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NICDC
NATIONAL INDUSTRIAL CORRIDOR DEVELOPMENT CORPORATION
India Reimagined

NATIONAL INDUSTRIAL CORRIDOR DEVELOPMENT CORPORATION LTD

Guidance Document for Preparation of
Detailed Project Report

JUNE 2026



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CHAPTER 1

INTRODUCTION

1.1 Introduction

BHAVYA Scheme (Bharat Audyogik Vikas Yojna) is a Government of India initiative implemented through the National Industrial Corridor Development Corporation (NICDC) for the development of next-generation plug-and-play industrial parks across the country. Aligned with national programmes such as *Make in India*, *PM GatiShakti*, *Atmanirbhar Bharat*, and the National Industrial Corridor Development Programme (NICDP), the scheme aims to create globally competitive manufacturing ecosystems supported by integrated physical, digital, social, and environmental infrastructure. The scheme promotes investment-ready industrial regions with multimodal connectivity, smart infrastructure systems, sustainable planning principles, and ease of doing business to enhance industrial growth, employment generation, logistics efficiency, and regional economic development.

BHAVYA Scheme has been conceived as a Central Sector Scheme for the development of approximately 100 world-class industrial parks with plug-and-play infrastructure capable of supporting manufacturing, logistics, warehousing, MSMEs, and associated industrial activities. The scheme operationalizes the vision of transforming India into a globally competitive manufacturing hub through integrated industrial infrastructure, logistics connectivity, urban ecosystems, and supply chain integration.

The scheme emphasizes:

- Development of investment-ready industrial parks with integrated infrastructure.
- Adoption of PM GatiShakti principles for multimodal connectivity and logistics efficiency.
- Provision of core, value-added, and social infrastructure.
- Promotion of sustainable, resilient, and smart industrial ecosystems.
- Enhancement of ease of doing business through streamlined approvals and investor-friendly frameworks; and
- Development of future-ready industrial ecosystems through integrated planning, digital infrastructure, and efficient governance mechanisms.

Under BHAVYA framework, industrial parks are envisaged as integrated economic growth centres incorporating industrial infrastructure, environmental safeguards, smart utility systems, worker-centric urban amenities, and sustainable planning principles to support long-term industrial competitiveness and regional development.

1.2 Need for the Guidebook:

To ensure consistency, technical robustness, and implementation readiness across all proposed industrial parks, this DPR Guidance Document has been prepared as a comprehensive framework for the preparation of Master Plans and Detailed Project

Reports (DPRs) under BHAVYA Scheme. It serves as a common reference for State Governments, consultants, Special Purpose Vehicles (SPVs), and implementing agencies to prepare technically sound, investment-ready, sustainable, and regulation-compliant industrial development proposals.

Specifically, the guidebook is intended to:

- Establish planning principles, development strategies, and infrastructure design criteria for integrated industrial parks and manufacturing clusters.
- Provide guidance on infrastructure demand assessment, engineering methodologies, utility planning, and spatial planning approaches.
- Define mandatory Service Level Benchmarks (SLBs), statutory clearances, environmental safeguards, and regulatory compliance requirements.
- Standardize the preparation of technical studies, engineering drawings, DPR components, financial assessments, and implementation strategies.
- Facilitate the development of resilient, climate-responsive, and resource-efficient industrial ecosystems.
- Support the creation of smart and digitally enabled industrial infrastructure incorporating ICT, SCADA, IoT, ICCC, and Digital Twin readiness.
- Enable transformation of fragmented land parcels into cohesive industrial growth centres through integrated master planning and phased implementation strategies.

1.3 How to Read the Guidebook

The guidebook is organized into thematic and sector-specific chapters covering major planning and infrastructure domains. To ensure consistency in interpretation and preparation of DPRs, each chapter follows a structured format comprising the following components:

1.3.1 Purpose

Defines the objective, planning intent, and expected outcomes of the respective infrastructure or planning sector. This section clarifies the deliverables and performance expectations to be demonstrated within the DPR.

1.3.2 Required Project Components

Identifies the mandatory infrastructure elements, planning components, engineering studies, surveys, and design requirements that must be included in the project formulation process.

1.3.3 Methods, Standards, Sources, and References

Specifies the applicable national and international standards, guidelines, manuals, codes, and reference frameworks to be adopted during planning and design. These may include IRC, CPHEEO, BIS, MoEF&CC guidelines, CEA standards, PM GatiShakti principles and relevant State regulations.

1.3.4 Planning and Design Methodology

Provides guidance on analytical methods, assessment procedures, design approaches, modelling techniques, and planning methodologies to be adopted during preparation of the Master Plan and DPR.

1.3.5 Deliverables, Formats, and Design Checks

Provides indicative templates, schedules, checklists, calculations, drawings, and design validation requirements to ensure completeness, consistency, and technical quality of DPR submissions.

1.4 Guidebook Approach:

The guidebook shall be interpreted as an integrated planning and engineering framework in which all infrastructure sectors are interconnected and collectively contribute to the development of sustainable, efficient, resilient, and investment-ready industrial ecosystems.

The preparation of industrial park Master Plans and DPRs requires a balanced integration of engineering systems with socio-economic, environmental, financial, institutional, and governance considerations. Accordingly, this guidebook incorporates both technical and non-technical aspects essential for holistic and comprehensive industrial infrastructure development.

The guidebook promotes:

- Efficient project execution and phasing.
- Financial viability and funding readiness.
- Statutory and environmental compliance.
- Infrastructure integration and utility coordination.
- Monitoring and governance mechanisms; and
- Long-term operation and maintenance planning.

The framework established through this guidebook is intended to support the development of high-quality industrial infrastructure aligned with national industrial development objectives, global manufacturing standards, and sustainable urban-industrial growth principles.

1.5 Disclaimer

This document is intended to serve as an indicative framework for preparation of the Detailed Project Report (DPR) for the proposed scheme/project. The Consultant/Agency shall suitably incorporate all project-specific, site-specific, and area-specific requirements, investigations, studies, designs, approvals, and statutory provisions as necessary for the respective project.

The DPR shall be prepared in accordance with the latest applicable codes, standards, guidelines, and statutory requirements issued by relevant authorities. In case of any discrepancy, the applicable statutory provisions and approved standards shall prevail. The responsibility for completeness, accuracy, adequacy, and technical soundness of the DPR shall solely rest with the PMNC/Agency preparing the DPR.

CHAPTER 2

MASTER PLANNING

2.1 Introduction

Master Planning forms the foundation of the DPR by converting the approved Master Plan layout into implementable, market-responsive and phase-wise development components.

This chapter establishes the planning framework for preparation of the Industrial Park Master Plan by defining the project context, development vision, regional setting, existing site conditions, and planning considerations. The chapter provides an understanding of the strategic importance of the project area, its regional connectivity, physical characteristics, land availability, infrastructure context, and development potential to support preparation of integrated and sustainable development proposals.

2.1.1 Background

Master planning ensures that industrial development is undertaken in a sustainable and organised manner, minimizing risks to natural resources, the environment, biodiversity, climate resilience and surrounding communities, while maintaining adequate provisions for infrastructure, traffic management, waste and wastewater systems, buffer zones, worker amenities and eco-efficient mobility. A well-planned industrial area promotes economic efficiency, environmental quality, social well-being, operational efficiency, reduced compliance risks, and improved public and market perception.

This section outlines the project context, institutional framework, and administrative background associated with the development of the industrial node. It establishes the strategic significance of the project within regional and national industrial and infrastructure development initiatives.

The section shall include:

- Details of the project location, planning area, and development intent.
- Identification of the nodal agencies, implementing authorities, and stakeholder institutions involved in project development and implementation.
- Reference to relevant industrial corridors, economic zones, infrastructure programs, and regional development initiatives associated with the project.
- Key administrative and planning milestones including project initiation, stakeholder consultations, surveys, and planning studies undertaken during DPR preparation.

2.1.2 Planning Process

It is also pertinent to understand and follow the required planning processes in order to develop the site master plan for industrial areas. State Town & Country Planning Acts and Urban and Regional Development Plan Formulation and Implementation Guidelines (URDPFI) should be used in order to design and develop any spatial plans in the urban/regional context. The same processes should be followed while preparing sustainable site master plans of new industrial areas or for retrofitting any existing areas.

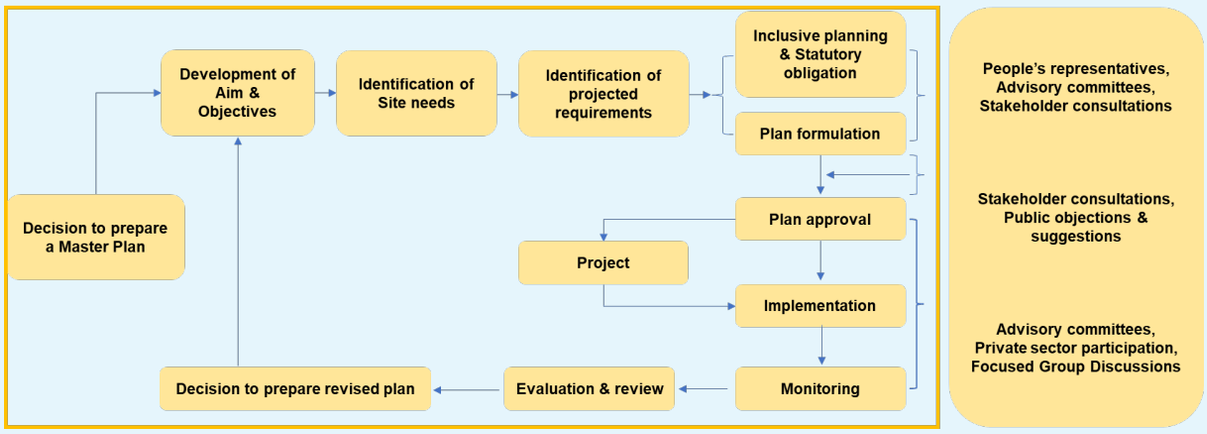


Figure 2.1: Planning Process

2.2 Methodology of Planning

The preparation of the Master Plan for Industrial Park shall be undertaken through a phased and structured approach to establish a comprehensive spatial, physical, environmental and socio-economic development framework for sustainable development. The study shall include assessment of existing conditions, growth trends, infrastructure requirements, investment potential, and development opportunities through spatial analysis, field investigations, stakeholder consultations, and data-driven planning approaches.

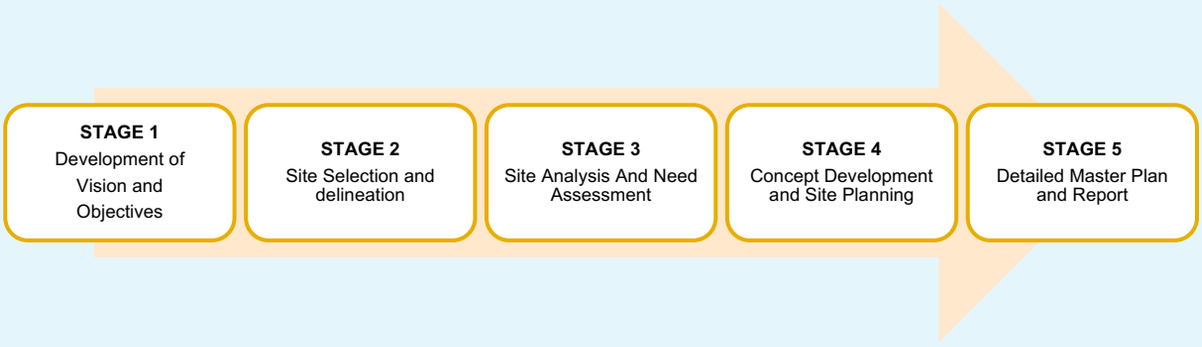


Figure 2.2: Methodology of Planning

Stage 1: Vision & Development Framework

It is essential to define the overall development vision for the industrial area at the very beginning of the project so that its requirements can be addressed in a more organized, planned, and sustainable manner. While preparing the vision and objectives for the industrial area, key questions must be answered, such as what types of industries will be accommodated, how the zones will be structured, and what expectations the different stakeholders may have.

Since the main purpose of any industrial area is to support and strengthen the economic development of the region, the planning process should also focus on achieving the following targets:

- Total investments
- Tax revenues for the government
- Total employment generation
- Employment opportunities for local residents

A master plan is a long-term blueprint outlining specific proposals for how an area should develop. The vision is the central guiding principle of the entire plan, formulated from understanding the local context, benchmarking studies, and aspirational goals. The formulation of the vision, objectives and spatial approach is a critical phase that sets the long-term direction for the Industrial Park.

Define the Planning Approach Considering that a Master plan is a macro-level, long-term plan, the following approaches must be integrated into the framework:

- Robust Framework Approach: A flexible block-concept approach that adapts to changing market trends and technologies, ensuring plots can be amalgamated or sub-divided without disrupting the core road/utility structure.
- Sustainable Framework Approach**:** An approach prioritizing the "Live-Work-Play" concept, mitigating environmental impacts through Eco-models, green buffers, and preserving natural terrain.
- Implementable Approach**:** The plan must be realistic, featuring clear phasing, actionable projects, and distinct Development Control Regulations (DCRs) to ensure "Ease of Doing Business".

Stage 2: Site selection and delineation

As per the development requirements of the proposed industrial area, suitable sites should be identified. A detailed site analysis should be carried out to examine the physical characteristics of each site, covering aspects such as topography, drainage, soil quality, meteorology, hydro-geomorphology, and other relevant parameters.

Before final selection and delineation/acquisition, the shortlisted site should undergo an Environmental Impact Assessment (EIA) in accordance with the provisions of the Environment (Protection) Act, 1986 and the rules framed thereunder. Conducting an EIA is also recommended for smaller sites, even where the provisions of the Environment (Protection) Act, 1986 and related rules may not be mandatorily applicable.

The planning boundary shall be delineated based on a comprehensive assessment of regional connectivity, economic linkages, infrastructure networks, environmental conditions, settlement patterns, and development potential. The delineation process shall establish a balanced planning framework that supports industrial growth, logistics integration, sustainable infrastructure development, and regional economic integration.

Stage 3: Site Analysis and Need Assessment

A comprehensive assessment of the project area is required to understand its physical, environmental, infrastructure, socio-economic, and planning characteristics before preparing the industrial park master plan. This stage helps determine the development potential of the site, identify constraints, define infrastructure requirements, and ensure that future planning is aligned with sustainability standards.

The assessment should begin with the **delineation of the planning boundary**, considering administrative limits, revenue records, regional industrial influence, logistics corridors, connectivity, natural features, and future expansion potential. This ensures that the planning area is logically defined and suitable for long-term industrial development.

A GIS-based base map should be prepared by integrating satellite or UAV imagery, cadastral maps, transport networks, utility infrastructure, settlements, administrative boundaries, and environmental features. This provides a reliable spatial foundation for analysing the site and preparing development proposals.

The physical and environmental features of the site should be carefully examined, including topography for hilly and non-hilly areas, slope, drainage, hydrology, natural features, soil conditions, floodplains, wetlands, water bodies, drainage corridors, geological stability, CRZ restrictions, protected areas, utility easements, and statutory buffers. This helps identify **developable and non-developable areas**, protect environmentally sensitive zones and integrate natural systems into the planning framework.

The analysis of topography and slope helps determine land suitability for infrastructure and industrial development. Gentle slopes may be suitable for development, while steep or unstable terrain may require conservation, slope protection, or restricted

development. Similarly, drainage and hydrology studies help identify natural water flow, flood-prone areas, recharge zones, and drainage constraints, which are critical for stormwater management and flood-resilient infrastructure planning.

The assessment should also document natural and ecological features such as forests, vegetation, agricultural land, water bodies, rocky outcrops, biodiversity zones, protected forests, wetlands, wildlife corridors, and conservation buffers. This ensures that environmentally sensitive planning principles are adopted and ecological impacts are minimized.

In addition, the assessment should review existing land use, industrial activities, infrastructure systems, environmental conditions, socio-economic characteristics, workforce profile, housing demand, and development trends through surveys, secondary data, stakeholder consultations, and spatial analysis. This helps understand both the current situation and future development needs of the industrial area.



Scenario building, population estimation, and area requirement assessment help determine the future development needs of the industrial park. Economic trend analysis and market demand assessment are used to identify target industries and prepare different growth scenarios, such as base case and high-growth case. These scenarios help estimate industrial land demand, land absorption, infrastructure needs, and revenue potential.

Population trend and area estimation support the planning of housing, utilities, amenities, transport, and social infrastructure based on projected workforce, demographic patterns, and trip generation. This ensures that the master plan is not limited to industrial land allocation alone but also addresses the supporting residential and infrastructure requirements.

This directly correlates with industrial park planning as it provides a demand-based foundation for deciding land use, infrastructure sizing, service provision, and phased development, thereby ensuring balanced, sustainable, and economically viable industrial growth.

Regional Context & Connectivity

This section evaluates the strategic geographic positioning of the site and its integration into wider economic and transportation networks.

- Macro Location**:** Define the site's position relative to major economic corridors and metropolitan areas.
- Trunk Infrastructure**:** Map the site's direct external linkages. Detail the specific national and state highways providing access.
- Multi-modal Logistics**:** Provide distances to critical transit hubs, such as the nearest railway stations, adjacent airports and regional seaports for freight export.
- The proposed industrial park to be assessed within its wider regional context, including surrounding economic corridors, industrial clusters, logistics networks, urban settlements, labour markets, raw material sources, and utility systems. The assessment shall identify existing and proposed connectivity to highways, expressways, railway lines, ports, airports, inland container depots, multimodal logistics parks, freight corridors, power grid infrastructure, water sources, gas pipelines and digital networks.
- The PM Gati Shakti National Master Plan Portal should be used to examine existing and proposed multimodal infrastructure, such as Rail siding, Sea port, ICD, MMLP, etc., and identify missing links, assess planned projects, and support coordinated infrastructure augmentation. Findings from the portal to be cross-verified with field surveys, satellite imagery, state agency data, utility providers and stakeholder consultations.
- External infrastructure interventions should be identified to make the industrial park operational and investment ready. Each intervention to be mapped with

concerned implementing agency, estimated cost, timeline, approval requirement & project dependency.

Stage 4: Concept Development and Site Planning

The formulation of schematic or conceptual proposals serves as a blueprint for transforming fragmented land parcels into cohesive urban areas. It translates the findings from the existing situation analysis and the vision into tangible master plan options.

Planning and design considerations are to be elaborated. This covers the following aspects:

i) Zoning concepts with division of different industrial uses and facilities,
ii) Area programme with proposed land use distributions, provisions for infrastructure etc.
iii) Measures for compliance with development controls/ bye-laws
iv) Thematic maps/layers of – land use plan, zoning plan, traffic and transportation plan, areas and open spaces, infrastructure- social, technical, environmental
v) Usually, several different design concepts as 2D concepts or better as 3D visualizations of- road cross- sections, road avenues, integration of rain water harvesting in landscaped areas, entrance zones, landmarks, signage, public spaces, bus stops, shelters/health posts and social infrastructure, etc. are required to figure out the optimum layout of the industrial area.

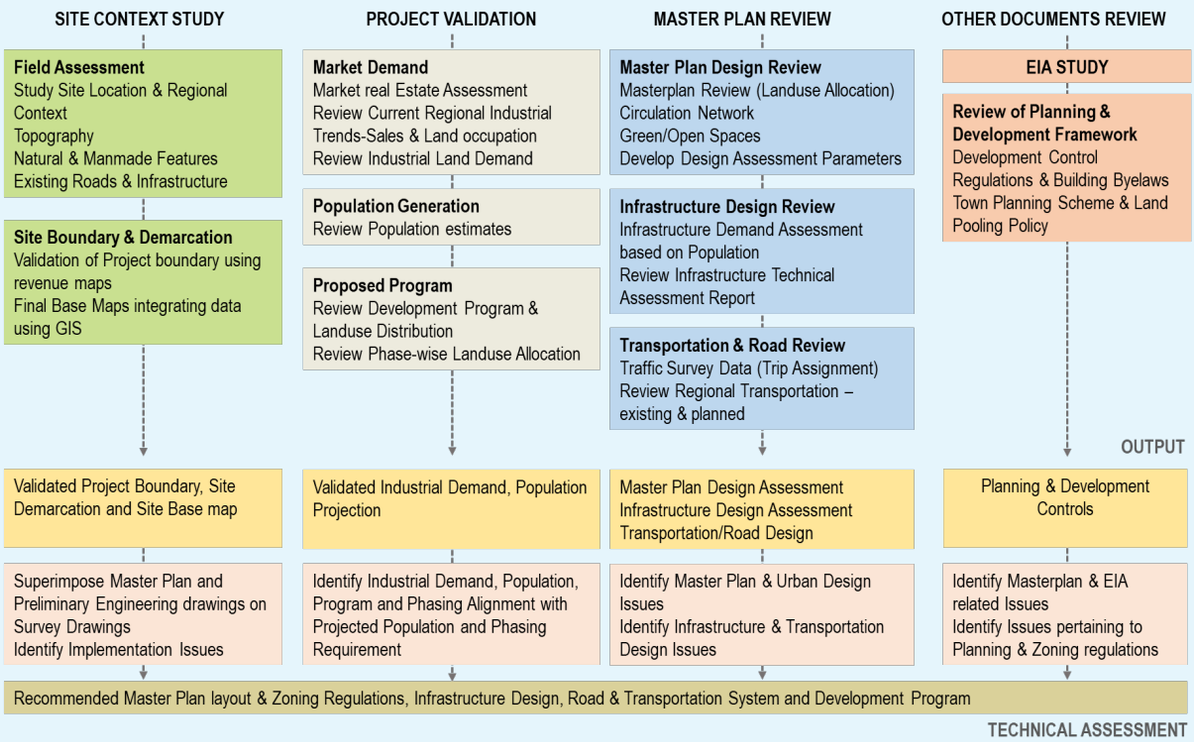
The Site Master Plan is prepared as a comprehensive document that can guide the development of the Industrial Park. The key contents of the report are:

- Overview – location, total area of the site, expected number of industries, expected number of service-related industries supporting the main industry, project cost, expected employment generation, targeted investments etc.
- Land use break-up of the site, assignment of specific functions to individual areas.
- Designation of areas/sites for industries according to types and relative environmental impact etc. Elaboration of permissible industries and restricted industries.
- Basic infrastructure (road network, electricity, water supply, gas, eco–friendly transportation, security, fencing, fire and disaster management etc.).
- Technical infrastructure (green factory buildings, renewable energy/energy efficiency provisions, business centre, warehouses, training centre, design centre, incubators etc.).
- Environmental infrastructure (storm water drainage (separate from wastewater network), sewerage/wastewater conveyance, wastewater treatment and

disposal facilities, solid waste management facilities, green/open spaces/ landscapes, environmental monitoring, etc.).

- Social infrastructure (food and beverages facilities, training/entrepreneurship development facilities, recreational facilities, gender specific infrastructure – provisions for women employees, barrier free infrastructure to enable people with disabilities, guest house, public toilets, health centre etc.
- Management structures for developing the industrial area and operating the infrastructure and services.
- Design concepts and visualisations (2D/3D drawings) of the features suggested in the Site Master Plan.
- Statement on compliance with applicable standards, legal requirements, criteria, guidelines, procedures etc. (including environmental considerations/criteria, "green" criteria, environmental clearances etc.).
- Use of GIS-based spatial analysis, remote sensing, thematic mapping, and participatory approaches to support evidence-based planning and proposal preparation.

Based on the comparative assessment alternative options are developed considering Specialized Clustering, Mixed-Use Zoning or the Mixed-Industry Clustering).



Stage 5: Detailed Master Plan and Report

Detailed Master Plans are developed for Industrial Parks to designate different land uses and plan the required infrastructure. These plans serve as the foundation for the

overall development of the industrial park. Therefore, it is essential to incorporate Sustainability Standards at the planning stage.

Step 1: include undertaking detailed assessment of the site allocated for the industrial park. The important thematic layers to be prepared to assess the existing situation and undertake gap analysis are given below.

i) Base map including natural and man-made features on site and in its immediate surroundings, in an appropriate scale.
ii) Land use plan showing all the uses of the land within site as per the standards area distribution.
iii) Zoning plan showing demarcation of zones for different industrial uses wherein units producing similar products and needing similar infrastructure are co-located in a zone and optimal block/zone size and sub-zone sizes and orientation at the site as per the site development objectives, topography and climate.
iv) Transportation plan including road network showing hierarchies of road-widths as per the estimated passenger car units (PCU) counts, turning radii of suitable width for the commercial vehicles, typical geometric design for each road cross sections or roundabouts, standard road cross sections for all hierarchies including utility corridors (foot paths, bicycle tracks, sewage, storm water drainage, broad band lines, waste-bins, toilets, street lights etc.) where required, provision of bus stops for internal mobility of the employees and visitors from public spaces to identified zonal drop points, parking plan for commercial and domestic (motorised and non-motorised) vehicles, railways and terminal facilities, if required, pedestrian and bicycling routes and infrastructure.
v) Stormwater management plan including stormwater drains as per natural drainage flow, rain water harvesting systems, ground water recharge systems etc.
vi) Wastewater management plan including provisions for conveyance lines for industrial waste water effluent to CETP, contour-based location of CETP, decentralised waste water treatment systems.
vii) Environmental infrastructure plan including provisions for waste collection, common disposal points, disposal points for hazardous waste etc., sites for composting facilities as per estimated biodegradable waste, distribution of areas, buffer zones along the site boundary, surrounding highly polluting industries and also surface water bodies, landscape design of the areas, road avenues and rain water harvesting ponds with biodiversity preservation, selection of indigenous species of flora and fauna, provisions for urban heat island mitigation and fresh air corridors, usage of green spaces for functional use with economic value, example restaurants, kiosks, horticulture, commercial plantation.
viii) Physical infrastructure plan including provisions for power infrastructure, energy efficiency and usage of non-renewable sources of energy at industry and industrial park level.

ix) Social infrastructure plan showing provisions for medical facilities, training facilities, specific provisions for promoting women in industrial park, child-care centres, public toilets, fire and disaster management services, canteens, driver and worker accommodation etc.
x) Business and other specific infrastructure plan like warehouses, decentralised waste water treatment plant, steam distribution, piping racks for solvent, pipelines for treated water for reuse, high TDS & low TDS pipelines for industrial wastewater, fire hydrant lines, incubators, training centres, meeting rooms, conference halls, guest houses, weigh bridges, automobile service stations, product testing facility etc.
xi) Mapping should preferably be done in GIS (Geographic Information System) with spatial and attribute data. This will make analysis and future updating of the maps and master plan easy.

Step 2: Detail out design concepts that can be used during implementation of the site master plan. 2D/3D visualisations to be provided. This includes for example:

i) Landscaping concept
ii) Building concept
iii) Streetscape
iv) Energy and renewable energy systems
v) Infrastructure & services
vi) Passive design - Passive design maximises the use of 'natural' sources of heating, cooling and ventilation to create comfortable conditions inside buildings. It harnesses environmental conditions such as solar radiation, cool night air and air pressure differences to drive the internal environment.
vii) Urban design – this can make a decisive contribution to the quality and significance of buildings and industrial districts alike. Recommendations may be expressed by the Industrial Park Management paired with a fixed percentage of the construction costs to be spent for art. Local artists or design colleges in close proximity can help to maintain a high level of creativity while keeping costs low.
viii) Design quality - design of open space / amenity, design of architecture, art on location, design of all measures that are to be implemented etc.
ix) Unique skyline - skylines serve as unique fingerprints. A district's unique skyline, comprising buildings with different heights, designs, uses, as well as parks or mountains etc., may be of great benefit to the district by attracting tourism and thereby increasing land value and creating job opportunities.

Step 3: Detail out financial viability aspects and infrastructure and services delivery mechanisms for various provisions made in the site master plan.

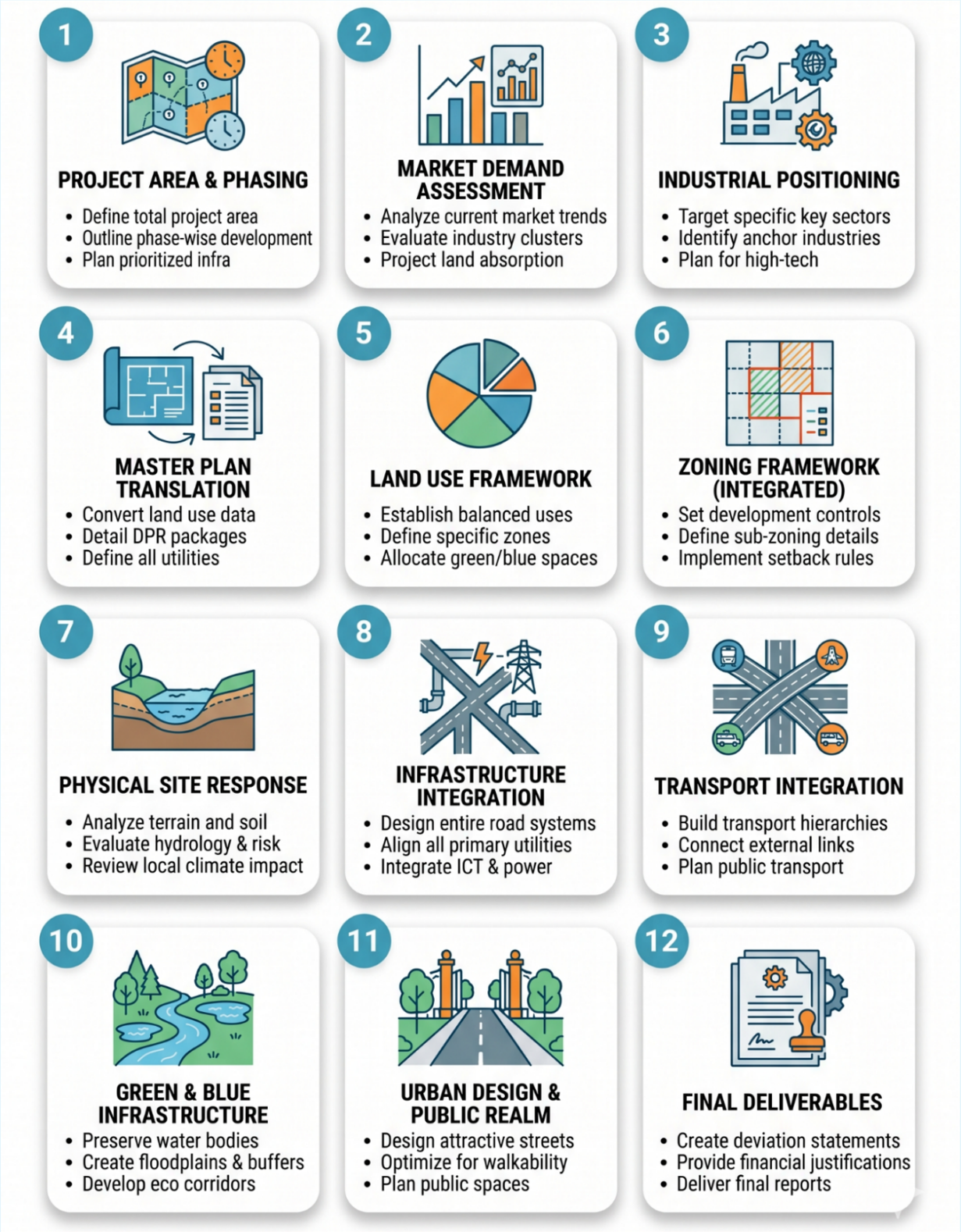


Figure 2.3: Planning Stages for the Master Planning

Step 4: Final Master Plan & Implementation Framework. The section presents:

i) The finalized spatial and regulatory framework for the industrial park after incorporation of stakeholder consultations, statutory observations, environmental appraisal recommendations, and detailed engineering assessments.
ii) The Final Master Plan establishes the approved land use structure by the authority, mobility framework, infrastructure systems, utility corridors, environmental buffers and development controls for implementation.
iii) It forms the statutory basis for phased development, infrastructure execution, land allotment, investment promotion, and future development approvals.

Step 5: Submission of the Final Master Plan based on:

i) Stakeholder consultations, public representations, environmental appraisal recommendations, and technical review observations. The planning process should integrate concerns related to environmental protection, mobility efficiency, social impact, infrastructure feasibility, and regulatory compliance.
ii) The final planning structure should also incorporate modifications arising from detailed topographical studies, engineering assessments, environmental scoping, and statutory requirements to ensure technical viability and implementation readiness.

2.3 Market Demand and Industrial Positioning

One needs to carry out market demand assessment to ensure that the industrial park is aligned with actual investor demand, regional competitiveness, and feasible industrial sectors. The assessment shall examine regional industrial trends, existing industrial clusters, land absorption patterns, investor enquiries, competing industrial parks, sectoral growth prospects, logistics advantages, labour availability, raw material linkages, supply-chain ecosystems and applicable policy incentives.

Based on this assessment, the target sectors and positioning strategy for the industrial park to be defined. Sector selection shall be guided by market demand, site suitability, infrastructure requirements, environmental compatibility, utility intensity, logistics needs, workforce availability and investor potential.

A demand-led industrial development framework shall be adopted, where each industrial zone is supported by clear sector rationale, infrastructure requirement, plot-size logic, market absorption potential, and implementation priority.

