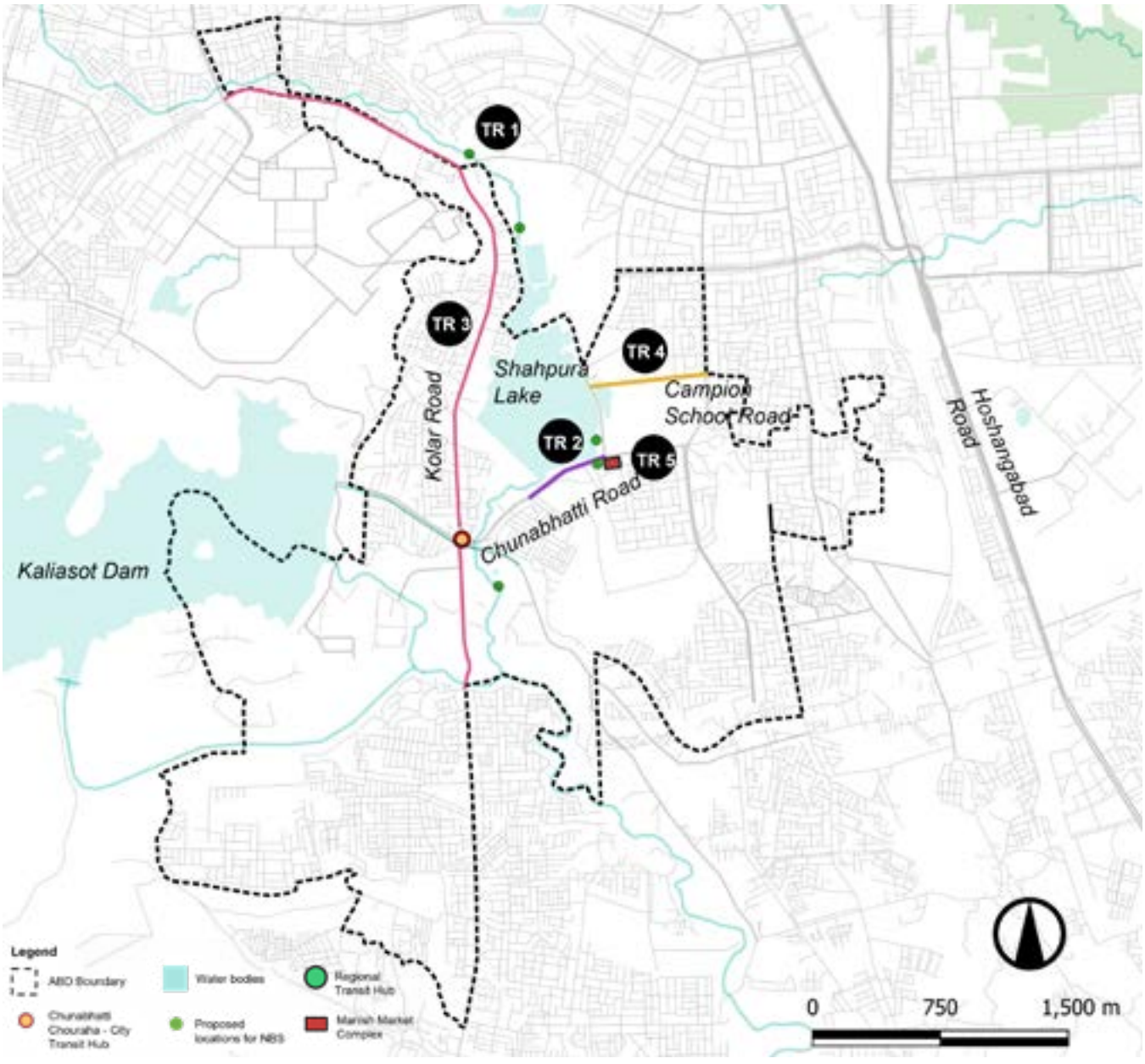
Legend

ABD Boundary | Water bodies | 0-75 PPH | 75-150 PPH | 150-300 PPH | > 300 PPH

City Forest | Natural grasslands | Residential land use | Commercial - Public and Semi Public - Industrial

Map 3.12: a. Distribution of average residential population density in 250x250m grid in 2018;
b. Analysis of land use distribution in ABD; c. Analysis of distribution of natural areas

Source: a. Residential population density for Bhopal in 2018, using density data from Worldpop.org, https://www.worldpop.org.
b. Land use classification using Land Use Land Cover data for 2017 provided by Earth Observation for Sustainable Development under E04USD – Urban Project: Bhopal city Report



Map 3.13: Spatial representation of proposed Transformative Projects (TR) in ABD

Source: UN-Habitat

3.6.3 Transformative Project – 1: Nature-based solutions for preservation of ecology

This project incorporates Intervention 2.2 – Urban biodiversity assessment and conservation by BELL to pilot NbS for treating the effluent wastewater that enters Shahpura Lake. It also improves the edge conditions along the Kaliasot riverbank, with the following intended outcomes:

1. Preserving eco-sensitive sites by developing active public spaces fostering community engagement
2. Enabling adaptive reuse of these sites with a component of community-learning; demonstration space for technical and ecological innovation; and piloting NbS

Existing Scenario – Shahpura Lake

Around 8 MLD of untreated sewage water enters the Shahpura Lake every day. The overflow of this enters the Kaliasot River through Swarna Jayanti Park. In addition, residential colonies and commercial establishments along the lake inlet and outlet canals, as well as informal settlements encroaching upon the canal banks, empty their untreated sewage and wastewater directly into these canals. This issue has been identified during site surveys and published in various media reports and articles.[69]

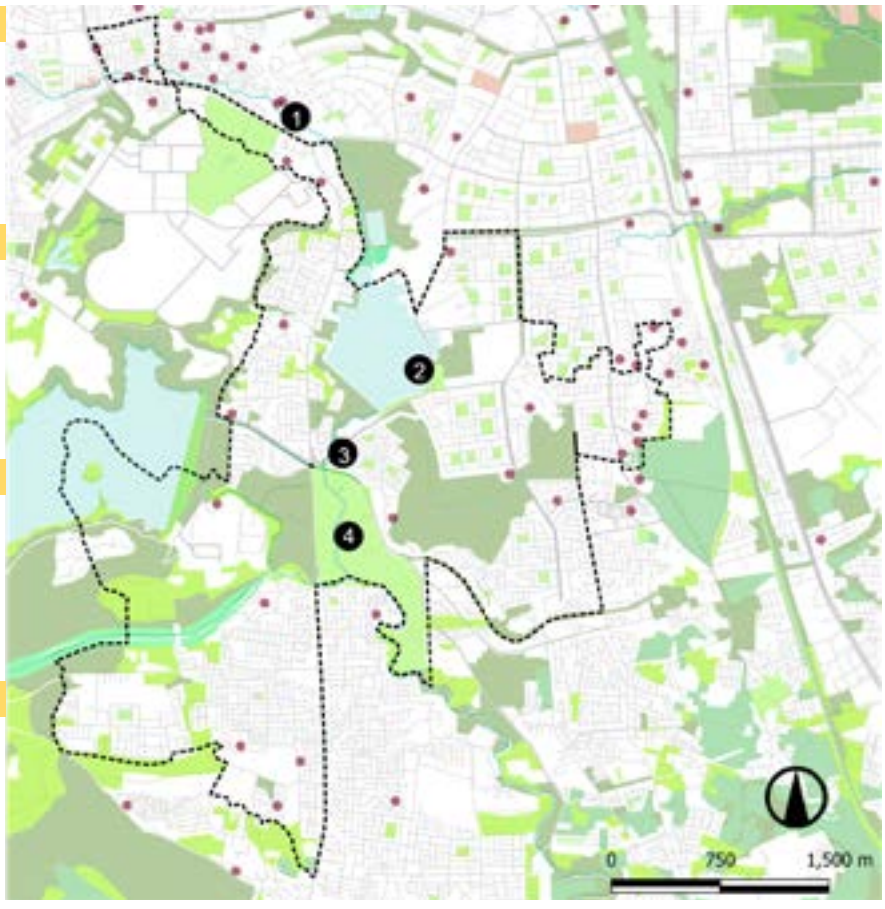
69 'Shahpura Lake fish unfit for consumption, says study', Times of India, March 2019 https://timesofindia.indiatimes.com/city/bhopal/shahpura-lake-fish-unfit-for-consumption-says-study/articleshow/68553518.cms.

Sewage entering inlet canal from Harshvardhan Colony

Sewage entering Shahpura Lake from inlet canal

Overflow from Shahpura Lake to Swarna Jayanti Park

Untreated sewage flowing through Swarna Jayanti Park



Legend

Municipal Boundary | SCS ABD boundary | Water bodies | City Forest | Urban green areas | Agricultural land | Natural grasslands | Informal Settlements

Map 3.14: Key sites highlighting pollution by untreated sewage

Source: UN-Habitat

The following NbS are proposed for achieving the intended outcomes of Transformative Project-1:

a. Decentralized Wastewater Treatment Systems (DEWATS) to treat effluent sewage
b. Floating treatment wetlands to improve the water quality of Shahpura Lake
c. Adaptive re-use of the protected land along Swarna Jayanti Park and Kaliasot River

a. DEWATS to treat effluent sewage

Sewage and wastewater can be treated through low-cost, NbS like DEWATS, floating treatment wetlands, or a combination of both. During UN-Habitat's on-ground site assessments, several locations were found suitable for implementing these sewage treatment interventions. These locations are indicated in Map 3.14.

Conventional sewerage systems are often difficult or unfeasible to construct due to financial limitations, lack of space, or the rapid growth of unplanned settlements. DEWATS provide modular solutions with easy maintenance and independence from most other urban infrastructural systems. This makes it suitable for treating wastewater in lakes and waterbodies, as well as in urban informal settlements.[70] DEWATS applications are based on the principle of low maintenance, since the crucial parts of this system work without energy or fuel. Modular DEWATS with varying capacities can be integrated into the inlet canals of Shahpura Lake, as well as other water bodies near informal settlements and low-income communities to remediate the water bodies. One such example of a DEWATS, treating sewage flowing through the inlet canal near Harshwardhan slum, is illustrated in Figure 3.18.

The combination of the DEWATS and bioswales[71] along the inlet canal to Shahpura Lake may be used to treat the effluent water and reduce the volume of organic pollutants before they enter Shahpura Lake.

70 Decentralised Wastewater Treatment System (DEWATS), Forum on Eco-Efficient Water Infrastructure Development: Good Practices of Eco-efficient Water Infrastructure, UH-Habitat; https://www.unescap.org/sites/default/files/6.%20Singh-UNHABITAT.pdf.

71 A bioswale is a ditch with vegetation and a porous bottom. The top layer consists of enhanced soil with plants, below which is a layer of gravel, scoria or baked clay pellets packed in geotextile. These materials have large empty spaces, allowing the rainwater to drain off. The layer is packed in geotextile to prevent it from becoming clogged by sludge or roots; https://www.urbangreenbluegrids.com/measures/bioswales.

DECENTRALIZED WASTEWATER TREATMENT IN KACHHPURA, AGRA, BY CURE INDIA

A DEWATS was installed at Kachpura slum to improve the sanitation conditions of the settlement. The DEWATS treats approximately 50 KLD of the total wastewater, which it receives from 5 clusters of slums through a common drain. The capital cost is approximately Rs. 11 lakh, and it requires nominal yearly maintenance expenses.

