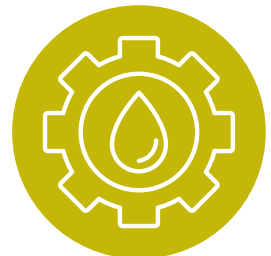
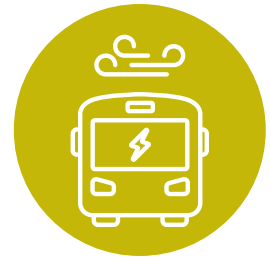




# ADVANCING CITY CLIMATE ACTION IN MADHYA PRADESH

Towards a low-carbon,  
climate-resilient **GWALIOR**

## Executive Summary



## Gwalior City Climate Action Plan

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Department of Environment, Government of Madhya Pradesh, 2023

## DISCLAIMER

This document is prepared by WRI India in partnership with Environmental Planning & Coordination Organisation (EPCO), Department of Environment, Government of Madhya Pradesh to support Gwalior city in developing its Climate Action Plan. The data and information used for preparing this report have been sourced from Gwalior city, State Government departments, published sources of Government of India, etc. While due care has been taken to ensure authenticity of the data and other information used, any error in their accuracy or interpretation is absolutely unintentional.

## About WRI India

WRI India is a research organization that turns big ideas into action at the nexus of environment, economic opportunity, and human well-being.

**Design credits:** Manasi Nandakumar (*Senior Communications Associate, WRI India*) and Ronak Naik



Source: Gwalior Smart City Development Corporation Ltd.

**GULSHAN BAMRA (IAS)**  
**PRINCIPAL SECRETARY**



Department of Environment  
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## Preface

No evidence is required to prove that climate is changing and that too because of increased human activities which have serious repercussions on economic development and natural resource management. Various recent extreme weather events in Madhya Pradesh, urban flooding, and untimely rains have shown that developing localised mitigation and resilience strategies is the need of the hour.

Paris Agreement 2015 and Glasgow Pact 2021 have shown the commitments from the international communities for reducing or mitigating GHG emissions, however to resolve this global issue, there lie the local solutions at sub-national level, district level and city level. Hon'ble Prime Minister of India has also launched the LiFE Movement which emphasizes on change in the lifestyle and behavioural patterns of living. He has stressed on reduce, reuse and recycle concepts as also on the circular economy to be an integral part of our lifestyle and for sustainable development. Concept of inclusivity is also very much integrated with this movement.

We in Madhya Pradesh are also committed to addressing the challenge of climate change in order to pursue the state's development goals in a sustainable manner.

Taking the cue from Ministry of Housing & Urban Affairs (MoHUA) as part of Climate Smart Cities Assessment Framework, the preparation of Climate Action Plans (CAPs) of all the 7 smart cities of MP by State Knowledge Management Centre on Climate Change (SKMCCC), EPCO and WRI India are steps towards making the local authorities equipped with strengths for tackling the challenge of climate change. The city level GHG inventorisation also helps in quantifying the actions to reduce the CO<sub>2</sub> emissions and offsetting the current emissions.

The City level Climate Action Plans (CAPs) for all the 7 smart cities have been drafted after wide consultations and participation with city experts so as to bring all the stakeholders on board and make their say.

I appreciate the efforts of EPCO and WRI India for taking the lead in preparing the City level Climate Action Plans.

These CAPs have flagged important issues which require attention and are expected to be implemented by the local authorities & SPVs.



(Gulshan Bamra)



## Foreword

As extreme weather events unfold across the globe, the climate crisis has reached our doorstep. While India is on track to achieve the Nationally Determined Contributions, the State of Madhya Pradesh (MP) is determined to lead India's fight against this impending crisis by policy-governance reforms and inculcating a climate action culture in the society. With MP's complex urban challenges and increasing climate risks and disasters, sustained actions ensuring cities to prepare for and develop the ability to thrive in the varying climate is crucial. In MP, the rising urban population has created a reason to be concerned about climate change, and therefore the interventions at the city level are deemed important.