2.3.1. Methodology

The demand for industrial land within the proposed Industrial Park to be carried out through a blend of statistical projection of historic industrial investments and on-ground validation of demand. The demand framework has been depicted in Figure below:

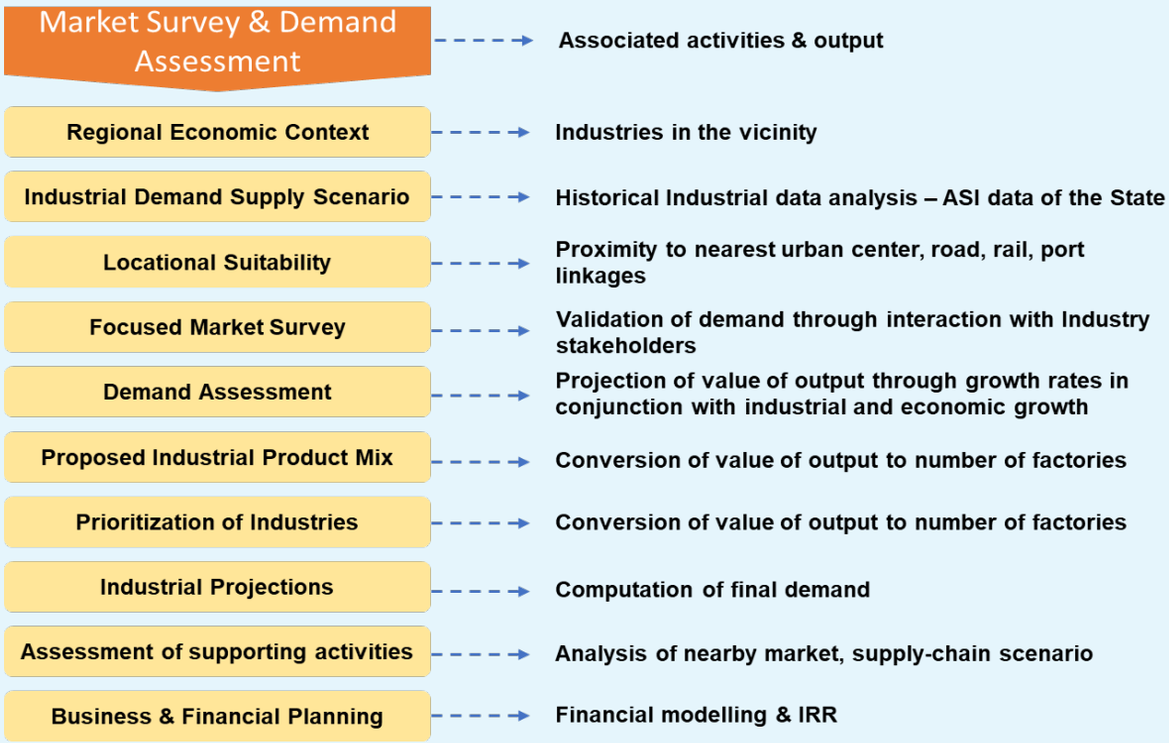


Figure 2.4: Demand Analysis Methodology

Task 1: Review of regional economic scenario and

Review of industrial ecosystem in the region to understand the regional context and its importance in term of spatial, functional and economic linkages for future development and implementation of Industrial Park;

Task 2: Market and Demand Assessment

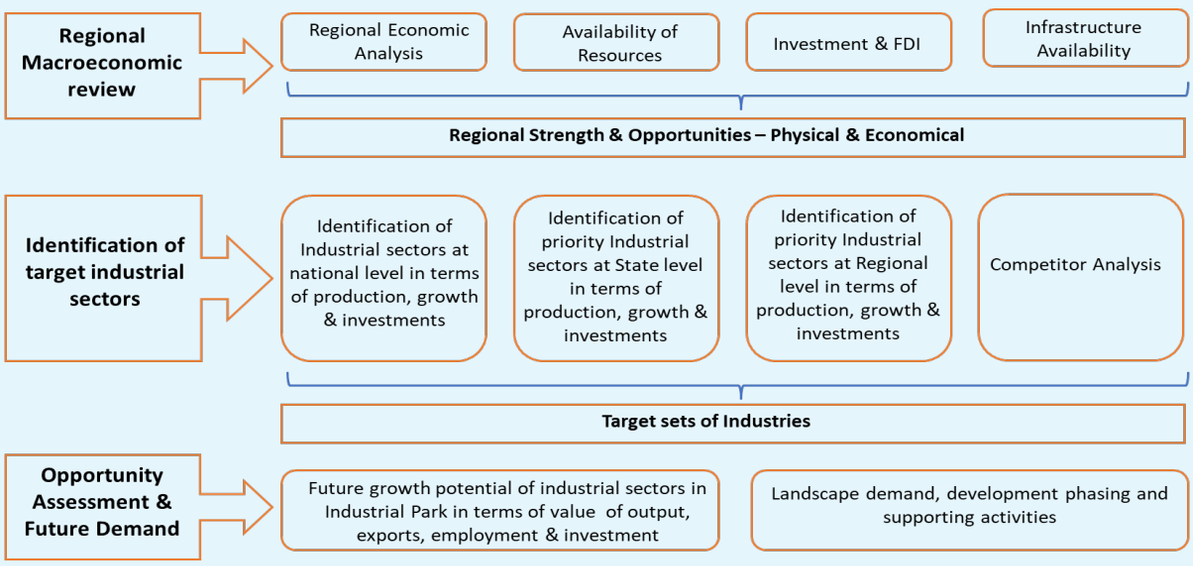
- Review the Macro-economic and manufacturing landscape of the region which provides snapshot of State's GDP and the development of the manufacturing sector. This helps to understand the information related to economic sectors, demand supply scenario of the proposed industrial product mix and its market perspective;
- Evaluate the locational suitability and inherent attractiveness of the proposed industries at the proposed site;
- Validate the findings of the demand assessment and the proposed product mix in terms of industries and supporting activities;

- Carry out a focused market survey and demand assessment specific to the proposed IA.
- Prioritization of industries for the proposed development;
- Derive the preferred development format based on prioritization, industry attractiveness and regulatory framework.
- Evaluate the industrial positioning to fit in the overall national framework of industrial development and supply-chain framework.

Task 3: Benchmarking Studies

Identification of suitable and comparable case studies with regard to Industrial Parks with a view:

- To understand parallel and current practices on Industrial Parks of similar scale in India and Internationally,
- To understand product mix, master planning, land procurement, implementation mechanism, designing and engineering of similar manufacturing clusters, and
- To understand relevance of green development and Sustainable Industrial Park in context of proposed project.



2.3.2. Framework for Market Assessment and Critical Gap Assessment

The suitable and optimal industry/product mix for the proposed Industrial Park to be derived keeping in perspective the State, District and local industrial strengths as well as Indian industrial sectorial growth and vision. Growth sectors under Make in India and State Industrial Policy are also explored to understand the suitability of some of the sunshine sectors that may possibly come up in region.

a) Market Demand Assessment

Deriving an optimal industrial product mix for Industrial Park is done by identification of prominent industry groups at National and State level, which may be carried out by prioritizing the industries based on the parameters as shown in the figure below.

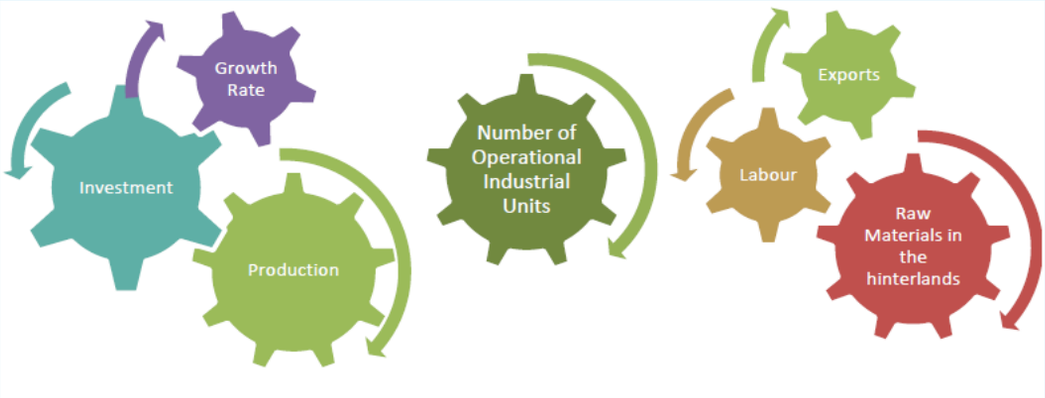


Figure 2.5 Parameters for Industrial prioritization

b) Identification of Priority Industrial Sectors

The figure below depicts the methodology and the various parameters to be considered for identification of Priority Industrial Sectors at National, State and Regional level.

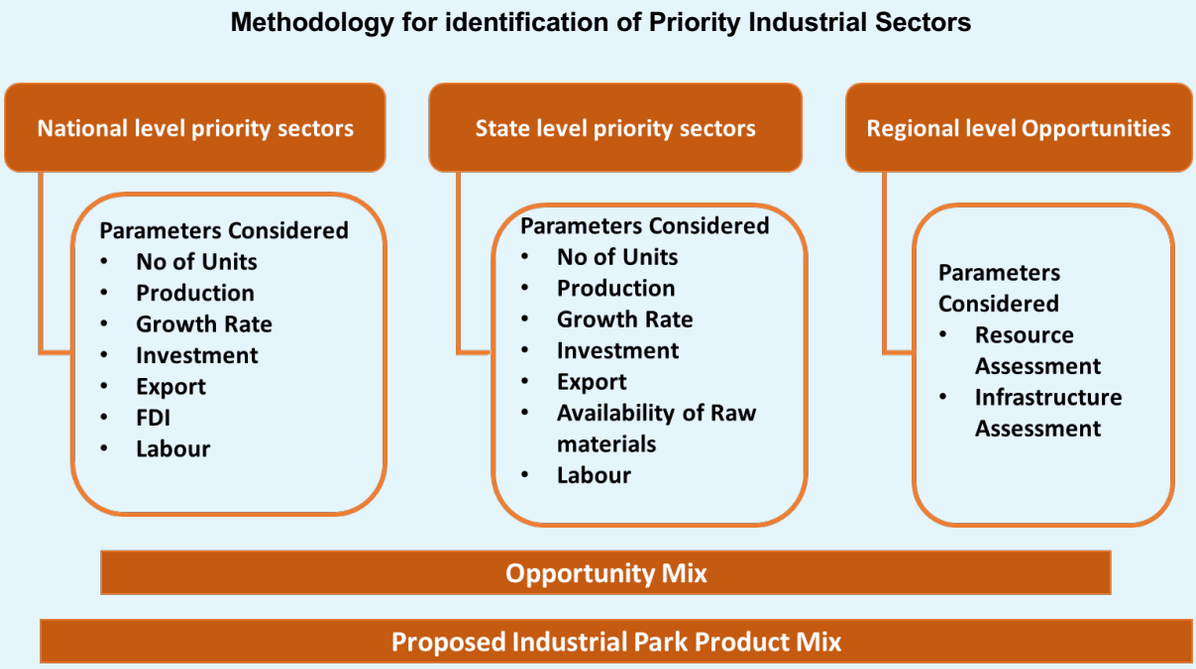


Figure 2.6 Methodology for identification of Priority Industrial Sectors

2.4 Technical Aspects of the Master Plan

2.4.1 Final Land Use & Zoning Plan

The Final Land Use Plan establishes the approved zoning structure and exact spatial demarcation of all development components within the project area. The framework defines finalized allocation of industrial, residential, commercial, institutional, utility, transportation, and recreational land uses based on planning standards and development objectives.

The zoning structure should ensure compatibility between land uses, operational efficiency, environmental compliance, and long-term development flexibility while preserving natural features, ecological corridors, drainage systems, and mandatory buffer zones.

Table 2.1: Indicative Land Use Distribution

Land Use Category	Developable Area (%)	Primary Function
Industrial	40% – 60%	Manufacturing, and industrial activities
Residential	2% – 3%	Workforce housing and residential development
Commercial	3% – 4%	Retail, offices and business support services
Public / Semi-Public	2% – 3%	Institutional, healthcare and educational facilities
Transport & Communication	10% – 12%	Road network and logistics infrastructure
Recreational / Open Space	8% – 10%	Parks, buffers and ecological greens
Utilities & Services	2% – 3%	WTP, STP, CETP and utility systems
Logistics	3% - 5%	Warehouse, Cold storage, Loading and Unloading space.
Water Bodies & Special Areas	As Applicable	Natural drainage and environmentally sensitive areas

Source: Master Plans of IMC at Orvakal, Palakkad, Hisar

Key Components

- Finalized land use zoning
- Industrial classification and segregation
- Residential and mixed-use allocation
- Open space and buffer integration
- Utility and infrastructure reservations
- Transportation and logistics corridors

2.4.2 Provisions of Infrastructure Planning

Some of the aspects are given below as examples that should be included as part of the spatial planning exercise:

1) **Mobility - eco efficient transportation**

a) External road linkages to nearby settlements or housing areas where from the workers/ employees will travel to the Industrial Park and to the railway station, bus station, etc.

b) For internal mobility, provisions for bicycle tracks, adequate parking facilities, extensive pedestrian network consisting of sidewalks along roads and pathways in the green belts (greenways) have to be incorporated.

c) Maintaining a hierarchy of vehicular road networks within the site would help in easy traffic movement. A suggestive road hierarchy is mentioned in table below:

Table 2.2: Road Hierarchy Planning

Arterial Roads ROW of 45–60 m	• Primary roads are designed to ensure high mobility within the industrial park, carrying the highest traffic volumes and longest trips at speeds of 50–60 km/h, with no frontage access, no vehicle standing, minimal cross-traffic, and intersection spacing of at least 500 m.
Sub Arterial Roads ROW of 30- 36 m	• Sub-arterial roads support intra-urban through traffic with restricted carriageway access and may function as arterial roads due to their overlapping role. • They carry similar traffic volumes, allow frontage access but no vehicle standing, handle high cross-traffic, and are designed for speeds up to 50 km/h with high-capacity intersections spaced at least 300 m apart.
Distributor/ Collector Roads ROW of 20- 24 m	• Collector roads distribute traffic from access streets to arterial and sub-arterial roads, supporting speeds of around 30 km/h with free frontage access, no vehicle parking, heavy cross-traffic, and minimum intersection spacing of 150 m.
Access Streets ROW of 12- 18 m	• Access roads provide direct access to adjoining properties and areas, carrying lower traffic volumes at low speeds.
Local Street ROW of 9 - 10 m	• Access streets provide free access to residences, businesses or other adjoining properties, with provisions for parking and pedestrian movement.

2) Stormwater Management

a) Storm water drains all across the industrial park in accordance with terrain and drainage.
b) Decentralized storm water management system for cost effectiveness.
c) Collection and treatment of run-off of first rains at the rate of 1-hour peak rainfall and 80% run-off coefficient to avoid any contamination risks.
d) Ponding and integration into green landscapes.
e) Recycle/reuse provisions for industrial, horticulture/irrigation uses.

3) Wastewater Management

a) Provision for wastewater conveyance system in accordance with slopes and zoning of industries.
b) Provision of common effluent treatment plant (CETP), sewage treatment plant.
c) Provision for storage of treated wastewater (guard pond) and provisions for recycle/reuse.

4) Solid Waste Management

a) Provisions for collection, transportation, storage and disposal of wastes.
b) Recycling centre for e-waste, vermi-compost plant, handmade paper plant etc.

5) Green/Open Spaces/ Landscapes

a) Central green – lungs for the Industrial area
b) Green belts at the periphery- to act as buffer
c) Vertical and horizontal stretches of greens spreading in the form of avenue plantation and greenways
d) Greens at the plot level

6) Resource Efficiency

a) Provisions for rainwater harvesting recycle/reuse of water.
b) Provisions for recycle/reuse of treated wastewater.
c) Provisions of renewable energy & use of environment friendly materials.

2.4.3 Scale of a Site Master Plan

The Site Plan, Master Plan and thematic layers of Plans to be in appropriate scales:

- A Site Plan should be drawn at a scale of not less than 1:1000 or as per the State Regulations showing all physical details of the land, boundaries of the land, the surrounding existing layouts/lands, and existing approach road to the land where the layout is proposed.

- Detailed Master Plan (or sometimes called as Layout Plan) should be drawn to a scale of not less than 1:500 or as per the State Regulations showing

boundaries of land, proposed number of building plots with dimensions and area of each plot and its uses, alignment and width of the proposed streets/roads, dimensions and areas of open space/green areas provided, infrastructure provided etc. and all the other uses of land.

- If the plan approving authority prescribes a scale more detailed than the above, then the same should be adopted. The plans should be in digital form so that optical reductions (and not enlargement) of map size can be made as required.

2.4.4 Block-Level Planning & Plot Configuration

The Final Master Plan translates broad zoning into detailed block-level planning and plot configurations. The planning framework should organize the project area into functional development blocks that support operational efficiency, infrastructure accessibility, and phased implementation.

The industrial zones should be earmarked based on homogeneity of function of the industrial activity and their inter-relationship to get the best use of land.

Each zone should be divided into blocks of appropriate size, which can be subdivided into plots. Depending on demand for size of the plot, smaller plots could be clubbed together. Also, in the future, without changing infrastructure, the plots could be combined or sub-divided as per demands persisting then.

The plotting structure should provide flexibility for future amalgamation or subdivision of plots without affecting the primary road hierarchy, utility systems, or drainage networks. The framework should accommodate multiple industrial typologies ranging from anchor industries and logistics hubs to MSMEs and ancillary units.

Table 2.3: Indicative Plot Configuration Standards

Plot Category	Indicative Plot Size	Primary Function
Mega / Anchor Plots	25 - 50 Acres	Large-scale manufacturing and anchor industries
Medium Industrial Plots	5 – 25 Acres	Processing, assembly and logistics facilities
Small Industrial Plots	1 – 5 Acres	Light industries and vendor units
MSME / Micro Plots	Up to 1 Acre	Ancillary industries and flatted factories
Common Amenity Plots	As Required	Administrative and workforce support facilities

Source: Industrial Policies of Tamil Nadu, Gujarat, Maharashtra, Odisha and Assam

**The size range of given plot category should be adopted based on the State's policy.*

Key Components

- Block-level development structure
- Flexible and modular plotting framework
- Sector-specific industrial allocation
- Shared logistics and common amenities
- Utility accessibility and service integration
- Provision for future expansion and reconfiguration

2.4.5 Housing for Industrial Workers

Social infrastructure is not optional for industrial worker housing, it is an essential complement that determines whether workers stay long-term or migrate seasonally.

Housing is essential for the industrial workers in the proposed industrial parks and should be planned such that a minimum requirement is met within the industrial park though there may be Urban Agglomeration and Local Bodies in close vicinity of the proposed industrial park. The DPR shall plan and estimate the housing requirements, locate and segregate housing area for different types of housing based on the requirements of project/ worker groups. The industrial worker housing is recommended to be developed at a high density, with minimum 100 dwelling units per hectare for non-hilly states category and minimum 25 dwelling units per hectare for hilly states category using Fast Track Construction technology. The sizes for the same can be referred from the Secure, Affordable, Flexible and Efficient (S.A.F.E.) housing document.

Site planning shall strictly adhere to 'walk-to-work' and 'plug-and-play' principles to facilitate a safe ecosystem where workers can commute within a reasonable distance independently of private transport. The planned built form of the housing should be such that it reflects the local characteristics and aspirations of the people.

Depending upon the industrial park’s overall area, social infrastructure facilities such as primary health care centres (PHC), community health care centres (CHC), day-care etc. may be planned. The elements of Secure, Affordable, Flexible and Efficient (S.A.F.E.) housing can be referred from the following link :-

https://www.niti.gov.in/sites/default/files/2024-12/SAFE_Accommodation_Worker_Housing_for_Manufacturing_Growth.pdf

2.5 Built to Suit (BTS) & Ready-Built Sheds (RBS)

Build-to-Suit (BTS) is a commercial real estate development model in which a property is custom-designed and constructed specifically for a single, pre-identified tenant. Unlike traditional leasing — where a business searches for available space and adapts its operations to what exists — the BTS model starts with the tenant's operational requirements and builds the facility around them.

In a BTS arrangement, a developer or investor funds and manages construction of a new facility to meet the exact specifications of a prospective or existing tenant. Upon completion, the tenant enters into a long-term lease — typically spanning 10 to 20 years — and occupies the purpose-built space without having committed upfront capital to property ownership.

The model has been used for decades as companies of all sizes seek to expand into new locations or upgrade facilities, while preserving the capital they would otherwise tie up in real estate. Today, BTS is recognized as a cornerstone of the modern industrial, logistics, retail, and healthcare real estate markets.

Table 2.4: BTS Area Industry-wise bifurcation

Industry	Built Up Area of Modules
Electrical & Electronics	500 to 2,000 m^2
Automotive Components	
Agricultural & Food Related Machinery & Equipment	
Textile/Apparel	
Construction Material	

Table 2.5: Pre-built BTS Factory Specifications

Pre-Built BTS Factory Specifications	
Product Characteristics	• Standard design pre built unit equipped with office and storage space • Typical Height ranging from 5 – 7 meters • High preference exhibited primarily by the medium scale manufacturing units

	• For higher area vertical development-Modular floor plates with provision for partitioning to accommodate 2-3 units per floor
Permitted Usage	Very Light Manufacturing, Trading & Distribution, Assembling, Packaging, Storing
Features	Dedicated entry & exit points, ramp for vehicles, loading docks for containers & trucks
Utilities	Electricity, Water and Gas connections

2.6 Development Control Regulations & Urban Design Framework

This chapter establishes the statutory planning controls, development regulations, and urban design guidelines governing the industrial park. It defines the framework for land use management, building permissions, environmental safeguards, mobility integration, and public realm quality to ensure orderly, safe, and sustainable urban development. The regulations are derived from applicable State Building Rules, URDPFI Guidelines, environmental norms and infrastructure standards.

The landscape strategy shall be developed in response to the site's existing landscape features and shall harmonize them with the requirements of a smart industrial development. It shall improve the natural character of the site, enhance ecological value, provide safe and inclusive green movement corridors for worker well-being and create a distinct identity through site-specific landscape features.

2.6.1 Planning Norms & Regulatory Framework

This section establishes the statutory and regulatory basis governing the development of the industrial park. The Development Control Regulations (DCRs) shall align with applicable State Building Rules, Industrial Area Development Regulations, URDPFI Guidelines, IRC, and environmental regulations issued by MoEFCC and State Pollution Control Boards.

The framework ensures that all proposed developments comply with land use compatibility, fire and life safety standards, environmental safeguards, infrastructure capacities, and accessibility norms. Special provisions may also apply for hazardous industries, logistics facilities, warehousing, utilities, and high-impact industrial operations.

Key Components

- State Building Rules/Industrial Area Development Board building rules and GDCR provisions
- URDPFI planning norms
- IRC road and mobility standards
- MoEFCC and SPCB environmental regulations
- PESO and industrial safety guidelines

2.6.2 Land Use Regulations & Buffer Controls

Land use regulations define the permissible and restricted activities within each planning zone to ensure compatible development patterns and environmental safety. Industrial zones shall be classified based on pollution categories such as Red, Orange, Green, White industries, with appropriate separation from residential /public-use area.

The regulations shall also establish mandatory buffer zones around environmentally sensitive areas, utility corridors, drainage channels, water bodies, forests, and hazardous installations. These safeguards help reduce environmental risks, maintain ecological continuity, and ensure long-term operational safety of the park.

Key Components

- Permissible and non-permissible land uses
- Industrial zoning by pollution category
- Mixed-use and transition zone regulations
- Green belt and buffer requirements
- Utility corridor protection zones
- No Development Zones (NDZ)

Table 2.6: Indicative Buffer & Environmental Control Norms

Feature / Utility Corridor	Minimum Buffer Requirement	Planning Purpose
Major Water Bodies / Lakes	30 m from FTL (Full Tank Level	Flood protection & ecology
Natural Drains / Streams	5 m – 15 m	Drainage preservation
Forest / Eco-sensitive Areas	1 Km – 10 Km	Ecological protection
Industrial–Residential Interface	15 m – 50 m Green Buffer	Pollution mitigation
HT Power Corridors	15 m - 50 m	Safety clearance
Gas / Petroleum Pipelines	15 m – 30 m	Risk mitigation

Source: National Green tribunal, MoEFCC, CEA safety regulation, Building Byelaws of Maharashtra, Tamil Nadu, Gujarat, Odisha and Assam

**The Buffers of given Features should be adopted based on the National & State guidelines.*

2.6.3 Urban Design Guidelines

Urban design guidelines establish the visual, spatial, and functional character of the industrial park. The objective is to create a well-structured, inclusive, and aesthetically cohesive environment that supports productivity, safety, and quality of life.

The guidelines address streetscape design, signage systems, lighting standards, landscape integration, public realm design, and universal accessibility. Emphasis is placed on walkability, climate responsiveness, shaded pedestrian environments, and consistent urban character across the park.

Key Components

- Streetscape and public realm design
- Universal accessibility standards
- Pedestrian-friendly infrastructure
- Landscape and green edge treatments
- Street furniture and smart poles
- Wayfinding and signage systems
- Energy-efficient lighting standards

Table 2.7: Indicative Signage & Streetscape Standards

Signage Type	Location	Maximum Height	Minimum Clearance	Statutory code
Gantry / Directional Signage	Arterial Roads	As per structural truss engineering *(typically 7.5m to 8.5m total structure height)*.	5.5 m	IRC:67
Regulatory Signage	Footpath / MUZ	2.5 m	2.1 m	IRC: 67
Advertisement Signage	Designated Zones	3.0 m	2.5 m	IRC: 46 and State Municipal Corporation Byelaws
Informational Signage	Public Areas	2.5 m	2.0 m	IRC: 67 and IRC: 99

Source: IRC:67-2022 Code of Practice for Road Signs

2.6.4 Compliance & Approval Mechanism

All developments within the industrial park shall require approval from the competent planning and industrial development authority. Building proposals shall be reviewed for compliance with land use regulations, environmental conditions, infrastructure capacities, fire safety norms, and development controls prior to issuance of approvals.

Periodic monitoring and enforcement mechanisms shall be established to ensure continued compliance during construction and operational stages. Special approvals may be required for hazardous industries, high-rise structures, bulk utilities, and environmentally sensitive developments.

Key Components

- Development permission process
- Building plan scrutiny mechanism
- Environmental compliance review
- Fire and safety clearances
- Utility and infrastructure approvals
- Construction monitoring and enforcement

2.7 Implementation Strategy & Execution Framework

The implementation and phasing of a master plan involve a strategic approach to execute its objectives and projects over a designated timeline. For an industrial park, this process includes integrating governance mechanisms such as Special Purpose Vehicles (SPVs) or Industrial Area Development Authorities (IADA) with the overall master plan and ensuring compliance with state and national legal frameworks.

2.7.1 Implementation Mechanisms & Phasing

Implementation of various proposals and identified projects requires a thorough assessment and step-by-step approach. Phasing breaks down the park's implementation into manageable segments, prioritizing infrastructure projects based on urgency, market demand, and investment attractions. The development is typically organized into short-term, medium-term, and long-term phases to align with the financial capacity and land absorption rates.

Table 2.8: Implementation Mechanisms for Industrial Parks

Implementation Mechanism	Industrial Planning Application
Micro-level / Block Plans	Delineating development schemes for specific industrial blocks, allowing for flexible plot amalgamation or subdivision based on tenant requirements.

Development Regulations	Utilizing customized Building Byelaws and Zoning Regulations (e.g., separating Red/Orange industries from green zones) to regulate safe development.
Governance & Policy	Establishing an Industrial Area Development Authority (IADA) or SPV and integrating approvals via online single-window clearance systems. Indicative compliance/clearances generally required for Industrial Parks is placed at **Annexure-1**.
Development Projects	Executing anchor infrastructure projects first, such as trunk roads, Common Effluent Treatment Plants (CETPs), and multi-modal logistics hubs.

Table 2.9: Base Factors for Development Phasing

Base Factor	Strategic Focus for Industrial Phasing
Economic Potential & Investment	Prioritize areas with high economic potential, immediate availability of developable land, and maximum investment attraction (e.g., plots closest to National Highways).
Infrastructure Deficiencies	Focus initial phases on establishing critical utilities (water, power, sewerage) that are essential for the operation of early anchor tenants.
Workforce & Social Factors	Phase in worker housing, healthcare, and skill development centres in tandem with industrial cluster operationalization to support the "walk-to-work" concept.

2.7.2 Monitoring Mechanism

It is recommended to establish a dedicated Monitoring and Evaluation Cell within the SPV or Development Authority to facilitate the continuous assessment of progress related to the master plan's implementation. The authority must identify the sequence for executing various projects and communicate this to the monitoring cell.

Furthermore, a Geographic Information System (GIS)-based platform, integrated with an Integrated Command and Control Centre (ICCC) and monitoring dashboards, should be developed to oversee activities.

Table 2.10: GIS-Based Monitoring Criteria

Evaluation Criteria	Monitoring Objective
Land Conversions & Allotment	Tracking Non-Agriculture (NA) conversions and the real-time status of industrial plot allotments.
Development Permissions	Monitoring the issuance of Consent to Establish (CTE), Consent to Operate (CTO), and building plan approvals to ensure "Ease of Doing Business".
Infrastructure Development	Tracking the physical progress of roads, underground utilities, green buffers, and critical facilities like substations.
Stages of Development Schemes	Overseeing the step-by-step progress of block-level town planning or land pooling schemes.

To support these monitoring activities, the authority should compile an annual report detailing the progress of the industrial park. Should any development activities deviate from the proposals outlined in the master plan, appropriate corrective measures and grievance redress mechanisms must be implemented.

CHAPTER 3

ROADS & TRANSPORTATION SYSTEM

3.1. About this Chapter:

This chapter outlines the requirements and technical expectations for preparation of the Roads & Transportation component of the Detailed Project Report (DPR) to be submitted by the State/SPV/Implementing Agency under BHAVYA Scheme.

The chapter serves as the reference framework for planning, design, engineering, implementation, operation, maintenance, and future expansion of integrated transportation infrastructure for Industrial Cities and Manufacturing Clusters.

The DPR shall establish a safe, efficient, sustainable, resilient, multimodal, and future-ready transportation system capable of supporting industrial logistics movement, passenger mobility, public transport integration, emergency access, and long-term economic growth.

The proposed Roads & Transportation framework may include:

- External connectivity infrastructure
- Internal hierarchical road network
- Junctions and interchanges
- Freight and logistics infrastructure
- Footpaths and cycle tracks
- Public transport infrastructure
- Utility corridors
- Smart traffic systems
- Road safety infrastructure
- Storm water drainage systems
- Street-lighting systems
- ITS and SCADA systems

The DPR shall establish the overall transportation philosophy, traffic-demand assessment, road hierarchy, mobility strategy, safety framework, sustainability measures, operational philosophy, and lifecycle maintenance strategy.

3.2 Concept Note:

BHAVYA Scheme envisages development of world-class industrial infrastructure with efficient logistics connectivity, multimodal transportation integration, resilient mobility systems, and future-ready road infrastructure.

The Roads & Transportation System for the proposed Industrial Park shall be planned as an integrated transportation framework ensuring efficient movement of industrial freight, passenger traffic, public transport, emergency vehicles, and non-motorized transport.

The planning philosophy shall emphasize:

- Efficient industrial logistics movement
- Seamless regional connectivity
- Hierarchical road network planning
- Complete streets concept
- Public transport integration
- Universal accessibility
- Safety and resilience
- Sustainable and green mobility
- Smart traffic-management systems
- Future scalability and phased expansion

The DPR shall establish transportation systems aligned with applicable IRC codes, MoRTH guidelines, National Building Code, urban street-design guidelines, and industrial-park infrastructure requirements.

3.3 Design Basis

This section shall establish the overall planning philosophy, traffic-design criteria, operational objectives, and service-level requirements for the proposed Roads & Transportation System.

3.3.1 Planning Horizon & Development Phasing

The DPR shall define the adopted planning horizon, intermediate development phases, activation strategy, and phase-wise transportation infrastructure development linked with industrial occupancy and traffic growth.

3.3.2 Basis of Traffic Demand Assessment

The DPR shall establish the methodology and assumptions adopted for traffic-demand estimation based on industrial typology, employee projections, logistics movement, freight generation, land use, and regional connectivity.

3.3.3 Road Hierarchy Philosophy

The DPR shall establish a hierarchical road network comprising arterial roads, sub-arterial roads, collector streets, industrial roads, local streets, and service roads. Indicative Road Hierarchy:

Table 3.1: Road Hierarchy

Road Type	Typical ROW
Arterial Roads	45-60 m
Sub-Arterial Roads	30- 36 m
Collector Streets	20 - 24 m

Access Streets	12- 18 m
Local Streets	9 - 10 m

The DPR shall establish carriageway widths, medians, utility corridors, footpaths, cycle tracks, plantation zones, drainage systems, and future-widening provisions.

3.3.4 Complete Streets & Multimodal Mobility Philosophy

The DPR shall adopt complete-street principles integrating pedestrians, cyclists, public transport users, industrial freight movement, and private vehicles within a safe and accessible transportation framework.

3.3.5 External Connectivity Strategy

The DPR shall explore to establish seamless connectivity of road, rail, airport, freight terminals, ports, tapping point for power infrastructure, water allocation, gas, OFC (Optical fibre cable), logistics etc. An indicative template on external connectivity is enclosed in the table below:

Table 3.2: External Connectivity template

Sl. No	External Infra	Demand Qty as per DPR	Details of source (capacity)	Executing Agency	Sanctioned Cost (₹) Cr	Status
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	Water Supply	-	-	-	-	-
2	Power	-	-	-	-	-
3	Road	-	-	-	-	-
4	Rail	-	-	-	-	-
5	Gas	-	-	-	-	-
6	Telecom	-	-	-	-	-

3.3.6 Internal Road Network Strategy

The DPR shall establish the internal transportation network, connectivity hierarchy, block-level accessibility, emergency access systems, utility integration, and traffic-dispersal mechanisms.

3.3.7 Reliability, Redundancy & Resilience Criteria

The DPR shall establish redundancy provisions, alternate access systems, emergency routes, disaster resilience measures, and operational continuity requirements.

3.3.8 Intelligent Transport Systems (ITS) & Smart Monitoring

The DPR shall establish the smart mobility framework including adaptive traffic systems, GPS monitoring, CCTV systems, SCADA integration, smart signals, and integrated command-and-control systems.