Image 3.6: Planted filter bed for root zone treatment of wastewater

Source: https://www.cseindia.org/decentralised-wastewater-treatment-system-at-kachpura-village-in-agra-3770

FIGURE 3.18 Illustration of application of ecological elements in Harshwardhan Colony slums

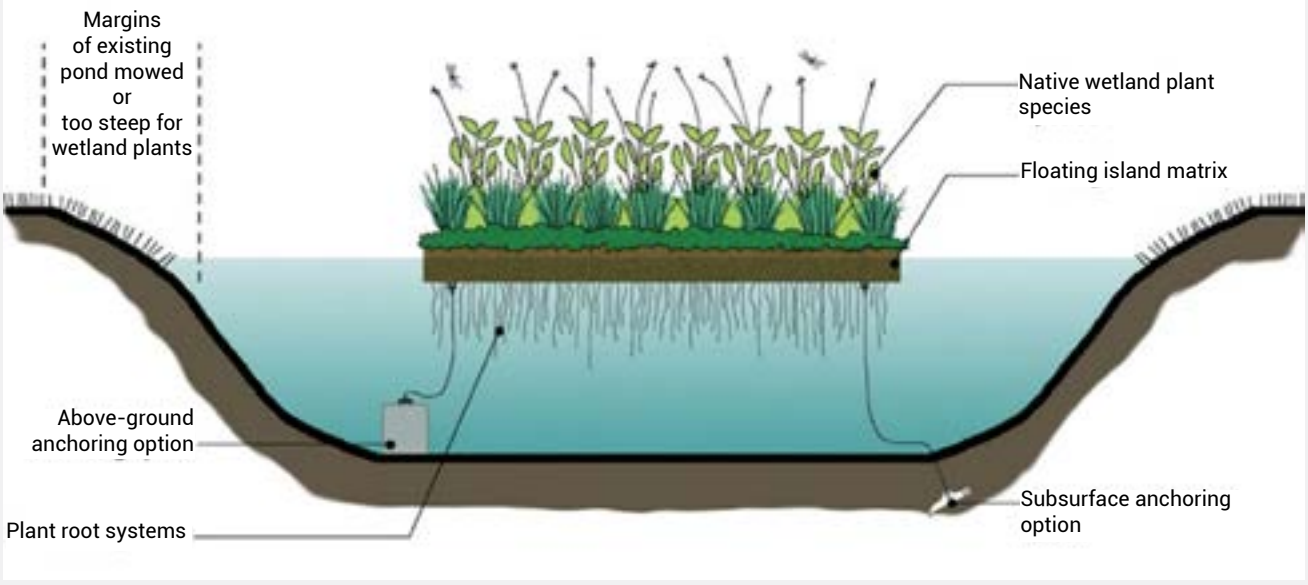
Source: UN-Habitat

b. Floating treatment wetlands to improve the water quality of Shahpura Lake

Constructed floating treatment wetlands have become a recognized method of water treatment, which effectively removes unwanted pollutants through natural processes. These wetlands are low-cost, artificial islands that float on the water surface and provide an optimal habitat for microbial and plant species. The unique ecosystem that develops on the floating islands captures nutrients and transforms common pollutants of the lake into harmless by-products. A pilot of 3,000 sq. ft. of floating treatment wetlands are recommended for Shahpura Lake to provide the much-needed supportive treatment required to maintain the water quality.

Thus, the DEWATS reduces the organic waste in the effluent wastewater reaching the lake, and floating treatment wetlands additionally help to regulate the water quality of the lakes and water bodies.

FIGURE 3.19 Principle of floating treatment wetlands



Source: https://tcwp.tamu.edu/floating-wetland-islands

Floating wetlands along Punggol waterway in Singapore

Source: https://isoteamgreen.com/floating-wetlands

Floating wetlands in Bellandur Lake, Bangalore

Source: thebetterindia.com/87836/bellandur-lake-Bengaluru-water-pollution-innovative-solutions

c. Adaptive re-use of the protected land along Swarna Jayanti Park and Kaliasot River

Swarna Jayanti Park is a city forest on the northern banks of the Kaliasot River, spread over 42 hectares. Managed by the BMC, the park includes space for exercising, walking, and cycling around the urban forest. The overflow of Shahpura Lake flows through Swarna Jayanti Park, creating natural bioswales, before meeting the Kaliasot River at the southern tip of the park.

On the southern banks of the Kaliasot River, high-rise residential buildings and hostels of the Sarvdharam neighbourhood maintain little-to-no buffer between the river and the high-density developments. Multiple, densely populated slums like the Damkheda Colony also encroach the riverbanks. This makes the slum settlements and residential developments highly vulnerable, as they are highly susceptible to floods. The existing conditions of the North and South riverbanks are illustrated in Map 3.15.

IMAGE 3.7 Untreated sewage flowing through Swarna Jayanti Park

Source: UN-Habitat

IMAGE 3.8 The existing edge condition of the southern bank of the Kaliasot River, along Sarvdharma Colony

Source: UN-Habitat

Map 3.15: Existing features of the Kaliasot River and encroachments by informal settlements on its banks

Source: UN-Habitat

Ecologically-sensitive and adaptive reuse spaces are proposed along the Kaliasot Riverfront, particularly where the river meets Swarna Jayanti Park. These are summarized in Table 3.12, and range from restorative to semi-public and public spaces. The areas are mapped in Map 3.16, as well as in the before-and-after sections of Figure 3.20.

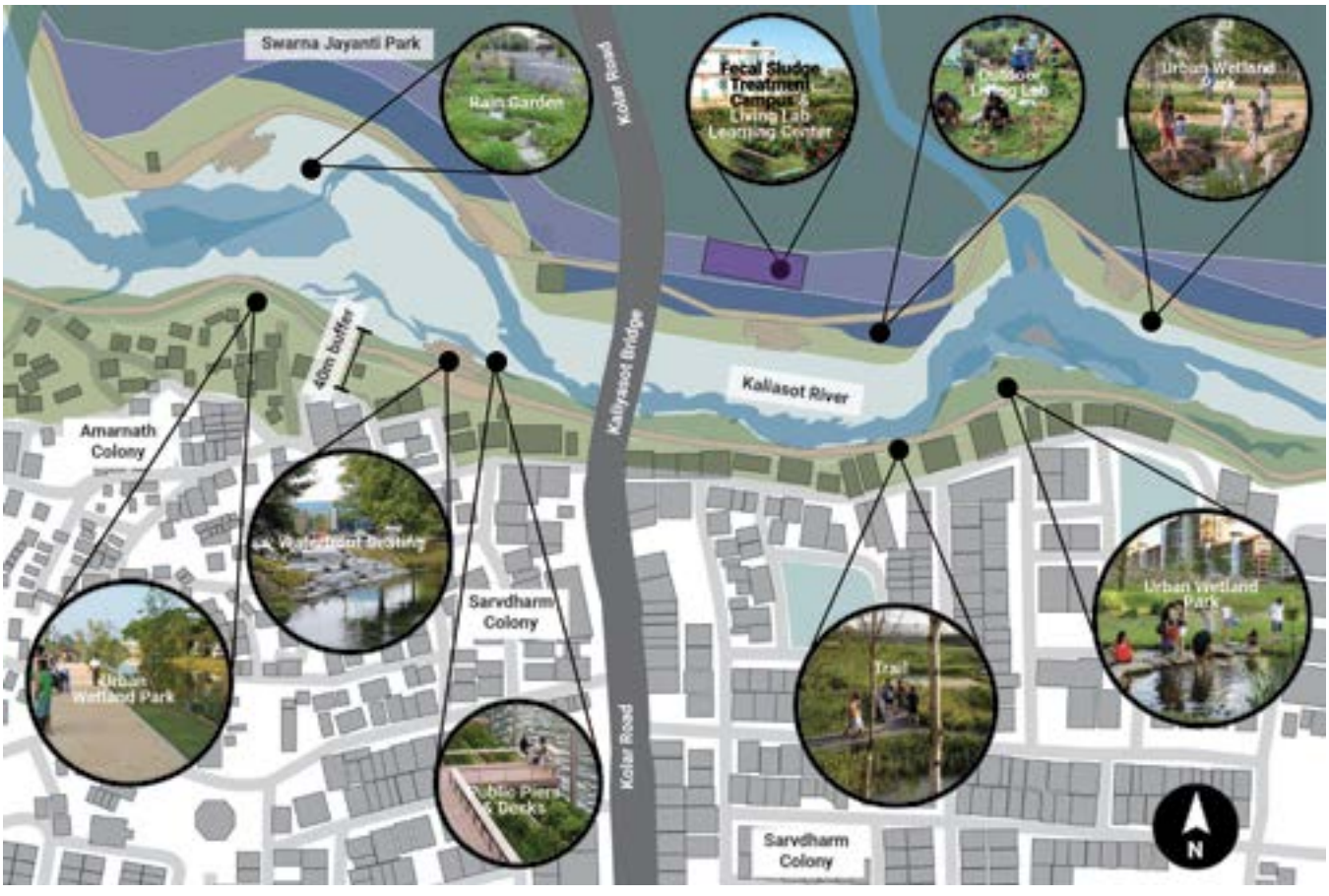
IMAGE 3.9 Aerial view of Swarna Jayanti Park (city forest) viewed from Chunabhatti Chouraha facing south

Source: UN-Habitat

TABLE 3.12 Wetland matrix for allocation of adaptive reuses on eco-sensitive land

	Layers of Wetland	Zon	Flood Risk	Activities	Purpose	Type
NATURAL RESOURCE		River	High	Freshwater and aquatic life protection area	Conservation	Passive
		Forest	Low	Wildlife protection area Forest trails	Conservation Recreation	Passive
RIPRARIAN BUFFER ZONE		• Ecological buffer zone • Wetland and wildlife preservation zone	High	Marshland Natural vegetation maintenance	Stream renaturation Bio-retention areas Carbon sink	Passive
		• Seasonal public space • Research zone	Medium	Wetland trails (temporary/ seasonal) Public pier Public seating Outdoor Living Labs	Bio-retention areas Community learning	Passive
RECREATIONAL ZONE		• Infrastructure zone • Educational zone • Waterfront public space and recreation zone • Commercial zone	Low	• Wastewater treatment + Living Lab Learning Center • Urban Wetland park (permament) • Playground • Riverfront walking trail	Remediation and community learning	Active

Source: UN-Habitat



Map 3.16: Proposed urban amenities and spaces along the Kaliasot River and its riverbanks

Source: UN-Habitat

FIGURE 3.20 Illustration of learning spaces and interactive spaces along Swarna Jayanti Park and Kaliasot River

Source: UN-Habitat

Estimated Project Costs

The cost estimations for the above-mentioned NbS for Transformative Project-1 are summarized in Table 3.13:

TABLE 3.13 Summary of estimated project costs for Transformative Project - 1

Project	Components	Estimated Project Cost (INR lakh)
Incorporate bioswales, decentralized wastewater treatment systems, and other eco-sanitation systems (NbS) to treat the raw sewage along high-density informal settlement areas interfacing with water bodies and wetlands.	**Floating treatment wetlands –** 3,000 sq. ft. of floating islands with aquatic plants in Shahpura Lake	105.7
	Bioswales (trench with plantation) – 500-m long and 1-m wide trench with plantation along the canal in Harshwardhan Colony	860.2
	DEWATS 300 KLD capacity plant set up along the southern bed of Shahpura Lake	225.2

Source: Various sources have been used in the calculation of project costs. Refer to Annex 7, Cost Estimates Methodology for the cost breakdown and assumptions.

3.6.4 Transformative Project – 2: Identification of preservation zones and activating public spaces near Shahpura Lake

This project incorporates Intervention 2.3 - Enable Ecologically Sensitive Public Spaces, and Intervention 2.4 - Establish City-level Guidelines for Urban Forestry and Public Space. It illustrates the advantages of having city-level policies to guide the mapping and monitoring of natural assets. It also demonstrates the applicability of various NbS and classification of urban green spaces to activate public spaces and include more adaptive reused spaces.

In the ABD area, around 42 per cent of the green area is forest cover and 16 per cent is grassland (see Map 3.12).

It is advised to map these areas in detail and preserve them as city forests or designated urban green areas.[72] The critical areas needing preservation through strategic interventions[73] for improving the city's urban green cover are illustrated in Map 3.17.

Mapping the above-listed preservation zones may achieve the following:

a. Creation of an additional 50 ha of land where plantation and urban greening interventions may be implemented.
b. Activation of existing public spaces on the southern bank of Shahpura Lake by integrating Pahadi Mandir forest patch (around 2 ha) to create more active public spaces and NMT facilities.
c. Pilot community based urban agri-forestry in publicly managed urban green areas under the guidance of BMC. Community farming may create additional livelihood opportunities and promote a green economy for the city.

Ekant Park

Catchment of Shahpura Lake spread over 21 ha and maintained as urban park by BMC. Mapping the land to prevent encroachment and plantation programs to improve green cover. DEWSATS, bioswales and ground water recharge interventions can be piloted and tested.

Shahpura Lake Buffer

Preservation zones proposed under BDP 2005 not completely implemented. Encroachment by informal settlements and residential colonies. Bansal Hospital is a major bio-medical threat to the lake. Fresh mapping and conservation of buffer. Plantation and greening measures to be employed.