In this connection, the Climate Smart Cities Assessment Framework (CSC-AF) issued by Ministry of Housing & Urban Affairs (MoHUA) plays an important role in devising the appropriate actions to keep our cities safe from the adverse impacts of climate change. This brings an opportune time to integrate the concerns of climate change into our on-going program & policies and achieve the goal of low carbon development with inclusive growth.

It has been a very good opportunity for EPCO to join the LiFE movement launched by Hon'ble Prime Minister of India during Glasgow CoP. All the concepts of LiFE have been tried and addressed in the cities while developing the plans.

It is also important for us to develop well researched strategies specific to the cities to respond effectively to the possible impacts of climate change. To address these challenges, City level Climate Action Plans (CAPs) have been developed by State Knowledge Management Centre on Climate Change, EPCO in association with WRI India. The CAPs have highlighted key concerns and strategies for actions as per the indicators outlined in the CSCAF.

I would like to acknowledge the efforts of EPCO professionals and WRI India team for their commendable work. I would also like to extend my gratitude towards UADD, all the SPVs and other stakeholders for extending their support to formulate these plans and providing necessary data and information to make these plans more robust.

**(Mujeebur Rehman Khan)**



## Acknowledgements

Environmental Planning and Coordination Organization (EPCO) is grateful to Mr Gulshan Bamra, Principal Secretary, Government of Madhya Pradesh, Environment Department; Mr Mujeebur Rehman Khan, Executive Director EPCO; and other team members from EPCO for their continuous support and guidance at various stages of developing the inclusive-climate action plan for Gwalior city.

We extend gratitude to Commissioner, Urban Administration and Development Department (UADD) for facilitating the plan development process and providing necessary guidance. We also are grateful to Commissioner, Gwalior Municipal Corporation and Chief Executive Officer of Gwalior Smart City Development Corporation Limited for constant support in providing valuable city level inputs and facilitating data collection across all departments and parastatal agencies. We would also like to thank all officers and city experts from concerning line departments and external agencies who contributed to the development and refinement of this plan through timely provision of data and valuable insights during stakeholder consultations.

EPCO would like to thank World Resources Institute (WRI) India, especially Mr Madhav Pai, CEO, Dr OP Agarwal, Senior Advisor and Former CEO, Ms Ulka Kelkar, Director, Climate Program for providing technical support to EPCO and Gwalior city, which played a key role for developing this plan.

We would also take this opportunity to appreciate the efforts made by the study team Mr Saransh Bajpai, Mr Prateek Barapatre, Ms Ramya MA, Ms Faiza Solanki and Ms Avni Agrawal for providing their expertise to assist in the research and development of the climate action plan.

Lastly, we would like to thank the internal reviewers from WRI India including Ms Marie Duraisami, Ms Sumedha Malaviya, Mr Dhilon Subramanian, Ms Azra Khan, Ms Chaitanya Kanuri and Ms Sahana Goswami for providing valuable feedback to strengthen the sectoral strategies in the plan

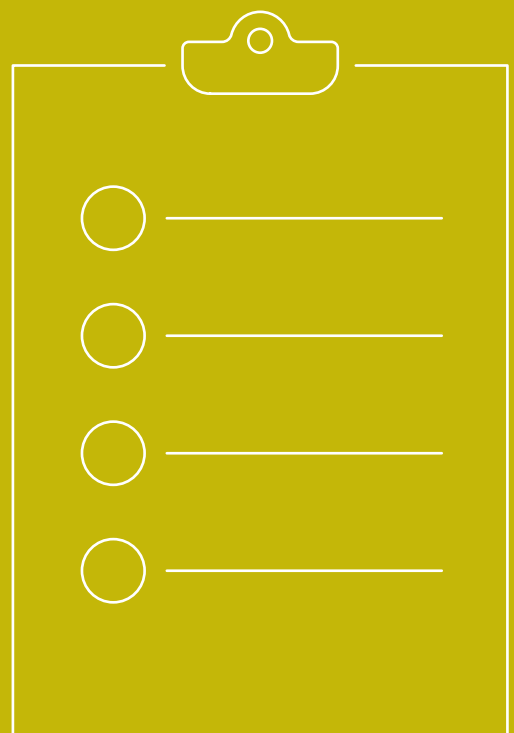
(Lokendra Thakkar)