3.3.9 Sustainability & Green Mobility Measures

The DPR shall establish sustainability measures including EV infrastructure, non-motorized transport systems, energy-efficient street lighting, green corridors, and low-carbon mobility strategies.

3.3.10 Applicable Codes, Standards & Technical References

The DPR shall identify the applicable codes, standards, manuals, guidelines, benchmarks, and statutory provisions adopted for planning, design, construction, operation, and maintenance of the proposed Power Supply System.

3.4 Indicative References:

- IRC Codes
- MoRTH Specifications
- IRC: SP:41 – At Grade Intersections
- IRC:86 – Geometric standards for urban roads
- IRC:92 – Interchanges in urban areas
- IRC-SP:99 – Expressway Standards
- IRC:11 – Cycle Track Design
- IRC:35 – Road Markings
- IRC:37 – Design of Flexible pavements
- IRC:58 – Design of Plain Joined Rigid Pavements
- IRC:65 – Traffic Rotaries/Roundabouts and related geometric design
- IRC:73 – Geometric design standards for Rural highways
- IRC:67 – Road Signs
- IRC:88 – Road Safety Audit
- IRC:103 – For pedestrian facilities
- Ministry of Housing & Urban Alleviation-Urban Street Design Guideline
- BIS / IS Standards
- Service Level Benchmarks

This section outlines the applicable Service Level Benchmarks (SLBs) for the proposed Road Network, primarily based on the benchmarks prescribed by the MoRTH specifications/ IRC Codes and other relevant standards.

The DPR shall specify the adopted service levels against each benchmark parameter in a comparative tabular format, along with the proposed compliance approach. The adopted values shall generally meet or exceed the prescribed benchmark levels. Any deviation from the applicable benchmarks shall be supported with adequate project-specific technical justification.

Table 3.3: Service Level benchmarks

Sl. No	Service Level Benchmarks (SLBs)	Benchmark Value
1	Road Network Coverage	100% Planned Development Area
2	Pavement Design Life	20 Years (Flexible) & 30 Years (Rigid)
3	Footpath Provision	Both Sides of Major Roads
4	Cycle Track Provision	Arterial & Sub-Arterial Roads
5	Street Lighting Coverage	100% of planned area
6	Level of Service (LOS)	LOS C or Better
7	Universal Accessibility Compliance	Mandatory
8	Smart Traffic Monitoring Coverage	Critical Junctions
9	Emergency Access Coverage	100% Industrial Areas
10	Road Safety Audit Compliance	Mandatory

3.5 Adopted Design Standards & Norms

The DPR shall summarize the design standards, planning norms, technical references, and manuals adopted for preparation of the Roads & Transportation DPR.

The following codes, standards, manuals, guidelines, and references may be considered during preparation of the DPR, including but not limited to:

3.5.1 Design Parameter

Table 3.4: Design Parameters Roads & Transportation system

Sl. No.	Design Parameter / Component	Reference Code / Manual
1	Design Speed	IRC Codes
2	Pavement Design	IRC:37 (Flexible) & IRC :58 (Rigid)

3	Junction Design	IRC: SP:41
4	Footpath Design	IRC:86
5	Cycle Track Design	IRC:11
6	Road Signs & Markings	IRC:67 / IRC:35
7	Street Lighting	IE Standards
8	Drainage Design	MoRTH / IRC Codes
9	Geometric Design	IRC Guidelines
10	Road Safety Audit	IRC: SP 88
11	Utility Corridors	Project Specific
12	ITS & SCADA Systems	Smart Mobility Standards

3.6 Traffic Demand Assessment

This section shall establish phase-wise and ultimate-year traffic assessment for the proposed Industrial Park. The assessment shall include:

- Passenger traffic assessment
- Freight and logistics traffic
- Employee movement assessment
- Public transport demand
- Parking demand assessment
- Pedestrian & NMT demand
- Traffic forecasting
- Peak-hour traffic analysis
- Junction capacity analysis

3.6.1 Industrial Traffic Assessment

The DPR shall assess industrial traffic generated from manufacturing units, warehouses, logistics hubs, and freight movement.

3.6.2 Passenger Traffic Assessment

The DPR shall assess employee traffic, visitor traffic, residential traffic, and commercial traffic.

3.6.3 Freight & Logistics Traffic Assessment

The DPR shall assess truck traffic, freight corridors, logistics movement, container traffic, and industrial cargo flows.

3.6.4 Public Transport Assessment

The DPR shall establish bus routes, public transport terminals, employee shuttle systems, and future mass-transit integration.

3.6.5 Pedestrian & Non-Motorized Transport Assessment

The DPR shall establish pedestrian demand, cycling demand, universal accessibility requirements, and last-mile connectivity.

3.6.6 Junction Capacity & LOS Analysis

The DPR shall establish capacity analysis for critical intersections, roundabouts, grade separators, and signalized junctions.

3.6.7 Parking Assessment

The DPR shall establish parking requirements for industrial, commercial, logistics, and public infrastructure.

3.6.8 Future Traffic Growth & Forecasting

The DPR shall establish long-term traffic growth projections and future infrastructure augmentation requirements.

3.7 Major Project Components

This section shall establish the technical configuration, sizing philosophy, operational framework, implementation strategy, traffic-management framework, environmental safeguards, safety provisions, resilience criteria, and utility-integration requirements for all major components of the proposed Roads & Transportation System.

3.7.1 External Connectivity Infrastructure

The DPR shall establish the framework for external road connectivity with NHs, SHs, freight corridors, railway terminals, airports, and logistics infrastructure.

3.7.2 Internal Road Network

The DPR shall establish the complete internal road network including road hierarchy, carriageways, medians, utility corridors, service roads, and access-control systems.

3.7.3 Road Hierarchy & Typical Cross Sections

The DPR shall include typical cross sections for all categories of roads. Indicative Cross-Section Components:

- Carriageway
- Median
- Utility Corridor
- Footpath
- Cycle Track
- Plantation Strip
- Drainage System
- Street Lighting

Indicative Typical Road Sections components:

For Arterial Road – 60 m – 45 m ROW

- Dual carriageway with central median
- Service roads
- Cycle track & footpath
- Utility corridor
- Storm-water drain

For Sub-Arterial Road – 36 m- 30 m ROW

- Divided carriageway
- Median for future widening
- Footpath and cycle track
- Utility corridor

For Collector Street – 24 m- 20 m ROW

- Divided carriageway
- Utility corridor
- Footpath and NMT infrastructure

For Access Street – 18 m-12 m ROW

- Two-way carriageway
- Footpath and utilities

For Residential Street – 9m /12 m ROW

- Local access roads
- Traffic calming measures
- Universal accessibility provisions.

Indicative Pavement Design Formulae

Indicative Traffic Design

$N = 365 \times [(1+r)^n - 1]/r \times A \times D \times F$

Where:

N = Cumulative standard axles
A = Initial commercial vehicles per day
r = Annual growth rate
n = Design life
D = Lane distribution factor
F = Vehicle damage factor

Stopping Sight Distance (SSD)

$SSD = vt + v^2/2gf$

Where:

v = Speed of vehicle
t = Reaction time
g = Acceleration due to gravity
f = Coefficient of friction

Super Elevation Formula

$e = v^2/225R$

Where:

e = Super elevation
v = Speed in kmph
R = Radius of curve

3.7.4 Junction & Interchange Infrastructure

The DPR shall establish the planning and design framework for:

- Roundabouts
- At-grade intersections
- Signalized intersections
- Grade separators
- Flyovers
- Cloverleaf interchanges
- Left-in left-out junctions

The DPR shall establish junction-capacity calculations, channelization plans, turning-radius requirements, signalization philosophy, and safety provisions.

3.7.5 Footpaths & Universal Accessibility

The DPR shall establish continuous pedestrian infrastructure in compliance with IRC:86 and universal-accessibility requirements.

3.7.6 Cycle Track & NMT Infrastructure

The DPR shall establish dedicated cycle-track infrastructure, green mobility corridors, bicycle parking, and NMT connectivity.

3.7.7 Public Transport Infrastructure

The DPR shall establish bus bays, terminals, employee transit systems, public transport integration, and future transit corridors.

3.7.8 Truck Terminals & Logistics Infrastructure

The DPR shall establish truck terminals, logistics hubs, freight parking, container yards, and industrial logistics infrastructure.

3.7.9 Road Safety & Traffic Management Systems

The DPR shall establish:

- Crash barriers
- Road signage
- Pavement markings
- Traffic-calming systems
- Speed-control measures
- Safety audits
- Emergency response systems

3.7.10 Street Lighting & Utility Corridors

The DPR shall establish street-lighting systems, electrical utility corridors, telecom corridors, water pipelines, and integrated utility planning.

3.7.11 ITS, ICT & Smart Mobility Systems

The DPR shall establish:

- Adaptive traffic signals
- CCTV systems
- Smart parking systems
- GPS-enabled fleet systems
- Variable message signs
- SCADA systems
- Integrated command-and-control systems

3.7.12 Storm Water & Roadside Drainage

The DPR shall establish roadside drainage systems, culverts, cross-drainage structures, rainwater management, and flood resilience measures.

3.7.13 Entry / Exit Gate

The DPR shall establish a mandate of at least one Park Entry/Exit Plaza with: ANPR, FASTag-compatible gate, dynamic VMS, EV charging (4–6 chargers initial), visitor management system.

3.8 O&M framework

The DPR shall establish a comprehensive operation and maintenance framework covering manpower deployment, preventive maintenance, pavement-condition monitoring, road-marking maintenance, street-lighting systems, traffic-signal operations, drainage maintenance, complaint management, ITS systems, and emergency-response arrangements.

Table 3.5: O&M framework

O&M Framework Component	Key Considerations
Preventive Maintenance Program	Scheduled maintenance for pavements, junctions, drainage, and transportation infrastructure.
Pavement & Road Maintenance	Overlay works, pothole repairs, and shoulder maintenance.
Traffic Signal & ITS Maintenance	Maintenance of traffic signals, CCTV systems, SCADA systems, sensors, and smart-mobility infrastructure.
Street Lighting Maintenance	Maintenance of poles, luminaires, cabling, and electrical systems.
Drainage Maintenance	Cleaning and desilting of roadside drains and storm-water systems.
Road Safety Management	Maintenance of signage, markings, crash barriers, and safety infrastructure.
Emergency Response Plan	Accident response systems, traffic diversion plans, and disaster management arrangements.
Traffic Monitoring & MIS Reporting	Traffic analytics, GPS systems, command-and-control systems, and operational dashboards.

3.9 CAPEX & OPEX Assessment

This section shall establish the phase-wise Capital Expenditure (CAPEX) and Operational Expenditure (OPEX) assessment for the proposed Roads & Transportation System covering all transportation, mobility, utility, safety, smart-

infrastructure, and operational components required for implementation and long-term sustainability.

The assessment shall include all civil, pavement, junction, drainage, utility, street-lighting, ITS, SCADA, safety, logistics, and allied infrastructure required for development and operation of the integrated transportation framework.

The cost estimation shall be based on applicable Schedule of Rates (SoR), MoRTH specifications, approved market rates, recent comparable projects, OEM budgetary quotations, and accepted estimation methodologies.

The DPR shall establish phase-wise investment linked with development phasing, traffic growth, industrial occupancy, and future expansion strategy.

Table 3.6: Capex & Opex Assessment

Category	Key Considerations
Civil Infrastructure	Roads, bridges, culverts, junctions, footpaths, cycle tracks, and utility corridors, Retaining wall/Toe wall (wherever applicable)
Pavement Infrastructure	Flexible pavements, rigid pavements, shoulders, medians, and road furnishings.
Junction & Interchange Infrastructure	Roundabouts, signalized junctions, flyovers, interchanges, and grade separators.
Utility & Drainage Infrastructure	Storm-water drains, utility ducts, pipelines, cable trenches, and roadside utilities.
Street Lighting Systems	Poles, luminaires, cabling, smart-lighting systems, and control panels.
ITS & Smart Mobility Systems	CCTV, SCADA, adaptive traffic systems, GPS systems, smart parking, and command centers.
Road Safety Infrastructure	Signage, road markings, crash barriers, bollards, and safety systems.
O&M Cost	Pavement maintenance, energy consumption, manpower, cleaning, monitoring, and repairs.
Lifecycle Replacement	Replacement of lighting systems, ITS infrastructure, road furniture, and pavement rehabilitation.

3.10 Checklist for Mandatory Deliverables.

The DPR shall include all technical deliverables, studies, calculations, drawings, approvals, and reports necessary for technical appraisal and implementation.

Table 3.7: Mandatory Deliverables Checklist

Sl. No	Deliverables	Checks
1	Traffic Demand Assessment	☐
2	Road Hierarchy Plan	☐

3	External Connectivity Plan	☐
4	Internal Road Network Plan	☐
5	Typical Cross Sections	☐
6	Junction Design Drawings	☐
7	Traffic Forecasting Report	☐
8	Pavement Design Calculations	☐
9	Road Safety Audit	☐
10	Drainage Design	☐
11	Utility Corridor Plan	☐
12	Street Lighting Design	☐
13	ITS & SCADA Framework	☐
14	Parking Assessment	☐
15	Public Transport Plan	☐
16	CAPEX & OPEX Assessment	☐
17	O&M Framework	☐
18	Implementation Phasing Plan	☐
19	Statutory Approvals & Clearances	☐

CHAPTER 4

WATER SUPPLY

4.1 About this Chapter:

This chapter outlines the requirements and technical expectations for the Water Supply component of the Detailed Project Report (DPR) to be submitted by the State/SPV/implementing agency. It serves as the reference framework for preparation and technical evaluation of the proposed water supply scheme by the appraisal authority.

The chapter aims to ensure that the proposed Industrial Park under this scheme is supported by a reliable, resilient, scalable, and future-ready water supply system covering source development, treatment, storage, transmission, distribution, reuse, and monitoring infrastructure.

The DPR shall demonstrate that the proposed scheme is capable of meeting the projected domestic, industrial, process, utility, firefighting, landscaping, and other water demands within the project area across all development phases and up to the adopted design horizon. The proposed system shall also incorporate provisions for water conservation, treated wastewater reuse, operational reliability, and long-term sustainability.

The proposed water supply system shall be planned as a resilient, digitally enabled and resource – efficient utility infrastructure capable of supporting long-term industrial growth, investment readiness, sustainability objectives and operational reliability under varying demand and climate conditions.

4.2 Concept Note:

BHAVYA Scheme envisages the development of future-ready, sustainable, and efficient Industrial Parks with high-quality infrastructure aimed at enhancing industrial productivity, operational reliability, and long-term resource efficiency. The infrastructure framework shall include integrated core utilities such as internal roads, underground utility networks, drainage systems, common treatment facilities, ICT infrastructure, and administrative systems. Considering water and power infrastructure as major lifecycle cost components, the planning approach shall prioritize efficiency, resilience, sustainability, and ease of operations.

The Water Supply system for the proposed Industrial Park shall be planned as an integrated utility network comprising water sourcing, transmission, treatment, storage, distribution, reuse, monitoring, and control systems. The overall planning philosophy shall aim to ensure reliable and continuous water supply for domestic, industrial, process, utility, landscaping, and firefighting requirements across all phases of development.

The proposed system architecture shall broadly include source infrastructure, Water Treatment Plants (WTPs), zonal storage reservoirs, transmission mains, distribution networks, pumping systems, recycled water infrastructure, and smart monitoring systems. The planning approach shall emphasize water conservation, reuse of treated

wastewater, reduction of non-revenue water, operational efficiency, and adoption of digital utility management systems.

Water demand assessment shall be derived from the proposed land use pattern, industrial typologies, development phasing, and applicable planning benchmarks. Separate assessment and planning shall be undertaken for freshwater and recycled water systems to promote sustainable water management and minimize dependency on freshwater resources.

The water supply network shall be planned using appropriate hydraulic modelling and engineering analysis tools in accordance with applicable standards, codes, and service level benchmarks. Subsequent sections of this document elaborate the technical requirements, planning principles, design considerations, and infrastructure components to be addressed in the DPR.

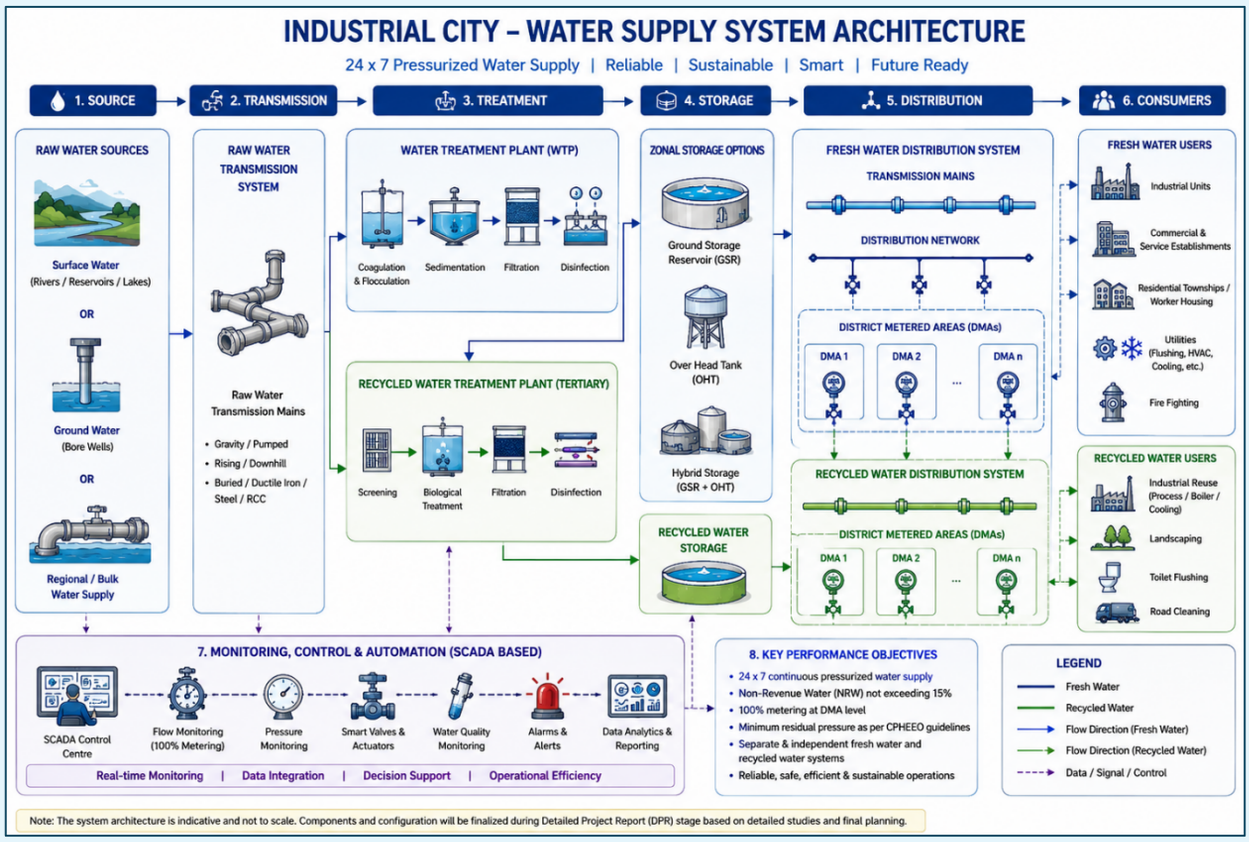


Figure 4.1: Indicative Water Supply System Architecture

4.3 Design Basis

This section shall establish the overall planning philosophy, design criteria, operational objectives, and minimum service level requirements for the proposed Water Supply system. The DPR shall clearly define the technical basis adopted for infrastructure planning, demand assessment, hydraulic performance, operational reliability, sustainability measures, and future scalability of the system. The design basis and service level benchmarks established under this section shall govern the planning,

sizing, phasing, and performance evaluation of all subsequent water supply infrastructure components proposed in the DPR.

4.3.1 Planning Horizon & Development Phasing

The DPR shall define the adopted planning horizon, intermediate development stages, and phase-wise infrastructure augmentation strategy considering projected industrial growth, land development pattern, and future expansion requirements of the Industrial City.

4.3.2 Basis of Population & Industrial Growth Projection

The DPR shall establish the methodology and assumptions adopted for estimating resident population, floating population, worker population, industrial occupancy, and future industrial growth based on the approved master plan and proposed industrial typologies.

4.3.3 Service Level Objectives

The DPR shall define the proposed service level targets for continuity of supply, system reliability, pressure management, water quality, metering coverage, operational efficiency, monitoring, and customer-level service delivery in accordance with applicable standards and project requirements.

4.3.4 Water Supply Philosophy

The DPR shall describe the overall water supply approach including freshwater sourcing, treatment, storage, transmission, distribution, reuse, and system integration strategy proposed for ensuring reliable and sustainable water supply across all phases of development. The philosophy shall define the approach for meeting domestic and industrial water demands across all phases of development, including provisions for process water requirements, integration of recycled water for suitable non-potable and industrial applications, and optimization of freshwater use. The DPR shall also demonstrate the proposed system reliability measures, redundancy provisions, phased infrastructure augmentation strategy, and compliance with applicable standards and regulatory requirements to ensure uninterrupted and efficient service delivery.

4.3.5 Freshwater & Recycled Water Framework

The DPR shall define the planning philosophy for freshwater and recycled water systems including intended reuse applications, separation of networks, reuse targets, and measures proposed for minimizing freshwater dependency and preventing cross-contamination.

The framework shall establish a clear water reuse hierarchy, prioritizing the use of treated wastewater for industrial processes, utility services, cooling systems, landscaping, flushing, construction activities, and other suitable non-potable

applications, with freshwater reserved primarily for potable and other quality-sensitive uses. The DPR shall identify phase-wise recycled water utilization targets, assess the reuse potential across various sectors, and demonstrate the strategy for maximizing treated wastewater reuse and promoting circular water management.

4.3.6 Reliability, Redundancy & Resilience Criteria

The DPR shall establish the reliability and redundancy provisions proposed for critical infrastructure components including source systems, pumping stations, treatment facilities, transmission mains, storage reservoirs, and power backup arrangements to ensure uninterrupted system operations under peak and emergency conditions.

4.3.7 Pressure Zoning & Distribution Philosophy

The DPR shall define the proposed distribution strategy including pressure zoning approach, hydraulic considerations, storage integration, balancing arrangements, and network configuration proposed for achieving equitable and continuous pressurized water supply.

4.3.8 NRW Reduction & Metering Strategy

The DPR shall define the proposed approach for reduction and monitoring of Non-Revenue Water (NRW) through bulk metering, consumer metering, District Metered Areas (DMAs), pressure management, leak detection, and network monitoring systems.

4.3.9 Automation & Smart Water Management Systems

The DPR shall describe the proposed automation and digital monitoring framework including SCADA systems, instrumentation, telemetry, smart metering, centralized monitoring systems, and data-driven operational controls for efficient utility management.

4.3.10 Sustainability & Resource Efficiency Measures

The DPR shall establish the sustainability measures proposed for water conservation, energy-efficient operations, reuse optimization, resource recovery, climate resilience, and long-term environmental performance of the Water Supply system.

4.3.11 Applicable Codes, Standards & Technical References

The DPR shall identify the applicable codes, standards, manuals, guidelines, benchmarks, and statutory provisions adopted for planning, design, construction, operation, and maintenance of the proposed Water Supply system and its individual infrastructure components.

4.3.12 Water Security & Source Sustainability

The DPR shall establish the Source sustainability for the Water demand. Preference shall be given to projects minimizing freshwater dependency through treated wastewater reuse and integrated water-resource optimization.

4.4 Service Level Benchmarks

This section outlines the applicable Service Level Benchmarks (SLBs) for the proposed Water Supply system, primarily based on the benchmarks prescribed by the Ministry of Housing and Urban Affairs (MoHUA) and other relevant standards.

The DPR shall specify the adopted service levels against each benchmark parameter in a comparative tabular format, along with the proposed compliance approach. The adopted values shall generally meet or exceed the prescribed benchmark levels. Any deviation from the applicable benchmarks shall be supported with adequate project-specific technical justification.

Table 4.1: Service level Benchmarks for water supply system

Sl. No	Service Level Benchmarks (SLBs)	MoHUA Value
1	Coverage of Water Supply Connections	100%
2	Per-Capita Supply of water (Domestic)	135 LPCD*
3	Extent of Non-revenue Water	≤ 15%
4	Extent of metering	100%
5	Continuity of water supplied	24 x 7 Supply
6	Efficiency in redressal of customer complaints	≥ 80%
7	Quality of Water Supplied	100% (IS 10500 :2012)
8	Cost Recovery	100%
9	Efficiency in collection of Water charges	100%

* Domestic water supply norms shall be appropriately assessed for the project considering the proposed land use, occupancy pattern, industrial character, and applicable planning standards for phase wise development. Industrial and process water demand shall be assessed separately based on the proposed industrial typologies and utility requirements.

4.5 Adopted Design Standards & Norms

This section shall summarize the design standards, codes, guidelines, reference manuals, and planning norms adopted for preparation of the Water Supply DPR. The objective of this section is to establish a consolidated technical reference framework for all design parameters and infrastructure components, thereby avoiding repetitive citation of standards in subsequent sections of the DPR.

The DPR shall clearly identify the adopted design criteria, corresponding reference standards, and applicable codal provisions for individual system components. In cases where project-specific requirements necessitate deviation from standard codal provisions or commonly adopted engineering practices, the DPR shall provide adequate technical justification and supporting rationale for such deviations.

The following codes, standards, manuals, guidelines, and references may be considered during preparation of the DPR, including but not limited to:

4.5.1 Design Period

Table 4.2: Design Period

Component	Reference Code / Manual	Commonly adopted Design Period
Source Infrastructure	CPHEEO Manual	30-50 Years
Water Treatment Plant (Civil)	CPHEEO Manual	30 Years
Water Treatment Plant (Process & E&M components)	CPHEEO Manual	30 Years
Transmission Mains	CPHEEO Manual	30 years
Distribution Network	CPHEEO Manual	30 years
Service Reservoirs (ESR/GLSR/CWR)	CPHEEO Manual	15-30 years
Pump House Structures	CPHEEO Manual	30 years
Pumping Machinery & Equipment (E&M)	CPHEEO Manual	15 years
SCADA, Instrumentation & Automation Systems	Industry Practice / OEM Recommendations	10-15 years

4.5.2 Water Demand Assessment Criteria

Table 4.3: Water Demand Assessment

Component	Reference Code / Manual	Commonly adopted criteria
Per Capita Supply (Domestic)	CPHEEO Manual;	135 lpcd
Per Capita Supply (Offices/Commercial)	CPHEEO Manual; (Fresh & Recycled)	45 lpcd (Varies based on occupancy, usage pattern & development style)
Non-Revenue Water Allowance	MoHUA SLB	≤ 15%
Sewerage Generation Factor (Domestic)	CPHEEO Manual	80% of Fresh water demand

Sewerage Generation Factor (Industrial)	CPHEEO Manual	60 - 80% of Fresh water demand (depending on proposed industry mix)
Peak Factor (Domestic)	CPHEEO Manual	2.5 (Varies as per the population band)
Peak Factor (Industrial)	CPHEEO Manual	1.2-2.0 (Varies as per Industry mix)
Horticulture/Irrigation demand	CPHEEO Manual/State Regulations	To be assessed based on the green area & irrigation strategy
Firefighting demand	CPHEEO Manual	1% of the Total Water Demand (Varies)
Treatment plant Efficiency	Industry Practices	≥ 95%

The above values are indicative planning criteria generally adopted for preparation of DPRs. The final adopted values shall be based on applicable standards, project-specific requirements, industrial typologies, development characteristics, sustainability objectives, and engineering assessment.

4.5.3 Network Design Parameters

Table 4.4: Network Design Parameters

Component	Reference Code / Manual	Commonly adopted criteria
Hydraulic Design Formula (Distribution network)	CPHEEO Manual	Hazen–Williams Equation (commonly adopted)
Hydraulic Design Formula (Transmission/Pumping network)	CPHEEO Manual;	Hazen–Williams and/or Darcy–Weisbach / Colebrook-White Equation
Hazen- Williams Coefficient (C- Value)	CPHEEO Manual; Manufacturer Recommendations	As per adopted Pipe Materials
Flow Velocity	CPHEEO Manual	Generally, 0.6-2.0 m/s
Minimum Pipe Diameter	CPHEEO Manual	Generally, 100-110mm
Depth of Cover	CPHEEO Manual	Generally, ≥1.0 m from pipe crown, subject to road classification and utility corridor requirement
Residual Pressure at Consumer Connection	CPHEEO Manual	Minimum 12m.
Network Configuration	Industry Practice	Close-loop Network for reliability & redundancy
Pipe Materials – Transmission Mains	CPHEEO Manual; Relevant BIS Standards	MS, DI or equivalent, based on hydraulic, structural, and operational requirement
Pipe Materials – Distribution network	CPHEEO Manual; Relevant BIS Standards	DI, HDPE or equivalent, based on pressure class and network requirements
Pumping Operation Hours	CPHEEO Manual	24 Hours (with Standby arrangements)
Type of Pumps	Project Specific	Preferably VFD

Balancing Storage	CPHEEO Manual	Generally, 33% to 50% of Average daily demand
Emergency Storage	CPHEEO Manual	4-8 Hours of Average Demand
Standby Pumping provisions	CPHEEO Manual	Minimum 1 Standby unit for All pumping systems
Power Backup	Project Specific	100% backup for critical facilities

4.5.4 Materials, Valves & appurtenances

Table 4.5: Materials, Valves & appurtenances

Component	Reference Code / Manual	Commonly adopted criteria
DI Pipes	IS 8329	May be adopted for Transmission Mains & Major Distribution Lines
HDPE Pipes	IS 4984	May be adopted for distribution Lines.
MS Pipes	IS 3589	May be adopted for Transmission Mains & Major Distribution Lines
Butterfly Valves	IS 13095	As per requirements
Sluice/ Gate Valves	IS 14846	As per requirements
Air Valves	IS 14845	As per requirements
Di Fittings	IS 9523	For DI Pipes
Valve Chambers	CPHEEO Manual	Preferable RCC Chambers with Maintenance & accessibility provisions.

4.6 Water Demand Assessment

This section of the DPR shall establish the phase-wise and ultimate water demand for the proposed industrial/manufacturing cluster based on approved land use, industrial typology, occupancy projections, utility requirements, and service-level benchmarks. The assessment shall clearly segregate potable, industrial/process, firefighting, horticulture, and recycled-water demands and shall form the basis for sizing of all downstream infrastructure components. The adopted methodology, assumptions, peak factors, losses, and design horizon shall be explicitly declared and supported through calculations and benchmark references.

4.6.1 Domestic Water Demand

Domestic demand shall be assessed based on projected residential population, worker accommodation, dormitories, staff housing, and associated institutional facilities proposed within the industrial area. The adopted per-capita norms shall be in

accordance with CPHEEO guidelines and applicable state regulations. Occupancy assumptions and phase-wise population projections shall be clearly stated in the DPR.

Table 4.6: Indicative Domestic Water Demand

Category	Indicative Norms
Residential Housing	135 LPCD
Workers Housing/Accommodation	70-100 LPCD
Institutional Facilities	70 LPCD
Transit Accommodation	Project specific assessment

4.6.2 Commercial Water Demand

Commercial water demand shall be estimated based on the proposed commercial floor area, office occupancy, logistics infrastructure, utility establishments, and common amenity facilities within the project area. Separate consideration shall be given to administrative buildings, food courts, commercial complexes, and support infrastructure generating non-industrial demand.

Table 4.7: Indicative Commercial Water Demand

Category	Indicative Norms
Office Buildings	Occupancy Based
Commercial Area	Floor-Area basis
Logistic Facilities	Utility Benchmark
Common Amenities	Occupancy & usage pattern

4.6.3 Industrial & Process Water Demand

Industrial and process water demand shall be assessed category-wise based on the proposed industrial mix, process-water intensity, plot-allocation pattern, expected industrial occupancy model, and benchmark consumption data from comparable industrial park developments. Generic per-capita norms **shall not be** adopted for industrial demand estimation.

The assessment shall distinctly consider potable, process, cooling, utility, and recycled-water requirements. Industrial water demand shall preferably be derived from case studies, benchmarking of comparable industrial estates/clusters, and demand assessments of similar industrial sectors. The adopted industrial water-demand norms shall be furnished separately in terms of KL/Ha/day along with supporting basis and references as part of the DPR annexures.

4.6.4 Firefighting & horticulture Demand

Firefighting demand shall be assessed in accordance with CPHEEO recommendations and applicable fire-safety regulations considering the industrial risk profile and redundancy philosophy. Although firefighting systems are generally preferred to be supplied through potable water, the DPR may explore the avenue for the use of treated wastewater/recycled water for firefighting applications, subject to compliance with applicable quality requirements, operational suitability, and approval of the competent authority.

Horticulture demand shall be estimated based on greenbelt area, avenue plantation, and landscape-development requirements, and shall be met exclusively through treated wastewater/recycled water for non-potable applications.

Even in the closed-loop water distribution systems, dedicated firefighting reserve storage shall be maintained to ensure reliable emergency response under peak-demand, power-failure, or system-disruption conditions. The firefighting reserve may be integrated within common storage infrastructure; however, the reserved capacity shall remain protected from routine operational drawdown.

Table 4.8: Indicative Firefighting & Horticluture Water

Category	Design Considerations
Fire Reserve	Dedicated Storage Provision
Fire Hydrant Network	As per Fire Strategy
Greenbelt Irrigation & landscape Demand	Area Based & seasonal requirement
Recycled water Reuse	Compulsory for Horticulture. Options may be explored for Firefighting & HVAC use subject to Water quality & approval from competent authority.