Pahadi Mandir Park

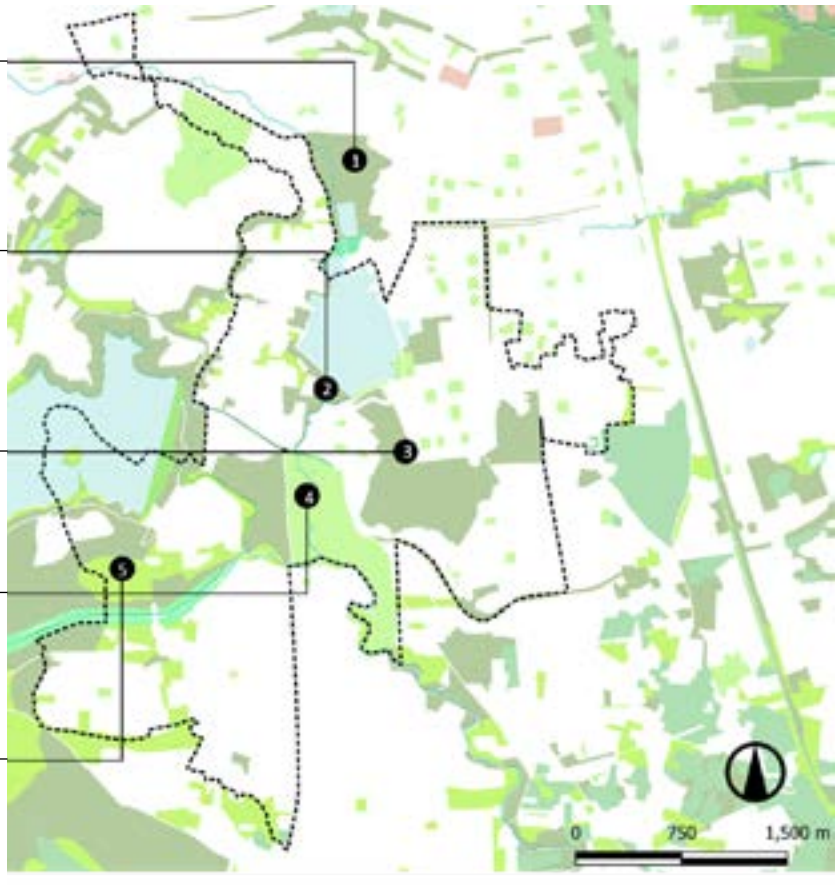
Hilly terrain, designate as conservation zone. Plantation and greening measures.

Swarna Jayanti Park

Urban forest area maintained by BMC. The overflow of Shahpura lake flows through the park creating natural bioswales. Adaptive use of forest area for leaning and experimenting nature-based solutions.

Forest between Kerwa – Kaliasot Dam

Proposed urban city forest. Fresh mapping of land is required. Plantation, water saucers for animals, and other forest related infrastructure development required.



Legend

Municipal Boundary | SCS ABD boundary | Water bodies | City Forest | Urban green areas | Agricultural land | Natural grasslands

Map 3.17: Key preservation and mapping sites in ABD

Source: UN-Habitat

72 Urban green areas are neighbourhood parks, which are publicly managed. Only 13 per cent of the total green areas in the ABD area are publicly managed (see Map 3.12). A city-level data repository is proposed to be created under the eco-living lab.

73 The city-level guidelines on Urban Forestry and Public Spaces may provide a policy framework to classify green areas in the city and recommend relevant adaptive reuse like urban farming, agro-forestry, community gardening, or community interaction spaces.

Activating public space along Shahpura lakefront

Currently, the lakefront development on the southern banks of Shahpura Lake is underutilized because of its inaccessibility. Enclosed by a fence, this site also has restricted entry from the Manisha Market end. The key recommendation is to improve the walking and cycling facilities along Chunabhatti Road and integrate the existing green spaces with the proposed NMT system.

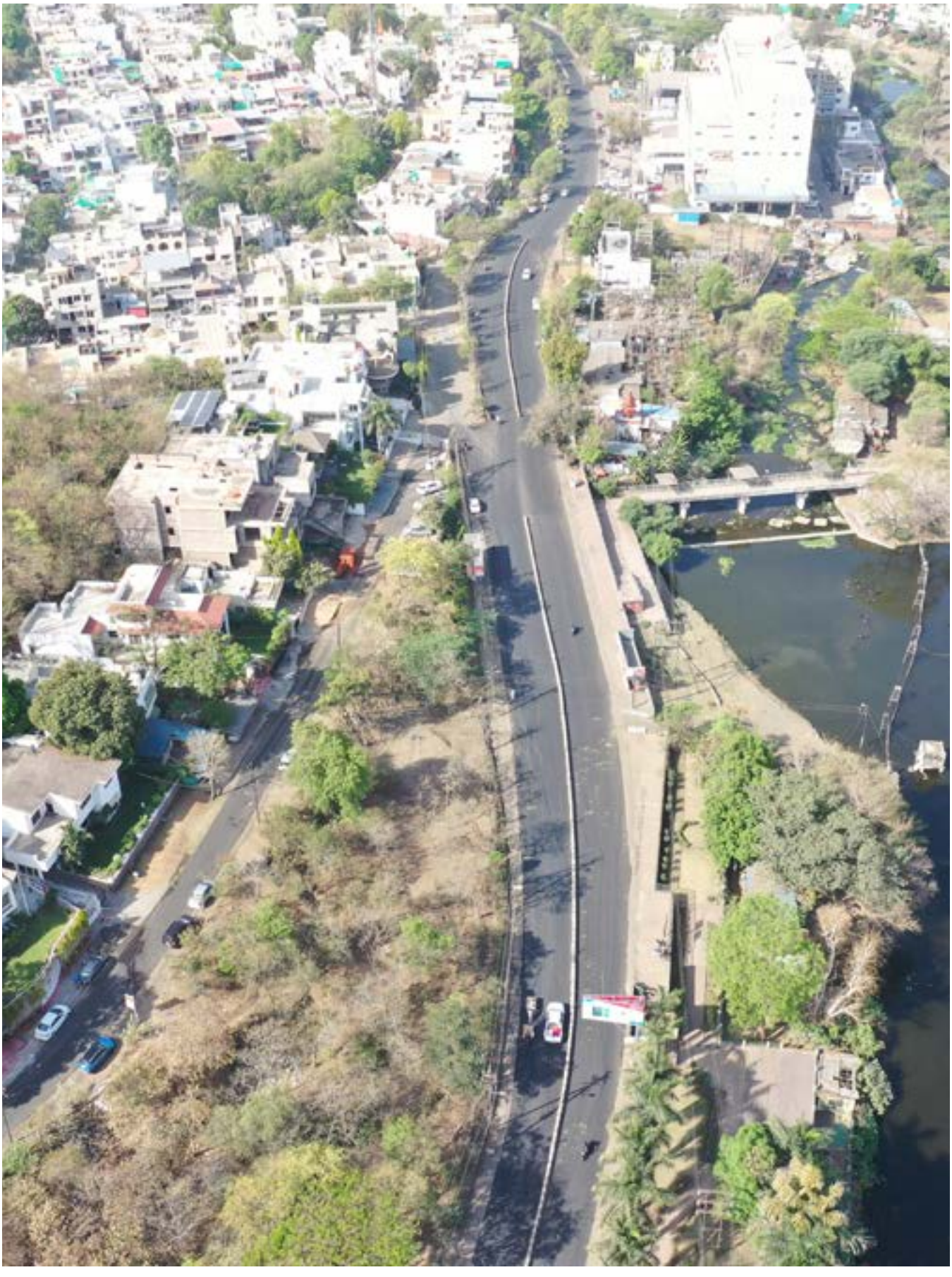
1. **Along Shahpura lakefront:** Creating more entry points to the lakefront in Manisha Market Chouraha (western end) and at the neighbourhood level near Amaltas Apartments. Integrating walkways and cycle lanes with the lakefront to create a pedestrian friendly plaza.
2. **Along Pahadi Mandir forest patch:** Mapping the forest patch to create a no-encroachment zone and develop it as a community park. Creating walkways and cycle lanes along Chunabhatti Road and an intermediate pedestrian road crossing to access the lakefront.

As a result of implementing the above recommendations, public spaces can be better integrated with the developments of the existing residential colonies. The recommendations also support the proposed Manisha Market redevelopment project, described in Transformative Project-5.

IMAGE 3.10 Shahpura lakefront development on the southern bank

Source: UN-Habitat

IMAGE 3.11 Chunabhatti Road with Shahpura lakefront on the right and Pahadi Mandir forest patch on the left.



Source: UN-Habitat

Estimated Project Costs and GHG Savings Potential

The total cost estimations for the proposed NbS for Transformative Project-2 are summarized in Table 3.14:

TABLE 3.14 Summary of estimated project costs for Transformative Project - 3

Project	Components	Estimated Project Cost (INR lakh)
Identifying preservation zones and activating public spaces near Shahpura Lake	**Plantation in buffer zones –** Additional 50 ha of land from mapping and plantation	290.7
	Community parks and community farming – Pilot project for urban farming in 2 ha of urban park land	50.0
	Redesign street along Shahpura lakefront to the South Streetscaping and integrating lakefront with Pahadi Mandir Park. Walkways and cycle corridors	394.0

Source: Various sources have been used in the calculation of project costs. Refer to Annex 7. Cost Estimates Methodology for the calculation breakdown and assumptions made.

The total GHG savings from the implementation of Transformative Project-2 is approximately 416 tCO2/annum and the components are summarized in Table 3.15:

TABLE 3.15 GHG savings potential for Transformative Project - 2

Transformative Project	Components	Potential GHG emissions (tCO_2e)	Remarks
Identifying preservation zones and activating public spaces near Shahpura Lake	**Plantation in buffer zones –** Additional 50 ha of land from mapping and plantation with native trees	-400 tCO_2/ annum	The unit GHG savings potential considered for 1 ha of plantation with trees is -8 tCO_2/ annum.
	Community parks and community farming –Pilot project for urban farming in 2 ha of urban park land	-16 tCO_2/ annum	Source: Chen (2015), Velasco et al. (2014), Nowak et al. (2013)

Note*: The GHG emission assessment is not exhaustive but demonstrative in nature. Detailed DPR and GHG inventory may be carried out for more accurate assessment.
Source: Chen (2015), Velasco et al. (2014), Nowak et al. (2013).

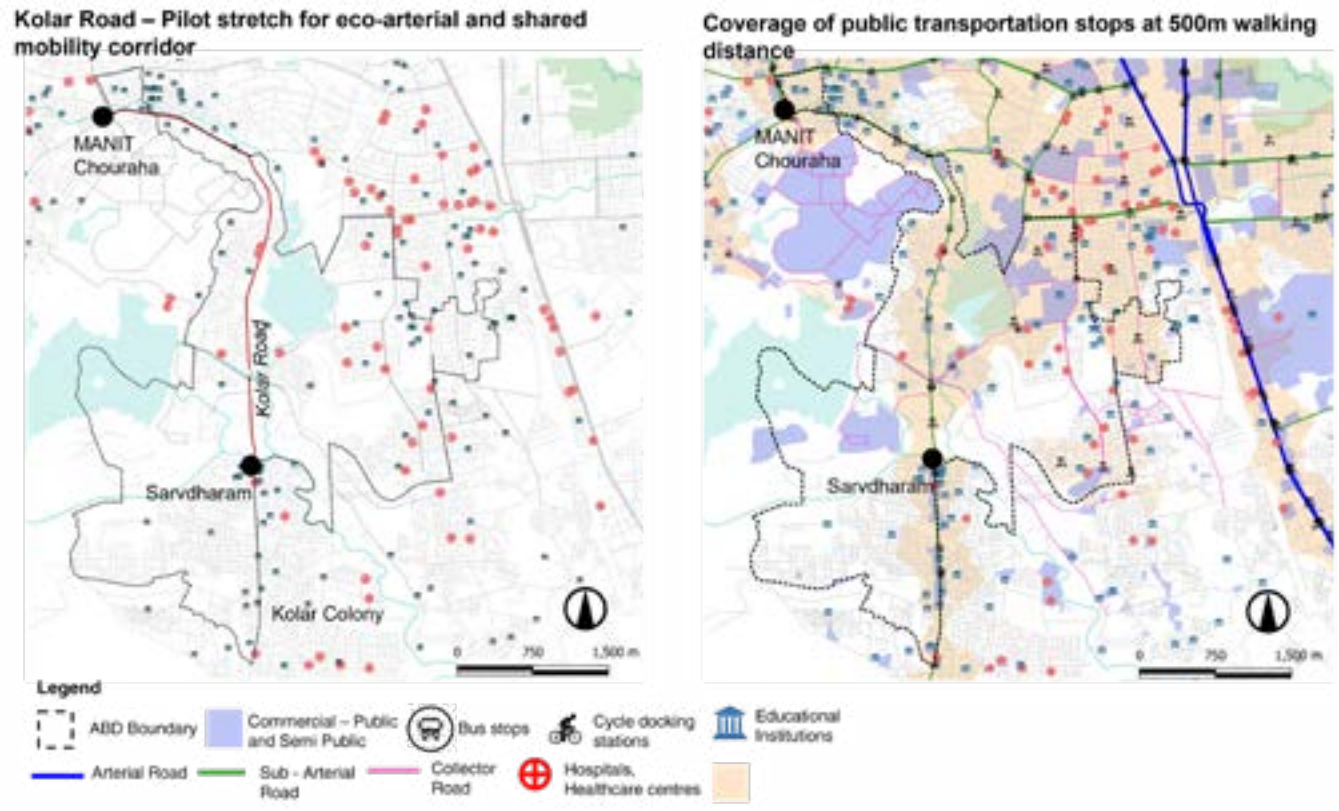
3.6.5 Transformative Project 3: Eco-arterial, shared mobility corridor – Kolar Road and Chunabhatti Chouraha

This project has two components and demonstrates the application of Intervention 3.1 – Eco Arterial Complete Streets Toolkit. The components include the development of Kolar Road as an eco-arterial road and of Chunabhatti Chouraha as a shared mobility hub.