**Coordinator,**  
State Knowledge Management  
Centre on Climate Change, EPCO





# EXECUTIVE SUMMARY





# Gwalior and its Vulnerability to Climate Change

Gwalior is the tourist capital of Madhya Pradesh — the fort being a notable attraction — and is among the eleven counter-magnet cities as defined by the National Capital Region Planning Board Act of 1985. More than half of Gwalior's land (54%) is under agricultural land use followed by residential land use (15%) and hills and hillocks (15%), recreational land use and scrub land (almost 2.5%), water bodies including lakes and rivers (less than 1%).

The city has three major nuclei: Lashkar, Hazira and Morar. Most of Lashkar is the Maharaj Bada, and a major part of the ABD area for Gwalior's smart city project is in this area. Lashkar's 803 acres are bordered by the Swarnarekha river to its north and west, Jai Vilas palace to the north-east, Chattris on the east, and dense urban settlements to the south.

The area deals with issues like congestion and lack of green spaces, but as an important trade hub, it will be necessary to ensure that a robust public transport system connects it to all major nodes of the city. Currently, throughout the ABD area, there is a lack of green open spaces right down to the neighbourhood level. The drainage system is encroached upon by construction; this, combined with the concreting of the Swarnarekha riverbed — which reduces percolation of rainwater — can lead to flooding. This indicates a need for a regulated wastewater management system.

According to EPCO's Vulnerability Assessment Report, there is a very high risk of decreasing availability of water, increasing crop water stresses, and increase in

frequency of extreme events like floods and droughts in the Representative Concentration Pathways (RCP) 4.5 mid-century and end-century scenarios. The city faces an extremely high forest vulnerability in the RCP 4.5 mid-century scenario; this reduces slightly to very high risk as per end-century projections. In terms of climate, the city faces a very high climate vulnerability in the RCP 4.5 mid-century risk projections, with a very high risk of decrease in average annual rainfall, increase in intensity of precipitation, and rise in heat index.

As part of the Smart Cities Mission, the Housing and Urban Affairs ministry's Climate Smart Cities Assessment Framework (CSCAF) aims to provide a roadmap to combat climate change through mitigation and adaptation measures while planning city-level development actions and policies. CSF-AF has five themes — energy and green buildings; urban planning, green cover and biodiversity; mobility and air quality; water resource management; and waste management — with 28 indicators among them.

WRI India is supporting EPCO and the MP government's departments of Environment and Urban Development and Housing as a technical partner, in planning adaptation and mitigation strategies and building a city climate action plan (CAP). The CAP is informed by the cities' greenhouse gas emissions profiles and vulnerability assessments. After reviewing data submitted by cities, the CAP identifies existing gaps in addressing future climate risks and recommends key action points across the CSC-AF's five thematic areas. It also proposes an institutional framework necessary to implement the recommendations.

## Climate Action Planning Process

WRI India adopted a four-pronged approach to prepare the Climate Action Plan:

- First, in February 2020, a planning-cum-launch workshop was organized in Bhopal with state and city officials, academicians and civil society organizations to apprise them of the relevance of developing a climate action plan and gather insights on the climate risks and development challenges faced by urban areas in MP.
- This was followed by a review of secondary literature to identify the city's vision and key sectoral priorities and develop a climate profile and greenhouse gas inventory for the city. This along with the vulnerability assessment by EPCO was used to identify climate risks and propose actions.
- Next, a stakeholders consultation workshop was organized in Gwalior, in September 2021, with participation from city officials, sectoral experts and civil society representatives, to present the preliminary findings and seek inputs on the goals and actions proposed.
- The final CAP provides prioritized sectoral actions, an implementation plan, and a governance mechanism for effective coordination and monitoring of implementation.