4.6.5 Summary of Total Water Demand

The DPR shall provide a consolidated phase-wise and ultimate-year water demand assessment covering domestic, commercial, industrial/process, utility, firefighting, horticulture, and recycled-water requirements. The demand assessment shall clearly identify freshwater demand, recycled-water demand, peak demand factors, wastewater generation, and infrastructure design demand adopted for sizing of intake systems, WTP, reservoirs, pumping systems, and distribution networks. Detailed calculations, assumptions, industrial benchmarking, occupancy projections, and adopted demand norms shall be enclosed as annexures to the DPR.

Table 4.9: Cumulative Water Demand

Demand Component	Unit Demand Criteria	Phase wise demand	Ultimate Design Horizon	Remarks
Domestic Demand	LPCD basis			
Commercial Demand	Occupancy/Floor Area			
Industrial Demand	KL/Ha/day			
Utility Demand	Project specific			
Firefighting Demand	CPHEEO			
Horticulture Demand	Area basis			
Total Freshwater Demand	Computed			
Recycled Water Demand	Computed			
Net Freshwater Requirement	Computed			
Wastewater Generation	% of water demand			
Peak Factor Adopted	CPHEEO / Project specific			
Design Demand Adopted	Computed			

4.6.6 Water Quality

This section shall establish the raw-water quality characteristics, treatment requirements, and treated-water quality objectives for the proposed system. The DPR shall identify critical parameters influencing treatment-process selection and mandatorily demonstrate compliance with the latest version of BIS:10500 standards for potable water.

Raw-water sampling and testing shall be mandatorily carried out in accordance with applicable codal provisions and CPHEEO guidelines, and the corresponding test reports shall be enclosed as annexures to the DPR. The sampling programme shall preferably cover multiple water sources, seasonal variations, and representative sampling events to adequately capture temporal variation in source-water quality. All laboratory analysis shall be carried out through a NABL-accredited laboratory.

4.6.7 Water Balance Diagram

The DPR shall include a comprehensive water balance diagram illustrating raw-water abstraction, treatment, potable-water distribution, industrial consumption, wastewater generation, treatment, recycled-water production, reuse applications, losses, and final

disposal/surplus arrangements. The water balance shall establish the overall sustainability and resource-efficiency framework of the proposed development.

Table 4.10: Component of Water Balance computation

Water Balance Component	Description / Requirement
Raw Water abstraction	Source wise water intake
WTP Output	Treated Potable water Generation
Industrial & Domestic Consumption	Category wise water Utilisation
Distribution Losses/NRW	System losses & UAF water
Wastewater generation	Domestic sewage & industrial effluent generation
STP/CETP treatment	Treatment & Recovery of Wastewater
Recycled water generation	Quantity Available for Reuse
Recycled water Utilization	Horticulture, utilities, process reuse, flushing, etc. Additional Firefighting/HVAC utilization may be explored.
Process losses	Non-Recoverable Losses
Surplus/Deficit Assessment	Net Water Balance Status
Disposal Arrangements	Disposal of surplus treated wastewater if any (preferable to be avoided and options to be explored for reuse applications in process water/industry etc.)

4.7 Major Project Components

This section shall establish the technical configuration, sizing philosophy, hydraulic integration, redundancy provisions, operational framework, and implementation strategy for all major components of the proposed water-supply system. The DPR shall demonstrate that the proposed infrastructure is adequately sized for phase-wise as well as ultimate demand conditions and is capable of ensuring reliable, energy-efficient, and scalable system performance.

The DPR shall include component-wise design basis, engineering calculations, hydraulic-model outputs, layout drawings, equipment sizing, operational philosophy, and utility integration requirements for all major infrastructure components forming part of the proposed system

4.7.1 Raw Water source, Intake & Transmission System

The DPR shall establish the proposed raw-water source, allocated quantity, intake arrangement, pumping requirements, and raw-water conveyance system required for transmission of water to the treatment facility or balancing reservoir. The design shall consider source sustainability, seasonal variation, transmission losses, right-of-way

constraints, hydraulic requirements, energy optimization, and future expansion provisions. Source-allocation approvals and relevant statutory clearances shall be enclosed as part of the DPR.

Table 4.11: Raw water key Considerations

Component	Design Considerations
Source Reliability	Long-term Sustainability
Intake Arrangements	Seasonal Operability
Transmission System	Hydraulic Adequacy
Pumping System	Energy Efficient & redundancy
Crossings & Utilities	Corridor Coordination

4.7.2 Water treatment Plant

The Water Treatment Plant (WTP) shall be designed based on ultimate water demand, raw-water quality characteristics, treatment objectives, operational flexibility, and modular expansion philosophy. The DPR shall establish the basis for selection of the treatment process through an appropriate treatment-process selection matrix and shall define the design criteria for all treatment units, hydraulic profile, unit sizing, sludge handling and disposal arrangements, automation and control systems, standby provisions, energy efficiency measures, and operational flexibility requirements. The proposed treatment scheme shall be supported by raw water quality assessment and treatability studies, wherever applicable, to demonstrate the adequacy and effectiveness of the selected process. Provision for advanced and tertiary treatment systems shall be incorporated, where required, to consistently achieve the desired treated water quality. The treated water shall mandatorily comply with the latest version of IS 10500 standards for potable-water supply.

Table 4.12: WTP key Considerations

Component	Design Considerations
Design Horizon	Ultimate demand basis
Treatment Objective	IS:10500 compliances
Plant Configuration	Modular & Expandable
Automation	SCADA enabled
Standby provisions	Mandatory for Critical Units
Redundancy	N+1 Redundancy mandatory for all critical units.

4.7.3 Clear Water Reservoirs & Master Balancing Reservoirs

Balancing reservoirs and storage infrastructure shall be designed considering peak demand variation, pumping schedules, firefighting reserve, emergency water storage requirements, and operational reliability of the overall system. The DPR shall provide storage-capacity calculations, redundancy philosophy, mass-curve analysis, and justification for proposed reservoir locations and staging arrangements.

4.7.4 Pumping System & Pumping Stations

The DPR shall establish the design basis, sizing philosophy, operational requirements, and redundancy provisions for all pumping systems proposed under the water-supply infrastructure. The assessment shall include raw-water pumping, clear-water pumping, intermediate boosting arrangements, distribution pumping, recycled-water pumping, and firefighting pumping systems, wherever applicable.

Pump sizing shall be based on design discharge, total dynamic head, operating hours, peak demand conditions, storage balancing philosophy, and future expansion requirements. The DPR shall include pump-capacity calculations, pump-head calculations, system curves, energy assessment, standby philosophy, surge analysis (where required), and power-supply arrangements.

The pumping system shall be designed to ensure operational reliability, energy efficiency, ease of maintenance, and uninterrupted service during emergency conditions. Adequate standby pumping capacity and backup power arrangements shall be provided for critical infrastructure components. Variable Frequency Drives (VFDs), automation systems, and energy-efficient pumping solutions shall preferably be considered for optimized operation. A comprehensive list of all electro-mechanical components including the suggested brand/make etc. may be annexed with this DPR for their suitable references.

Table 4.12: Pumping System & Pumping stations key Considerations

Component	Design Considerations
Pump Capacity	Ultimate Design Flow
Pump head	Static + Friction + Surge Conditions
Redundancy	Minimum N+1 philosophy
Surge protection	Mandatory
Energy Efficiency	IE3/IE4 motors, VFDs
Automation	SCADA controlled
Power reliability	Mandatory Power Back up & Dual feeder as applicable

4.7.5 Service Reservoirs (GSLR/ESR)

Ground-Level Service Reservoirs (GLSRs) and Elevated Service Reservoirs (ESRs) shall be planned based on pressure zoning, distribution-network hydraulics, topography, service coverage, and operational flexibility requirements. The DPR shall include reservoir-capacity calculations, locations, staging-height assessment, hydraulic integration, and service-zone delineation.

4.7.6 Distribution Network

The distribution network shall be designed as a hydraulically efficient and operationally reliable system capable of supplying potable and non-potable water to all consumers within the industrial area. The DPR shall establish the network philosophy, zoning approach, pipe-sizing criteria, pressure-management strategy, material selection, and redundancy provisions. Hydraulic modelling using recognized software platforms such as Water GEMS/EPANET/or equivalent shall be undertaken to validate system performance under peak-demand and firefighting conditions.

The potable Water network & Recycle water network shall be planned independently to avoid cross contamination. Both networks shall be developed as closed-loop distribution systems to ensure hydraulic reliability, operational flexibility, and continuity of supply. Appropriate provisions for emergency interconnections, isolation arrangements, and monitoring mechanisms shall be incorporated to facilitate system resilience and maintenance.

4.7.7 Plot/Property Connections & metering

The DPR shall establish the design philosophy and standard arrangements for plot/property connections including service connections, bulk metering, consumer metering, isolation valves, and utility-interface infrastructure. The connection system shall support accurate metering, operational isolation, ease of maintenance, and integration with smart utility-management systems. Separate provisions shall be mandatorily considered for potable and recycled-water supply systems as applicable.

4.7.8 Valves & Chambers

The DPR shall establish the requirement and placement philosophy for isolation valves, air valves, scour valves, pressure-reducing valves, flow-control valves, and associated chambers within the transmission and distribution network in accordance with CPHEEO guidelines and applicable codal provisions. Valve placement shall ensure operational flexibility, sectional isolation, pressure management, maintenance accessibility, and protection of the pipeline system.

Precast RCC valve chambers with suitable access arrangements shall preferably be adopted, wherever feasible, to facilitate faster construction, ease of maintenance, durability, and operational efficiency. Separate chamber covers with appropriate

identification markings/colour coding for different valve types shall be considered for ease of operation, maintenance, and asset identification.

4.7.9 Instrumentation, Automation & SCADA

The DPR shall include the proposed automation and SCADA framework for real-time monitoring and control of the water-supply system. The automation architecture shall cover flow monitoring, pressure monitoring, reservoir-level monitoring, pump operation, energy monitoring, water-quality monitoring, and centralized data acquisition systems. The system shall support operational optimization, leak detection analytics, pressure optimization, remote operation, IoT enabled metering and predictive maintenance strategies.

The proposed utility system shall preferably support future integration with integrated Command & Control Centres (ICCC) and digital utility management platforms.

4.7.10 Recycled Water System

The DPR shall establish the planning, design basis, operational philosophy, and integration framework for the recycled-water system proposed within the industrial/manufacturing cluster. The recycled-water system shall be planned to maximize reuse of treated wastewater and minimize dependence on freshwater sources, in line with sustainable water-management principles and applicable regulatory guidelines.

The DPR shall identify the proposed sources of recycled water, treatment standards, storage requirements, transmission arrangements, pumping requirements, distribution network, end-use applications, and quality-monitoring framework. Separate assessment shall be carried out for recycled-water demand for horticulture, utilities, flushing, cooling, process reuse, firefighting (where applicable), and other non-potable applications.

The recycled-water infrastructure shall operate through a dedicated distribution network adequately segregated from the potable-water system to avoid cross-contamination. The DPR shall establish the reuse philosophy, storage balancing requirements, pressure-management strategy, redundancy provisions, and operational safeguards for the recycled-water system. The Storage & distribution of the Recycled water shall be separately considered.

The quality of recycled water shall conform to applicable standards and end-use requirements. Adequate monitoring, metering, automation, backflow-prevention measures, and identification protocols shall be incorporated within the system design. The DPR shall also establish the overall recycled-water utilization efficiency and reduction in freshwater dependency proposed under the project.

4.8 O&M framework

The DPR shall establish a comprehensive operation and maintenance framework covering manpower deployment, preventive & predictive maintenance, asset management systems, reservoir cleaning, NRW reduction, emergency response, water-quality surveillance, Spare philosophy and SCADA operation.

Table 4.13: O&M Framework key Considerations

Category	Key Considerations
Preventive & Predictive Maintenance	Scheduled Program (Mandatory)
Water Quality Testing	Routine testing as per CPHEEO Guidelines
SCADA operation	Continuous Monitoring
Emergency Response	Contingency Plan
Energy Management	Efficient Tracking
Spare Philosophy	Tentative schedule

4.9 CAPEX & OPEX Assessment

This section shall establish the phase-wise Capital Expenditure (CAPEX) and Operational Expenditure (OPEX) for the proposed water-supply infrastructure system. The assessment shall include all civil, electromechanical, transmission, storage, distribution, automation, utility, and allied infrastructure components required for development and operation of the complete system.

The cost estimation shall be based on applicable Schedule of Rates (SoR), approved market rates, recent comparable projects, or other accepted estimation methodologies adopted by the implementing agency. The DPR shall clearly specify the basis of estimation, year of pricing, contingencies, escalation provisions, and applicable taxes/duties considered in the cost assessment.

The CAPEX assessment shall cover intake systems, transmission mains, WTP, pumping systems, reservoirs, distribution network, valves and appurtenances, utility crossings, SCADA systems, electrical infrastructure, and associated site-development works. The OPEX assessment shall include power consumption, chemical consumption, manpower, preventive maintenance, laboratory testing, SCADA operation, and asset-maintenance requirements.

The DPR shall also establish phase-wise investment planning and assess long-term operational sustainability considering energy efficiency, NRW reduction, automation, recycled-water integration, lifecycle asset-management requirements & costing.

Table 4.14: Capex & Opex Assessment key Considerations

Category	Key Considerations
Civil Infrastructure	WTP, reservoirs, chambers, buildings
Pipeline Infrastructure	Transmission & distribution network, Manholes, Chambers etc.
Electromechanical Systems	Pumps, motors, Valves, electrical systems etc,
Automation & SCADA	Monitoring and control systems
Metering Systems	Bulk & Plot level Metering
Utility Infrastructure	Power supply and utility works
O&M Cost	Power, chemicals, manpower, maintenance
Lifecycle Replacement	Long-term asset replacement provision, Asset depreciation, Inflation & escalations.

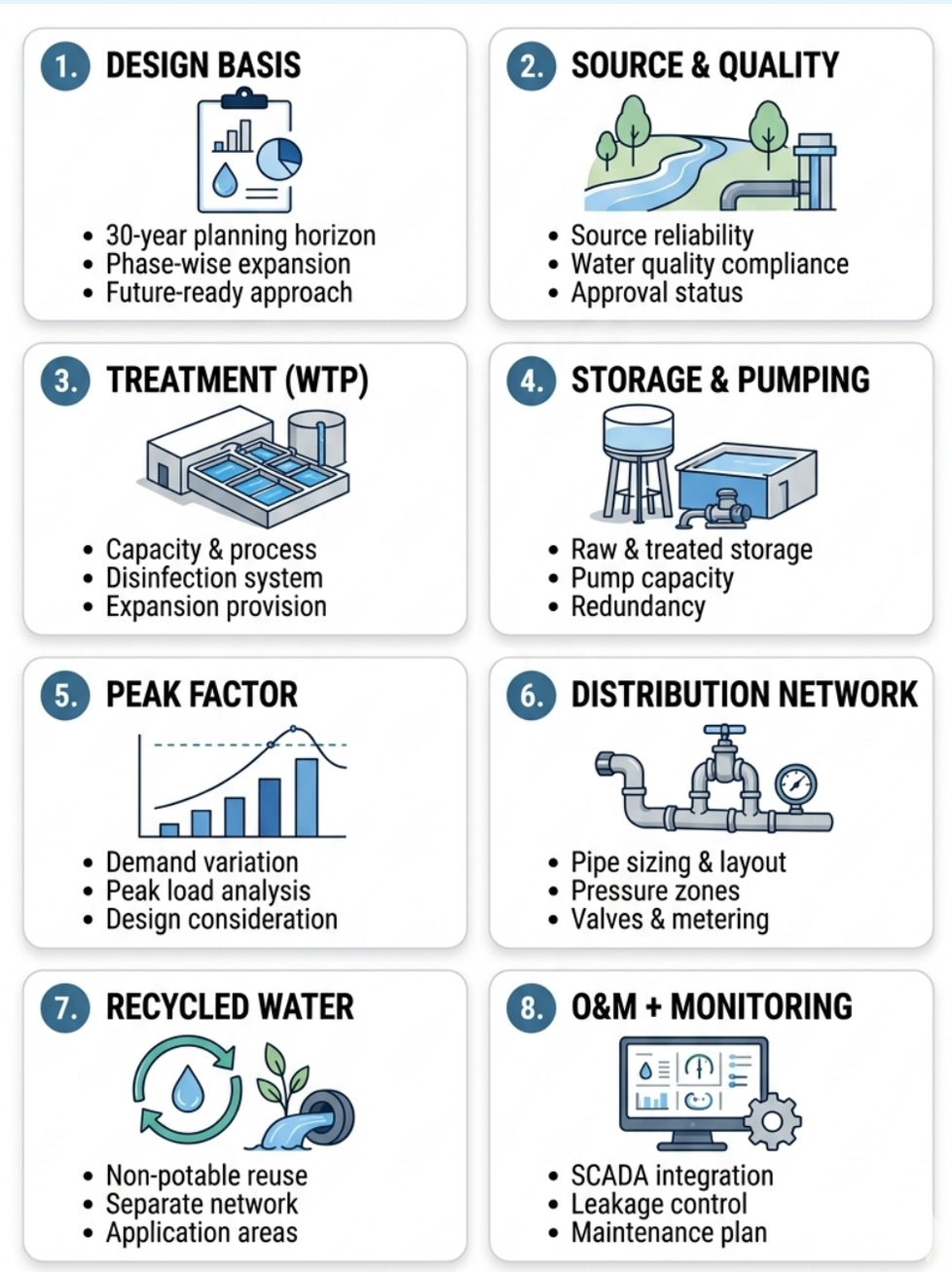
4.10 Checklist for Mandatory Deliverables.

The DPR shall include all technical deliverables, design documents, calculations, drawings, investigations, approvals, and supporting studies necessary for technical appraisal, implementation, operation, and future reference of the proposed water-supply system. All submissions shall be consistent with the adopted design criteria, phase-wise demand assessment, hydraulic analysis, recycled-water integration framework, and applicable CPHEEO/BIS standards adopted under the DPR.

Table 4.15: Mandatory Delievrable Checklist

Sl. No	Deliverables	Checks
1	Water Demand Assessment (Phase-wise & Ultimate)	☐
2	Industrial Water Benchmarking & KL/Ha/day Basis (Annexure)	☐
3	Adopted Design Criteria & Engineering Standards	☐
4	Water Balance Diagram (Freshwater + Recycled Water System)	☐
5	Raw Water Quality Investigation Report (NABL Accredited)	☐
6	Source Allocation / Water Abstraction NOC & Statutory Clearances	☐
7	Hydraulic Design Calculations	☐
8	Hydraulic Model Files/Outputs (Peak & Fire Demand Conditions)	☐
9	Pumping System Design Calculations (Head, Discharge, Redundancy) & Surge Analysis report.	☐
10	Water Treatment Plant Design Report (Process + Unit Sizing)	☐
11	Reservoir & Storage Sizing Calculations (Including Fire Reserve)	☐
12	Distribution Network Design (Zoning, DMA, Pressure Management) & surge analysis report	☐
13	Valve & Appurtenance Schedule with Chamber Details	☐
14	Recycled Water System Design (Separate Network & Reuse Plan)	☐

15	SCADA & Automation Architecture (Monitoring & Control Framework & Functional Philosophy	☐
16	Utility Corridor Layouts & Crossing Details (Road/Rail/Utilities)	☐
17	Engineering Drawings (GA, Plan, Profile, Sections, Schematics	☐
18	BOQ & Detailed Cost Estimates (CAPEX & OPEX)	☐
19	Implementation Phasing Plan Linked to Demand Growth	☐
20	Operation & Maintenance Framework (Asset & System Management	☐
21	Any other which shall be deemed applicable.	☐
		☐



CHAPTER 5

SEWERAGE & INDUSTRIAL EFFLUENT SYSTEM

5.1 About this Chapter:

This chapter outlines the technical requirements, planning philosophy, engineering expectations, design governance framework, and minimum deliverables for preparation of the Sewerage Network, Sewage Treatment Plant (STP), and Common Effluent Treatment Plant (CETP) components of the Detailed Project Report (DPR) for integrated industrial/manufacturing clusters under the Scheme.

The chapter is intended to function as a technical guidance document and DPR preparation framework for planning, design, appraisal, implementation, operation, maintenance, and evaluation of sewerage and wastewater-management infrastructure systems within Industrial Cities, Industrial Manufacturing Clusters, Integrated Industrial Townships, Industrial Parks, and associated economic-development zones.

The DPR shall demonstrate that the proposed scheme is capable of adequately collecting, conveying, treating, reusing, and safely disposing the projected domestic sewage and industrial effluent generated within the Industrial Park across all phases of development and up to the adopted design horizon.

The DPR shall further establish that the proposed sewerage and wastewater-management infrastructure has been planned to maximize treated-water reuse potential, reduce dependency on freshwater sources, improve overall water-use efficiency, and promote sustainable industrial-water management practices.

The proposed planning approach shall, wherever technically and economically feasible, incorporate principles of Zero Liquid Discharge (ZLD) wherever applicable, circular water economy, wastewater recycling, and resource recovery in accordance with applicable environmental regulations, CPCB/SPCB requirements, and long-term sustainability objectives of the Industrial City.

5.2 Concept Note:

The Sewerage Network, Sewage Treatment Plant (STP), and Common Effluent Treatment Plant (CETP) infrastructure for the proposed Industrial Park shall be planned as an integrated wastewater-management utility system designed to ensure safe collection, conveyance, treatment, reuse, and disposal of domestic sewage, industrial effluent, commercial wastewater, and utility wastewater generated within the planning area.

The proposed infrastructure shall be planned to support the projected development of the Industrial Park across all phases and up to the adopted design horizon while ensuring compliance with applicable environmental regulations, service-level benchmarks, and operational-performance requirements.

The proposed system architecture shall broadly comprise underground sewerage collection networks, trunk and interceptor sewer systems, industrial effluent conveyance systems, sewage and effluent pumping stations, rising mains, Sewage

Treatment Plants (STPs), Common Effluent Treatment Plants (CETPs), sludge-management systems, treated-water storage systems, recycled-water distribution systems, odour-control systems, instrumentation systems, and SCADA-based monitoring and control systems.

The planning philosophy shall prioritize:

- Environmentally compliant wastewater management
- Maximization of gravity-based conveyance systems
- Segregation of domestic sewage and industrial effluent streams
- Reliable and energy-efficient operation
- Minimization of untreated discharge and overflow conditions
- Maximization of treated-water reuse potential
- Reduction in freshwater dependency
- Lifecycle operational sustainability
- Ease of operation and maintenance
- Provision for future scalability and phased expansion

Wastewater generation assessment shall be derived from the approved land-use pattern, industrial typologies, process-water requirements, worker population, utility demand, commercial activities, development phasing, and applicable planning norms and benchmarks. Separate assessment and infrastructure planning shall be undertaken for domestic sewage systems, industrial effluent systems, and recycled-water systems.

The proposed sewerage and wastewater-treatment infrastructure shall be planned using appropriate hydraulic analysis, process-design methodology, and engineering assessment tools in accordance with CPHEEO guidelines, CPCB/SPCB requirements, BIS standards, environmental regulations, and applicable service-level benchmarks.

The DPR shall establish the technical basis, planning framework, design methodology, infrastructure configuration, operational philosophy, treatment strategy, reuse framework, implementation approach, and long-term sustainability measures proposed for the sewerage, STP, and CETP systems.

5.3 Design Basis

This section shall establish the overall planning philosophy, hydraulic criteria, treatment framework, operational requirements, environmental objectives, and infrastructure-planning principles adopted for the proposed Sewerage Network, Industrial Effluent Conveyance Network, Sewage Treatment Plant (STP), and Common Effluent Treatment Plant (CETP) systems under the DPR.

The DPR shall clearly establish the engineering rationale and technical basis adopted for assessment of domestic sewage generation, industrial effluent generation, hydraulic conveyance planning, industrial wastewater segregation, treatment-process

selection, treated-water reuse, sludge management, operational reliability, and future scalability of the proposed wastewater-management infrastructure for the Industrial City.

The proposed infrastructure shall be planned considering the approved land-use pattern, industrial typologies, worker population, process-water requirements, utility demand, development phasing, environmental obligations, and ultimate development potential of the Industrial City. The planning approach shall aim to ensure environmentally compliant, operationally reliable, hydraulically efficient, and sustainable wastewater management across all phases of development and up to the adopted design horizon.

The proposed wastewater-management framework shall broadly comprise underground sewerage networks, industrial effluent conveyance systems, trunk and interceptor sewer systems, effluent conveyance mains, sewage and effluent pumping stations, rising mains, STP infrastructure, CETP infrastructure, sludge-management systems, treated-water reuse systems, monitoring infrastructure, and SCADA-based operational-control systems.

5.3.1 Planning Horizon & Development Phasing

The DPR shall define the adopted planning horizon, intermediate stages of infrastructure augmentation, and phase-wise development strategy for the proposed sewerage and industrial effluent-management infrastructure. The adopted planning framework shall be aligned with the approved master plan, industrial-development strategy, projected wastewater generation, and long-term infrastructure requirements of the Industrial City.

The proposed infrastructure systems shall be planned with adequate provision for phased implementation and future expansion without major disruption to the operational network. The DPR shall clearly identify the base year, intermediate development phases, ultimate design year, and corresponding infrastructure-capacity requirements proposed under each development stage.

5.3.2 Wastewater Generation & Hydraulic Design Basis

The DPR shall establish the methodology, assumptions, norms, and design criteria adopted for assessment of domestic sewage generation, industrial effluent generation, commercial wastewater generation, utility wastewater generation, infiltration allowance, recycle streams, and peak-flow conditions.

Wastewater generation assessment shall be based on the approved land-use distribution, industrial typologies, process-water intensity, worker population, utility demand, applicable planning benchmarks, and projected development pattern of the Industrial City. Separate assessment shall be undertaken for domestic sewage systems, industrial effluent systems, and treated-water reuse systems wherever applicable.

The DPR shall clearly establish the adopted Average Daily Flow (AF), Maximum Daily Flow (MF), Peak Hourly Flow (PF), ultimate design flow, sewage-return factors, infiltration allowances, and peak-flow factors considered for hydraulic design of the sewerage and industrial effluent conveyance systems.

The hydraulic design philosophy shall prioritize gravity-based conveyance systems to the maximum extent feasible while ensuring adequate carrying capacity, self-cleansing velocity, prevention of surcharge conditions, operational reliability, and provision for future expansion.

5.3.3 Sewerage & Industrial Effluent Network Planning Philosophy

The DPR shall establish the overall planning philosophy for the underground sewerage network and industrial effluent conveyance network, including catchment delineation, sewerage zoning, industrial drainage zoning, hierarchy of branch, sub-trunk, trunk, and interceptor systems, pumping requirements, utility-corridor integration, and future connectivity provisions.

The planning approach shall prioritize segregation of domestic sewage and industrial effluent streams wherever technically and operationally required, considering industrial typologies, effluent characteristics, environmental requirements, treatment compatibility, and long-term operational sustainability.

The DPR shall establish the adopted pipe-material selection philosophy considering hydraulic performance, structural requirements, corrosion resistance, industrial effluent characteristics, soil conditions, installation methodology, lifecycle performance, and maintenance requirements.

The proposed network planning shall also consider accessibility for inspection and maintenance, reduction of pumping dependency, minimization of operational risk, and compatibility with phased urban and industrial development.

5.3.4 Industrial Effluent Management policy

Industrial effluent generated from manufacturing, process, utility, and associated industrial activities within the Industrial Park shall be collected and conveyed through a dedicated industrial effluent conveyance system separate from the domestic sewerage network.

The DPR shall establish the industrial typologies proposed within the planning area, anticipated effluent characteristics, source-level pretreatment requirements, industrial discharge standards, equalization requirements, and the overall framework adopted for collection, conveyance, monitoring, treatment, reuse, and disposal of industrial effluent.

The proposed industrial effluent management framework shall be planned considering treatment compatibility, environmental-compliance requirements, operational safety, lifecycle sustainability, and integration with the proposed CETP infrastructure.

The DPR shall also establish the provisions proposed for industrial discharge monitoring, pretreatment compliance, emergency isolation, and online monitoring systems in accordance with applicable CPCB/SPCB regulations and environmental standards.

5.3.5 Treatment Philosophy & Technology Selection

The DPR shall establish the treatment philosophy and technical basis adopted for selection of the proposed STP and CETP systems. The proposed treatment framework shall be developed considering influent wastewater characteristics, hydraulic loading, organic loading, variability in industrial effluent, treated-water reuse requirements, land availability, environmental-compliance requirements, energy consumption, operational reliability, and lifecycle sustainability.

The DPR shall include comparative assessment of suitable treatment technologies and establish the engineering basis adopted for selection of the proposed treatment process. The selected treatment system shall be technically justified with respect to treatment efficiency, operational flexibility, automation requirements, sludge generation characteristics, energy efficiency, ease of operation and maintenance, treated-water quality objectives, and long-term scalability.

The DPR shall also establish the proposed treatment-train configuration including preliminary treatment, primary treatment, biological treatment, tertiary treatment, disinfection systems, sludge-handling systems, odour-control systems, chemical-dosing systems, and treated-water reuse infrastructure.

5.3.6 Treated Water Reuse Policy

The DPR shall establish the treated-water reuse strategy proposed for the Industrial Park with the objective of maximizing wastewater recycling, reducing freshwater dependency, improving water-use efficiency, and promoting sustainable industrial-water management practices.

The proposed reuse framework shall identify the potential applications of recycled water including industrial process requirements, utility-water demand, cooling-water systems, landscaping, horticulture, firefighting storage, and other non-potable applications wherever feasible.

The DPR shall establish the adopted treated-water quality requirements, reuse-demand assessment, recycled-water storage systems, pumping requirements, distribution-network arrangements, quality-monitoring systems, metering systems, and cross-connection prevention measures proposed under the scheme.

The planning approach shall prioritize development of a dedicated recycled-water distribution network segregated from the potable-water network to prevent contamination and ensure operational reliability.

The DPR shall also establish a water reuse hierarchy and assess the feasibility of utilizing treated wastewater across various applications in accordance with the following planning principles:

Table 5.1: Treated water Reuse philosophy

Application	Reuse requirement
Landscaping, Green belts & horticulture	Mandatory
Toilet Flushing & other non-potable sanitary uses	Mandatory
HVAC/Air-conditioning system	Mandatory (Subject to water quality requirements)
Cooling Tower make up water	Mandatory (Subject to water quality requirements)
Construction, road washing etc.	Mandatory (wherever applicable)
Process Cooling water	Preferred
Boiler feed water	Preferred (after tertiary treatment/advance treatment as applicable)
Industrial Process water	To be assessed based on specific process-based water quality requirements

5.3.7 Sludge Management Philosophy

The DPR shall establish the sludge-management framework proposed for handling sludge generated from STP and CETP systems. The proposed sludge-management strategy shall consider sludge generation quantity, sludge characteristics, stabilization requirements, dewatering requirements, storage arrangements, transportation methodology, treatment requirements, disposal mechanisms, and opportunities for resource recovery wherever feasible.

The DPR shall establish the proposed sludge-thickening systems, sludge-drying arrangements, mechanical dewatering systems, sludge-handling infrastructure, temporary storage facilities, and final disposal arrangements proposed under the scheme.

The adopted sludge-management framework shall comply with applicable environmental regulations, CPCB/SPCB guidelines, hazardous-waste-management provisions wherever applicable, and other statutory requirements governing sludge handling and disposal.

5.3.8 Redundancy & Emergency Management

The DPR shall establish the reliability and redundancy philosophy adopted for critical sewerage, pumping, treatment, monitoring, and utility systems proposed under the scheme.

The DPR shall clearly identify redundancy provisions proposed for pumping systems, treatment units, standby power systems, instrumentation systems, SCADA systems, chemical-dosing systems, critical pipelines, and other critical infrastructure

components to ensure uninterrupted operation during equipment failure, maintenance shutdowns, or emergency conditions.

The proposed framework shall also establish emergency bypass philosophy, overflow-management measures, emergency-storage provisions, flood-protection measures, backup power arrangements, alarm systems, emergency-response procedures, and contingency-management mechanisms proposed for the wastewater-management infrastructure.

5.3.9 Digital Utility, Automation & Smart Infrastructure Framework

The DPR shall establish the proposed automation and smart utility-management framework for the sewerage network, industrial effluent systems, pumping stations, STP, CETP, and recycled-water infrastructure proposed under the Industrial City. The proposed framework shall aim to improve operational efficiency, infrastructure reliability, environmental compliance, energy management, preventive maintenance, utility monitoring, and lifecycle sustainability of the wastewater-management systems.

The proposed framework shall establish the SCADA architecture, instrumentation systems, online monitoring systems, centralized operational-control systems, smart metering systems, GIS-based utility mapping systems, and digital asset-management philosophy proposed for monitoring and management of the wastewater-management infrastructure.

The DPR shall also establish the proposed framework for integration of automation systems, online flow and water-quality monitoring systems, alarm-management systems, data-acquisition systems, communication systems, and centralized utility-management systems for efficient operation and regulatory compliance of the proposed infrastructure.

The proposed automation and smart utility-management framework shall be planned considering operational reliability, interoperability, scalability, redundancy requirements, ease of maintenance, cybersecurity considerations, future expansion requirements, and compatibility with long-term smart industrial-city infrastructure objectives.

5.3.10 Sustainability & Resource Efficiency Measures

The DPR shall establish the sustainability measures proposed for water conservation, energy-efficient operations, reuse optimization, resource recovery, climate resilience, and long-term environmental performance of the Water Supply system.

5.3.11 Industrial Water Pretreatment Policy

The DPR shall establish the industrial wastewater pretreatment philosophy, identifying industries requiring source-level pretreatment prior to discharge into the common conveyance or treatment system. The framework shall define influent quality

requirements, discharge standards, and pretreatment measures including equalization at plot level, pH neutralization, oil and grease removal, heavy metal removal, toxic stream segregation, shock-load attenuation, and other industry-specific treatment requirements, as applicable. The DPR shall also define provisions for flow measurement, online monitoring, compliance verification, and admission control to protect downstream conveyance, treatment, recycling, and disposal infrastructure.