1. Development of NMT facilities and tree lining along Kolar Road

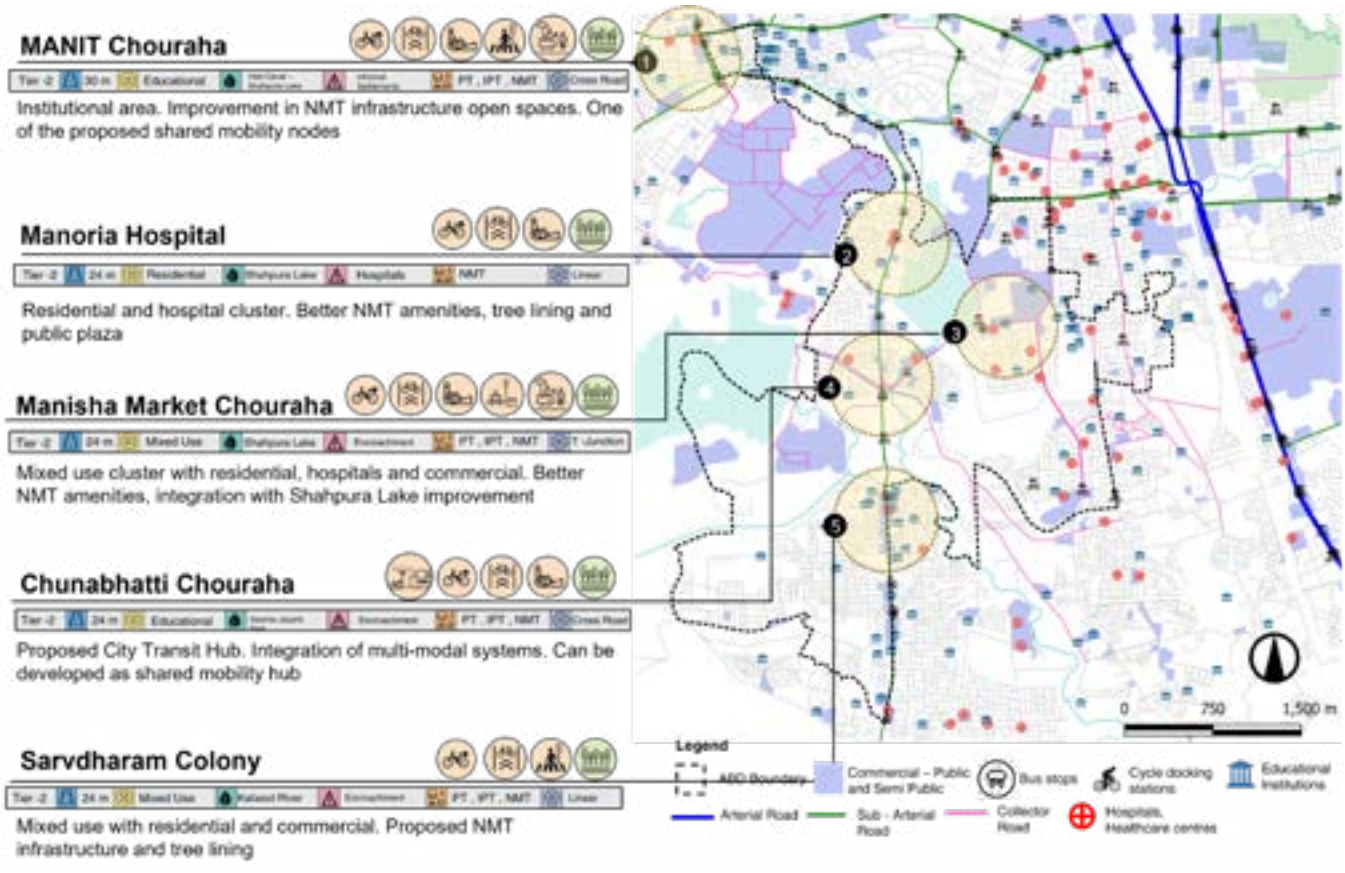
Kolar Road is a sub-arterial road connecting Bhopal with Kolar Dam, which is situated 45 km to the South of the city. Kolar Colony, a town which was integrated with BMC in 2014, is a peripheral residential colony experiencing rapid urban growth. Recent real estate development and cheaper land prices have contributed to its growth. Several educational institutions and hospitals are present along the Kolar Road and the proposed corridor enjoys good coverage of public transit stops within a 500-m radius, as shown in Map 3.18.

At present, Kolar Road does not have footpaths or dedicated cycle lanes. The recent construction activities for upgrading the underground sewer network have left pedestrians and cyclists in despair. The Complete Streets Toolkit can be employed to design and integrate the NMT infrastructure with the existing cluster of activities in the area. The assessment of major nodes in ABD using the Toolkit and the proposed urban design elements are summarized in Figure 3.10 and Figure 3.11.



Map 3.18: a. Kolar Road and amenities along the corridor; b. Coverage of transit stops within 500-m radius.

Source: UN-Habitat



Map 3.19: Assessment of major nodes in ABD using Complete Streets Toolkit

Source: UN-Habitat

The recent upgradation of the underground sewerage network provides the opportunity to improve above-the-road amenities like footpaths, dedicated cycle corridors, and smart street elements like street lighting and security cameras. The Kolar Road stretch from MANIT Chouraha to Sarvdharam (5.7 km) may be developed as a smart road with improved NMT infrastructure under the next phase of the flagship Smart City Mission.

At present, Kolar Road is not tree-lined nor is it integrated with green spaces. As discussed in **Intervention 3.1**, Kolar Road may be developed as the eco-arterial road by including ecological street elements as recommended in Strategic Response 3 with smart road elements (see Figure 3.11).

IMAGE 3.12 Encroachment along MANIT Chouraha, which has no footpaths or cycling lanes

Source: UN-Habitat

IMAGE 3.13 Lack of footpaths or cycling lanes along Kolar Road

Source: UN-Habitat

2. Development of Chunabhatti Chouraha as Shared Mobility Hub

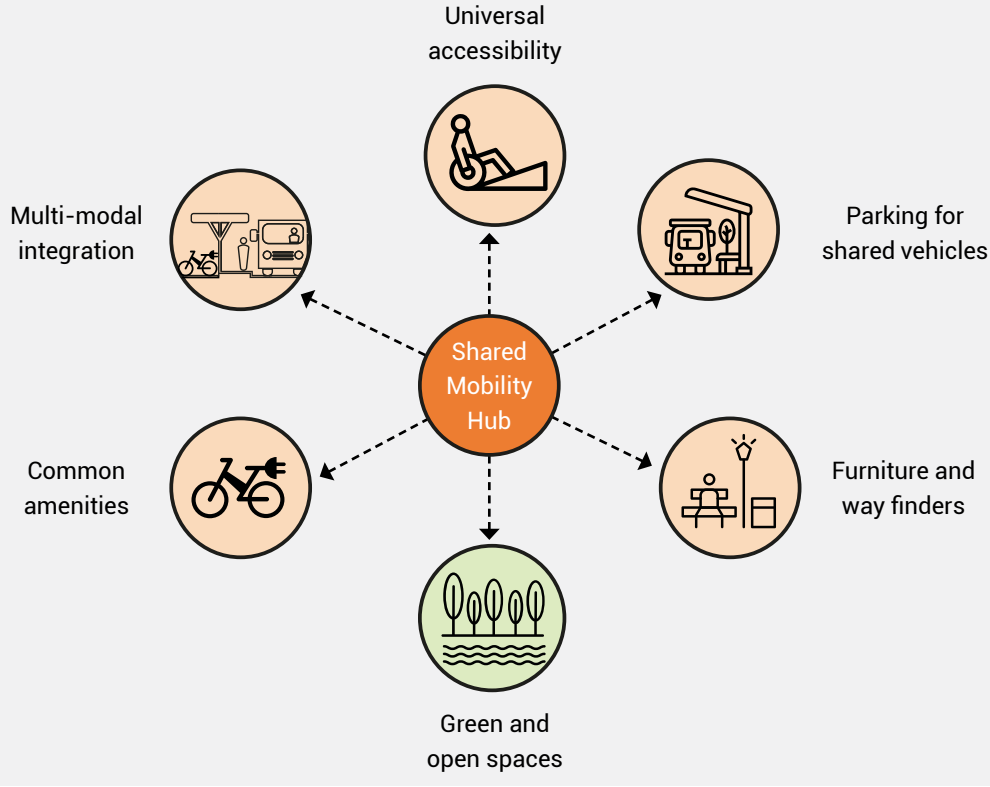
Chunabhatti Chouraha is identified as a city transit hub (see Intervention 3.2: Reorganizing the regional and city transportation networks). Here, a metro station is proposed, which will lie on the yellow line (from Ashoka Garden in the North to Mother Teresa School to the South) and will be developed in Phase 3 of the Bhopal Metro, or Bhoj Metro project.

Currently, although there is adequate access to public transit stops within a 500-m. walking distance (see Map 3.18) the frequency of buses is not sufficient to cater to the demand.[74] Several privately-operated minivans supplement this demand by providing a system of shared mobility services. This system can be strengthened by enabling clean fuel-run shared vehicles, like CNG vehicles and electric vehicles (EVs), and enabling safer transit options for women, children, and the elderly. Chunabhatti Chouraha can be the pilot hub for implementing a shared mobility corridor, along with corresponding urban design interventions. Intermediate hubs can be developed at MANIT Chouraha first, followed by the Nayapura Bus Stand, to complete the shared mobility corridor.

The following principles should be incorporated while designing shared mobility hubs:

- Include essential amenities which are commonly used by operators like charging stations and micro-grids for EVs, CNG filling stations, concessionaire spaces, parking, and green spaces.
- Design to cater to the needs of all users, inclusive of age and abilities. Urban design elements like tactile flooring, Braille boards and universally accessible ramps could be integrated to provide universal access.
- Design to adapt to future technological changes.
- Integrate different modal services to provide a seamless interface between public transport and first/last connectivity.
- Incorporate smart technology for data collation and solutions that create a better road user experience. Employing artificial intelligence (AI) and other technologies may facilitate seamless connections, encourage responsible use, and manage price controls.