**ES Figure 1: CAP development process (Source: WRI India)**

**INTENDED OUTCOME OF THE STEP**

**ENGAGEMENT OVERVIEW**



## Baseline Assessment

A baseline assessment was conducted through an analysis of the climate smart cities assessment framework, greenhouse gas inventory development, and a vulnerability assessment.

### Climate Smart Cities Assessment

Gwalior scores well in waste management, but requires significant improvement in the other areas, especially mobility and air quality (the city is one of the most polluted cities in India).

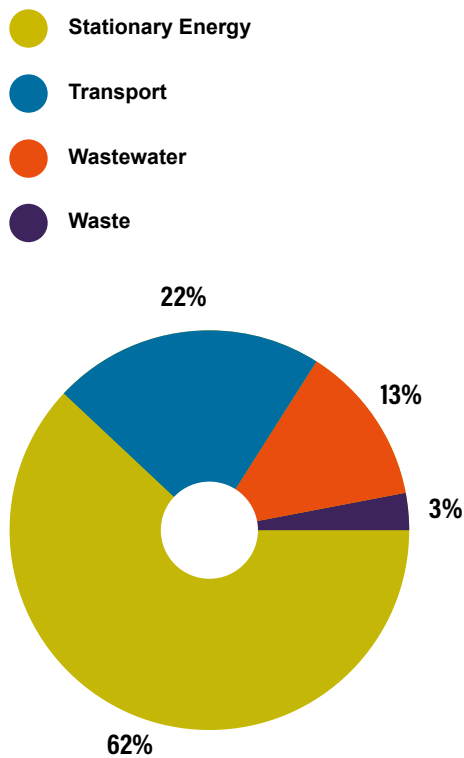
### Greenhouse Gas Emissions Inventory

In 2019, Gwalior’s GHG emissions (including emissions from electricity consumption in manufacturing industries) were 1.37 mtCO<sub>2</sub>e (1 tCO<sub>2</sub>e per person). The emissions inventory was compiled to the Global Protocol for Communities (GPC) BASIC standards using C40’s City Inventory Reporting and Information System (CIRIS). The contribution of the four sectors to total emissions in the city: 62% from stationary energy (most of this from energy and electricity use in residential buildings); 22% from transportation; 3% from waste, and 13% from wastewater.