5.3.12 Applicable Codes, Standards & Technical References

The DPR shall clearly identify all applicable codes, standards, technical manuals, environmental regulations, statutory provisions, and engineering references adopted for planning, design, construction, operation, and maintenance of the proposed sewerage and wastewater-management infrastructure.

The adopted references shall generally include CPHEEO guidelines, BIS standards, CPCB/SPCB regulations, MoEFCC requirements, electrical safety regulations, environmental standards, industrial wastewater-management guidelines, and other applicable statutory and technical provisions relevant to the proposed infrastructure systems.

All hydraulic analysis, treatment-process design, equipment selection, utility planning, structural design, electrical systems, automation systems, environmental-compliance systems, and operational frameworks proposed under the DPR shall conform to the adopted standards and applicable regulatory requirements.

5.4 Service Level Benchmarks

The DPR shall establish the proposed service-level benchmarks for the Sewerage Network, Industrial Effluent Conveyance Network, STP, CETP, treated-water reuse systems, and associated wastewater-management infrastructure proposed under the scheme. The adopted benchmarks shall be aligned with applicable CPHEEO guidelines, CPCB/SPCB requirements, environmental regulations, MoEFCC provisions, and other applicable standards and statutory requirements relevant to sewerage and industrial wastewater-management infrastructure.

The proposed service-level benchmarks shall form the basis for planning, design, sizing, performance assessment, operational monitoring, infrastructure evaluation, environmental compliance, and long-term asset management of the proposed wastewater-management systems for the Industrial City.

The adopted benchmarks shall aim to ensure safe collection, conveyance, treatment, reuse, and disposal of domestic sewage and industrial effluent while minimizing environmental impact, reducing freshwater dependency, improving operational efficiency, and promoting sustainable and circular water-management practices. The planning framework shall incorporate Zero Liquid Discharge (ZLD) principles as a mandatory consideration for industrial wastewater management and treated-water reuse planning under the proposed development.

Indicative service-level benchmarks to be adopted under the DPR are provided below. The DPR may suitably refine the benchmarks based on project-specific requirements, industrial typologies, statutory obligations, environmental-clearance conditions, and applicable regulatory provisions.

Table 5.2: Service Level Benchmarks

Sl. No	Service Level Benchmarks (SLBs)	Indicative Benchmarks
1	Sewerage & Industrial Effluent Collection Coverage	100%
2	Collection efficiency of Sewerage Network	100%
3	Adequacy of Sewerage treatment Capacity	100%
4	Quality of Sewerage Treatment – Treatment Compliance as per CPCB/SPCB norms	100%
5	Extent of Treated water Reuse	≥50%
6	Extent of Cost Recovery in Waste water Management	100%
7	Efficiency in redressal of customer complaints	≥ 90%
8	Efficiency in collection of Sewage Water charges	≥90%
9	Segregation of Domestic Sewerage & industrial effluent	Mandatory
10	Untreated Waste water Discharge/Bypass	Nil (in all design conditions)
11	Overflow incidence	Nil (in all design conditions)
12	SCADA & Online Monitoring Coverage	100% Mandatory
13	Standby Power Availability	Mandatory (for all critical facilities)
14	Redundancy for all Critical equipment	Mandatory (N+1 Philosophy)
15	Odor Control Provisions	Mandatory (for all critical facilities)
16	Sludge-Disposal Compliance	100%
17	Online Flow & quality Monitoring	100% at defined locations
18	Emergency Storage/Bypass provisions	Mandatory
19	Asset Accessibility for O&M	100%
20	Environmental Compliance	Mandatory as per CPCB/SPCB/Other guidelines
21	Zero liquid Discharge Framework	Industry specific
22	CETP uptime	≥95%
23	Industrial Pretreatment	Mandatory (Industry specific requirements)

The DPR shall provide a comparative statement indicating the adopted service-level benchmarks, proposed design provisions, compliance methodology, monitoring mechanisms, operational framework, and performance-monitoring arrangements proposed for achieving the identified service standards under the project. Any deviation from the indicative service-level benchmarks shall be explicitly identified and technically justified within the DPR, along with the corresponding mitigation measures, operational implications, and project-specific constraints considered while adopting such deviations.

5.5 Adopted Design Standards & Norms

This section shall summarize the design standards, codes, guidelines, reference manuals, and planning norms adopted for preparation of the Water Supply DPR. The objective of this section is to establish a consolidated technical reference framework for all design parameters and infrastructure components, thereby avoiding repetitive citation of standards in subsequent sections of the DPR.

The DPR shall clearly identify the adopted design criteria, corresponding reference standards, and applicable codal provisions for individual system components. In cases where project-specific requirements necessitate deviation from standard codal provisions or commonly adopted engineering practices, the DPR shall provide adequate technical justification and supporting rationale for such deviations.

The following codes, standards, manuals, guidelines, and references may be considered during preparation of the DPR, including but not limited to:

5.5.1 Design Period

Table 5.3: Design Period

Component	Reference Code / Manual	Commonly adopted Design Period
Sewerage & Industrial Effluent Conveyance Network	CPHEEO Manual	30 Years
STP/CETP/Pumping Stations (Civil)	CPHEEO Manual	30 Years
STP/CETP/Pumping Stations (Process & E&M components)	CPHEEO Manual	15 Years
Rising Mains	CPHEEO Manual	30 years
Sludge Handling System	Industry Practices	15 years
SCADA, Instrumentation & Automation Systems	Industry Practice / OEM Recommendations	10-15 years

5.5.2 Wastewater generation & treatment criteria

Table 5.3: Wastewater generation & treatment criteria

Component	Reference Code / Manual	Commonly adopted criteria
Domestic Sewage generation factor	CPHEEO Manual;	Generally, 80% of Fresh water demand
Industrial effluent generation	CPHEEO Manual/Industry assessment	Generally, 75% of Fresh water Demand
Peak Factor- Sewerage	CPHEEO Manual	2.5 (varies with population)
Peak Factor- Industrial	CPHEEO Manual	3.0 (Varies as per Industry types)
STP/CETP treatment Efficiency	CPHEEO Manual/ Industry Practices	100%
ZLD adherence	CPCB/SPCB guidelines	As per Industry Specific requirements
Treated Water Reuse	CPCB/SPCB Guidelines	To be Maximized. Options to be explored for industrial process application also
Sludge Handling & Disposal	CPHEEO Manual/CPCB/SPCB/ Hazardous Waste Rules	Mandatory & 100% compliance

The above values are indicative planning criteria generally adopted for preparation of DPRs. The final adopted values shall be based on applicable standards, project-specific requirements, industrial typologies, development characteristics, sustainability objectives, and engineering assessment.

5.5.3 Network Design Parameters

Table 5.4: Network Design Parameters

Component	Reference Code / Manual	Commonly adopted criteria
Hydraulic Design Formula (Gravity Sewer network)	CPHEEO Manual	Manning's Formula (commonly adopted)
Hydraulic Design Formula (Rising Main/Pumping network)	CPHEEO Manual;	Hazen–Williams and/or Darcy–Weisbach equation.
Minimum Self cleansing Velocity	CPHEEO Manual	≥ 0.6 m/s
Maximum Velocity	CPHEEO Manual	≤3.0 m/s as per adopted pipe materials & hydraulic Designs
Minimum Pipe Diameter – Sewerage	CPHEEO Manual	Generally, 200mm
Minimum Pipe Diameter – Industrial Effluent	CPHEEO Manual	Generally, 160mm
Capacity of Sewer	CPHEEO Manual	Max. 0.80 times diameter at Ultimate peak flow
Depth of Cover	CPHEEO Manual	Generally, ≥1.0 m from pipe crown, subject to road

		classification and utility corridor requirement
Infiltration & Inflow	CPHEEO Manual	Minimum – 5000 L/Ha/day Minimum- 500 L/Km of Sewer /day Minimum 250/L/day/manhole
Network Configuration	Industry Practice	Close-loop Network, Gravity Based System at maximum feasible extent
Pipe Materials – Rising Mains	CPHEEO Manual; Relevant BIS Standards	DI or equivalent, based on hydraulic, structural, and operational requirement
Pipe Materials – Conveyance System	CPHEEO Manual; Relevant BIS Standards	DI, HDPE or equivalent, based on pressure class and network requirements
Manhole Spacing	CPHEEO Manual	Within 30m for Sewerage/effluent carrying Pipes.
Pumping Operation Hours	CPHEEO Manual	24 Hours (with Standby arrangements)
Type of Pumps	Project Specific	Preferably VFD
Standby Pumping provisions	CPHEEO Manual	Minimum 1 Standby unit for All pumping systems
Power Backup	Project Specific	100% backup for critical facilities

5.5.4 STP, CETP Process Design parameters

Table 5.5: Process Design Parameters

Component	Reference Code / Manual	Commonly adopted criteria
Treatment Technology Selection	Best Industry Practice/ CPHEEO Manual	Suitable based on influent & treated water Characteristics
Equalization Provision	Best Industry Practices	Mandatory for CETP system
Preliminary treatment Units	CPHEEO Manual	Mandatory
Biological Treatment system	CPHEEO Manual	As per the influent characteristics/adopted treatment process
Tertiary Treatment System	CPCB/ Reuse Requirements	As per treated water reuse applications
Sludge Management system	Best Industry Practices	Mandatory as per requirements
Odour control units	Best Industry Practices	Mandatory for critical units
Automation & monitoring	CPHEEO Manual	Mandatory

5.5.5 Materials, Valves & appurtenances

Table 5.6: Inidcative Materials Considerations

Component	Reference Code / Manual	Commonly adopted criteria
DI Pipes	IS 8329	May be adopted for Rising Mains / pumping Lines
HDPE Pipes	IS 14333	May be adopted for conveyance system.
Butterfly Valves	IS 13095	As per requirements
Sluice/ Gate Valves	IS 14846	As per requirements
Air Valves	IS 14845	As per requirements
Di Fittings	IS 9523	For DI Pipes
Valve Chambers	CPHEEO Manual	Preferable RCC Chambers with Maintenance & accessibility provisions.

The above values are indicative planning and design criteria generally adopted for preparation of DPRs for industrial wastewater-management infrastructure. The final adopted values shall be based on applicable standards, project-specific requirements, industrial typologies, environmental obligations, sustainability objectives, operational philosophy, treatment requirements, and detailed engineering assessment carried out.

5.6 Design of Major Project Components

This section shall establish the technical configuration, sizing philosophy, hydraulic integration, treatment framework, redundancy provisions, operational philosophy, and implementation strategy for all major components of the proposed Sewerage Network, Industrial Effluent Conveyance Network, STP, CETP, treated-water reuse systems, and associated wastewater-management infrastructure under the DPR.

The DPR shall demonstrate that the proposed infrastructure is adequately sized for phase-wise and ultimate design-flow conditions and is capable of ensuring reliable, environmentally compliant, energy-efficient, operationally sustainable, and scalable wastewater-management performance across the Industrial City.

The DPR shall include component-wise design basis, engineering calculations, hydraulic assessments, treatment-process design, equipment sizing, layout drawings, operational philosophy, redundancy provisions, utility integration requirements, and performance criteria for all major infrastructure systems proposed under the project.

The proposed infrastructure planning shall establish the technical basis and design framework for sewerage collection systems, industrial effluent conveyance systems, trunk and interceptor systems, pumping stations, rising mains, STP infrastructure, CETP infrastructure, equalization systems, sludge-management systems, treated-

water reuse systems, SCADA systems, electrical systems, odour-control systems, and associated utility infrastructure proposed under the scheme.

5.6.1 Design of Wastewater Collection System

The DPR shall establish the planning criteria, hydraulic design basis, alignment philosophy, construction methodology, and operational framework adopted for the proposed sewerage collection system and industrial effluent conveyance system with due reference to the adopted standards, codes, manuals, and norms specified in the previous sections of the DPR. The DPR shall generally address the following design aspects for the wastewater collection system:

5.6.1.1 Design Period:

The adopted design period for sewerage and industrial effluent conveyance systems shall be established in accordance with CPHEEO guidelines and the overall project development horizon.

5.6.1.2 Peak Factor:

The DPR shall establish the adopted peak factors for domestic sewage and industrial effluent systems considering population characteristics, industrial variability, and operational conditions.

5.6.1.3 Minimum & Maximum Velocity of Flow:

The adopted hydraulic velocity criteria shall ensure self-cleansing conditions while preventing scouring, erosion, sediment deposition, and excessive head loss within the network.

5.6.1.4 Minimum Size of Sewer / Effluent Line:

The DPR shall establish the minimum permissible pipe diameter considering hydraulic performance, maintenance accessibility, blockage prevention, and future scalability.

5.6.1.5 Hydraulic Design Formula:

The DPR shall establish the adopted hydraulic design methodology and equations for gravity-flow and pressure systems with reference to applicable CPHEEO guidelines and engineering standards.

5.6.1.6 Horizontal Alignment Criteria:

The DPR shall establish the alignment philosophy considering ROW availability, utility corridors, accessibility, road hierarchy, future maintenance requirements, and constructability considerations.

5.6.1.7 Vertical Alignment Criteria:

The adopted vertical alignment shall consider gravity-flow optimization, utility crossings, minimum cover requirements, outfall integration, and pumping minimization philosophy.

5.6.1.8 Sewer Gradient:
The DPR shall establish the adopted gradient criteria required for maintaining design velocity and hydraulic performance within the network.

5.6.1.9 Flooding & Ponding Areas:
The proposed alignment shall consider flood-prone areas, waterlogging zones, drainage constraints, and operational-risk conditions.

5.6.1.10 Bedding & Backfilling:
The DPR shall establish the adopted bedding, pipe-support, and backfilling methodology considering soil conditions, loading conditions, groundwater conditions, and pipe-material requirements.

5.6.1.11 Minimum Clearance & Pipe Position within ROW:
The DPR shall establish the minimum horizontal and vertical clearances from other utilities and the adopted utility-corridor positioning philosophy.

5.6.1.12 Property / Plot Connections:
The DPR shall establish the criteria adopted for plot connections, industrial connections, inspection chambers, and interface arrangements with the trunk system.

5.6.1.13 Pipes & Appurtenances:
The DPR shall establish the criteria adopted for selection of pipes, specials, valves, fittings, and associated network appurtenances.

5.6.1.14 Pipe Materials:
The DPR shall undertake a comparative technical assessment of alternative pipe materials proposed for sewerage and industrial effluent conveyance systems considering hydraulic performance, corrosion resistance, structural strength, lifecycle cost, constructability, maintenance requirements, soil conditions, effluent characteristics, pressure conditions, and long-term operational suitability. The final selection of pipe materials shall be technically justified based on the adopted design criteria and project-specific requirements.

5.6.1.15 Pipe Laying & Jointing:
The DPR shall establish the construction methodology, jointing system, leakage-control measures, and installation requirements proposed for the network.

5.6.1.16 Manholes:
The DPR shall establish the planning criteria, spacing philosophy, accessibility requirements, and structural considerations adopted for manhole systems.

5.6.1.17 Types of Manholes:
The DPR shall establish the applicability and use of standard, drop, junction, inspection, and special manhole arrangements proposed under the project.

5.6.1.18 Size of Manholes:
The adopted manhole sizing criteria shall be established considering pipe diameter, depth, maintenance accessibility, and operational requirements.

5.6.1.19 Drop Manholes:
The DPR shall establish the criteria adopted for provision of drop arrangements under steep-gradient or level-difference conditions.

5.6.1.20 Junction Manholes:
The DPR shall establish the planning criteria adopted for junctions between branch, sub-trunk, and trunk systems.

5.6.1.21 Side Entry Manholes:
The DPR shall establish the applicability and planning criteria for side-entry arrangements wherever required.

5.6.1.22 Manhole Covers & Frames:
The DPR shall establish the adopted loading standards, material specifications, and accessibility requirements for manhole covers and frames.

5.6.1.23 Rungs / Access Systems:
The DPR shall establish the access provisions and safety arrangements proposed for deep manholes and maintenance access.

5.6.1.24 Road & Utility Crossings:
The DPR shall establish the methodology adopted for crossings of roads, drains, railways, utility corridors, and other infrastructure interfaces.

5.6.1.25 Layout & Network Plan:
The DPR shall include layout drawings, network plans, hydraulic profiles, utility integration details, and longitudinal sections required for establishing the technical adequacy of the proposed system.

5.6.1.26 Smart Monitoring & GIS Integration Systems:
The DPR shall establish the proposed framework for integration of sewerage & industrial effluent conveyance system with SCADA system, online flow monitoring system, smart metering system, GIS-based utility mapping system, digital asset management and centralized utility monitoring platforms under this project.
The DPR shall establish the monitoring philosophy, instrumentation locations, communication systems, alarm systems, and operational integration framework

proposed for efficient monitoring, preventive maintenance, hydraulic assessment, and lifecycle management of the wastewater collection system

5.6.2 Pumping System & pumping Stations

The DPR shall establish the planning philosophy, sizing basis, redundancy framework, operational strategy, and infrastructure requirements adopted for sewage pumping stations, industrial effluent pumping stations, and associated pumping systems proposed under the project. The DPR shall generally address the following design aspects for pumping infrastructure:

5.6.2.1 Civil Structures:
The DPR shall establish the structural configuration, layout requirements, accessibility provisions, durability considerations, and operational requirements adopted for pumping-station structures.

5.6.2.2 Screen Chambers:
The DPR shall establish the screening philosophy, screen sizing, screening arrangements, and debris-management provisions proposed for protection of downstream systems.

5.6.2.3 Selection of Pumps, Head & Discharge:
The DPR shall undertake comparative assessment of alternative pumping arrangements, pump configurations, operating philosophies, and equipment options considering hydraulic efficiency, energy consumption, redundancy requirements, surge conditions, operational flexibility, maintenance requirements, lifecycle cost, and long-term operational reliability. The selected pumping system shall be technically justified through detailed hydraulic and techno-economic evaluation.

5.6.2.4 Number of Pumps & Redundancy:
The DPR shall establish the redundancy philosophy and standby provisions adopted for critical pumping systems.

5.6.2.5 Surging & Water Hammer:
The DPR shall establish the surge-analysis criteria and protection measures proposed for pressure systems and rising mains.

5.6.2.6 Wet Well Design:
The DPR shall establish the sizing philosophy, detention requirements, operational levels, and maintenance considerations adopted for wet wells.

5.6.2.7 Internal Lining & Waterproofing:
The DPR shall establish the corrosion-protection systems, lining requirements, and waterproofing measures adopted for pumping structures.

5.6.2.8 Floor Slope:
The DPR shall establish the drainage philosophy and floor-slope criteria adopted for pumping stations.

5.6.2.9 Odour-Control Units:
The DPR shall establish the odour-management strategy and odour-control systems proposed for pumping facilities.

5.6.2.10 Lighting & Ventilation:
The DPR shall establish the lighting standards, ventilation requirements, and occupational-safety provisions adopted for pumping infrastructure.

5.6.2.11 Power Backup:
The DPR shall establish the backup-power philosophy and emergency power arrangements proposed for uninterrupted operation.

5.6.2.12 Flow Measurement Devices:
The DPR shall establish the flow-monitoring systems, instrumentation requirements, and SCADA integration proposed for pumping systems.

5.6.2.13 Automation, Remote operation & preventive Maintenance:
The DPR shall establish the proposed automation framework for pumping systems including SCADA integration, remote monitoring systems, automated control systems, pump-health monitoring systems, alarm-management systems, energy-monitoring systems, and predictive-maintenance systems proposed for pumping infrastructure.
The DPR shall establish the operational philosophy, redundancy provisions, communication systems, and centralized monitoring framework proposed for efficient and reliable operation of the pumping systems

5.6.3 Sewerage Treatment Plant (STP)

The DPR shall establish the treatment philosophy, process-design framework, technology-selection basis, operational strategy, and infrastructure requirements adopted for the proposed STP systems.

The DPR shall generally address the following design aspects for STP infrastructure:

5.6.3.1 Influent & Treated Effluent Quality:
The DPR shall establish the adopted influent characteristics, treated-water quality standards, discharge norms, and reuse requirements.

5.6.3.2 Technology Selection & Comparison:
The DPR shall undertake a comparative assessment of feasible treatment technologies considering influent characteristics, treatment efficiency, land

requirement, energy consumption, sludge generation, automation requirements, operational complexity, lifecycle cost, treated-water reuse objectives, scalability, environmental compliance, and long-term operational sustainability. The selected treatment technology shall be technically justified through an appropriate techno-economic comparison framework.

5.6.3.3 Design Computations for Individual Units:
The DPR shall include design calculations and sizing criteria adopted for all treatment units and process systems.

5.6.3.4 Redundancy Provisions:
The DPR shall establish the standby philosophy and redundancy provisions proposed for critical treatment systems and equipment.

5.6.3.5 Power Backup:
The DPR shall establish the emergency power arrangements and backup systems proposed for uninterrupted treatment operations.

5.6.3.6 Land Requirement:
The DPR shall establish the land-area assessment and space-planning considerations adopted for the STP infrastructure.

5.6.3.7 Process Flow Diagram:
The DPR shall include process-flow diagrams and hydraulic profiles establishing the treatment sequence and process integration.

5.6.3.8 Essential Facilities within STP:
The DPR shall establish the utility systems, laboratory facilities, administrative areas, chemical storage, access roads, drainage systems, and support infrastructure proposed within the STP campus.

5.6.3.9 O&M Protocols:
The DPR shall establish the operation, maintenance, safety, monitoring, and asset-management framework proposed for the STP systems.

5.6.3.10 Electrical, Mechanical & Instrumentation Systems:
The DPR shall establish the design basis and operational philosophy adopted for E&M systems and instrumentation infrastructure.

5.6.3.11 Flow Management & SCADA Controls:
The DPR shall establish the automation philosophy, monitoring framework, and SCADA integration proposed for the STP systems.

5.6.3.12 Online Monitoring & Smart Utility Integration:
The DPR shall establish the proposed framework for integration of STP systems with online water-quality monitoring systems, instrumentation systems, energy-monitoring systems, digital process-control systems, centralized utility-management systems, and predictive-maintenance systems proposed for the project.

The DPR shall establish the proposed monitoring locations, automation philosophy, reporting systems, operational analytics framework, and integration requirements proposed for regulatory compliance, operational optimization, and lifecycle management of the STP infrastructure

5.6.3.13 Storage Reservoirs for Treated Water:
The DPR shall establish the sizing criteria, balancing requirements, and operational philosophy adopted for treated-water storage systems.

5.6.4 Common effluent treatment Plants

The DPR shall establish the planning framework, treatment philosophy, process-design basis, operational strategy, and environmental-compliance framework adopted for the CETP systems proposed under the project.

The DPR shall generally address the following design aspects for CETP infrastructure, but not limited to:

5.6.4.1 Influent Effluent Characteristics:
The DPR shall establish the adopted industrial wastewater characteristics, variability considerations, shock-load conditions, and design influent assumptions.

5.6.4.2 Pre-treatment Requirements:
The DPR shall establish the source-level pre-treatment philosophy and industrial discharge requirements proposed under the project.

5.6.4.3 Technology Selection & Process Compatibility:
The DPR shall undertake a comparative assessment of feasible CETP treatment technologies and process configurations considering industrial typologies, influent variability, shock-load handling capability, chemical-treatment requirements, sludge generation, ZLD compatibility, operational reliability, environmental compliance, lifecycle cost, treated-water recovery objectives, and long-term sustainability. The selected process configuration shall be supported through detailed technical justification and comparative evaluation.

5.6.4.4 Equalization Systems:
The DPR shall establish the equalization philosophy and balancing requirements adopted for handling hydraulic and organic fluctuations.

5.6.4.5 Treatment Units & Process Systems:
The DPR shall establish the design basis and sizing criteria adopted for individual treatment units and process systems.

5.6.4.6 Chemical Dosing Systems:
The DPR shall establish the chemical-treatment philosophy and dosing systems proposed for CETP operations.

5.6.4.7 Sludge Management Systems:
The DPR shall establish the sludge-handling, dewatering, storage, transportation, and disposal framework proposed for CETP systems.

5.6.4.8 Online Monitoring, Automation & Smart Utility Systems:
The DPR shall establish the proposed framework for integration of CETP infrastructure with online water-quality monitoring systems, industrial discharge monitoring systems, SCADA systems, automated process-control systems, chemical-dosing automation systems, centralized monitoring systems, and predictive-maintenance systems proposed for the project.
The DPR shall establish the monitoring philosophy, instrumentation systems, reporting framework, communication systems, compliance-monitoring systems, and operational-control systems proposed for efficient operation, environmental compliance, emergency management, and lifecycle sustainability of the CETP infrastructure. The framework shall also define the integration requirements with applicable CPCB/SPCB online monitoring platforms and other regulatory reporting systems, as applicable.

5.6.4.9 ZLD Framework:
The DPR shall assess the applicability of Zero Liquid Discharge (ZLD) based on the proposed industrial profile, wastewater characteristics, regulatory requirements, and water management objectives. Where applicable, the DPR shall define the ZLD framework, including wastewater segregation, recycle and recovery systems, reject management, and final residue disposal arrangements, along with an assessment of technical and operational feasibility.

5.7 O&M framework

The DPR shall establish a comprehensive operation and maintenance framework covering manpower deployment, preventive maintenance strategy, asset management, reservoir cleaning, NRW reduction, emergency response, water-quality surveillance, and SCADA operation.

Table 5.7: O&M framework Key considerations

Category	Design Considerations
Preventive Maintenance	Scheduled Program
Water Quality Testing	Routine testing as per CPHEEO Guidelines
SCADA operation	Continuous Monitoring
Emergency Response	Contingency Plan
Energy Management	Efficient Tracking
Digital Environmental compliance system	Mandatory

5.8 CAPEX & OPEX Assessment

This section shall establish the phase-wise Capital Expenditure (CAPEX) and Operational Expenditure (OPEX) for the proposed Wastewater network system. The assessment shall include all civil, electromechanical, transmission, storage, distribution, automation, utility, and allied infrastructure components required for development and operation of the complete system.

The cost estimation shall be based on applicable Schedule of Rates (SoR), approved market rates, recent comparable projects, or other accepted estimation methodologies adopted by the implementing agency. The DPR shall clearly specify the basis of estimation, year of pricing, contingencies, escalation provisions, and applicable taxes/duties considered in the cost assessment.

The CAPEX assessment shall cover intake systems, transmission mains, STP/CETP, pumping systems, reservoirs, distribution network, valves and appurtenances, utility crossings, SCADA systems, electrical infrastructure, and associated site-development works. The OPEX assessment shall include power consumption, chemical consumption, manpower, preventive maintenance, laboratory testing, SCADA operation, and asset-maintenance requirements.

The DPR shall also establish phase-wise investment planning and assess long-term operational sustainability considering energy efficiency, leakage detection, automation, recycled-water integration, and lifecycle asset-management requirements.

Table 5.8: Capex & Opex Key considerations

Category	Design Considerations
Civil Infrastructure	STP/CETP, reservoirs, Pumping stations chambers, buildings
Pipeline Infrastructure	Rising Mains & conveyance network, Manholes, Chambers etc.
Electromechanical Systems	Pumps, motors, Valves, electrical systems etc,

Automation & SCADA	Monitoring and control systems
Metering Systems	Bulk & Plot level Metering
Utility Infrastructure	Power supply and utility works
O&M Cost	Power, chemicals, manpower, maintenance
Lifecycle Replacement	Long-term asset replacement provision

5.9 Checklist for Mandatory Deliverables.

The DPR shall include all technical deliverables, design documents, calculations, drawings, investigations, approvals, and supporting studies necessary for technical appraisal, implementation, operation, and future reference of the proposed wastewater & treatment system. All submissions shall be consistent with the adopted design criteria, phase-wise demand assessment, hydraulic analysis, recycled-water integration framework, and applicable CPHEEO/BIS standards adopted under the DPR.

Table 5.9: Mandatory Deliverables Checklist

Sl. No.	Mandatory Deliverable	Compliance
A. Planning, Design Basis & Investigations		
1	Approved Master Plan / Land-use Plan	□
2	Planning Horizon & Development Phasing Assessment	□
3	Industrial Typology, Wastewater Characterization Assessment & Treatability study	□
4	Wastewater Generation & Hydraulic Design Basis Report	□
5	Recycled Water Demand & Reuse Market Assessment	□
6	Water Balance Diagram & Flow Assessment	□
7	Design Criteria, Codes & Standards Statement	□
8	Service Level Benchmark Compliance Statement	□
B. Sewerage & Industrial Effluent Network Systems		
9	Sewerage & Industrial Effluent Network Design Report	□
10	Sewerage Catchment & Industrial Effluent Zoning Plan	□
11	Sewerage & Industrial Effluent Network Layout Drawings	□
12	Hydraulic Profiles & Longitudinal Sections	□
13	Utility Corridor Coordination & Crossing Details	□
14	Pipe Material Evaluation & Selection Justification	□
15	Pumping System Design & Hydraulic Assessment	□
16	Pumping Station Layouts, Electrical & Mechanical Drawings	□
C. STP, CETP & Recycled Water Systems		
17	STP Design Basis, Process Selection & Design Report	□
18	STP Process Flow Diagram, Hydraulic Profile & Layout Drawings	□
19	CETP Design Basis, Influent Assessment & Design Report	□
20	CETP Process Flow Diagram, Hydraulic Profile & Layout Drawings	□
21	Industrial Pretreatment & ZLD feasibility/Compliance Framework	□
22	Sludge Management & Disposal Framework	□
23	Treated Water Reuse & Recycled Water Distribution Framework	□
24	Odour Control & Environmental Compliance Framework	□
D. Electrical, Automation & Smart Utility Systems		

25	Electrical Load Assessment & Power Backup Framework	□
26	Single Line Diagrams (SLD) & Electrical System Drawings	□
27	SCADA, Automation & Instrumentation Framework	□
28	Online Monitoring, Smart Metering & Utility Monitoring Framework	□
29	GIS Based Utility Mapping & Digital Asset Management Framework	□
30	Emergency Response Framework	□
E. Costing, Implementation & Project Governance		
31	CAPEX, OPEX & life Cycle Cost Assessment	□
32	Testing, commissioning, Performance validation Framework	□
33	O&M Philosophy, Staffing & Preventive Maintenance Framework	□
34	Environmental, CPCB/SPCB & Statutory Compliance Assessment	□
35	Statutory Approval Matrix, Risk Assessment & DPR Compliance Statement	□

CHAPTER 6

DRAINAGE & STORM WATER MANAGEMENT

6.1 About this Chapter:

This chapter presents the planning approach, design basis, hydrological assessment, hydraulic design criteria and infrastructure requirements for the proposed Storm Water Drainage (SWD) system for the industrial / manufacturing city. The chapter covers:

- Assessment of existing drainage characteristics and natural drainage systems;
- Hydrological investigations and runoff assessment;
- Storm water drainage planning and outfall strategy;
- Design of roadside drains, trunk drains and cross-drainage structures;
- Rainwater harvesting and runoff mitigation measures;
- Flood management and climate resilience considerations;
- Operation and maintenance framework.

The chapter shall establish that the proposed storm water drainage system is hydraulically adequate, technically sound, maintainable and capable of safely managing runoff under ultimate development conditions.

6.2 Concept Note:

The storm water drainage system for the proposed industrial / manufacturing park has been planned as an integrated surface runoff management system intended to safely collect, convey and dispose storm runoff generated from industrial, commercial, transportation, utility and open areas under ultimate development conditions.

The proposed system has been conceptualized considering the existing terrain characteristics, natural drainage pattern, watershed behaviour, outfall availability, proposed land use and future urbanization impacts. The planning approach aims to preserve natural drainage paths to the extent feasible while minimizing flood risks, water logging and downstream hydraulic impacts.

The proposed drainage network shall comprise roadside drains, secondary carrier drains, trunk drains, culverts, cross-drainage structures, detention / recharge systems and outfall arrangements integrated with the proposed road hierarchy and grading strategy.

The drainage planning philosophy further incorporates runoff attenuation, rainwater harvesting, groundwater recharge and climate resilience measures to mitigate the impact of increasing imperviousness and extreme rainfall events associated with urban and industrial development.

The chapter establishes the hydrological basis, hydraulic design criteria, drainage zoning, outfall planning methodology and infrastructure requirements for development of a technically sound, hydraulically adequate and maintainable storm water drainage system for the project area.

6.3 Design Basis

This section shall establish the overall planning philosophy, hydrological framework, hydraulic design basis, flood-management approach, operational requirements, runoff-management strategy, and infrastructure-planning principles adopted for the proposed Storm Water Drainage (SWD) system under the DPR.

The DPR shall clearly establish the engineering rationale and technical basis adopted for assessment of catchment characteristics, runoff generation, rainfall analysis, hydraulic conveyance planning, outfall strategy, flood routing, runoff attenuation, rainwater harvesting, and long-term storm water management for the Industrial City.

The proposed storm water drainage infrastructure shall be planned considering the approved land-use pattern, industrial typologies, road hierarchy, grading strategy, terrain characteristics, utility corridors, environmental obligations, external catchment contribution, development phasing, and ultimate development potential of the Industrial City. The planning approach shall aim to ensure hydraulically adequate, environmentally sustainable, operationally reliable, climate-resilient and maintainable storm water management infrastructure across all phases of development and up to the adopted design horizon.

The proposed storm water management framework shall broadly comprise roadside drainage systems, underground storm drainage systems wherever applicable, secondary and trunk storm drains, interceptor drains, culverts and cross-drainage structures, outfall systems, flood-routing corridors, detention and retention systems, recharge structures, rainwater-harvesting infrastructure, pumping systems wherever required, monitoring infrastructure, and SCADA-based operational-control systems.

6.3.1 Planning Horizon & Development Phasing

The DPR shall define the adopted planning horizon, intermediate infrastructure augmentation stages, and phase-wise development strategy for the proposed storm water drainage infrastructure. The adopted planning framework shall be aligned with the approved master plan, projected urbanization pattern, industrial-development strategy, proposed grading plan, and long-term drainage requirements of the Industrial City.