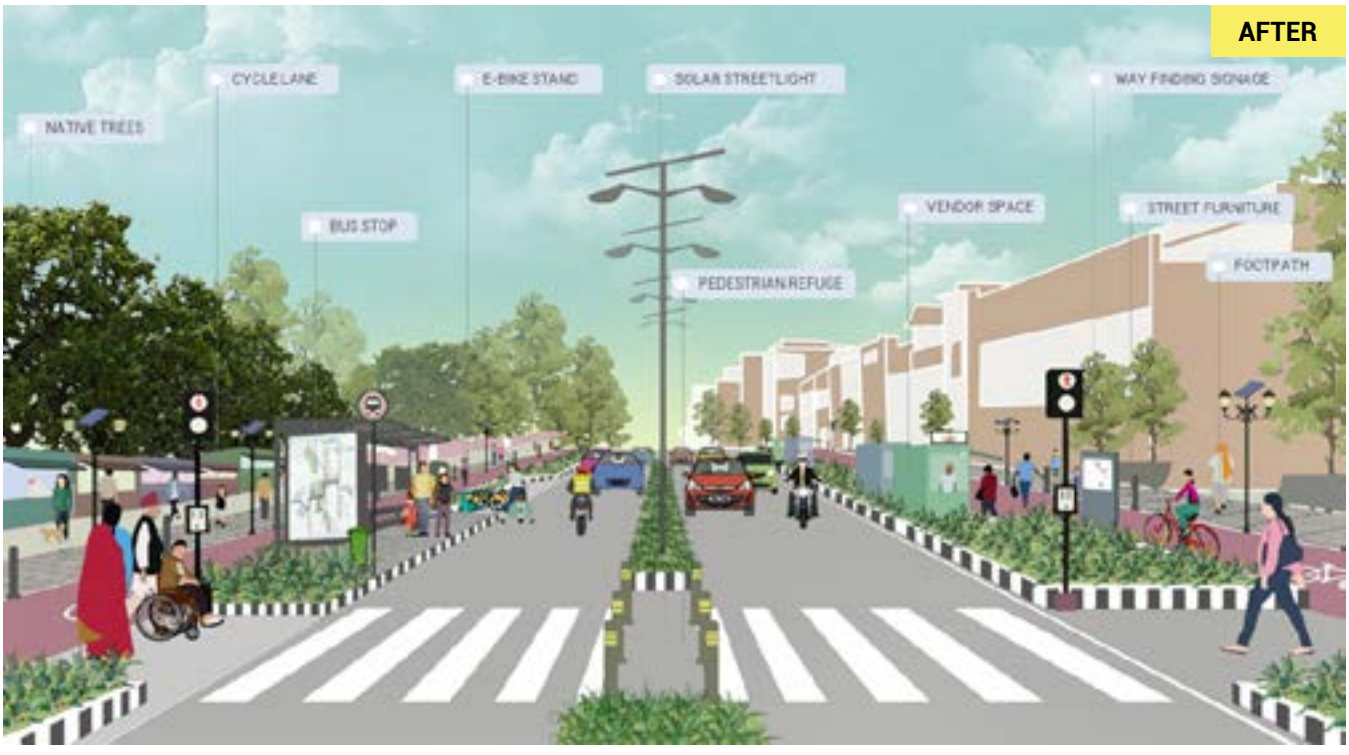
FIGURE 3.21 Proposed elements in shared mobility hub



Source: UN-Habitat

74 Sustainable Transport Index, Bhopal, 2019, p 33; https://www.unescap.org/sites/default/d8files/knowledge-products/Bhopal_%20India.pdf.

FIGURE 3.22 Illustration of application of Complete Streets Framework along Kolar Road to develop it as Eco-arterial Street.



Estimated Project Costs and GHG Savings Potential

The estimated project costs for Transformative Project 3 are summarized in Table 3.16:

TABLE 3.16 Summary of estimated project costs for Transformative Project - 3

Project	Components	Estimated Project Cost (INR lakh)
Development of eco-arterial and shared mobility corridor in Kolar Road	**Streetscaping tree lining along Kolar Road –** Plantation of trees along Kolar Road in identified spaces	194.7
	Smart Road with dedicated NMT corridor Footpath, dedicated cycling lane, docking stations, tactile flooring, underground service duct, tree plantation, furniture, and Street Art (proposed for 12 km)	120.0
Development of Chunabhatti Chouraha as Shared Mobility Hub and City Transit Hub	**Development of Chunabhatti Chouraha as Shared Mobility Hub and City Transit Hub** Bus stop, dedicated cycle lane, parking, electric vehicle charging, parking bay for shared vehicles	175.2

Source: Various sources have been used in the calculation of project costs. Refer to Annex 7. Cost Estimates Methodology for the calculation breakdown and assumptions made.

The total GHG savings for Transformative Project 3 are around 84 tCO2e. Only the component of tree lining has been considered for this calculation, as other components like the construction of NMT facilities and shared mobility hubs cannot be currently assessed without a proper assessment of demand, and potential user surveys.

However, these components may facilitate a modal shift towards NMT and public transportation, which may reduce the overall emissions from the transportation sector. Table 3.17 summarizes the GHG savings potential of the proposed transformative project.

TABLE 3.17 Project GHG savings potential for Transformative Project - 4

Transformative Project	Components	Potential GHG emissions (tCO_2e)	Remarks
Identification of preservation zones and activating public spaces near Shahpura Lake	**Streetscaping tree lining along Kolar Road –** Plantation of trees along Kolar Road in identified spaces. Proposed plantation of 1200 trees on both side of 5.6 km road stretch.	-84 tCO_2/annum	The unit GHG savings potential considered for 1 tree = -0.07 tCO2/annum. Source: Sharma, Pradhan, Others (2020)

Source: Sharma, Pradhan, Others (2020)
Note*: The GHG emissions assessment is demonstrative, not exhaustive in nature. A detailed DPR and GHG inventory may be carried out for a more accurate assessment.

3.6.6 Transformative Project 4: Pedestrian Street – Campion School Road

The fourth Transformative Project demonstrates the application of Intervention 3.1 – Eco-Arterial Complete Streets Assessment Toolkit for the development of NMT. It also illustrates the development possibilities for Campion School Road into a pedestrian-only plaza, which encourages a modal shift towards active mobility like walking and cycling in the neighbourhood.

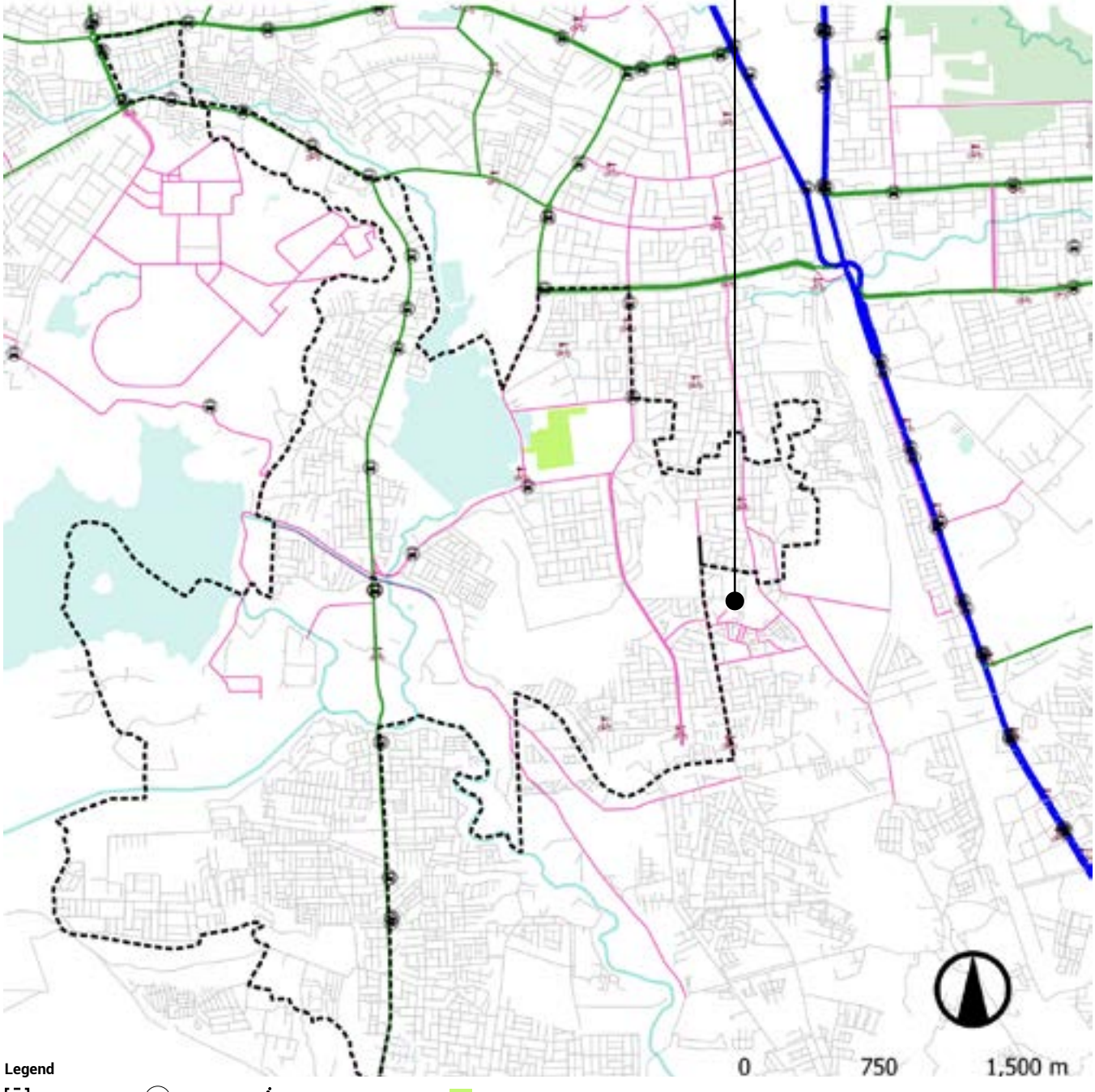
Campion School is an educational institution in the ABD neighbourhood, lying to the East of Shahpura Lake (see Map 3.20). The school lies on Campion School Road, which is currently a hub for street food and hosts multiple street food carts and kiosks along the stretch. Aside from basic circulation during office hours on weekdays, the street is activated as a food street in the evenings, typically after sunset.

Currently, Campion School Road faces traffic congestion, unorganized parking, and dark corners. Despite these issues, it has the potential to become a thriving public

Campion School Road

TIER 3	18M	EDUCATIONAL	SHAHPURA LAKE	ENCROACHMENTS	PEDESTRIANS, MTW	T-JUNCTION

This road is flanked by institutional area but mainly to access Campion School. There is a secondary access to government housing colony leading from this road. Shahpura Joggers' park is situated on the west of the road which can be integrated with proposed public plaza.



Legend

ABD Boundary | Bus stops | Cycle docking stations | Shahpura Joggers' Park | Arterial Road | Sub - Arterial Road | Collector Road

Map 3.20: Map showing the location of Campion School Road and activity mapping

Source: UN-Habitat

Map 3.21: Before and after traffic re-routing for creating the pedestrian plaza in Campion School Road

Source: UN-Habitat

plaza and landmark in the city by reinforcing and activating the public realm in the area. To realize this, the fourth Transformative Project proposes a reorganization of vehicular movement, street food vendors and gathering spaces that currently exist. This proposal is detailed in the subsequent sections.

Traffic re-routing and prioritising pedestrian movement

Campion School Road is currently a throughfare for vehicles. To create a pedestrian-only plaza, motor vehicular access and parking should be restricted in a phased manner, to the end-points of the plaza. These end-points are located near the AICUF Ashram entrance on the West side and near the Campion School entrance on to the East, as shown in Map 3.21. Street food vending spaces should also be restricted to the area between these two points. Such a configuration allows normal circulation to the government housing colonies in the area, without causing any alteration or restriction. Dedicated parking for motorized and non-motorized vehicles, bicycles and EV rental stations and EV charging stations should also be developed at optimal locations at both ends of the plaza.

Additionally, Complete Streets features should be incorporated throughout the ABD area, with a particular focus on the pedestrian plaza for public amenities, services and intermodal connectivity. The eco-arterial complete streets assessment Toolkit, applicable mobility and ecological elements, outlined in Strategic Response-3: Eco-Arterial Complete Streets Network, should be referenced to assess the existing street and design the public pedestrian plaza. One such envisioned scenario with the transformative elements is illustrated in Figure 3.23.

IMAGE 3.14 Campion School Road – a proposed pedestrian street with vending spaces

Source: UN-Habitat

FIGURE 3.23 Before and after illustrations of pedestrian street development along Campion School Road

Source: UN-Habitat

Estimated Project Costs

The estimated cost for developing a pedestrian plaza along Campion School Road with the recommended urban design elements is around Rs. 184.8 lakh. Table 3.18 lists these details:

TABLE 3.18 Summary of estimated project costs for Transformative Project - 5

Project	Components	Estimated Project Cost (INR lakh)
Development of pedestrian plaza with food vending activities along Campion School Road by reorganizing traffic and parking	Organized vending spaces, parking, and walkways for pedestrian movement	184.8
	Urban design elements like street furniture, street lighting, green planters, display boards, permeable pavements, and street art.	

Source: Various sources have been used in the calculation of project costs. Refer to Annex 7. Cost Estimates Methodology for the calculation breakdown and assumptions made.

3.6.7 Transformative Project – 5: Redevelopment of Manisha Market in Shahpura, to promote PPP in affordable housing

This Transformative Project proposes the redevelopment of Manisha Market, a sector market[75] in the ABD area, into a mixed-use, affordable housing development. This project combines the application of two strategic interventions – Intervention -1.1: Revitalize urban core through densification, and Intervention 4.4: Housing Development – Increase affordable housing stock through redevelopment.

In Bhopal, sector markets are mostly underutilized land parcels, which are potentially viable affordable housing projects with the proper redevelopment process that includes private sector participation, under the provisions of the PMAY affordable housing policies.[76]

Existing Context

Manisha Market is a mixed-use neighbourhood market or sector market, spread over 0.56 ha on public land, with retail shops on the ground floor and residential units on the upper floors. Occupants have been awarded long-term lease instead of ownership of the units. Approximately 35 retail shops exist on the ground floors, with an open, paved courtyard in the centre. The upper floors contain residential units that are mostly dilapidated or unused. The fourth Transformative Project, therefore, provides an opportunity to refurbish the market complex aligned with the updated vision and goals for the ABD area.