**ES Table 1: CSCAF 2.0 Scores for Gwalior (Source: CSCAF 2.0 submission by Gwalior city)**

Overall Score as per CSCAF 2.0	Energy and Green Buildings	Urban Planning, Green Cover and Biodiversity	Mobility and Air Quality	Water Management	Waste Management
★★	★★	★★	★	★★	★★★★★
<b>CSCAF 2.0 Score</b>	2275	117	43	200	486
<b>Current measures being undertaken in the city</b>	<ul style="list-style-type: none"> <li>Promoting restoration and adaptive reuse of heritage buildings like heritage building precinct near Urvai gate at Gwalior fort and Old collectorate Gorkhi palace.</li> <li>A goal of meeting at least 20% of total power demand from renewables.</li> <li>Solar panels on public buildings.</li> <li>Increasing LED streetlights on a PPP basis.</li> </ul>	<ul style="list-style-type: none"> <li>GIS Mapping of open spaces and water bodies.</li> <li>Linking Pradhan Mantri Awaz Yojana to the Ankur program, which rewards citizens for tree plantation.</li> <li>82% of the municipal area is under tree cover.</li> <li>Has a disaster management cell.</li> <li>A plan for a 50-hectare forest and zoological park near KSR hospital.</li> <li>Maintains 520 gardens and parks.</li> </ul>	<ul style="list-style-type: none"> <li>Five multi-level parking locations identified.</li> <li>Three continuous ambient air quality monitoring stations; two continuous emissions monitoring stations.</li> <li>6067 LPG vehicles and 6981 CNG vehicles registered in the city; six CNG stations.</li> </ul>	<ul style="list-style-type: none"> <li>Water resources assessment, demand Management Strategy and Implementation Plan in place.</li> <li>NRW is around 30-40%.</li> <li>10-20% of wastewater is recycled and reused.</li> </ul>	<ul style="list-style-type: none"> <li>GMC has a Private Sector Participation model for solid waste.</li> <li>100% segregated waste collection<sup>7</sup>.</li> <li>Material Recovery Facility (MRF) of 100 TPD.</li> <li>17% of wet waste is composted.</li> <li>C&amp;D waste collected at four centres.</li> </ul>
<b>Areas of improvement</b>	<ul style="list-style-type: none"> <li>Increase LED streetlights (around 3% in 2019).</li> <li>Implement measures for promoting green buildings.</li> <li>Increase power generation from RE sources (&lt;5% currently).</li> <li>Promote rooftop solar in residential and commercial buildings.</li> </ul>	<ul style="list-style-type: none"> <li>Develop actions, allocate budget and monitor implementation for water body and green space conservation.</li> <li>No actions for biodiversity conservation. A biodiversity committee is a first step.</li> <li>Increase per capita green space from 1 m<sup>2</sup> to at least 10 m<sup>2</sup>.</li> <li>Prepare a disaster management plan and document loss and damage due to disasters.</li> </ul>	<ul style="list-style-type: none"> <li>Increase number of buses (currently 0.02 buses per 1000 population)</li> <li>Increase coverage of NMT (5% of roads with NMT network currently)</li> <li>Increase share of clean-fuel shared mobility (currently 0%)</li> </ul>	<ul style="list-style-type: none"> <li>Reduce NRW</li> <li>Revive the Swarnarekha river.</li> <li>Conduct flood risk assessment and prepare action plan.</li> <li>Conduct energy audit for pumping stations and treatment plants.</li> </ul>	<ul style="list-style-type: none"> <li>Capture methane gas from landfills.</li> <li>Central bio methanation plant required</li> <li>Increase wet waste composting.</li> <li>Increase waste recycling.</li> <li>Set up plastic waste collection centres and MRF.</li> <li>Set up 50 TPD construction and demolition waste recycling centre.</li> </ul>