The proposed drainage infrastructure shall be planned with adequate provision for phased implementation and future augmentation without major disruption to the operational system. The DPR shall clearly identify the base year, intermediate development phases, ultimate design year, and corresponding drainage-capacity requirements proposed under each stage of development.

6.3.2 Hydrological & Hydraulic Design Basis

The DPR shall establish the methodology, assumptions, hydrological criteria, rainfall analysis framework, runoff assessment methodology, hydraulic design criteria, and flood-management approach adopted for planning and design of the proposed storm water drainage infrastructure.

The hydrological assessment shall be based on terrain characteristics, watershed delineation, approved land-use distribution, surface characteristics, industrial development pattern, proposed grading strategy, runoff characteristics, and external catchment contribution within and adjoining the Industrial City. The DPR shall clearly establish the adopted:

- Rainfall data sources;
- Intensity-duration-frequency relationships;
- Design storm criteria;
- Design return periods;
- Runoff coefficients;
- Time of concentration;
- Peak runoff estimation methodology;
- Climate resilience considerations;
- Flood routing philosophy.

Hydraulic design of the storm water drainage system shall prioritize gravity-based conveyance systems to the maximum extent feasible while ensuring adequate carrying capacity, permissible flow velocities, prevention of surcharge and prolonged water-logging conditions, operational reliability, maintainability, and provision for future expansion.

6.3.3 Storm Water Drainage Planning Philosophy

The DPR shall establish the overall planning philosophy for the proposed storm water drainage network including drainage zoning, watershed integration, hierarchy of roadside drains, branch drains, secondary drains, trunk drains, interceptor drains, outfall systems, detention systems, and flood-routing corridors.

The planning approach shall prioritize preservation and integration of natural drainage systems to the extent feasible while minimizing obstruction to existing drainage paths and reducing downstream hydraulic impacts resulting from urbanization and industrial development. The DPR shall establish the adopted drainage-network planning philosophy considering:

- Terrain characteristics;
- Natural drainage paths;
- Grading strategy;

- Road hierarchy;
- Utility-corridor integration;
- Flood vulnerability;
- Maintainability;
- Future connectivity and expansion requirements.

The proposed planning framework shall also prioritize gravity-based drainage systems, minimum dependency on pumping, minimization of operational risk, optimization of hydraulic flow conditions, and integration of runoff attenuation and recharge measures within the drainage network.

6.3.4 Existing Drainage Integration & Regional Drainage connectivity

The DPR shall establish the framework adopted for integration of the proposed storm water drainage system with the existing natural drainage systems, regional drainage networks, existing culverts, natural outfalls, downstream waterways, and adjoining drainage infrastructure within and surrounding the Industrial City. The planning approach shall identify and evaluate:

- Existing natural drainage paths and nallah systems;
- Existing roadside drains and regional storm drainage systems;
- Existing culverts, cross-drainage structures and hydraulic crossings;
- External catchments contributing runoff into the project area;
- Downstream drainage constraints and tailwater conditions;
- Existing flood-prone and water-logging locations;
- Existing ponds, lakes, canals and receiving water bodies;
- Encroachments or obstructions affecting natural drainage behaviour.

The DPR shall establish that the proposed drainage planning preserves natural drainage characteristics to the extent feasible and avoids adverse impacts on upstream and downstream hydrology due to proposed development activities. The proposed drainage framework shall establish the methodology adopted for:

- Interception and diversion of external runoff;
- Integration of existing drains within the proposed network;
- Augmentation of downstream drainage infrastructure wherever required;
- Flood routing through natural and engineered drainage corridors;
- Mitigation of hydraulic bottlenecks and backflow conditions.

The DPR shall further establish that the carrying capacity of downstream drainage systems and receiving outfalls has been assessed for the proposed ultimate development runoff under the adopted design conditions.

6.3.5 Outfall planning & Flood Routing Philosophy

The DPR shall establish the overall outfall planning and flood-routing philosophy adopted for the proposed storm water drainage system. The planning framework shall identify:

- Natural outfall systems;
- Receiving water bodies;
- Downstream drainage constraints;
- Tailwater conditions;
- Flood-prone zones;
- External catchment inflows;
- Major flood-routing corridors.

The DPR shall establish the proposed framework for safe routing and disposal of runoff generated under both normal and extreme rainfall events without causing adverse hydraulic impacts within or downstream of the project area. The proposed outfall planning shall also establish provisions for:

- detention systems;
- emergency overflow routing;
- flood bypass arrangements;
- outfall protection measures;
- erosion-control measures;
- downstream flood-impact mitigation.

6.3.6 Rainwater harvesting & Runoff Mitigation Strategy

The DPR shall establish the runoff mitigation and rainwater-harvesting framework proposed for the Industrial Park with the objective of reducing incremental runoff generated due to urbanization and industrialization, improving groundwater recharge, and enhancing long-term water sustainability.

The proposed framework shall identify suitable provisions for detention, retention, recharge, infiltration and reuse of storm water through integration of recharge pits, recharge trenches, detention ponds, retention ponds, landscaped recharge systems, permeable surfaces, and plot-level rainwater-harvesting systems wherever feasible.

The DPR shall establish the adopted framework for integration of runoff attenuation and recharge systems with the proposed storm water drainage network, grading strategy, open-space planning, and environmental-management systems.

6.3.7 Climate Resilience & Urban Flood Management Framework

The DPR shall establish the climate resilience and urban flood-management philosophy adopted for the proposed storm water drainage infrastructure.

The proposed framework shall consider increasing short-duration extreme rainfall events, future urbanization impacts, flood vulnerability of critical infrastructure, operational reliability during extreme events, and long-term resilience of the drainage infrastructure. The DPR shall establish the proposed framework for:

- Flood-risk assessment;
- Major-minor drainage hierarchy;
- Surcharge management;
- Flood-routing corridors;
- Emergency overflow management;
- Critical infrastructure protection;
- Redundancy provisions wherever required.

The proposed framework shall also evaluate incorporation of runoff attenuation measures, decentralized recharge systems, detention facilities, rainwater-harvesting systems, and Sustainable Urban Drainage Systems (SUDS) to improve flood resilience, reduce peak runoff, enhance groundwater recharge, and minimize downstream hydraulic impacts resulting from urbanization and industrial development.

6.3.8 Digital utility monitoring & Smart Infrastructure

The DPR shall establish the proposed framework for monitoring, operational management, and digital utility integration for critical storm water drainage infrastructure within the Industrial City.

The proposed framework may include rainfall-monitoring systems, water-level monitoring arrangements at critical locations, flood-warning systems, GIS-based drainage mapping, and digital asset-management systems for improving operational monitoring, preventive maintenance, and emergency-response capability of the storm water drainage network.

SCADA integration and automated monitoring systems, wherever proposed, shall generally be limited to critical infrastructure components such as storm water pumping stations, detention systems, major outfall structures, and vulnerable flood-management corridors requiring active operational monitoring and emergency management.

The proposed framework shall prioritize gravity-based drainage systems with minimum dependence on pumping and complex automation systems.

6.3.9 Applicable Codes, Standards & Technical References

The DPR shall clearly identify all applicable codes, standards, technical manuals, hydrological references, statutory provisions, and engineering guidelines adopted for planning, design, construction, operation, and maintenance of the proposed storm water drainage infrastructure.

The adopted references shall generally include the latest revisions of CPHEEO Manual on Storm Water Drainage Systems (2019), IRC codes related to urban drainage and cross-drainage works, relevant BIS standards, CWC flood-estimation practices, MoHUA guidelines, environmental regulations, rainfall and hydrological data references, and other applicable statutory and technical provisions relevant to the proposed infrastructure systems.

All hydrological assessment, hydraulic analysis, drainage-network planning, culvert and cross-drainage design, outfall planning, flood-management measures, recharge systems, structural design, utility integration, monitoring systems, and operational frameworks proposed under the DPR shall conform to the adopted standards and applicable regulatory requirements.

6.4 Service Level Benchmarks

The DPR shall establish the proposed service-level benchmarks and performance requirements for the storm water drainage infrastructure proposed under the scheme. The adopted benchmarks shall be aligned with applicable CPHEEO guidelines, IRC codes and manuals, BIS standards, and other applicable statutory and technical provisions relevant to storm water drainage systems.

The adopted service-level framework shall form the basis for hydrological assessment, hydraulic design, flood management, infrastructure sizing, and operational planning of the proposed storm water drainage system for the Industrial City.

The proposed storm water drainage infrastructure shall be planned to meet or exceed the adopted service-level benchmarks under the prescribed design conditions while minimizing flooding, water logging, surcharge conditions, erosion, and downstream hydraulic impacts.

Indicative service-level benchmarks to be adopted under the DPR are provided below. The DPR may suitably refine the benchmarks based on project-specific requirements, terrain characteristics, land-use pattern, flood vulnerability, and applicable statutory provisions.

Table 6.1: Service Level Benchmarks

Sl. No	Service Level Benchmarks (SLBs)	Indicative Benchmarks
1	Storm Water Drainage Coverage	100%
2	Incidence of Water logging	Nil (In all Design conditions)
3	Preservation of Natural Drainage System & Paths	Mandatory
4	Adequacy of Drainage network & Cross drainage Structures	100%
5	Accessibility for Maintenance, Inspection & desilting of Drainage system	100%
6	Environmental & regulatory Compliances	100%

The DPR shall provide a comparative statement indicating the adopted service-level benchmarks, corresponding design provisions, and compliance methodology proposed under the project. Any deviation from the adopted benchmarks shall be explicitly identified and technically justified within the DPR along with the corresponding mitigation measures and project-specific constraints considered while adopting such deviations.

6.5 Adopted Design Standards & Norms

This section shall summarize the design standards, codes, guidelines, reference manuals, hydrological references, and planning norms adopted for preparation of the Storm Water Drainage (SWD) DPR. The objective of this section is to establish a consolidated technical reference framework for hydrological assessment, hydraulic design, structural design, flood management, and operational planning of the proposed storm water drainage infrastructure, thereby avoiding repetitive citation of standards in subsequent sections of the DPR.

The DPR shall clearly identify the adopted design criteria, corresponding reference standards, and applicable codal provisions for individual system components. In cases where project-specific requirements necessitate deviation from standard codal provisions or best engineering practices, the DPR shall provide adequate technical justification and supporting rationale for such deviations.

The following codes, standards, manuals, guidelines, and references may be considered during preparation of the DPR, including but not limited to:

6.5.1 Design Period

Table 6.2: Design Period

Component	Reference Code / Manual	Commonly adopted Design Period
Storm Water Drainage Network	CPHEEO Manual	30 Years
Primary/Trunk Drains	CPHEEO Manual/ IRC SP:50	30 Years
Culverts & Cross Drainage structures	Relevant IRC codes	30 Years
Storm water pumping Systems (Civil) if required.	CPHEEO Manual	30 years
Storm water pumping Systems (E&M) if required.	Industry Practices	15 years
Instrumentation & Monitoring Systems	Industry Practice / OEM Recommendations	10-15 years

6.5.2 Hydrological & hydraulic Design criteria

Table 6.3: Design Criteria

Component	Reference Code / Manual	Commonly adopted criteria
Rainfall Analysis	IMD Data/ CPHEEO manual	Based on Historical rainfall data
Design Storm Methodology	CPHEEO Manual/IRC SP:50	Rational Method or other suitable hydrological method
Design return Period	CPHEEO Manual/IRC SP:50	Based on hierarchy and criticality of Drainage infrastructure.
Run-off coefficient	CPHEEO Manual/IRC SP:50	Based on land use & surface characteristics
Time of concentration	CPHEEO Manual/IRC SP:50	As per adopted hydrological method
Hydraulic Design formula	CPHEEO Manual	Manning's Formula
Permissible velocity	CPHEEO Manual/IRC SP:50	As per drain type & hydraulic condition
Freeboard	CPHEEO Manual/IRC SP:50	As per drain type & hydraulic condition
Drainage Gradient	CPHEEO/IRC guidelines	To maintain adequate hydraulic performance and minimize silting
Flood Routing/Outfall design	CPHEEO Manual/IRC SP:50	Mandatory
External Catchment considerations	CPHEEO Manual/IRC SP:50	Mandatory considerations

The above values are indicative planning and design criteria generally adopted for preparation of DPRs for storm water drainage infrastructure. The final adopted values shall be based on applicable

standards, project-specific requirements, terrain characteristics, rainfall characteristics, flood vulnerability, downstream constraints, and detailed engineering assessment carried out under the DPR.

6.5.3 Drainage Network Planning Parameters

Table 6.4: Network Design Parameters

Component	Reference Code / Manual	Commonly adopted criteria
Drainage Network	CPHEEO Manual	Separate Storm Water Drainage network.
Drainage Configuration	CPHEEO Manual /Industry Practices;	Gravity based drainage system to the maximum possible extent.
Roadside Drainage	CPHEEO Manual/IRC SP:50	According to Grading & drainage requirements.
Open/ Covered Drains	CPHEEO Manual/IRC SP:50	Based on location, accessibility, safety, and maintenance consideration. (Preferable Covered Drains)
Inspection & desilting Access	CPHEEO Manual	Mandatory
Cross-drainage Structures	Relevant IRC codes	Mandatory for Natural drainage crossings
Erosion protection Measures	IRC / Best industry practices	Mandatory at vulnerable locations.

6.5.4 Flood Management & Recharge Measures

Table 6.5: Flood Management & Recharge Measures

Component	Reference Code / Manual	Commonly adopted criteria
Rainwater harvesting	CGWB/State guidelines	To be integrated wherever feasible
Recharge Structures	CGWB/Best Industry Practices	As per site suitability
Protection of Natural Drains	CPHEEO Manual	Mandatory
Flood protection Measures	Best Industry Practices	For Critical & vulnerable infrastructure

6.5.5 Materials & appurtenances

Table 6.6: Indicative Materials Considerations

Component	Reference Code / Manual	Commonly adopted criteria
RCC Drains	Relevant BIS standards	May be adopted for Primary/trunk/ Road drains

RCC pipes	IS 458	May be adopted for conveyance system and/or for culverts and underground drainage applications wherever applicable
RCC precast Drain elements	Relevant BIS standards	As per requirements
Cover/Gratings	Relevant BIS standards	As per requirements
Manholes & Chambers	CPHEEO/Relevant BIS standards	RCC chambers with maintenance & access provisions

The above values/codes are indicative planning and design criteria generally adopted for preparation of DPRs for storm water drainage infrastructure. The final adopted values shall be based on applicable standards, project-specific requirements, terrain conditions, hydraulic requirements, operational philosophy, maintainability requirements, and detailed engineering assessment carried out under the DPR.

6.6 Design of Major Project Components

This section shall establish the hydrological framework, hydraulic design philosophy, infrastructure configuration, flood-management approach, operational requirements, resilience framework, and implementation strategy adopted for all major components of the proposed Storm Water Drainage (SWD) infrastructure under the DPR.

The DPR shall demonstrate that the proposed storm water drainage infrastructure is technically adequate for the adopted design storm conditions, external catchment contribution, phase-wise development requirements, ultimate development scenario, and long-term urbanization impacts while ensuring safe, reliable, hydraulically efficient, maintainable, and climate-resilient storm water management across the Industrial City.

The DPR shall include component-wise hydrological assessment, hydraulic computations, runoff analysis, flood-routing assessment, drainage-network design, sizing calculations, structural considerations, utility integration requirements, layout drawings, operational philosophy, maintainability provisions, and implementation framework for all major storm water drainage infrastructure proposed under the project.

The proposed infrastructure planning shall establish the technical basis and design framework for roadside storm water drains, covered drainage systems, underground storm water conduits, secondary drains, trunk drains, interceptor drains, culverts, cross-drainage structures, outfall systems, flood-routing corridors, recharge systems, detention systems, erosion-protection systems, storm water pumping systems wherever required, storm water inlet systems, inspection chambers, monitoring systems, and associated drainage appurtenances proposed under the scheme. The proposed storm water drainage infrastructure shall prioritize:

- Gravity-based drainage systems;
- Target Zero instances of flooding and water logging;
- Preservation and integration of natural drainage systems;
- Hydraulic adequacy under ultimate development conditions;
- Reduction of operational and maintenance risks;
- Flood resilience and emergency drainage capability;
- Ease of inspection, desilting, and maintenance accessibility;
- Integration with grading strategy, road hierarchy, and utility corridors;
- Long-term operational sustainability and scalability.

The design of all storm water drainage components shall conform to the adopted standards, manuals, hydrological practices, environmental requirements, and statutory provisions specified under the DPR.

6.6.1 Hydrological Assessments & Design Storm Analysis

The DPR shall establish the hydrological assessment framework, rainfall-analysis methodology, runoff-estimation philosophy, and design storm criteria adopted for planning and design of the proposed storm water drainage infrastructure. The DPR shall generally address the following design aspects for hydrological assessment and runoff estimation:

6.6.1.1 Rainfall Analysis

The DPR shall establish the adopted rainfall-analysis methodology considering IMD records, available historical rainfall data, storm characteristics, rainfall intensity-duration-frequency relationships, temporal rainfall distribution, spatial variability, and extreme rainfall conditions relevant to the project area.

6.6.1.2 Catchment Delineation

The DPR shall establish the catchment delineation framework considering topography, grading pattern, natural drainage paths, development pattern, external catchment contribution, road network, utility corridors, and outfall locations.

6.6.1.3 Design Return Period

The DPR shall establish the adopted design return periods for various storm water drainage components considering drainage hierarchy, infrastructure criticality, road classification, industrial sensitivity, flood risk, operational importance, and applicable CPHEEO and IRC codes.

6.6.1.4 Runoff Estimation Procedure

The DPR shall establish the adopted methodology for estimation of runoff considering land-use characteristics, imperviousness, runoff travel path, catchment slope, infiltration characteristics, grading pattern, development density, and ultimate development conditions.

6.6.1.5 Rational Method & Hydrological Formulae

The DPR shall establish the adopted hydrological methods and formulae used for runoff estimation including Rational Method and other suitable hydrological approaches adopted for various drainage catchments under the project

6.6.1.6 Runoff Coefficient

The DPR shall establish the adopted runoff coefficients for industrial areas, paved surfaces, landscaped zones, utility areas, open spaces, and other land-use categories considering surface characteristics and future urbanization conditions.

6.6.1.7 Time of Concentration

The DPR shall establish the adopted methodology and criteria for estimation of time of concentration considering catchment geometry, hydraulic flow path, slope conditions, surface roughness, and drainage-network configuration.

6.6.1.8 Design Flow Estimation

The DPR shall establish the methodology adopted for estimation of peak runoff and design discharge for all storm water drainage components considering ultimate development scenario, external catchment contribution, surcharge conditions, tailwater effects, and flood-routing requirements.

6.6.2 Hydraulic Design of SWD system

The DPR shall establish the hydraulic design philosophy, sizing criteria, hydraulic-performance requirements, and flow-management framework adopted for design of the proposed storm water drainage infrastructure. The DPR shall generally address the following hydraulic design aspects:

6.6.2.1 Hydraulic Design Methodology:

The DPR shall establish the adopted hydraulic-design approach and criteria for design of storm water drainage systems considering hydraulic efficiency, flow stability, sediment transport, flood management, energy dissipation, operational reliability, and maintenance requirements.

6.6.2.2 Hydraulic Design Formula:

The DPR shall establish the adopted hydraulic formulae and equations for storm water drainage design with reference to applicable CPHEEO guidelines and engineering standards.

6.6.2.3 Manning's equation & roughness Coefficient:

The DPR shall establish the adopted Manning's roughness coefficients and hydraulic parameters considered for design of lined drains, covered drains, underground conduits, culverts, and open-channel systems.

6.6.2.4 Design Velocity & Self Cleansing Criteria:

The DPR shall establish the adopted velocity criteria required for maintaining adequate hydraulic performance while preventing silting, stagnation, erosion, sediment deposition, turbulence, and structural deterioration within the drainage network.

6.6.2.5 Free Board:

The DPR shall establish the adopted freeboard criteria considering drain hierarchy, hydraulic conditions, surcharge considerations, flood risk, and operational safety requirements.

6.6.2.6 Hydraulic Gradient & Drain Slope:

The DPR shall establish the adopted hydraulic-gradient criteria, longitudinal slope requirements, and flow conditions required for efficient conveyance and prevention of adverse hydraulic conditions within the drainage network.

6.6.2.6 Transition Losses & Hydraulic junctions:

The DPR shall establish the criteria adopted for hydraulic transitions, drain junctions, flow bifurcation, confluence locations, level differences, and associated head-loss considerations.

6.6.2.7 Tailwater effects & Backwater conditions:

The DPR shall establish the methodology adopted for assessment of tailwater conditions, backflow risks, downstream surcharge conditions, and outfall-control effects influencing the hydraulic performance of the drainage system.

6.6.2.8 Hydraulic Computation sheets:

The DPR shall include hydraulic calculations, conduit-sizing calculations, hydraulic profiles, flow-capacity assessment, and supporting computation sheets for all storm water drainage (SWD) components proposed under the project.

6.6.3 Design of Stormwater Drainage Network

The DPR shall establish the planning philosophy, alignment framework, drainage hierarchy, network configuration, and infrastructure-integration approach adopted for the proposed storm water drainage network. The DPR shall generally address the following design aspects for the storm water drainage network.

6.6.3.1 Drainage Hierarchy & Network Configuration:

The DPR shall establish the proposed hierarchy of tertiary drains, roadside drains, secondary drains, trunk drains, interceptor drains, and outfall systems along with the corresponding catchment allocation and drainage-network configuration.

6.6.3.2 Covered Drainage Philosophy:

Covered storm water drainage systems shall generally be adopted within developed urban areas, industrial plots, logistics areas, commercial areas, utility corridors, and pedestrian-accessible zones of the Industrial City. Open drains shall generally be avoided except along natural drainage channels, existing drainage paths, peripheral drainage corridors, and locations where open-channel conveyance is necessitated due to hydraulic and flood-management considerations.

6.6.3.3 Selection of Drain Type:

The DPR shall undertake comparative assessment of alternative drain configurations including circular conduits, rectangular drains, trapezoidal drains, covered drains, underground conduit systems, and open-channel systems considering hydraulic efficiency, maintenance accessibility, construction feasibility, utility integration, lifecycle cost, and operational requirements.

6.6.3.4 Alignment Criteria:

The DPR shall establish the horizontal and vertical alignment philosophy considering grading pattern, road geometry, utility corridors, outfall integration, flood-routing requirements, hydraulic performance, accessibility requirements, and future maintenance considerations.

6.6.3.5 Road Side Drainage system:

The DPR shall establish the design approach, sizing philosophy, collection efficiency, and drainage integration framework adopted for roadside storm water drainage systems along the proposed road network.

6.6.3.6 External Catchment Considerations:

The DPR shall establish the framework adopted for interception, diversion, routing, and management of runoff contribution from external catchments entering the proposed development area.

6.6.3.7 Storm water Manholes & inspection Chambers:

The DPR shall establish the planning criteria, spacing philosophy, sizing requirements, accessibility provisions, structural considerations, and maintenance requirements adopted for storm water manholes and inspection chambers.

6.6.3.8 Road & Utility Crossings:

The DPR shall establish the methodology adopted for crossings of roads, drains, railways, utility corridors, pipelines, and other infrastructure interfaces.

6.6.3.9 Layout Drawings & Hydraulic Profile:

The DPR shall include drainage-network layouts, catchment plans, hydraulic profiles, utility integration details, longitudinal sections, and key cross-sections required for establishing the technical adequacy of the proposed system.

6.6.4 Stormwater Inlets & Collection System:

The DPR shall establish the planning framework, hydraulic criteria, collection efficiency requirements, and spacing philosophy adopted for storm water inlet systems. The DPR shall generally address the following design aspects:

6.6.4.1 Types of Inlets:

The DPR shall establish the applicability and use of curb inlets, grated inlets, gully pits, combination inlets, trench drains, and other inlet arrangements proposed under the project.

6.6.4.2 Design & location of inlets:

The DPR shall establish the design criteria, interception capacity, spacing philosophy, hydraulic capacity requirements, and placement methodology adopted for storm water inlets considering road geometry, grading pattern, runoff accumulation, traffic movement, pedestrian safety, and maintenance accessibility.

6.6.4.3 Silt & debris Management:

The DPR shall establish the provisions proposed for interception and management of silt, debris, floating material, and solid waste entering the storm water drainage network.

6.6.5 Culverts, cross-Drainage Structures & Outfall system:

The DPR shall establish the planning philosophy, hydraulic design framework, structural considerations, and integration requirements adopted for culverts, cross-drainage structures, and outfall systems proposed under the project. The DPR shall generally address the following design aspects.

6.6.5.1 Culverts & Cross Drainage Structures:

The DPR shall establish the hydraulic design criteria, sizing methodology, waterway assessment, afflux considerations, and structural framework adopted for culverts and cross-drainage structures.

6.6.5.2 Outfall design:

The DPR shall establish the hydraulic integration framework, outfall-capacity assessment, discharge conditions, tailwater considerations, erosion-control measures, and downstream integration philosophy adopted for storm water outfall systems.

6.6.5.3 Erosion Protection:

The DPR shall establish the erosion-control measures, slope-protection systems, energy-dissipation arrangements, scour-protection measures, and bank-protection provisions proposed under the project.

6.6.6 Design Considerations for special Area:

The DPR shall establish the special design criteria and engineering considerations adopted for storm water drainage systems in areas having unique terrain conditions, flood vulnerability, or hydraulic constraints.

6.6.6.1 Hilly Areas & Steep Terrain:

The DPR shall establish the design considerations adopted for hilly terrain, steep-gradient zones, and high-velocity flow conditions including slope stabilization, cascade arrangements, erosion protection, hydraulic transitions, and energy-dissipation measures.

6.6.6.2 Flood-prone & low-lying areas:

The DPR shall establish the flood-management measures, emergency-routing philosophy, drainage augmentation provisions, flood-protection measures, and operational safeguards proposed for flood-prone and low-lying areas.

6.6.7 Storm Water Pumping Systems:

The DPR shall establish the planning philosophy, sizing basis, redundancy framework, operational strategy, and infrastructure requirements adopted for storm water pumping systems wherever gravity-based drainage is not feasible.

6.6.7.1 Pumping Philosophy:

The DPR shall establish the basis for adoption of storm water pumping systems and demonstrate that gravity-based drainage has been prioritized to the maximum feasible extent.

6.6.7.2 Selection of Pumps:

The DPR shall undertake comparative assessment of alternative pumping arrangements considering hydraulic efficiency, flood-management requirements,

operational reliability, redundancy requirements, energy consumption, surge conditions, and lifecycle cost.

6.6.7.3 Pumping Main:

The DPR shall establish the design basis, hydraulic criteria, material-selection philosophy, surge-protection requirements, and outfall integration framework adopted for storm water pumping mains.

6.6.7.4 Redundancy & Power back up:

The DPR shall establish the standby philosophy, backup-power arrangements, emergency operation framework, and redundancy provisions proposed for critical pumping infrastructure.

6.6.7.5 Monitoring & Automation:

The DPR shall establish the monitoring framework, instrumentation systems, alarm systems, flood-warning systems, and automation philosophy proposed for storm water pumping infrastructure.

6.6.8 Rainwater Harvesting & Sustainable Drainage system:

The DPR shall establish the framework adopted for integration of rainwater harvesting, recharge systems, runoff attenuation measures, and sustainable storm water management practices within the proposed development. The DPR shall generally highlight following aspects:

6.6.8.1 Rainwater Harvesting Integration:

The DPR shall establish the proposed framework for integration of rainwater harvesting systems with the storm water drainage network or within the project area through different best industry practices wherever feasible.

6.6.8.2 Groundwater recharge:

The DPR shall establish the planning criteria and applicability of recharge pits, recharge trenches, recharge wells, infiltration systems, and associated groundwater-recharge measures proposed under the project.

6.6.8.3 Detention & retention System:

The DPR shall establish the applicability and sizing philosophy adopted for detention systems, retention systems, balancing systems, and runoff-attenuation measures for critical drainage catchments.

6.6.8.4 Sustainable Storm water Management:

The DPR shall evaluate the applicability and integration of Sustainable Urban Drainage Systems (SUDS), Water Sensitive Urban Design (WSUD) measures, and

other sustainable storm water management approaches within the proposed Industrial Park infrastructure. The proposed framework shall aim to reduce runoff generation, attenuate peak discharge, improve groundwater recharge, minimize urban flooding, reduce burden on downstream drainage infrastructure, and improve long-term hydrological sustainability of the development.

6.6.8.5 Monitoring & Automation:

The DPR shall establish the monitoring framework, instrumentation systems, alarm systems, flood-warning systems, and automation philosophy proposed for storm water pumping infrastructure.

6.7 Project Cost Estimation & Lifecycle O&M Assessment:

This section shall establish the phase-wise Capital Expenditure (CAPEX) and Operational Expenditure (OPEX) assessment for the proposed Storm Water Drainage infrastructure under the DPR. The assessment shall include all civil, hydraulic, structural, electromechanical, utility, monitoring, environmental-protection, and allied infrastructure components required for development, operation, maintenance, and long-term sustainability of the complete storm water drainage system.

The cost estimation shall be based on applicable Schedule of Rates (SoR), approved market rates, recent comparable infrastructure projects, or other accepted estimation methodologies adopted by the implementing agency. The DPR shall clearly establish the basis of estimation, year of pricing, rate basis, contingencies, escalation provisions, utility-shifting provisions, applicable taxes and duties, and project-specific assumptions considered during preparation of the cost estimates.

The CAPEX assessment shall include storm water drains, underground conduits, trunk drains, interceptor drains, culverts, cross-drainage structures, outfall systems, storm water inlets, manholes, recharge systems, detention systems, erosion-protection works, pumping infrastructure wherever applicable, utility shifting, road restoration, SCADA and monitoring infrastructure wherever proposed, electrical systems, landscaping restoration, and associated site-development works.

The OPEX assessment shall include desilting operations, drain cleaning, inspection and maintenance activities, pumping power consumption wherever applicable, manpower deployment, monitoring-system operation, preventive maintenance, flood-management preparedness, emergency-response requirements, periodic rehabilitation works, and long-term asset-maintenance requirements.

The DPR shall also establish phase-wise investment planning and assess long-term operational sustainability considering maintainability, desilting requirements, flood resilience, energy efficiency, lifecycle asset management, operational risks, and future augmentation requirements of the proposed storm water drainage infrastructure.

Table 6.8: Cost Estimation & Lifecycle O&M Assessment

Category	Indicative Components
Civil & Hydraulic Infrastructure	Roadside drains, covered drains, underground conduits, trunk drains, interceptor drains, culverts, outfall structures, headwalls, chambers
Storm water Collection Systems	Inlets, gully pits, catch basins, gratings, inspection chambers, manhole.
Structural & protection Works	Retaining structures, erosion protection, slope protection, energy dissipation arrangements etc.
Utility Shifting & Restoration	Utility relocation, road restoration, pavement reinstatement, landscaping restoration etc, as applicable.
Monitoring & Smart Infrastructure	Flood-warning systems, flow-monitoring systems, rainfall-monitoring systems, GIS integration
O&M Cost	Power, manpower, maintenance Cost etc.

6.8 Checklist for Mandatory Deliverables.

The DPR shall include all technical deliverables, hydrological assessments, hydraulic calculations, engineering drawings, investigations, cost assessments, statutory considerations, and supporting documents necessary for technical appraisal, implementation, operation, maintenance, and future reference of the proposed Storm Water Drainage infrastructure.

All submissions shall be consistent with the adopted design criteria, rainfall analysis, runoff assessment, hydraulic design framework, grading strategy, flood-management philosophy, applicable CPHEEO guidelines, IRC codes, BIS codes, environmental requirements, and other adopted standards under the DPR.

Table 6.9: Mandatory Deliverables Checklist

Sl. No.	Mandatory Deliverable	Compliance
	A. Planning, Investigations & Design Basis	
1	Approved Master Plan / Land-use Plan	□
2	Planning Horizon & Development Phasing Assessment	□
3	Topographical Survey, Contour Plan & Existing Drainage Assessment	□
4	Rainfall Analysis, Catchment Delineation & Runoff Assessment	□
5	Hydrological & Hydraulic Design Basis Report	□
6	Design Criteria, Codes & Standards Statement	□
7	Service Level Benchmark Compliance Statement	□
	B. Storm Water Drainage Network & Hydraulic Infrastructure	
8	Storm Water Drainage Network Design Report	□
9	Drainage Layout Drawings, Catchment Plan & Drainage Zoning Plan	□

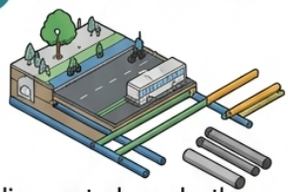
10	Hydraulic Profiles, Longitudinal Sections & Computation Sheets	□
11	Drain Type Selection & Hydraulic Design Justification	□
12	Roadside Drainage, Storm Water Inlet & Manhole Details	□
13	Trunk Drains, Culverts, Cross-Drainage Structures & Outfall Design	□
14	Utility Crossing, Road Crossing & Corridor Coordination Details	□
15	Storm Water Pumping System Design wherever applicable	□
16	Erosion Protection, Scour-Control & Flood-Management Measures	□
	C. Sustainable Drainage & Smart Infrastructure Systems	
17	Rainwater Harvesting, Recharge & SUDS / WSUD Integration Framework	□
18	Flood Routing, External Catchment & Waterlogging Mitigation Assessment	□
19	Monitoring, SCADA & Flood Warning Framework wherever applicable	□
20	GIS-Based Utility Mapping & Asset Management Framework	□
	D. Costing, Implementation & O&M Framework	
21	Project Cost Estimation, BOQ & Lifecycle O&M Assessment	□
22	O&M Philosophy, Desilting & Preventive Maintenance Framework	□
23	Environmental & Statutory Compliance Assessment	□
24	Risk Assessment, Implementation Schedule & DPR Compliance Statement	□

1 DESIGN PERIOD



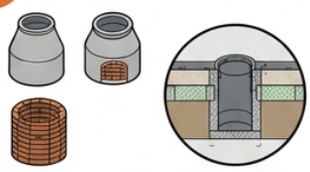
- 30-year horizon
- Phased expansion
- Superblock planning

2 SEWER NETWORK



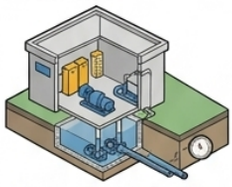
- Alignment, slope, depth
- Min size >=150mm
- Pipe material selection

3 MANHOLES



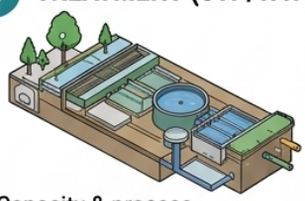
- At junctions, bends, intervals
- Based on function & spacing
- Access & maintenance

4 PUMPING



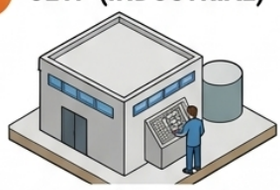
- Wet well, pumps, rising main
- Backup, surge protection
- Reliable operation

5 TREATMENT (STP/WWTP)



- Capacity & process
- Sludge handling & compliance
- Disinfection & treatment

6 CETP (INDUSTRIAL)



- Based on effluent type & load
- Monitor quality parameters
- Ensure regulatory compliance

7 REUSE / DISPOSAL



- Reuse (landscaping, cooling)
- Safe discharge
- Sustainable water management

8 O&M + MONITORING



- SCADA, flow meters, sampling
- Maintenance & emergency systems
- System performance monitoring

CHAPTER 7

SOLID WASTE MANAGEMENT

7.1 About this Chapter:

This chapter outlines the requirements and technical expectations for the Solid Waste Management (SWM) component of the Detailed Project Report (DPR) to be submitted by the State/SPV/implementing agency. It serves as the reference framework for preparation and technical evaluation of the proposed SWM system for the Industrial Park under BHAVYA Scheme.