Several government housing complexes exist in the ABD area, with a total of 1,100 housing units, in addition to residential neighbourhoods with bungalows. The proposed mixed-use, affordable housing project facilitates a compact, mixed-income neighbourhood that mitigates potential gentrification of the area.

As discussed in Section 3.2.1, the low-density opportunity land parcels with access to three or more urban amenities[77] in the ABD area were mapped. The areas highlighted in red in Map 3.22 show the current density of Manisha Market Complex.

Other examples of in-situ rehabilitation of settlements in the city, which are not situated on eco-sensitive land, include a multi-story low-income housing complex in the Nehru Nagar slums, constructed in 2012. The Shyam Nagar and Sanjey Nagar slums are currently being upgraded with multi-story housing complexes.

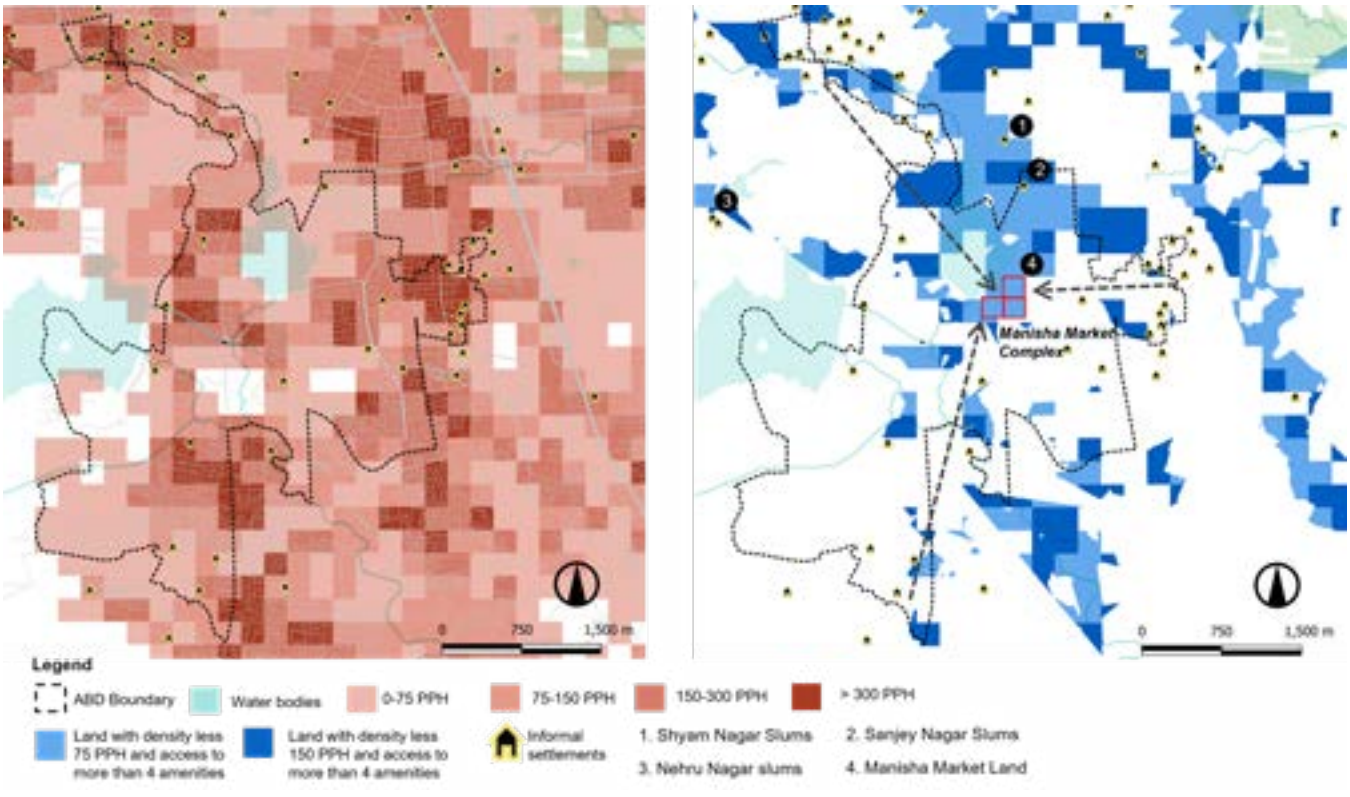
75 Mixed-use neighbourhood markets, which are developed in residential areas. Sector markets were proposed under BDP 2005.

76 Affordable Housing in Partnership and Affordable Rental Housing Complexes (ARHCs) for Migrant Workers/ Urban Poor components under PMAY. Report 'PPP models for affordable housing projects, 2017,' by MoHUA was referred during project formulation; https://mohua.gov.in/upload/uploadfiles/files/PPP%20Models%20for%20Affordable%20Housing.pdf.

77 See Intervention 4.2 – Housing Development – Promote increase in affordable housing stock, of Strategic Response – 4: Urban retrofitting in informal settlements.

IMAGE 3.15 Existing development in Manisha Market Complex, Shahpura

Source: UN-Habitat



Map 3.22: a. Residential population density 2018;
b. Low-density opportunity land parcels for redevelopment

Source: UN-Habitat

IMAGE 3.16 Multi-storey, LIG housing complex in the Nehru Nagar slums developed by city authorities

Source: UN-Habitat

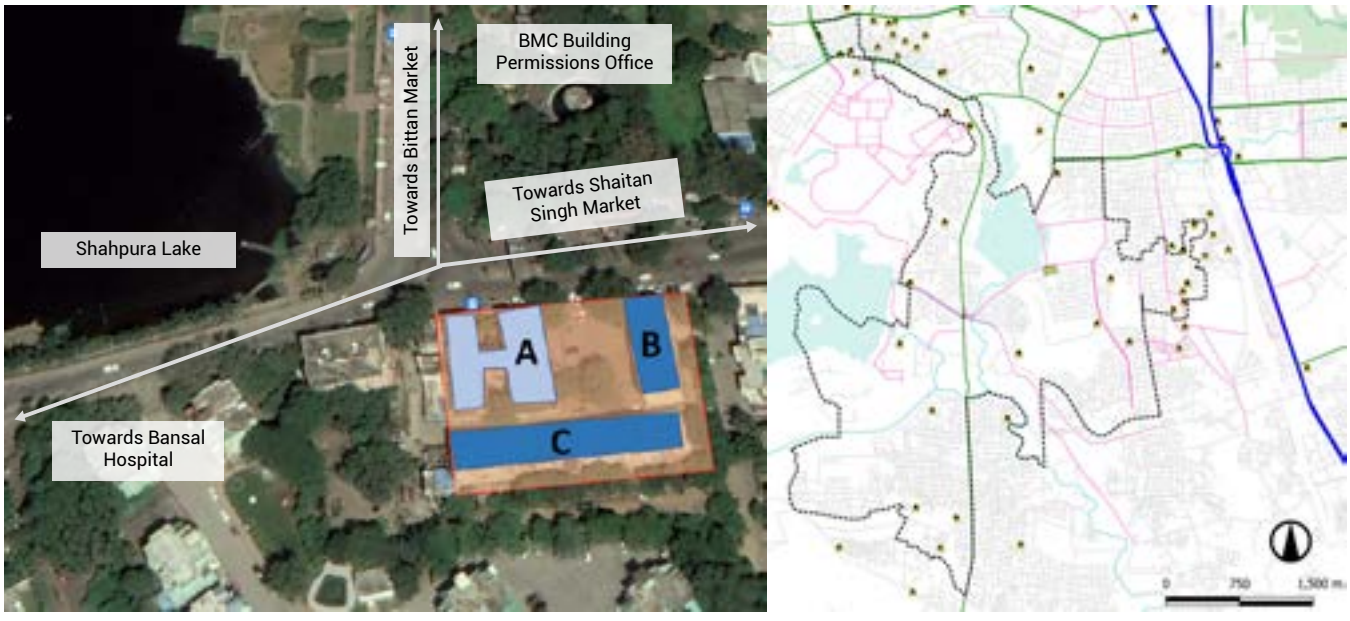
IMAGE 3.17 Multi-storey housing complex under construction in the Shyam Nagar and Sanjey Nagar slums

Source: UN-Habitat

KEY HIGHLIGHTS

- Commercial functions are located on the ground floors, while residential units are located on the upper floors – under-utilized FAR
- Several housing units lie vacant
- Structures of a few residential blocks are dilapidated and require improvements
- Manisha Market is situated in the city's Residential-1 zone, which promotes redevelopment, according to the draft BDP 2031
- Exists on prime land, as it is situated close to Shahpura Lake, Bansal Hospital and various educational institutions
- Market redevelopment project with private sector participation can become the pilot project in the city, with the potential of replicating the model to other viable sites.

As shown in Map 3.22 and Table 3.18, the existing Manisha Market development utilizes 1.3 FAR, which is 65 per cent of the total permissible FAR, according to land use zoning regulations (see proposed zoning recommendations in Table 3.1). Approximately 3,980 sq. m. is available without availing any FAR incentives for adding more affordable housing units. This is possible by following two redevelopment models, explained in Figure 3.24.



Map 3.23: Location with respect to Shahpura Lake, context and built-up summary of Manisha Market Complex

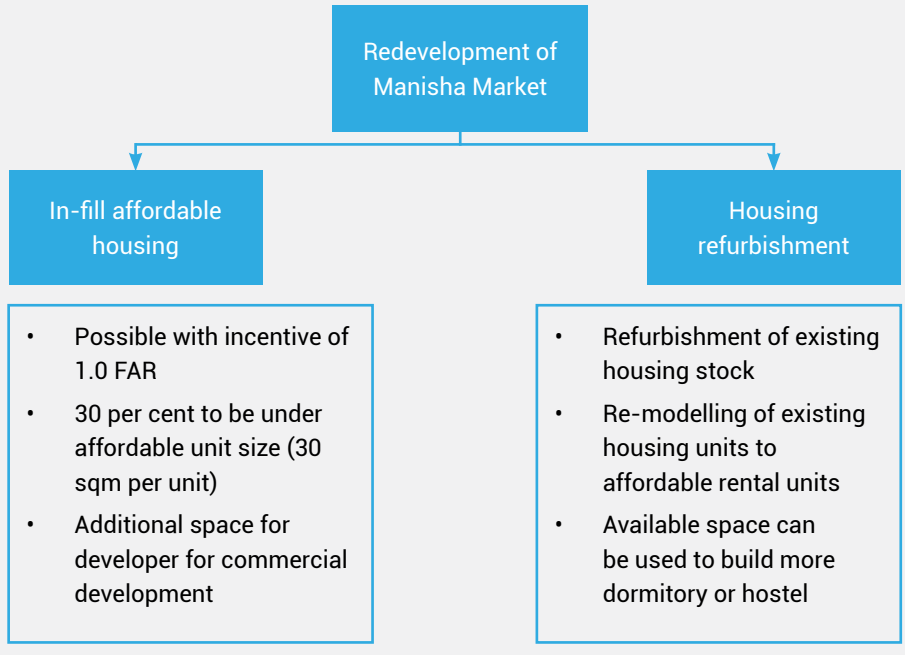
Source: Google Earth Imagery

TABLE 3.19 Summary of land utilization and existing built-up in Manisha Market Complex

Block	Area (sq. m.)	No. of floors	Total BUA (sq. m.)
A	1,098	G+2	2,992
B	345	G+3	1,253
C	866	G+3	3,146
Total	2,309	-	7,392
Land (Total FAR 2)	5,686		11,372
Available built-up for future development Current scenario without any incentives			3,980

Source: Approximate measurements have been taken from Google Earth imagery. A detail survey is recommended.

FIGURE 3.24 Proposed models for the redevelopment of Manisha Market



Source: UN-Habitat

Model 1: In-fill affordable housing

Redevelopment of the entire market complex is supported by an increase in FAR by the local authorities (BMC/ TNCP), which is one of the incentives. This model is based on the provisions under the Affordable Housing in Partnership (AHP) component of the PMAY-U scheme. In addition, the proposed metro station at the nearby Chunabhatti Chouraha will complement the densification strategy with a supplementary incentive of 1.0 FAR, to bring the total incentives to 3.0 FAR. The new built-up allocation is summarized in Figure 3.25.