**ES Figure 2: GHG Emissions Profile** (Source: WRI India analysis using primary data)

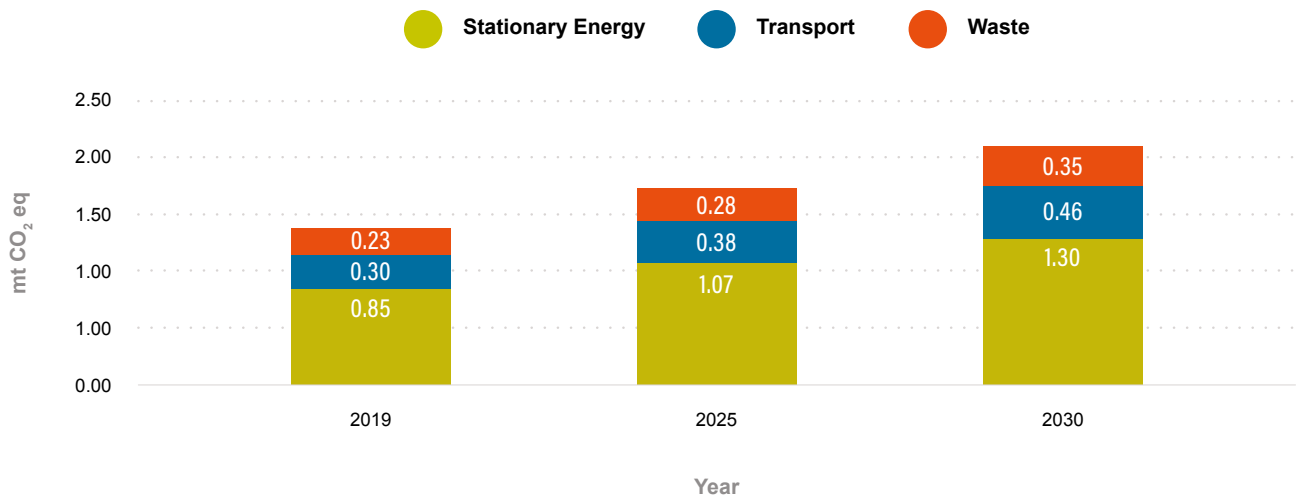


The business-as-usual projected emissions for Gwalior are presented in ES Figure 3. The emissions are projected to increase by 26% by 2025 and 53% by the end of the decade till 2030, compared to the baseline emissions of 2019 if no action is being taken. This creates an urgent need for the city to implement measures presented in the report for achieving its vision of low carbon and climate resilient development.

### Vulnerability Assessment

According to this analysis, Gwalior has a low composite vulnerability. For water resources, Gwalior is very highly vulnerable; That is, there is a very high risk of decreasing water availability, increasing stresses on crop water, and increase in frequency of extreme events like floods and droughts.

**ES Figure 3: Projected emissions for Gwalior** (Source: WRI India analysis using primary data)



**ES Table 2: Future Climate Risks for Gwalior** (Source: CEEW, 2020)

Projected Climate Changes	Potential Impacts and Risks
Warmer conditions, including more intense and frequent high-temperature extremes and heat wave days.	<ul style="list-style-type: none"> <li>Warm days are likely to increase by 50 before the end of the century. If air quality also decreases, this could have further negative health effects including increases in mortality.</li> <li>Increase in water stress and drought-like events</li> </ul>
Higher annual rainfall totals and change in frequencies	<ul style="list-style-type: none"> <li>In a high emissions scenario, by 2100, total annual rainfall in the city is likely to increase 9% from 2010 levels.</li> <li>In 2015, the city received 211.5 mm of precipitation; in 2019, it was 821.9 mm. This indicates extreme variation in precipitation trends.</li> </ul>

# Goals and Sectoral Strategies

Goals and actions were prepared to ensure Gwalior achieves a low carbon and climate-resilient growth while

also reducing inequality and increasing inclusivity in development.