The chapter aims to ensure development of an integrated, sustainable, efficient, and future-ready Solid Waste Management system covering waste generation assessment, collection, segregation, transportation, processing, recycling, treatment, disposal, monitoring, and institutional management.

The DPR shall demonstrate that the proposed SWM system is capable of managing municipal solid waste, industrial non-hazardous waste, commercial waste, horticulture waste, inert waste, and other identified waste streams generated within the project area across all development phases and up to the adopted design horizon.

7.2 Concept Note:

BHAVYA Scheme envisages the development of future-ready, sustainable, and efficient Industrial Parks with high-quality infrastructure aimed at enhancing industrial productivity, operational reliability, and long-term resource efficiency. The infrastructure framework shall include integrated core utilities such as internal roads, underground utility networks, drainage systems, common treatment facilities, ICT infrastructure, and administrative systems. Considering water and power infrastructure as major lifecycle cost components, the planning approach shall prioritize efficiency, resilience, sustainability, and ease of operations.

The Solid Waste Management system for the proposed Industrial Park shall be planned as an integrated utility and environmental-management framework ensuring efficient collection, segregation, transportation, treatment, recovery, recycling, and scientific disposal of solid waste. The planning philosophy shall emphasize waste minimization, source segregation, circular-economy principles, resource recovery, composting, recycling, energy recovery, and reduction of landfill dependency. Separate assessment and planning shall be undertaken for biodegradable waste, recyclable waste, inert waste, industrial non-hazardous waste, and domestic hazardous waste.

The proposed SWM architecture may include waste-storage infrastructure, primary collection systems, transfer stations, Material Recovery Facilities (MRFs), composting/bio methanation facilities, waste-processing plants, sanitary landfill facilities, ICT-enabled monitoring systems, and associated transportation infrastructure.

The SWM plan preparation is based on a complete review and understanding of the special features of the project. Understanding the major sources generating solid wastes, type of waste, physical and chemical characteristics of the solid waste a Solid Waste Management Plan has been prepared. Different management for different type of wastes like Municipal Solid Waste (MSW), e-waste, Bio-Medical Waste, Construction and Demolition Waste, Hazardous and Other Wastes, Battery waste Management Plans are developed under the umbrella of Solid Waste Management Plan. Industrial waste management attracts totally different types of approach and its very industry specific. End to end management plans for all solid waste which will be generated in the Industrial Park are considered.

- Development of approach for waste management and service levels.
- Estimates of quantity of solid waste expected to be generated over the planning horizon and evolving the overall approach towards effective and safe management.
- Broad assessment of infrastructure for collection, transport, treatment (including recycling) and safe disposal of municipal solid waste.
- Designing waste management system under the paradigm of an eco-industrial park for maximizing waste recycling and resource recovery among different industrial units.

The DPR shall establish the technical basis for phase-wise infrastructure development, operational sustainability, environmental compliance, and long-term resilience of the proposed SWM system.

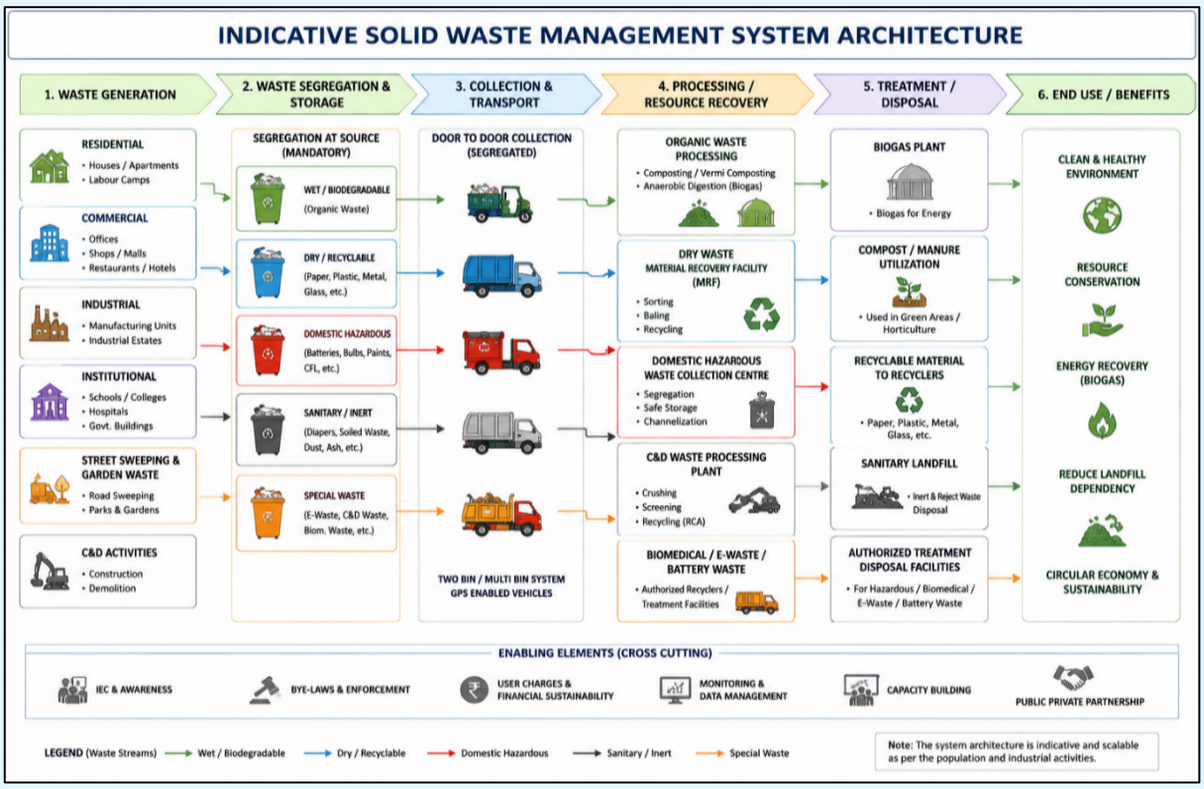


Figure 7.1: Indicative Solid Waste Management (SWM) System Architecture

7.3 Design Basis

This section shall establish the overall planning philosophy, design criteria, operational objectives, and minimum service level requirements for the proposed Solid Waste Management (SWM) system. The DPR shall define the adopted planning horizon, waste-generation projections, waste characterization methodology, collection philosophy, transportation framework, processing strategy, environmental safeguards, and service-level objectives for the SWM system.

7.3.1 Planning Horizon & Development Phasing

The DPR shall define the adopted planning horizon, intermediate development stages, and phase-wise infrastructure augmentation strategy considering projected industrial growth, land development pattern, and future expansion requirements of the Industrial City.

7.3.2 Basis of Population & Industrial Growth Projection

The DPR shall establish the methodology and assumptions adopted for estimating resident population, floating population, worker population, industrial occupancy, and future industrial growth based on the approved master plan and proposed industrial typologies.

7.3.3 Waste Generation & Characterization Methodology

The DPR shall establish the methodology adopted for phase-wise and ultimate-year waste quantification and characterization based on projected population, industrial typologies, land use pattern, commercial activities, occupancy levels, and applicable waste-generation benchmarks supported through field studies, sampling, and waste-composition analysis.

7.3.4 Source Segregation Philosophy

The DPR shall define the source segregation philosophy for systematic separation of waste streams at the point of generation through a multi-bin collection system covering biodegradable, recyclable, domestic hazardous, sanitary, and special waste in accordance with applicable SWM Rules and resource-recovery objectives.

7.3.5 Collection & Transportation Strategy

The DPR shall establish an efficient and environmentally compliant collection and transportation strategy covering door-to-door collection, mechanized sweeping, transfer systems, route optimization, vehicle deployment, and GPS-enabled monitoring mechanisms.

7.3.6 Waste Processing & Resource Recovery Philosophy

The DPR shall define the waste-processing and resource-recovery philosophy emphasizing segregation, recycling, composting, bio methanation, (Refuse-Derived Fuel) RDF generation, waste-to-energy integration, and maximization of material recovery to minimize landfill dependency.

7.3.7 Landfill & Scientific Disposal Framework

The DPR shall establish the framework for scientific disposal of inert waste and process rejects through engineered landfill systems incorporating leachate management, environmental safeguards, gas venting, monitoring, and long-term closure provisions.

7.3.8 Reliability, Redundancy & Resilience Criteria

The DPR shall define the reliability and redundancy provisions for critical SWM infrastructure including collection systems, processing facilities, backup equipment, emergency storage, and contingency arrangements to ensure uninterrupted operations during peak and emergency conditions.

7.3.9 Automation & Smart Monitoring Systems

The DPR shall establish the proposed automation and digital monitoring framework including GPS-enabled vehicles, RFID systems, SCADA integration, weighbridges, IoT-based monitoring, MIS platforms, and centralized command-and-control systems for efficient SWM operations.

7.3.10 Sustainability & Circular Economy Measures

The DPR shall establish sustainability measures focused on waste minimization, reuse, recycling, resource recovery, energy generation, reduction of carbon footprint, and promotion of circular-economy principles across the SWM value chain.

7.3.11 Applicable Codes, Standards & Technical References

The DPR shall identify the applicable codes, standards, manuals, guidelines, benchmarks, and statutory provisions adopted for planning, design, construction, operation, and maintenance of the proposed Solid Waste Management system and its individual infrastructure components.

7.4 Service Level Benchmarks

This section outlines the applicable Service Level Benchmarks (SLBs) for the proposed Solid Waste Management (SWM) system, primarily based on the benchmarks prescribed by the Ministry of Housing and Urban Affairs (MoHUA) Solid Waste Management Rules, 2016 and other relevant standards.

The DPR shall specify the adopted service levels against each benchmark parameter in a comparative tabular format, along with the proposed compliance approach. The adopted values shall generally meet or exceed the prescribed benchmark levels. Any deviation from the applicable benchmarks shall be supported with adequate project-specific technical justification.

Table 7.1: Service Level Benchmarks

Sl. No	Service Level Benchmarks (SLBs)	MoHUA Value
1	Household Level Coverage of Solid Waste Collection Services	100%
2	Efficiency of Municipal Solid Waste Collection	100%
3	Extent of Segregation of Municipal Solid Waste	100%
4	Extent of Scientific Processing of Municipal Solid Waste	Value
5	Extent of Scientific Disposal of Municipal Solid Waste	100%
6	Frequency of Street Sweeping	Daily / As per Road Hierarchy
7	Coverage of Door-to-Door Collection	100%
8	Coverage of Source Segregation System	100%
9	Complaint Redressal Efficiency	≥80%
10	GPS/ICT Enabled Monitoring of Waste Transportation	100%
11	Collection Efficiency of User Charges	100%
12	Landfill Disposal restricted only to Inert & Processing Rejects	Mandatory
13	Processing of Wet/Biodegradable Waste through Composting/Bio methanation	Mandatory
14	Compliance with SWM Rules 2016	100%
15	Elimination of Open Dumping & Open Burning of Waste	100% Compliance

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7.5 Adopted Design Standards & Norms

This section shall summarize the design standards, codes, guidelines, reference manuals, and planning norms adopted for preparation of the Solid Waste Management System in the DPR. The objective of this section is to establish a consolidated technical reference framework for all design parameters and infrastructure components, thereby avoiding repetitive citation of standards in subsequent sections of the DPR.

The DPR shall clearly identify the adopted design criteria, corresponding reference standards, and applicable codal provisions for individual system components. In cases where project-specific requirements necessitate deviation from standard codal provisions or commonly adopted engineering practices, the DPR shall provide adequate technical justification and supporting rationale for such deviations.

The following codes, standards, manuals, guidelines, and references may be considered during preparation of the DPR, including but not limited to:

7.5.1 Design Parameter

Table 7.2: Design Parameters

Design Parameter / Component	Reference Code / Manual	Commonly adopted Criteria/ Standards
Waste Generation Rate	CPHEEO Manual on Municipal Solid Waste Management	0.35–0.45 kg/capita/day (Residential)
Commercial Waste Generation	CPHEEO Manual / Project Specific Assessment	0.10–0.20 kg/capita/day
Industrial Non-Hazardous Waste Generation	Project Specific / Industrial Benchmarking	Based on Waste Quantity & Haul Distance
Transfer Station Design Criteria	CPHEEO Manual / CPCB Guidelines	100% Collection Coverage
Processing Plant Design Period	CPHEEO Manual	Generally 15–20 Years
Material Recovery Facility (MRF) Design	CPCB Guidelines / Industry Practices	Based on Segregated Dry Waste Quantity
Composting Plant Design Criteria	CPHEEO Manual / CPCB Guidelines	Based on Organic Waste Fraction
Bio methanation Plant Design Parameters	MNRE / CPCB Guidelines	Based on Biodegradable Waste Characteristics
RDF/Waste-to-Energy Criteria	CPCB / MoEFCC Guidelines	Waste with CV >1500 kcal/kg
Vehicle Routing & Transportation Criteria	CPHEEO Manual / Industry Practices	GPS Enabled Route Optimization
Primary Collection Vehicle Capacity	Industry Practice	2.5–3 Cum Mini Tippers
Secondary Transportation Vehicle Capacity	Industry Practice	5–6 Cum Mechanized Tippers
Scientific Landfill Design Standards	SWM Rules 2016 / CPCB Guidelines	Engineered Landfill with Leachate Management
Leachate Collection & Treatment	CPCB Guidelines	Mandatory for Landfill Facilities
Construction & Demolition Waste Management	C&D Waste Rules 2016	Reuse/Recycling Preferred

7.6 Waste Generation Assessment

This section of the DPR shall establish the phase-wise and ultimate-year solid waste generation assessment for the proposed Industrial/Manufacturing Cluster based on approved land use, projected population, industrial typologies, employment generation, commercial development, logistics activities, institutional facilities, utility areas, and applicable planning benchmarks. The assessment shall form the basis for planning and sizing of all downstream Solid Waste Management (SWM) infrastructure components including collection systems, transfer stations, Material Recovery Facilities (MRFs), composting/bio methanation facilities, RDF/Waste-to-Energy systems, landfill facilities, and transportation infrastructure.

The DPR shall clearly define the adopted methodology, assumptions, generation factors, waste-characterization studies, segregation philosophy, collection efficiency, recycling targets, and design horizon adopted for preparation of the waste generation assessment. The waste assessment shall comprehensively cover the following waste streams:

7.6.1 Domestic Solid Waste

Domestic solid waste generation shall be assessed based on projected residential population, worker accommodation, dormitories, staff housing, transit accommodation, and associated residential facilities proposed within the project area. The adopted waste-generation norms shall be in accordance with CPHEEO guidelines, applicable state regulations, and project-specific benchmarking studies.

The DPR shall clearly establish:

- Phase-wise residential population projections
- Occupancy assumptions
- Per-capita waste generation norms
- Segregation ratios for wet, dry, and domestic hazardous waste
- Seasonal variation considerations
- Collection efficiency assumptions

Indicative domestic waste streams may include biodegradable waste, recyclable waste, sanitary waste, domestic hazardous waste, packaging waste, and inert fractions.

7.6.2 Commercial Waste

Commercial waste generation shall be assessed based on proposed commercial floor area, office spaces, retail developments, food courts, hospitality establishments, logistics facilities, administrative buildings, and common amenity areas within the industrial park. The DPR shall identify:

- Occupancy-based waste generation

- Floor-area-based waste generation criteria
- Waste composition characteristics
- Recyclable content assessment
- Food and organic waste quantities
- Collection frequency requirements

Separate consideration shall be given to high-footfall commercial zones and logistics hubs generating substantial packaging and dry recyclable waste.

7.6.3 Industrial Non-Hazardous Waste

Industrial non-hazardous waste generation shall be assessed category-wise based on the proposed industrial mix, manufacturing typologies, process characteristics, utility requirements, and expected industrial occupancy within the industrial area. Generic per-capita norms shall not be adopted for industrial waste estimation.

The DPR shall preferably derive industrial waste-generation factors through:

- Benchmarking of comparable industrial estates
- Industrial case studies
- Process-specific waste assessments
- Sector-wise waste-generation studies

The assessment shall distinctly identify:

- Process waste
- Packaging waste
- Scrap materials
- Recyclable industrial waste
- Utility sludge
- Organic industrial waste
- Reusable by-products

The DPR shall also establish opportunities for industrial symbiosis, resource recovery, recycling, and circular-economy integration among industries within the cluster.

7.6.4 Horticulture & Green Waste

Horticulture and green waste generation shall be assessed based on greenbelt areas, avenue plantation, landscaped zones, parks, open spaces, and seasonal vegetation management requirements proposed within the project area.

The DPR shall establish:

- Area-wise green waste generation
- Seasonal variations
- Mulching and composting potential
- Reuse strategy for manure generation and landscaping applications

The DPR shall preferably maximize reuse of horticulture waste through composting, mulching, and bio methanation applications.

7.6.5 Construction & Demolition Waste

Construction & Demolition (C&D) waste assessment shall be undertaken for both construction-phase and operational-phase activities considering infrastructure development, industrial construction, utility works, road works, and future redevelopment activities within the project area. The DPR shall establish:

- Estimated C&D waste quantities
- Material composition (concrete, steel, bricks, soil, masonry, wood, asphalt, etc.)
- Reuse and recycling potential
- Temporary storage arrangements
- Disposal strategy
- Integration with authorized C&D waste recycling facilities

The DPR shall also identify opportunities for reuse of processed C&D waste in road subgrade, filling, landscaping, and non-structural applications.

7.6.6 Recyclable Waste Streams

The DPR shall establish the recyclable waste generation potential within the project area including:

- Plastics
- Paper & cardboard
- Glass
- Metals
- Textiles
- Packaging waste
- E-waste components

The assessment shall include:

- Waste segregation ratios
- Recovery efficiency targets
- Material Recovery Facility (MRF) capacity assessment
- Recycling linkages with authorized recyclers
- EPR compliance requirements for plastic waste

The DPR shall also establish the proposed framework for resource recovery and recycling integration within the industrial ecosystem.

7.6.7 Inert Waste & Residual Rejects

The DPR shall establish the quantity of inert waste, non-recyclable waste, street sweeping waste, processing rejects, and residual waste requiring scientific landfill disposal.

The assessment shall include:

- Street sweeping waste generation
- Drain desilting waste
- Landfill reject quantities
- Inert material characterization
- Seasonal and operational variation

The DPR shall establish measures to minimize landfill dependency through improved segregation, recycling, processing, and recovery systems.

7.6.8 Hazardous / Domestic Hazardous Waste

Where applicable, the DPR shall separately identify hazardous and domestic hazardous waste streams generated within residential, commercial, institutional, utility, and industrial areas.

Indicative waste streams may include:

- Paint containers
- Chemicals and solvents
- Batteries
- CFLs and tube lights
- Sanitary waste
- Household medical waste
- E-waste
- Laboratory waste

The DPR shall establish:

- Separate collection mechanisms
- Temporary storage arrangements
- Handling and transportation systems
- Linkages with authorized treatment and disposal facilities
- Compliance with applicable Hazardous Waste Rules and E-Waste Rules

7.6.9 Waste Characterization Studies

The DPR shall include detailed waste-characterization studies covering:

- Physical characteristics
- Chemical characteristics

- Moisture content
- Bulk density
- Calorific value
- Organic fraction
- Recyclable fraction
- Inert fraction
- Seasonal variation assessment

The characterization studies shall preferably be supported through:

- Field sampling
- Waste audits
- Laboratory analysis
- Benchmarking of comparable industrial parks
- CPHEEO/CPCB reference studies

7.6.10 Waste Flow Diagram

The DPR shall include a comprehensive waste-flow diagram illustrating:

- Waste generation sources
- Source segregation
- Primary collection
- Secondary transportation
- Transfer stations
- Processing facilities
- MRF operations
- Composting/bio methanation systems
- RDF/Waste-to-Energy systems
- Recycling pathways
- Landfill disposal systems
- Resource recovery loops
- Final treatment and disposal arrangements

The waste-flow diagram shall establish the overall sustainability, resource-efficiency, recycling, and circular-economy framework proposed under the project.

7.7 Major Project Components

This section shall establish the technical configuration, sizing philosophy, operational framework, implementation strategy, environmental safeguards, redundancy provisions, and utility integration requirements for all major components of the proposed Solid Waste Management (SWM) system. The DPR shall demonstrate that the proposed infrastructure is adequately planned for phase-wise as well as ultimate-

year waste generation conditions and is capable of ensuring reliable, sustainable, efficient, and environmentally compliant SWM operations throughout the project lifecycle.

The DPR shall include component-wise design basis, engineering calculations, layout drawings, equipment sizing, routing plans, processing-capacity assessment, environmental-management provisions, ICT integration framework, operational philosophy, and future scalability provisions for all SWM infrastructure components proposed under the project.

7.7.1 Waste Storage & Segregation Infrastructure

The DPR shall establish the planning philosophy and design framework for waste storage and source-segregation infrastructure proposed within residential, commercial, industrial, institutional, utility, and public areas of the Industrial City. The infrastructure shall support systematic segregation, temporary storage, efficient collection, operational hygiene, and prevention of cross-contamination among different waste streams.

The DPR shall establish:

- Source segregation philosophy
- Multi-bin storage systems
- Color coding standards
- Household/community bin sizing
- Common-area waste storage arrangements
- Public litter-bin requirements
- Industrial waste storage areas
- Hazardous waste segregation provisions
- Accessibility and collection compatibility

Separate storage arrangements shall be considered for:

- Wet/Biodegradable waste
- Dry/Recyclable waste
- Domestic hazardous waste
- Sanitary waste
- E-waste
- Biomedical waste
- Construction & Demolition waste
- Industrial hazardous waste

The DPR shall also establish maintenance arrangements, washing facilities, odour-control provisions, and public-awareness systems associated with waste storage infrastructure.

7.7.2 Primary Collection System

The DPR shall establish the design basis and operational framework for the primary collection system covering door-to-door collection, household collection, institutional collection, commercial collection, and waste collection from common/public areas.

The DPR shall define:

- Collection frequency
- Collection coverage
- Route optimization
- Vehicle deployment strategy
- Collection manpower requirements
- Segregated collection methodology
- Community participation mechanisms
- Collection timing and operational schedules

The collection system shall ensure:

- 100% collection efficiency
- Segregated waste collection
- Minimal manual handling
- Prevention of littering and spillage
- Operational hygiene and safety

The DPR shall also establish:

- Bin lifting mechanisms
- Vehicle loading systems
- RFID/GPS integration
- Collection monitoring systems
- Grievance redressal mechanisms

7.7.3 Secondary Collection & Transportation System

The DPR shall establish the transportation strategy and infrastructure for movement of segregated waste from collection points, transfer stations, processing facilities, and disposal sites.

The DPR shall include:

- Vehicle sizing and capacity assessment
- Transportation route plans
- Transfer logistics
- Collection efficiency assessment
- Haul-distance analysis

- Fuel optimization strategy
- Vehicle turnaround analysis
- Parking and maintenance infrastructure

Indicative transportation infrastructure may include:

- Mini tipper vehicles
- Mechanized tippers
- Covered compactors
- Hook-loader systems
- Containerized transportation systems
- Mechanized road sweepers

The DPR shall establish separate transportation arrangements for:

- Wet waste
- Dry recyclable waste
- Inert waste
- Hazardous waste
- Biomedical waste
- C&D waste
- Industrial waste streams

All transportation systems shall comply with applicable environmental, safety, and operational standards.

7.7.4 Transfer Stations

The DPR shall establish the requirement, sizing philosophy, operational framework, and siting criteria for transfer stations proposed under the SWM system. Transfer stations shall facilitate efficient transfer of waste from primary collection vehicles to larger transportation systems while minimizing operational inefficiencies and transportation costs.

The DPR shall establish:

- Waste throughput capacity
- Storage capacity
- Compaction requirements
- Vehicle circulation plans
- Odour-control systems
- Drainage arrangements
- Wash-water management
- Fire-safety provisions

- Environmental safeguards

The DPR shall also include:

- Traffic circulation analysis
- Loading/unloading arrangements
- Segregated waste handling systems
- Utility integration requirements
- Expansion provisions for future phases

7.7.5 Material Recovery Facility (MRF)

The DPR shall establish the planning, sizing philosophy, process configuration, operational framework, and integration strategy for the Material Recovery Facility (MRF) proposed under the SWM system.

The MRF shall be designed for:

- Sorting of recyclable waste
- Recovery of recyclable materials
- Temporary storage of recovered materials
- Baling and compaction operations
- Integration with recycling vendors

The DPR shall establish:

- Segregation methodology
- Mechanical/manual sorting systems
- Conveyor systems
- Baling systems
- Storage arrangements
- Fire protection systems
- Worker safety measures
- Resource recovery targets

Indicative recyclable streams may include:

- Paper & cardboard
- Plastics
- Metals
- Glass
- Textile waste
- Packaging materials

The DPR shall establish linkages with authorized recyclers and resource-recovery systems.

7.7.6 Composting / Bio methanation Facilities

The DPR shall establish the design basis, treatment philosophy, sizing criteria, process configuration, and operational strategy for biodegradable-waste processing facilities proposed within the project area.

The assessment shall include:

- Organic waste generation
- Moisture characteristics
- Feedstock quality
- Seasonal variation
- Compost quality targets
- Biogas-generation potential

Indicative treatment technologies may include:

- Windrow composting
- In-vessel composting
- Vermicomposting
- Bio methanation systems
- Anaerobic digestion systems

The DPR shall establish:

- Processing capacity
- Retention periods
- Leachate management
- Odour-control systems
- Utility requirements
- Compost handling arrangements
- Biogas utilization strategy
- Environmental safeguards

The DPR shall also establish utilization plans for compost, digestate, and recovered energy.

7.7.7 Refuse Derived Fuel (RDF) / Waste-to-Energy Integration

The DPR shall establish the planning framework and technical feasibility for RDF generation and Waste-to-Energy integration from non-recyclable combustible waste streams.

The DPR shall identify:

- Waste calorific value
- RDF suitability assessment
- Waste pre-processing requirements
- Shredding and drying requirements
- Energy recovery potential
- End-use applications

The DPR shall establish:

- RDF production systems
- Fuel storage arrangements
- Environmental safeguards
- Emission-control systems
- Regulatory compliance requirements

The DPR shall also establish potential integration with:

- Cement industries
- Industrial boilers
- Co-processing facilities
- Waste-to-energy plants

7.7.8 Scientific Landfill Facility

The DPR shall establish the planning, sizing philosophy, environmental safeguards, and operational framework for scientific disposal of inert waste, process rejects, and non-recoverable residual waste.

The landfill facility shall comply with applicable SWM Rules, CPCB guidelines, and environmental standards.

The DPR shall establish:

- Landfill-capacity calculations
- Landfill life assessment
- Cell development strategy
- Bottom-liner systems
- Leachate collection systems
- Gas venting systems
- Storm-water management
- Groundwater monitoring systems
- Closure and post-closure plans

The DPR shall establish measures for:

- Reduction of landfill dependency
- Prevention of groundwater contamination
- Odour and vector control
- Fire protection
- Environmental monitoring

7.7.9 Construction & Demolition Waste Processing Facility

The DPR shall establish the planning framework and infrastructure requirements for collection, segregation, processing, recycling, reuse, and disposal of Construction & Demolition (C&D) waste generated within the project area.

The DPR shall identify:

- C&D waste quantities
- Material composition
- Processing technologies
- Crushing and screening systems
- Recycled aggregate production
- Storage and stockpiling areas

The DPR shall establish reuse opportunities for:

- Road sub-base materials
- Filling applications
- Pavement layers
- Landscaping applications
- Non-structural construction applications

7.7.10 ICT, GPS & SCADA-Based Monitoring Systems

The DPR shall establish the digital monitoring and smart-management framework proposed for the SWM system. The framework may include:

- GPS-enabled waste vehicles
- RFID tagging systems
- SCADA integration
- Smart bins
- Weighbridge systems
- Centralized command-and-control systems
- Real-time monitoring dashboards
- Mobile applications
- MIS reporting systems

The DPR shall establish:

- Fleet monitoring systems
- Route optimization
- Complaint redressal systems
- Data analytics framework
- Predictive maintenance systems
- Performance-monitoring KPIs

7.7.11 Environmental Monitoring Infrastructure

The DPR shall establish the environmental monitoring systems required for operation of the SWM infrastructure in compliance with applicable environmental standards. The DPR shall establish monitoring systems for:

- Ambient air quality
- Noise levels
- Groundwater quality
- Surface-water quality
- Leachate quality
- Odour monitoring
- Stack emissions (where applicable)

The DPR shall establish:

- Sampling frequency
- Monitoring locations
- Laboratory requirements
- Compliance reporting framework
- Environmental audit systems

7.7.12 Leachate Collection & Treatment Systems

The DPR shall establish the planning and design framework for leachate management associated with composting facilities, transfer stations, waste-processing facilities, and landfill systems. The DPR shall establish:

- Leachate generation assessment
- Collection systems
- Drainage arrangements
- Storage facilities
- Treatment technologies
- Recirculation arrangements
- Disposal/reuse systems

Indicative treatment technologies may include:

- Equalization systems
- Biological treatment
- Physio-chemical treatment
- Membrane systems
- Evaporation systems

The DPR shall establish environmental safeguards to prevent contamination of groundwater, surface water, and surrounding ecosystems.

7.8 O&M framework

The DPR shall establish a comprehensive operation and maintenance framework covering manpower deployment, preventive maintenance, waste collection schedules, processing-facility operations, environmental monitoring, complaint management, ICT systems, and emergency-response arrangements.

Table 7.3: O&M framework key considerations

Category	Design Considerations
Preventive Maintenance Program	Scheduled preventive maintenance framework for SWM infrastructure, vehicles, processing facilities, and utility systems.
Vehicle & Equipment Maintenance	Routine inspection, servicing, repair, fuel monitoring, and maintenance management for all SWM vehicles and equipment.
Processing Plant Operations	Standard operating procedures for MRF, composting, bio methanation, RDF, and landfill facilities including operational monitoring and manpower deployment.
Environmental Monitoring	Periodic monitoring of air, water, leachate, noise, odour, and environmental compliance parameters as per CPCB/SPCB guidelines.
Odour & Vector Control Measures	Provision of deodorization systems, sanitization, pest control, regular cleaning, and housekeeping arrangements for SWM facilities.
Fire & Emergency Response Plan	Emergency preparedness framework including firefighting systems, emergency response procedures, spill management, and disaster-response arrangements.
Digital Monitoring & MIS Reporting	ICT-enabled systems including GPS tracking, SCADA integration, RFID systems, MIS dashboards, and real-time monitoring mechanisms.
Health & Safety Management	Occupational health and safety framework including PPE provisions, worker training, medical surveillance, hygiene management, and safety audits.

7.9 CAPEX & OPEX Assessment

This section shall establish the phase-wise Capital Expenditure (CAPEX) and Operational Expenditure (OPEX) assessment for the proposed Solid Waste Management (SWM) system covering all infrastructure, utility, transportation, processing, environmental-management, automation, and operational components required for implementation and sustainable operation of the integrated SWM framework.

The assessment shall include all civil, mechanical, electrical, transportation, ICT, environmental, and allied infrastructure required for collection, segregation, transportation, treatment, recycling, recovery, monitoring, and scientific disposal of solid waste generated within the project area.

The cost estimation shall be based on applicable Schedule of Rates (SoR), approved market rates, recent comparable projects, OEM budgetary quotations, or other accepted estimation methodologies adopted by the implementing agency. The DPR shall clearly establish the basis of estimation, year of pricing, taxes and duties, contingencies, escalation provisions, and phasing assumptions considered in the cost assessment.