For the redevelopment project to qualify for an additional 1.0 FAR incentive, as per the affordable housing scheme,[78] at least 35 per cent of the built-up area should be reserved for affordable housing for economically weaker sections (EWS). According to PMAY guidelines, the carpet area for each affordable dwelling unit should not be more than 30 sq. m. The total available built-up area for redevelopment, after including FAR incentives, will be 17,058 sq. m. Of this, 43 per cent is existing built-up and will be retained in the redevelopment project (see Figure 3.25).

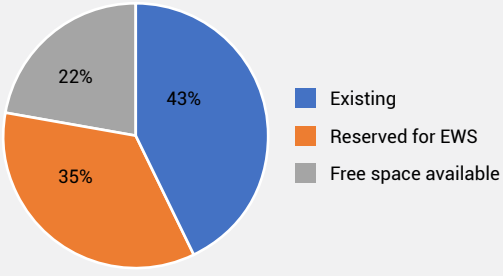
78 Affordable Housing in Partnership Guidelines, PMAY.

FIGURE 3.25 Proposed build-up relocation under redevelopment

Land - 5,686 sqm
Current FAR – 2.0
FAR Incentive - 1.0

Total FAR available for redevelopment - 3.0
Available built-up - 17,058 sqm

Built-up allocation



Existing - 43%
Existing residential and commercial development which will be preserved after redevelopment

Reserved for EWS Housing – 35%
As per PMAY, the redevelopment project should reserve at least 35% of units in affordable dwelling unit size of 30 sqm

Free space available – 22%
This can be used to add more affordable units, or allow developer to add residential or commercial units

Source: UN-Habitat

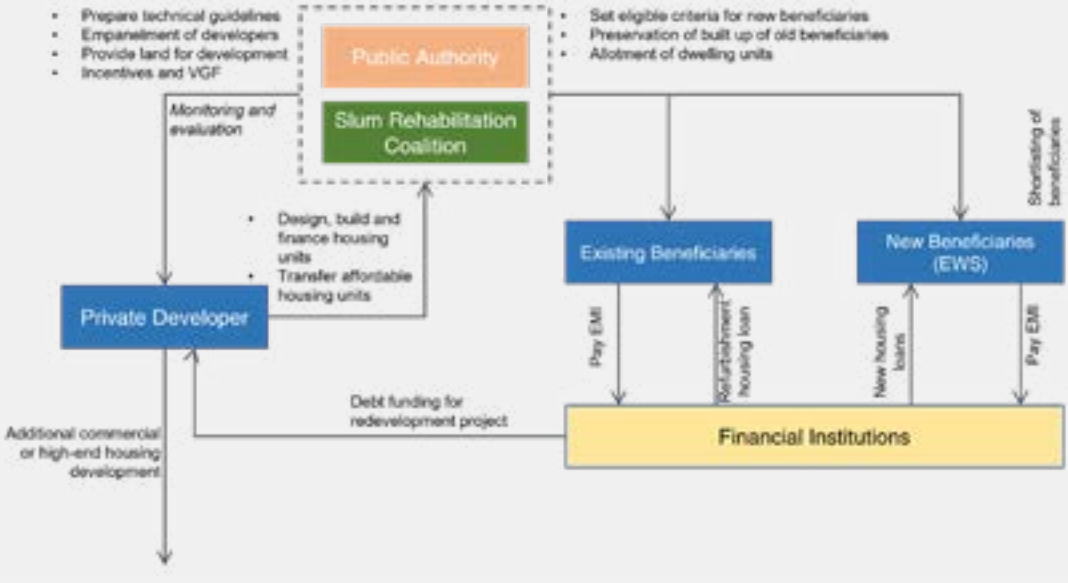
Around 130 affordable dwelling units[79] can be constructed under the reserved category (35 per cent) for EWS. City officials, along with representatives of the SRC, may identify suitable beneficiaries and allocate the dwelling units accordingly.

The remaining 22 per cent of the built-up area may be used to add additional affordable housing units or allow the private developer(s) to add additional residential or commercial units.

A Detailed Project Report (DPR) may provide an additional understanding of the financial feasibility of the project, and provide additional data for city officials to ascertain the built-up allocation for the benefit of the private developer. The DPR should also be prepared to ascertain the product mix (hostels, rental housing, dormitory, or commercial), revenue sharing, and mapping of vacant properties.

The process flow and allocation of responsibilities of stakeholders are summarized in Figure 3.26.

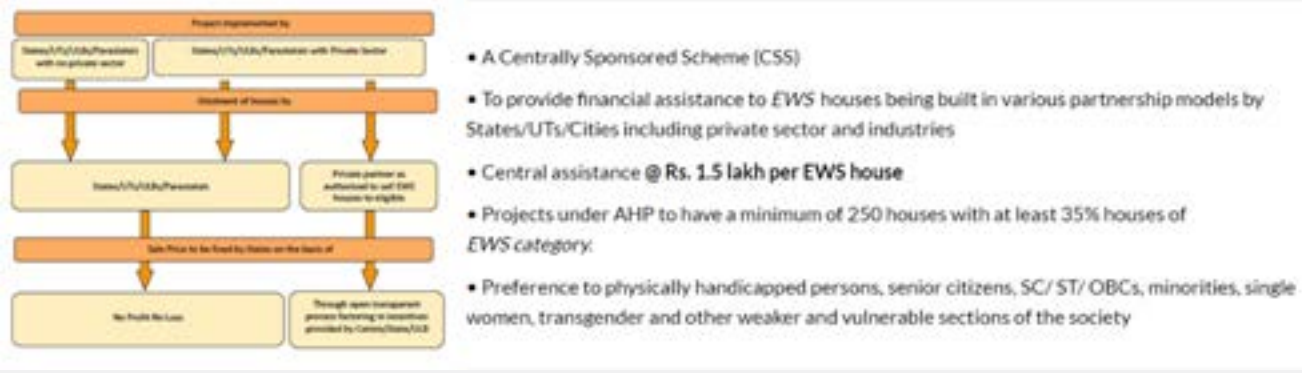
FIGURE 3.26 Allocation of project roles and responsibilities for the redevelopment of Manisha Market



Source: UN-Habitat

79 Thirty-five per cent of the total built-up area is 5,966 sq. m. Carpet area for each unit should be 30 sq. m. The super built-up area, which includes carpet area and space for common amenities like staircase, lobby, or elevator, if required, for each dwelling unit will be 45 sq. m. (5,966/45 = 132.22 ~130 dwelling units).

KEY HIGHLIGHTS OF AFFORDABLE HOUSING IN A PARTNERSHIP SCHEME



- A Centrally Sponsored Scheme (CSS)
- To provide financial assistance to *EWS* houses being built in various partnership models by States/UTs/Cities including private sector and industries
- Central assistance **@ Rs. 1.5 lakh per EWS house**
- Projects under AHP to have a minimum of 250 houses with at least 35% houses of *EWS category*.
- Preference to physically handicapped persons, senior citizens, SC/ ST/ OBCs, minorities, single women, transgender and other weaker and vulnerable sections of the society

Source: AHP scheme guidelines, https://pmay-urban.gov.in/ahp

Model 2: Refurbishment of existing housing stock

For providing adequate, accessible and dignified affordable rental housing to the urban poor in proximity to their workplace, this model involves the refurbishment of existing, unused residential properties into affordable rental units. It refers to the provisions recommended under the ARHC component of PMAY-U.

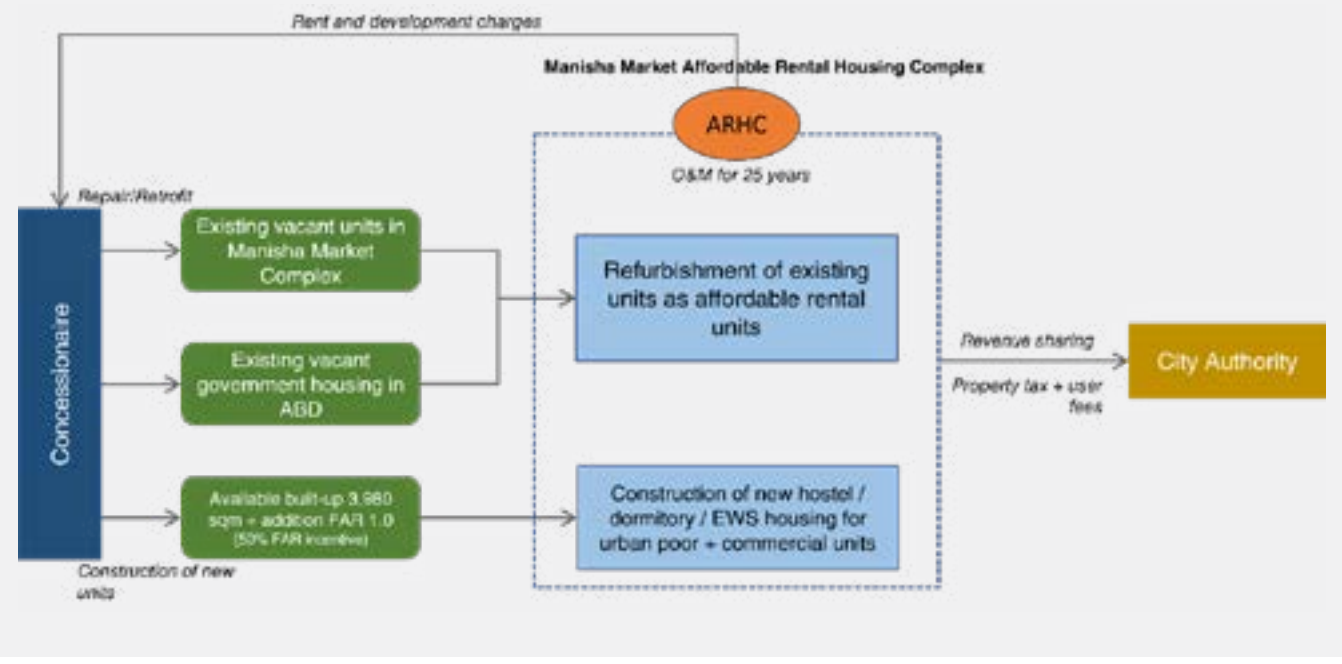
The ARHC guidelines recommend utilizing existing government-funded vacant houses to convert them into rental complexes through PPP or by public agencies. City authorities may establish a pilot redevelopment project for affordable rental housing through the case of the Manisha Market redevelopment, which may be replicated in other vacant government-funded housing. Interested concessionaires (private developer or public agency) can be selected through a technical and financial evaluation under the government tendering process (see Figure 3.27).

The concessionaire should repair/ retrofit housing units, fill in infrastructure gaps where required, and operate the units for 25 years through a profit-sharing model with city authorities. The process flow of the redevelopment of Manisha Market under ARHC is summarized in Figure 3.28.

FIGURE 3.27 Process flow diagram for selection of ARHC Concessionaire for refurbishment works

Source: UN-Habitat

FIGURE 3.28 Process flow diagram for the refurbishment of Manisha Market



Source: UN-Habitat

Estimated Project Costs and GHG Savings Potential

The project cost for the redevelopment of Manisha Market Complex, assuming current (2022) construction prices, is summarized in Table 3.20. To estimate the cost for the refurbishment project, a detailed survey of vacant assets for repair or retrofit will be required (as described in the DPR requirements) and, therefore, have not been included in the calculations.

The total GHG emissions for the proposed in Manisha Market redevelopment project are around 533.3 tCO_2/ annum, as detailed in Table 3.21.

TABLE 3.20 Summary of estimated project costs for Transformative Project - 6

Project	Components	Estimated Project Cost (INR lakh)
Redevelopment of Manisha Market in Shahpura, to promote PPP in affordable housing	**Redevelopment of Manisha Market in Shahpura** Redesign the market to utilize full land capacity and incentivize PPP in affordable housing	13,212.2

Source: Various sources have been used in the calculation of project costs. Refer to Annex 7. Cost Estimates Methodology for the calculation breakdown and assumptions made.

TABLE 3.21 Project GHG savings potential for Transformative Project – 6 - business as usual scenario

Transformative Project	Components	Potential GHG emissions (in tCO_2e)	Remarks
Redevelopment of Manisha Market in Shahpura	**Construction of affordable housing complex under PPP –** Construction of new 130 EWS housing units, saving the existing built-up area in the market complex	+533.3 tCO_2/ annum	The GHG emissions considered for construction of EWS housing unit is +4.1 tCO_2/ annum Source: Annex 5

Source: MISSING
Note*: The GHG emission assessment is not exhaustive but demonstrative in nature. Detailed DPR and GHG inventory may be carried out for more accurate assessment.

The emissions from this redevelopment project can be further reduced by employing green construction technology, ensuring sustainable design, renewable energy sources to power building services, maximizing natural ventilation and insulation, and improving access to public transportation. The carbon storage potential of green material substitutes is summarized in Table 3.21.