**ES Table 3: Summary of goals and actions for Gwalior (Source: WRI India)**

Goals	Actions	Outcomes
<b>Goal 1</b>  Green housing for all in Gwalior	<ul style="list-style-type: none"> <li>Promoting energy-efficient appliances in residential buildings.</li> <li>Promoting green and cool roofs in residential buildings.</li> <li>Implementing measures to promote green buildings in Gwalior.</li> <li>Mandating or incentivizing rooftop solar panels and solar water heaters in all new residential and commercial buildings including hotels, malls and hospitals</li> <li>Exploring common solar PV projects for community low-income housing</li> </ul>	<ul style="list-style-type: none"> <li>GHG emission reduction.</li> <li>Climate-resilient urban housing.</li> <li>Improved housing for all.</li> </ul>
<b>Goal 2</b>  Climate smart tourism in Gwalior	<ul style="list-style-type: none"> <li>Developing a pedestrian friendly heritage network trails and an electric hop on hop off bus service in tourist areas</li> <li>Incorporating zero-carbon building components in heritage redevelopment projects</li> <li>Dry waste recovery and plastic reverse vending machines at tourist centres</li> </ul>	<ul style="list-style-type: none"> <li>Reduce GHG emissions</li> <li>Strengthen sustainable and equitable economic activity</li> </ul>
<b>Goal 3</b>  Make Gwalior a solar city	<ul style="list-style-type: none"> <li>Implementing solar rooftop panels for all government buildings and public spaces</li> <li>Piloting solar-bus stops</li> <li>Awareness programs and tools for promoting residential rooftop solar</li> <li>Solarisation of sewage treatment plants and water pumping stations</li> </ul>	<ul style="list-style-type: none"> <li>GHG emission reduction.</li> <li>Increased penetration of renewable energy.</li> <li>Improved access to affordable energy.</li> <li>Reduced urban heat island effect and induced cooling effect.</li> </ul>
<b>Goal 4</b>  Improve air quality and make Gwalior a connected & accessible city	<ul style="list-style-type: none"> <li>Augmenting the existing bus fleet</li> <li>Fuel efficiency and driver training for diesel-powered public and private buses</li> <li>Setting up of infrastructure for service centres and charging stations for electric vehicles.</li> <li>Implementing a comprehensive data strategy for enhanced public transport ridership</li> <li>Strengthening NMT infrastructure in the city</li> <li>Improved parking management in Gwalior</li> <li>Scaling up and improving the uptake for Gwalior's public bicycle sharing system</li> </ul>	<ul style="list-style-type: none"> <li>Improvement in air quality.</li> <li>Decrease in negative health effects.</li> <li>Improved mobility access.</li> <li>Reduced travel by private motor vehicles.</li> </ul>
<b>Goal 5</b>  Green and blue resilient urban ecosystem	<ul style="list-style-type: none"> <li>De-concretization of the Swarnarekha and Morar rivers and integration of green infrastructure in river rejuvenation projects</li> <li>Developing inclusive green spaces in Gwalior</li> <li>Promoting green terraces.</li> <li>Developing a heat action plan</li> <li>Data, information, and awareness for biodiversity conservation.</li> </ul>	<ul style="list-style-type: none"> <li>Improved water security.</li> <li>Reduced flood risk.</li> <li>Improved air quality and climate resilience.</li> <li>Increased access to affordable drinking water through groundwater recharge</li> </ul>



Goals	Actions	Outcomes
<b>Goal 6</b>  Zero-waste Gwalior	<ul style="list-style-type: none"> <li>Decentralized composting in Gwalior</li> <li>Converting waste transport fleet to electric vehicles</li> <li>Public-private model for managing construction and demolition waste</li> <li>Revenue-generating models for recycling C&amp;D waste</li> <li>Innovative models for recycling plastic waste.</li> </ul>	<ul style="list-style-type: none"> <li>Reduced GHG emissions particularly from waste management</li> <li>Beautification of the city and improved access to clean energy sources.</li> <li>Increase in recycling rates.</li> </ul>
<b>Goal 7</b>  Water-resilient Gwalior	<ul style="list-style-type: none"> <li>Developing and implementing an NRW reduction strategy</li> <li>Disaster risk-reduction through developing and implementing an integrated flood and storm water management plan incorporating nature-based solutions</li> <li>Implementing energy-efficient water supply and wastewater management systems.</li> </ul>	<ul style="list-style-type: none"> <li>Reduced NRW losses.</li> <li>Increased access to potable water.</li> <li>Increased flood resistance</li> <li>Reduced water costs and improved equitable access.</li> <li>Better sewage management.</li> <li>Increased energy efficiency in water supply system.</li> </ul>

City authorities can select actions and recommendations in this plan to develop a detailed implementation plan for pilot projects that can be rolled out in the short, medium, and long term. The GHG emission profile of the city included in the plan can be used as a guiding analysis to prioritize implementation of actions in different sectors. The plan also provides guidance on mainstreaming actions with existing policies, schemes and programs to establish convergence of implementation.

Lastly, this plan must be treated as a dynamic document and must be updated regularly with the latest emissions profile of the city. It will be necessary to institute a city-level climate change cell — with representation from concerned ULB departments, Smart City, citizen forums, academic institutions and civil society — to lead and coordinate this process. Periodic stakeholder consultations would help in strengthening the plan as per the evolving requirements of the city.





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