TABLE 3.21 Basis data for GHG emissions assessment: Regular Housing Structure and Green Materials Substitute CO2 Storage Potential

Regular structure[1]	Green structure substitutes	CO_2 content ($kgCO_2$/ kg)	Total Mass[80] (kg)	GHG savings potential (tCO_2-eq/ annum)
Concrete (27%)	Fly Ash or Wood	-1.84	2,882	-5.30
Cement (42%)	Straw Bale	-1.76	4,430	-7.80
Ceramic (4%)	Cork	-2.06	430	-0.88
Burnt Clay (27%)	Bamboo, Earthen Clay, Hemp	-2.24	2,700	-6.05
TOTAL			10,441	-20.03

Note*: The negative number indicates carbon storage potential and a positive number indicates potential carbon emissions. Source: Kuttinen, M et al. (2021).

The green materials substitutes can cut down the emissions that would be caused by using regular construction materials. They have the additional potential to store 3,138.44 tCO_2-eq of carbon. Table 3.22 provides a comparison of carbon emissions between a business-as-usual scenario and a scenario where green construction materials are used.

TABLE 3.22 Example application – Housing 'business as usual' vs. sustainable construction approach for redeveloping Manisha Market

Redevelopment of Manisha Market	Total EWS units	Potential GHG emissions (tCO_2e) from business-as-usual EWS[81]	Potential GHG emissions (tCO_2e) from sustainable EWS
445 (existing 115 units + proposed 130 EWS units)	130	534.35	-3,138.44

Source: UN-Habitat

KEY FEATURES AND INCENTIVES PROVIDE FOR AFFORDABLE RENTAL COMPLEXES UNDER ARHC SCHEME

Source: ARHC scheme booklet, http://arhc.mohua.gov.in/filesUpload/ARHC-Booklet.pdf

80 The total mass of construction materials is calculated for construction of 130 EWS housing units. See Annex 3 for detailed analysis of quantity of construction materials..

81 The EWS group is defined as having an annual income of up to Rs. 1 lakh, and LIG as having an annual household income between Rs. 1–2 lakh, as per the Affordable Housing in Partnership scheme guidelines.

3.7 Actions and Interventions

The steps taken, the sources referenced, and the base metrics used to achieve the GHG potential savings and emissions, as well as the cost estimates for each intervention is included within the annex. The table below summarizes the key interventions and actions, as well as the total GHG emissions and block cost estimates.

S.No	Strategic Response	Proposed Action / Project	Components	Block Cost Estimate (INR. lakh.)	Climate Savings (in tCO2eq)	Convergence with National/ State Missions or Schemes	Location	Nature of Project	Implementation phase (Immediate, medium, long)	Implementing Agency	Sources of Finance
Policy Amendments or New Policy Guidelines											
1	Strategy 1 - Compact Development for urban core revitalization	Intervention 1.3 - Revise land use zoning to incentivize densification, affordable housing stock	• Increase the base FAR for RG-1 to 1.5 • Designate RG-1, RG-2 and RG-4 as TDR generating land for affordable housing	N/A	N/A	PMAY	Proposed BDP 2031 area	Policy Amendment	Immediate (0-3 years)	TNCP	Draft BDP 2031
2	Strategy 1 - Compact Development for urban core revitalization	Intervention 1.3 - Revise the Development Control Regulations to promote green buildings	• Provide incentives for construction of green buildings • Adopt compliances for rating green buildings	N/A	N/A	As per recommendations from Climate Smart Cities Assessment	Proposed BDP 2031 area	Policy Amendment	Immediate (0-3 years)	TNCP, BMC	Draft BDP 2031
3	Strategy 2 - Developing Bhopal as an Eco Living Lab	Intervention 2.1.b - Revise land use zoning to assign the region between Kerwa – Kaliasot Dam as City Forest.	• Revise the land use from Public,Semi-Public use to City Forest • Mapping of buffer to reduce conflict	N/A	N/A	As per the recommendations of National Green Tribunal	Proposed BDP 2031 area	Policy Amendment	Immediate (0-3 years)	TNCP	Draft BDP 2031
4	Strategy 2 and 3 - Developing Bhopal as an Eco Living Lab and Complete Streets Strategy	Intervention 2.3 - Draft the city level guidelines for Urban Forestry and Public Spaces (UFPS)	• Draw convergence with existing frameworks • Convene relevant stakeholders in green spaces and NMT • Provide legal framework for setting up of Eco-living Lab • Integration of existing Bhopal Placemaking Guidelines with Complete Streets Toolkit • Provide policy framework to regularly monitor, assess and design street infrastructure	N/A	N/A	The Biological Diversity Act 2002; Urban Greening Guidelines 2014	Proposed BDP 2031 area	New Policy Guideline	Immediate (0-3 years)	TNCP, BMC, CPA, BSCDCL, BCLL, BDA, MPBB,	AMRUT, Smart City Mission, BMC budget allocation

S.No	Strategic Response	Proposed Action / Project	Components	Block Cost Estimate (INR. lakh.)	Climate Savings (in tCO2eq)	Convergence with National/ State Missions or Schemes	Location	Nature of Project	Implementation phase (Immediate, medium, long)	Implementing Agency	Sources of Finance
Proposed Assessment and Survey											
5	Strategy 2 - Developing Bhopal as an Eco Living Lab	Intervention 2.1.a - Mapping and data repository of natural assets and resources	• Mapping to prepare People's Biodiversity Register, City Biodiversity Index and Environment Status Report • Reconciliation of public vacant land and ownership status	N/A	N/A	The Biological Diversity Act 2002; As per recommendations from Climate Smart Cities Assessment	Proposed BDP 2031 area	Survey and mapping	Immediate (0 - 2 years)	BMC, BSCDCL, TNCP, EPCO, MP Biodiversity Board	AMRUT, Smart City Mission, BMC budget allocation
6	Strategy 3 - Complete Streets Strategy	Intervention 3.2 - Prepare City Mobility Plan	• Reorganize public transportation as a feeder system to metro rail as well as improve the network coverage in periphery • Integration of multimodal systems and create opportunity for NMT development	N/A	N/A	City Mobility Guidelines 2014 by MoHUA	Proposed BDP 2031 area	Mapping and assessment	Medium (3-5 years)	BMC, BCLL, BSCDCL, MPMRCL	NA
7	Strategy 4 - Urban Retrofitting of Informal Settlements	Intervention 4.1: Conduct a comprehensive assessment of informal settlements in the city	• Identify the socio-economic-cultural demographics in informal settlements • Coverage of basic services, WASH, health and education • Existing land ownership, livelihood, gender-based demographics	N/A	N/A	PMAY	Proposed BDP 2031 area	Mapping and assessment	Immediate (0-3 years)	BMC, TNCP, BSCDCL	PMAY, Smart City Mission
Transformative Projects											
8	Strategy 2 - Developing Bhopal as an Eco Living Lab	TR 1 - Nature-based solutions for preservation of ecology	**Bioswales (Trench with plantation)** Bioswales, semi-permeable paved surfaces and ground water recharge (500 sq. m.)	860.2	-0.187	SBM 2.0 / Jal Jeevan Mission	Inlet canals and watershed of lakes. Can be combined with DEWATS in informal settlements - Pilot near Shahpura Lake	Green - Blue Infrastructure	Medium (3-5 years)	BMC, BSCDCL, CPA, Eco-Living Lab	AMRUT, Smart City Mission, PPP

S.No	Strategic Response	Proposed Action / Project	Components	Block Cost Estimate (INR. lakh.)	Climate Savings (in tCO2eq)	Convergence with National/ State Missions or Schemes	Location	Nature of Project	Implementation phase (Immediate, medium, long)	Implementing Agency	Sources of Finance
9			**Floating Treatment Wetlands** Small floating platforms with aquatic plants which can increase oxygen levels in surface water bodies and treat waste (300 sq. m.)	105.7	N/A	SBM 2.0 / Jal Jeevan Mission	Polluted surface waterbodies with high biological oxygen demand (BOD) - Pilot near Shahpura Lake	Sewage Treatment	Immediate (0-3 years)	BMC, BSCDCL, CPA, Eco-Living Lab	SBM 2.0, BMC budgetary allocations
10			**DEWATS** Decentralized nature-based sewage treatment near water bodies and informal settlements (capacity of 300 cum)	225.2	N/A	SBM 2.0 / Jal Jeevan Mission	Informal settlements near Harshvardhan colony and MANIT	Sewage Treatment	Medium (3-5 years)	BMC, PHE, Eco-Living Lab	AMRUT
11			**Plantation on preservation zones and buffer** Greening preservation zones and opportunity parcels (Around 50 ha)	290.7	-400	SBM 2.0 / Jal Jeevan Mission, Clean Air Action Plan for Bhopal, as per recommendations from Climate Smart Cities Assessment	Preservation zones identified under draft BDP 2031 in ABD	Green - Blue Infrastructure	Immediate (0-3 years)	MPPCB, EPCO, BDA, BMC, BSCDCL, Eco-Living Lab	Budgetary allocations, green bonds
12	Strategy 2 - Developing Bhopal as an Eco Living Lab	TR 2 - Identification of preservation zones and activating public spaces near Shahpura Lake	**Community Parks and community farming** Agro-forestry and community farming (around 2 ha)	50	-16	AMRUT, URDPFI	Preservation zones identified under draft BDP 2031 in ABD	Green - Blue Infrastructure	Medium (3-5 years)	BMC, CPA, BDA, Eco-Living Lab	Budgetary allocations, green bonds
13			**Redesign street along Shahpura Lakefront on the south** Streetscaping and integrating lakefront with Pahadi Mandir Park. Walkways and cycle corridors	394.0	N/A	Smart City Mission, Streets4People,	South of Shahpura Lake along Chunabhatti Road near Bansal Hospital	NMT Infrastructure	Medium (3-5 years)	BMC, BSCDCL	Budgetary allocations, green bonds, Smart City Mission

S.No	Strategic Response	Proposed Action / Project	Components	Block Cost Estimate (INR. lakh.)	Climate Savings (in tCO2eq)	Convergence with National/ State Missions or Schemes	Location	Nature of Project	Implementation phase (Immediate, medium, long)	Implementing Agency	Sources of Finance
14			**Streetscaping tree lining along Kolar Road –** Plantation of trees along Kolar Road in identified spaces	194.7	-84	Smart City Mission,	From MANIT Chouraha to Sarvdharam Clony along Kolar Road	Green - Blue Infrastructure	Immediate (0-3 years)	BMC, BSCDCL, BCLL	Smart City Mission
15	Strategy 3 - Complete Streets strategy for multimodal integration	Eco-arterial, shared mobility corridor - Kolar Road	**Smart Road with dedicated NMT corridor** Footpath, dedicated cycling lane, docking stations, tactile flooring, underground service duct, tree plantation, furniture and Street Art (proposed for 12 km)	7,540	N/A	Smart City Mission, Cycle4India Challenge	from MANIT Chouraha to Sarvdharam, and Shahpura Lake	Smart Roads and NMT	Medium (3-5 years)	BMC, BCLL, BSCDCL	Smart City Mission
16			**Development of Chunabhatti Chouraha as Shared Mobility Hub and City Transit Hub** Bus stop, dedicated cycle lane, parking, electric vehicle charging, parking bay for shared vehicles	382.2	N/A	Revised guidelines and standards for charging infrastructure for EV by Ministry of Power Madhya Pradesh Electric Vehicle (EV) Policy 2019,	from MANIT Chouraha to Sarvdharam, and Shahpura Lake	Shared mobility infrastructure	Immediate (0-3 years)	BMC, BCLL, BSCDCL	Smart City Mission
17	Strategy 3 - Complete Streets strategy for multimodal integration	Pedestrian Street - Campion School Road	**Placemaking and urban design of Campion School Road** Modification of existing vending zone near Campion School in Shahpura as a pedestrian plaza with no vehicle movement	184.8	N/A	Smart City Mission, Street4People Challenge	Campion School Street in Shahpura	NMT Infrastructure	Immediate (0-3 years)	BMC, BCLL, BSCDCL	Smart City Mission
18	Strategy 1 - Compact Development for urban core revitalization and Strategy 4 - Urban retrofitting of informal settlements	Redevelopment of Manisha Market in Shahpura, to promote PPP in affordable housing	**Redevelopment of Manisha Market in Shahpura** Redesign the market to utilize full land capacity and incentivize PPP in affordable housing	13,212	+ 534.3	PPP in affordable housing models in India by MoHUA; PMAY	Manisha Market, Shahpura	Affordable housing	Long (beyond 5years)	BMC, MPHIDB, BDA	PMAY, CMAY

Note:

Note:


Grand Trunk Road

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