The CAPEX assessment shall establish phase-wise investment requirements linked with projected waste generation, development phasing, industrial occupancy, and infrastructure expansion strategy. The OPEX assessment shall establish long-term operational sustainability considering fuel consumption, manpower deployment, utility consumption, preventive maintenance, lifecycle replacement, environmental compliance, and operational reliability of the SWM system. The DPR shall also establish opportunities for:

- Revenue generation through resource recovery
- Sale of recyclables
- Compost utilization
- RDF/Waste-to-Energy integration
- Carbon-credit opportunities
- User-charge recovery mechanisms
- PPP/Hybrid implementation models (where applicable)

The assessment shall also evaluate lifecycle replacement requirements for vehicles, mechanical equipment, ICT systems, and processing infrastructure to ensure long-term sustainability and uninterrupted operations.

Table 7.4: Capex & Opex Assessment key considerations

Category	Key Considerations
Civil Infrastructure	Transfer stations, processing facilities, landfill infrastructure, roads, drainage, buildings, parking, and utilities.

Pipeline Infrastructure	Leachate, drainage, water supply, firefighting, gas collection, and utility pipelines.
Electromechanical Systems	Processing equipment, conveyors, compactors, balers, pumps, blowers, DG sets, sweepers, and electrical systems.
Automation & SCADA	GPS, RFID, SCADA, weighbridges, CCTV, dashboards, and centralized monitoring systems.
Metering Systems	Weighbridges, energy meters, water meters, fuel-monitoring systems, and flow meters.
Utility Infrastructure	Water supply, firefighting, electrical systems, DG backup, lighting, communication, and drainage systems.
O&M Cost	Power, fuel, manpower, maintenance, consumables, environmental monitoring, and compliance costs.
Lifecycle Replacement	Replacement of vehicles, equipment, SCADA systems, ICT hardware, pumps, electrical systems, and landfill components.

7.10 Checklist for Mandatory Deliverables.

The DPR shall include all technical deliverables, studies, calculations, drawings, approvals, and reports necessary for technical appraisal and implementation.

Table 7.5: Mandatory Deliverables Checklist

Sl. No	Deliverables	Checks
1	Waste Generation Assessment	☐
2	Waste Characterization Study	☐
3	Service-Level Benchmark Compliance Matrix	☐
4	Waste Flow Diagram	☐
5	Collection & Transportation Plan	☐
6	Vehicle Routing & Fleet Assessment	☐
7	Transfer Station Design	☐
8	Processing Facility Design Report	☐
9	MRF & Recycling Framework	☐
10	Scientific Landfill Design	☐
11	Environmental Impact & Mitigation Measures	☐
12	ICT/GPS/Monitoring Framework	☐
13	O&M Framework	☐
14	CAPEX & OPEX Assessment	☐
15	Engineering Drawings & Layouts	☐
16	Statutory Approvals & Clearances	☐
17	Implementation Phasing Plan	☐
18	Any Other Applicable Supporting Document	☐

CHAPTER 8

ENVIRONMENT GUIDELINES

8.1 Background - Environment framework

Sustainability, environmental awareness, renewable resource management, etc plays a vital role in sustainable lifestyle. With the global carbon emissions rising day by day, it is essential to move towards reduction of environmental footprints. Govt of India has already committed to achieve the Net Zero emission target by year 2070. SPVs are expected to adopt the best practices of Environmental safeguards & Sustainability Further the SPVs / Industries are expected to further perform better than the compliance of statutory obligation and set higher goals for adoption of innovative techniques & consistent improvement. A detailed note and presentation on Environment & Sustainability framework is enclosed as detailed note as **Annexure-2**. Additionally, corporate social responsibilities / corporate environmental responsibilities for need based environmental safeguards in vicinity to the project area may be integrated in the DPR.

Key considerations for EIA / EC proposals

Suitable due diligence is required for the issues mentioned as under:

- To ascertain whether proposed site is falling in proximity / or situated within Eco Sensitive Area (ESA)
- Flood plain zoning analysis.
- To assess whether proposed site is situated within / or proximity of Critically Polluted Area.
- Requirement of Tree Felling Permission.
- To ascertain whether any wildlife corridor / Wildlife sanctuary is situated in vicinity.
- Applicability of Coastal Regulation Zone (CRZ), Regulations (if any).

8.2 Environmental Clearance

As per Environment Impact Assessment (EIA) Notification, 2006 and its subsequent amendments all the projects listed under this notification requires prior Environmental Clearance (EC) from the concerned regulatory authority; MoEF&CC for matters falling

under category ‘A’ and State Environmental Impact Assessment Authority (SEIAA) for matters falling under category ‘B’.

8.2.1.Category A projects:

- Industrial area projects housing atleast one category A industry, entire industrial area will be treated as category A project irrespective of the area.
- Industrial area greater than 500 ha area and housing at least one category B industry will be treated as category B project.

8.2.2.Category B projects:

- Industrial area project less than 500 ha area and housing at least one category B industry.
- Industrial area greater than 500 ha area and not housing any industry belonging to category A or B is treated as category B project.

8.3 Classification of EC application

- Industrial estate / park / area projects are classified at schedule 7(C)-Industrial estate / area under EIA Notification, 2006.
- Further Industrial area projects below 500 ha area and not housing any industry of Category ‘A’ or ‘B’ but contains building & construction projects > 20,000 Sq. mts built up area and / or development area more than 50 ha, are treated as Building Construction or Area Development Projects, listed at s.no 8(a) or 8(b) in the EIA Notification, 2006. Projects under this category requires EC from respective SEIAA at State level.
- Based on threshold of the project, the Environmental Clearance (EC) of the project is required to be obtained by the project proponent / SPV during pre construction stage. No construction work / development of trunk infrastructure is allowed before obtaining prior EC of the project.

8.4 Steps involved in the EC process are as under:

- Authorization of an official for submitting EIA / EC application and registration on MoEF&CC’s parivesh portal.

- Submission of Terms of Reference (ToR) application to MoEF&CC / SEIAA based on threshold of the project (by NABET accredited EC consultants).
- Deposition of ToR / EC application fee (as applicable for respective State).
- The baseline data used for preparation of EIA / EMP reports may be collected at any stage, irrespective of the request for ToR or the issue thereof. However, such a baseline data and the public consultation should not be older than 3 years, at the time of submission of the proposal, for grant of Environmental Clearance, as per ToRs prescribed.
- Consideration of ToR application by Expert Appraisal Committee (EAC), MoEF&CC / SEIAA.
- Grant of ToR by MoEF&CC / SEIAA for carrying out Environmental Impact Assessment (EIA) of the project.
- The Terms of Reference for the projects issued by the regulatory authority concerned, shall have the validity of four years from the date of issue.
- Submission of draft EIA to State Pollution Control Board (SPCB).
- Public Hearing to be conducted by the SPCB under chairmanship of District Collector (Public Hearing is exempted for Building Construction & Area Development Projects).
- Issuance of minutes of meeting of Public Hearing by SPCB.
- Submission of EC application along with final EIA to MoEF&CC / SEIAA (duly addressing comments / suggestions received during Public Hearing).
- Appraisal of EC proposal by the EAC, MoEF&CC / SEIAA based on the EIA report, EC application & outcome of the Public Hearing.
- Consideration of EC proposal by MoEF&CC / SEIAA.
- Grant of EC by MoEF&CC / SEIAA.
- Detailed work flow of Environmental Clearance for Category A and Category B project is enclosed as an **Annexure- 3** & **Annexure- 4** respectively.

8.5 Advertisement of grant of Environmental Clearance

After grant of Environmental Clearance (EC) of the project, the project proponent shall prominently advertise grant of EC in at least in two local newspapers of the District or State, of which one shall be in the vernacular language within seven days indicating that the project has been accorded

environment clearance and the details of MoEF&CC SEIAA website where it is displayed.

Further, the copies of the environmental clearance shall be submitted by the project proponents to the Heads of local bodies, Panchayats and Municipal Bodies in addition to the relevant offices of the Government who in turn must display the same for 30 days from the date of receipt.

8.6 Statutory compliance

Following, the grant of EC, the project proponents / SPVs are required to mandatorily comply with the time bound statutory compliances throughout the project cycle; such as *submission of six monthly EC compliance report to the MoEF&CC, submission of periodic compliance to State Pollution Control Board (SPCB), Labour compliance, preparation of prescribed mitigation & conservation plan agreed during EC application stage, implementation of approved Environmental Management Plan (EMP) etc*. Further the project proponents also require to obtain consent to establish (CTE) and consent to operate (CTO) from State Pollution Control Board.

8.7 Statutory obligation stipulated under EC

As per conditions stipulated in the EC letter, six monthly EC compliance comprises broadly of following parameters:

- Statutory filing of periodic compliance reports to MoEF&CC & SPCB.
- Preparation of site specific mitigation & conservation plan (as stipulated in EC).
- Self / third party Environmental audit.
- Establishment of EC cell at SPV.
- Compensatory afforestation & development of Green belt.
- Preparation of Environment policy.
- Action plan of Environmental Management Plan (EMP) implementation.
- Annual fund allocation for EMP and corporate Environmental Responsibility (CER).
- Hazard identification & risk assessment.
- Disaster management plan.
- Industrial effluent management.
- Air quality monitoring & preservation.
- Water quality monitoring & preservation.

- Energy conservation measures.
- Waste management.
- Noise monitoring & preservation.
- Rain water harvesting.

8.8 Applicable Legal & Policy framework

The applicable legal and policy framework for an Environmental Impact Assessment (EIA) and Environmental Clearance (EC) outlines the mandatory evaluations required for implementation of the project. Primarily, the Environmental Clearance is guided by the Environment (Protection) Act, 1986 and the EIA Notification, 2006 and subsequent amendments. Apart from Environmental Clearance, other applicable Environmental and other related regulations for the project are listed as below:

Table 8.1: Applicable Environmental and other Regulations for the project

Sl.no	Applicable regulations	Compliance / application
1	The Environmental (Protection) Act, 1986 and subsequent amendments	To protect and improve overall environment.
2	The EIA Notification, 2006 and subsequent amendments	For Environmental Clearance of the project.
3	Coastal Regulation Zone (CRZ) Notification, 2019 and subsequent amendments	Protection of coastal area and CRZ clearance.
4	The Air (Prevention and Control of Pollution) Act, 1981.	For consent to establish (CTE) & consent to operate (CTO) for upcoming industries / industrial area.
5	The Water (Prevention and Control of Pollution) Act, 1974 and Cess Act of 1977.	For consent to establish (CTE) & consent to operate (CTO) for upcoming industries / industrial area.
6	The Noise Pollution (Regulation and Control) rules, 2000. Noise Pollution (Regulation and Control) Amendment) Rules 2010.	Noise pollution regulation and control of noise pollution by the upcoming respective industries.

7	Hazardous and other waste (Management and Trans boundary Movement) Rules, 2016 and subsequent amendments	Hazardous wastes management
8	Solid Waste Management Rules, 2026	Handling, treatment and disposal of solid waste generated at Industrial area.
9	E-Waste (Management) Rules, 2022 and subsequent amendments	Management of E-Waste as consumer / producer.
10	Battery Waste Management Rules, 2022	For appropriate handling of used batteries by the upcoming industries
11	The Construction and Demolition (C&D) Waste Management Rules, 2025	Management of construction waste and materials as per the provisions of the storage and disposal of the Construction and Demolition (C&D) Waste Management Rules.
12	The Manufacture, Storage and Import of Hazardous Chemical Rules (as amended), 2000	Regulatory framework to prevent major industrial accidents and regulate the handling of hazardous substances
13	The Wildlife (Protection) Act, 1972 and subsequent amendments.	Applicable, if the proposed project is situated within eco sensitive zone and / or if in case any Wildlife Sanctuary is situated within 10 km of the

		proposed project and its eco sensitive zone is in draft stage.
14	The Van (Sanrakshan Evam Samvardhan) Adhiniyam, 1980	Applicable in case part & parcel of the proposed project / or project is situated within notified Forest Land.
15	The Plastic Waste Management Rules, 2016 and subsequent amendments	Processing & disposal of non-recyclable fraction of plastic waste.
16	The Ancient Monuments and Archaeological Sites & Remains Act, 1958 & subsequent amendments.	In case archaeological monument located within 10 km of the project site.
17	The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 & subsequent amendments.	For Projects wherein land acquisition / re-settlement is involved.
18	Fly Ash Notification, 2021	Use of fly ash as road laying, road and flyover embankments, shoreline protection structures in coastal districts and dams within 300 kms from the lignite or coal based thermal power plants.
19	Tree felling / Tree protection Rules	For tree felling permission as per State specific regulations.
20	Bio-Medical Waste Management (Second Amendment) Rules, 2019	Disposal of bio medical waste.
21	Ground Water NoC from CGWA / State Ground Water Authority.	For withdrawal of ground water / dewatering etc.

22	Motor Vehicles Act, And Its amendment, 2019	To operate vehicle havng Pollution Under Control Certificate (PUCC) and operation of construction vehicle.
23	State level local bye laws	For change in land use and approval of Lay out / master plan. Development of project in accordance with Land-use and Master plans.
24	No Objection Certificate for Height Clearance from Airport Authority of India (AAI)	Height clearance from AAI in case project is situated in proximity to the Airport.
25	Labour Licence	For deployment of workmen at construction site.
26	Registration under Building & other Construction Workers (Regulation of employment & conditions of services) Act, 1996	For labour cess
27	Contractor All Risk (CAR) insurance and other applicable policy, permits & approval of contractor.	To be obtained by the contractor before start of work for development of trunk infrastructure.

CHAPTER 9

POWER SYSTEM

9.1 About this Chapter:

This chapter outlines the requirements and technical expectations for the Power Supply System component of the Detailed Project Report (DPR) to be submitted by the State/SPV/Implementing Agency under BHAVYA Scheme.

The chapter serves as the reference framework for planning, design, technical evaluation, implementation, operation, and maintenance of the proposed power infrastructure for the Industrial City.

The DPR shall establish an integrated, efficient, reliable, sustainable, and future-ready electrical infrastructure system capable of meeting the projected industrial, commercial, residential, utility, and common-area power requirements across all development phases and up to the adopted design horizon.

The proposed power infrastructure framework may include grid connectivity systems, receiving substations, transmission and distribution networks, ring-main systems, transformers, street-lighting systems, renewable-energy integration, SCADA systems, emergency power systems, smart metering systems, and associated electrical utility infrastructure.

9.2 Concept Note:

The Power Supply System for the proposed Industrial Park shall be planned as an integrated electrical infrastructure framework ensuring uninterrupted, safe, reliable, and quality power supply for industrial operations, utilities, residential areas, commercial areas, and common infrastructure.

The planning philosophy shall emphasize:

- Reliable and redundant power supply systems
- Underground utility integration
- Energy-efficient electrical infrastructure
- Smart-grid and SCADA integration
- Renewable-energy integration
- Demand-side management
- Safety and resilience
- Ease of operation and maintenance
- Lifecycle sustainability

The proposed electrical infrastructure architecture may include:

- Grid connectivity infrastructure
- Receiving substations
- Transmission & distribution systems
- Ring-main distribution systems
- RMUs & distribution transformers

- Street-lighting systems
- Smart metering systems
- SCADA & ICT systems
- Renewable-energy systems
- DG backup systems
- Earthing & lightning-protection systems
- Utility corridors and electrical rooms

The DPR shall establish the technical basis for phase-wise power infrastructure development, load management, operational sustainability, energy efficiency, electrical safety, environmental compliance, and long-term resilience.

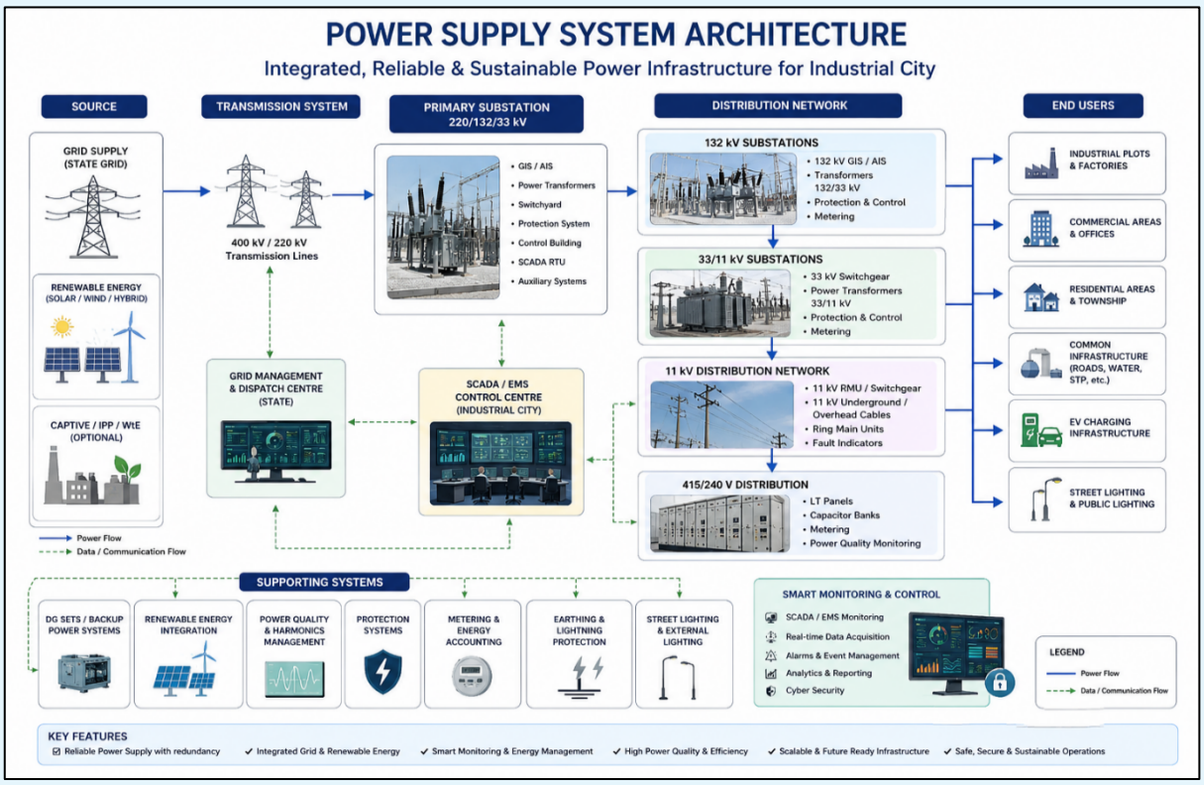


Figure9.1: Indicative Power Supply System Architecture

9.3 Design Basis

This section shall establish the overall planning philosophy, design criteria, operational objectives, and minimum service-level requirements for the proposed Power Supply System.

9.3.1 Planning Horizon & Development Phasing

The DPR shall define the adopted planning horizon, intermediate development stages, and phase-wise electrical infrastructure augmentation strategy considering projected industrial growth, occupancy, and future expansion requirements.

9.3.2 Basis of Demand Assessment

The DPR shall establish the methodology and assumptions adopted for estimating industrial, commercial, residential, utility, institutional, and common-area power demand based on approved master plans and industrial typologies.

9.3.3 Power Demand Assessment Methodology

The DPR shall establish the methodology adopted for connected-load estimation, maximum-demand analysis, diversity-factor assessment, load forecasting, load density assessment, and demand projections for all development phases.

9.3.4 Power Supply Philosophy

The DPR shall define the overall power-supply philosophy including grid connectivity approach, voltage hierarchy, redundancy criteria, distribution philosophy, emergency backup provisions, and future scalability requirements.

9.3.5 Distribution Network Strategy

The DPR shall establish the strategy for electrical transmission and distribution including underground cable systems, ring-main networks, transformer locations, feeder arrangements, and load balancing mechanisms.

9.3.6 Reliability, Redundancy & Resilience Criteria

The DPR shall define reliability and redundancy provisions including dual-source supply, standby feeders, backup transformers, emergency power systems, and contingency arrangements.

9.3.7 Automation & Smart Monitoring Systems

The DPR shall establish the proposed automation and smart-monitoring framework including SCADA systems, smart meters, GIS mapping, energy-monitoring systems, and centralized command-and-control systems.

9.3.8 Energy Efficiency & Sustainability Measures

The DPR shall establish sustainability measures focused on energy efficiency, renewable-energy integration, smart lighting systems, energy conservation measures, and reduction of carbon footprint.

9.3.9 Applicable Codes, Standards & Technical References

The DPR shall identify the applicable codes, standards, manuals, guidelines, benchmarks, and statutory provisions adopted for planning, design, construction, operation, and maintenance of the proposed Power Supply System.

Indicative References:

- Indian Electricity Act 2003
- Central Electricity Authority (CEA) Guidelines 2010
- National Electrical Code of India
- IEC Standards
- IEEE Standards
- BIS Standards
- Bureau of Energy Efficiency (BEE) Guidelines
- Local Utility / DISCOM Standards
- IS Standards (IS 732, 5613 & 3043)

9.4 Service Level Benchmarks

This section outlines the applicable Service Level Benchmarks (SLBs) for the proposed Power Supply system, primarily based on the benchmarks prescribed by the Central Electricity Authority (CEA) and other relevant standards.

The DPR shall specify the adopted service levels against each benchmark parameter in a comparative tabular format, along with the proposed compliance approach. The adopted values shall generally meet or exceed the prescribed benchmark levels. Any deviation from the applicable benchmarks shall be supported with adequate project-specific technical justification.

Table 9.1: Service Level Benchmarks

Sl. No	Service Level Benchmarks (SLBs)	Benchmark Value
1	Power Supply Reliability	24X7 Supply
2	Redundancy Provision	N+1/Dual Source
3	Voltage Regulation	As per CEA Norms
4	Distributions Losses	As per Utility Norms
5	SCADA Monitoring Coverage	100% Critical Infrastructure
6	Smart Metering Coverage	100%
7	Street Lighting Coverage	100% Road Network
8	Underground Cabling Coverage	100%
9	Renewable Energy Integration	Project Specific
10	Emergency Backup for Critical Utilities	Mandatory

9.5 Adopted Design Standards & Norms

This section shall summarize the design standards, codes, guidelines, reference manuals, and planning norms adopted for preparation of the Power Supply System in the DPR. The objective of this section is to establish a consolidated technical reference framework for all design parameters and infrastructure components, thereby avoiding repetitive citation of standards in subsequent sections of the DPR.

The DPR shall clearly identify the adopted design criteria, corresponding reference standards, and applicable codal provisions for individual system components. In cases where project-specific requirements necessitate deviation from standard codal provisions or commonly adopted engineering practices, the DPR shall provide adequate technical justification and supporting rationale for such deviations.

The following codes, standards, manuals, guidelines, and references may be considered during preparation of the DPR, including but not limited to:

9.5.1 Design Parameter

Table 9.2: Design Parameter

Sl.No.	Design Parameter / Component	Reference Code / Manual
1	Load Density	Based on Industrial Typology
2	Demand Factor	Project Specific
3	Diversity Factor	Industry Standards
4	Voltage Levels	Utility/DISCOM Standards
5	Transformer Loading	CEA / IS Standards
6	Underground Cabling	IEC / IS Standards
7	Street Lighting Levels	IRC Codes
8	Earthing System	IS 3043
9	Lightning Protection	IEC Standards
10	Energy Metering	Smart Metering Standards
11	SCADA Integration	Utility Standards
12	Renewable Energy Systems	MNRE, CERC/SERC Guidelines
13	Battery Energy Storage System	CEA Guidelines

9.6 Power Demand Assessment

This section shall establish the phase-wise and ultimate-year power demand assessment for the proposed Industrial City.

The DPR shall include:

- Connected load assessment
- Maximum demand estimation
- Load diversity analysis
- Demand forecasting
- Seasonal variation considerations
- Future expansion requirements
- Emergency load requirements
- Renewable-energy potential assessment

9.6.1 Industrial Power Demand

The DPR shall assess industrial power demand based on industrial typologies, process loads, utility requirements, and occupancy projections.

9.6.2 Commercial Power Demand

Commercial power demand shall be assessed based on commercial floor area, occupancy, HVAC requirements, lighting systems, and operational loads.

9.6.3 Residential & Utility Demand

The DPR shall establish residential and utility demand covering housing, hostels, administrative areas, utility buildings, and common facilities.

9.6.4 Common Infrastructure Demand

The assessment shall include power demand for street lighting, pumping systems, treatment plants, ICT infrastructure, and public utilities.

9.6.5 Emergency & Essential Load Assessment

The DPR shall identify critical and emergency loads requiring DG backup, UPS systems, or alternate supply arrangements.

9.6.6 Connected Load & Maximum Demand Analysis

The DPR shall establish connected-load assessment, maximum-demand calculations, and load-management philosophy.

9.6.7 Diversity & Load Factors

The DPR shall define diversity factors, coincidence factors, and load-factor assumptions adopted for sizing of electrical infrastructure.

9.6.8 Future Expansion & Demand Forecasting

The DPR shall establish phase-wise demand growth and future expansion provisions for substations, feeders, and utility corridors.

9.7 Major Project Components

This section shall establish the technical configuration, sizing philosophy, operational framework, implementation strategy, environmental safeguards, redundancy provisions, and utility integration requirements for all major components of the proposed Power Supply system.

9.7.1 Grid Connectivity Infrastructure

The DPR shall establish the proposed grid connectivity framework including incoming transmission lines, utility interface arrangements, and source substations.

9.7.2 Receiving Substation Infrastructure

The DPR shall establish the sizing philosophy, configuration, redundancy provisions, and layout requirements for receiving substations.

9.7.3 Transmission & Distribution Network

The DPR shall establish underground cable networks, feeder systems, voltage hierarchy, ring-main systems, and distribution arrangements.

9.7.4 RMU & Distribution Transformer System

The DPR shall establish the planning framework for RMUs, compact substations, distribution transformers, and associated switching infrastructure.

9.7.5 Street Lighting Infrastructure

The DPR shall establish the street-lighting system covering road hierarchy, illumination standards, smart-lighting systems, poles, cabling, and energy-efficient luminaires.

9.7.6 DG Backup & Emergency Power Systems

The DPR shall establish backup power systems for critical utilities, emergency services, treatment plants, ICT infrastructure, and essential facilities.

9.7.7 Renewable Energy Integration

The DPR shall establish renewable-energy integration opportunities including rooftop solar systems, utility-scale solar systems, battery-storage systems, and hybrid-energy solutions.

9.7.8 Metering Infrastructure

The DPR shall establish smart metering systems, energy monitoring systems, feeder metering, utility metering, and centralized billing infrastructure.

9.7.9 SCADA, ICT & Smart Monitoring Systems

The DPR shall establish SCADA integration, energy-monitoring systems, fault-detection systems, centralized control systems, GIS mapping, and ICT infrastructure.

9.7.10 Earthing & Lightning Protection System

The DPR shall establish earthing systems, lightning-protection systems, bonding arrangements, and electrical safety measures.

9.7.11 Electrical Safety & Fire Protection Systems

The DPR shall establish electrical safety measures, fire-detection systems, firefighting systems, emergency shutdown systems, and statutory safety provisions.

9.8 O&M framework

The DPR shall establish a comprehensive operation and maintenance framework covering manpower deployment, preventive maintenance of substations and electrical equipment, distribution-network operations, power-quality monitoring, complaint management, SCADA and ICT systems, energy accounting, safety management, and emergency-response arrangements for ensuring reliable and uninterrupted power supply operations.

Table 9.3: O&M Framework Key Considerations

O&M Framework Component	Key Considerations
Preventive Maintenance Program	Scheduled preventive maintenance framework for substations, transformers, cables, and electrical systems.
Transformer & Equipment Maintenance	Inspection, servicing, oil testing, relay testing, and maintenance of electrical equipment.
Distribution Network Operations	Feeder management, load balancing, fault rectification, and outage management.
SCADA & Digital Monitoring	Real-time monitoring, alarm management, analytics, and reporting systems.
Street Lighting Maintenance	Maintenance of poles, luminaires, control panels, and lighting systems.

Fire & Emergency Response Plan	Emergency preparedness for electrical faults, fire incidents, and power outages.
Electrical Safety Management	PPE, safety audits, shutdown procedures, and worker safety systems.
Energy Monitoring & MIS Reporting	

9.9 CAPEX & OPEX Assessment

This section shall establish the phase-wise Capital Expenditure (CAPEX) and Operational Expenditure (OPEX) assessment for the proposed Power Supply System covering all electrical, utility, automation, monitoring, renewable-energy, and associated infrastructure required for implementation, operation, and long-term sustainability of the integrated power infrastructure framework. The assessment shall include all civil, electromechanical, transmission, distribution, SCADA, ICT, metering, street-lighting, backup power, and allied infrastructure components required for reliable and uninterrupted power supply within the project area.

The cost estimation shall be based on applicable Schedule of Rates (SoR), approved market rates, OEM budgetary quotations, recent comparable infrastructure projects, utility standards, and other accepted estimation methodologies adopted by the implementing agency. The DPR shall clearly establish the basis of estimation, year of pricing, taxes and duties, contingencies, escalation provisions, phasing assumptions, and utility interface requirements considered in the cost assessment.

The CAPEX assessment shall establish phase-wise investment requirements linked with projected power demand, development phasing, industrial occupancy, load growth, and infrastructure expansion strategy. The OPEX assessment shall establish long-term operational sustainability considering power procurement cost, energy losses, manpower deployment, preventive maintenance, utility consumption, SCADA operations, testing and monitoring requirements, lifecycle replacement of critical electrical equipment, and overall reliability of the Power Supply System. The DPR shall also evaluate opportunities for renewable-energy integration, energy-efficiency measures, smart-grid systems, carbon-emission reduction, user-charge recovery mechanisms, and PPP/Hybrid implementation models, wherever applicable.

Table 9.4: Capex & Opex Assessment Key Considerations

Category	Design Considerations
Civil Infrastructure	Substations, electrical rooms, cable trenches, utility corridors, control buildings, and foundations.
Cable & Transmission Infrastructure	HT/LT cable networks, feeders, transmission systems, and utility connections.
Electromechanical Systems	Transformers, RMUs, switchgear, panels, DG systems, and electrical equipment.

Automation & SCADA	SCADA systems, communication systems, GIS systems, and centralized monitoring infrastructure.
Metering Systems	Smart meters, feeder meters, energy meters, and billing infrastructure.
Utility Infrastructure	Street lighting, electrical utilities, utility poles, emergency systems, and associated infrastructure.
O&M Cost	Power losses, manpower, maintenance, consumables, testing, energy monitoring, and utility charges.
Lifecycle Replacement	Replacement of transformers, switchgear, SCADA systems, cables, meters, and electrical equipment.

9.10 Checklist for Mandatory Deliverables.

The DPR shall include all technical deliverables, studies, calculations, drawings, approvals, and reports necessary for technical appraisal and implementation.

Table 9.5: Mandatory Deliverables Checklist

Sl. No	Deliverables	Checks
1	Power Demand Assessment	☐
2	Load Forecasting & Diversity Analysis	☐
3	Grid Connectivity Assessment	☐
4	Substation Design Report	☐
5	Transmission & Distribution Network Layout	☐
6	Electrical Single-Line Diagrams (SLD)	☐
7	Transformer & RMU Sizing Calculations	☐
8	Street Lighting Layout & Design	☐
9	SCADA & ICT Framework	☐
10	Renewable Energy Assessment	☐
11	Electrical Safety & Earthing Design	☐
12	Emergency Power Backup Framework	☐
13	CAPEX & OPEX Assessment	☐
14	O&M Framework	☐
15	Utility Coordination Drawings	☐
16	Statutory Approvals & Clearances	☐
17	Implementation Phasing Plan	☐
18	Any Other Applicable Supporting Documents	☐

CHAPTER 10

ICT INFRASTRUCTURE

10.1 Introduction

Information and Communication Technology (ICT) infrastructure constitutes the digital nervous system of the proposed Smart Industrial Park. It underpins the real-time operational intelligence, safety, utilities management, connectivity, and governance services that distinguish a BHAVYA park from a conventional industrial estate. The ICT framework presented in this chapter has been designed to align with the national priorities articulated under PM GatiShakti National Master Plan, the National Industrial Corridor Programme (NICP), the Smart Cities Mission architecture, and the Digital India initiative.

The park spanning 100 to 1,000 acres, shall be planned, designed, and delivered as a fully integrated digital park, wherein all physical assets—roads, utilities, buildings, gates, poles, and open spaces—shall be embedded with smart sensing, connectivity, and monitoring capabilities from inception. The ICT architecture shall ensure that the park is future-proof for at least 20 years, accommodating evolving Industry 4.0 technologies including Artificial Intelligence (AI), Internet of Things (IoT), Digital Twins, 5G private networks, and advanced robotics ecosystems.

This chapter presents a comprehensive techno-commercial description of the ICT infrastructure proposed for the park, covering passive infrastructure, active networking, command and control, cybersecurity, smart systems, and sustainability. All specifications, standards, and implementation guidelines herein conform to applicable national and international standards and Government of India policy frameworks.

10.2 ICT Vision & Objectives

The ICT vision for BHAVYA Smart Industrial Park is to establish a Unified, Intelligent, and Resilient Digital Ecosystem that enables real-time situational awareness, operational excellence, and a superior investor experience, while supporting sustainable and compliant industrial operations at global standards.

10.2.1 Strategic Objectives

- Provide high-bandwidth, low-latency, and always-on digital connectivity to every plot, building, and common area facility within the park.
- Deploy an Integrated Command & Control Centre (ICCC) as the operational brain of the park, enabling centralized monitoring and management of all smart systems.
- Ensure physical and cyber security across the entire park perimeter, entry-exit points, and critical utility corridors.

- Deliver plug-and-play ICT readiness enabling allottees to connect enterprise networks and operational systems from day one.
- Enable data-driven management through IoT sensing, AI analytics, and a GIS-based asset management platform.
- Establish a robust cybersecurity posture conforming to ISO/IEC 27001:2022 and CERT-In directives.
- Achieve Green ICT objectives by optimizing energy consumption of ICT assets and aligning with LEED/GRIHA sustainability criteria.
- Future-proof the ICT infrastructure for integration with 5G private networks, Digital Twin platforms, and emerging Industry 4.0 technologies.
- Align Park ICT operations with the PM GatiShakti data-sharing framework and State Industrial Infrastructure Corporation (SIIC) digital platforms.

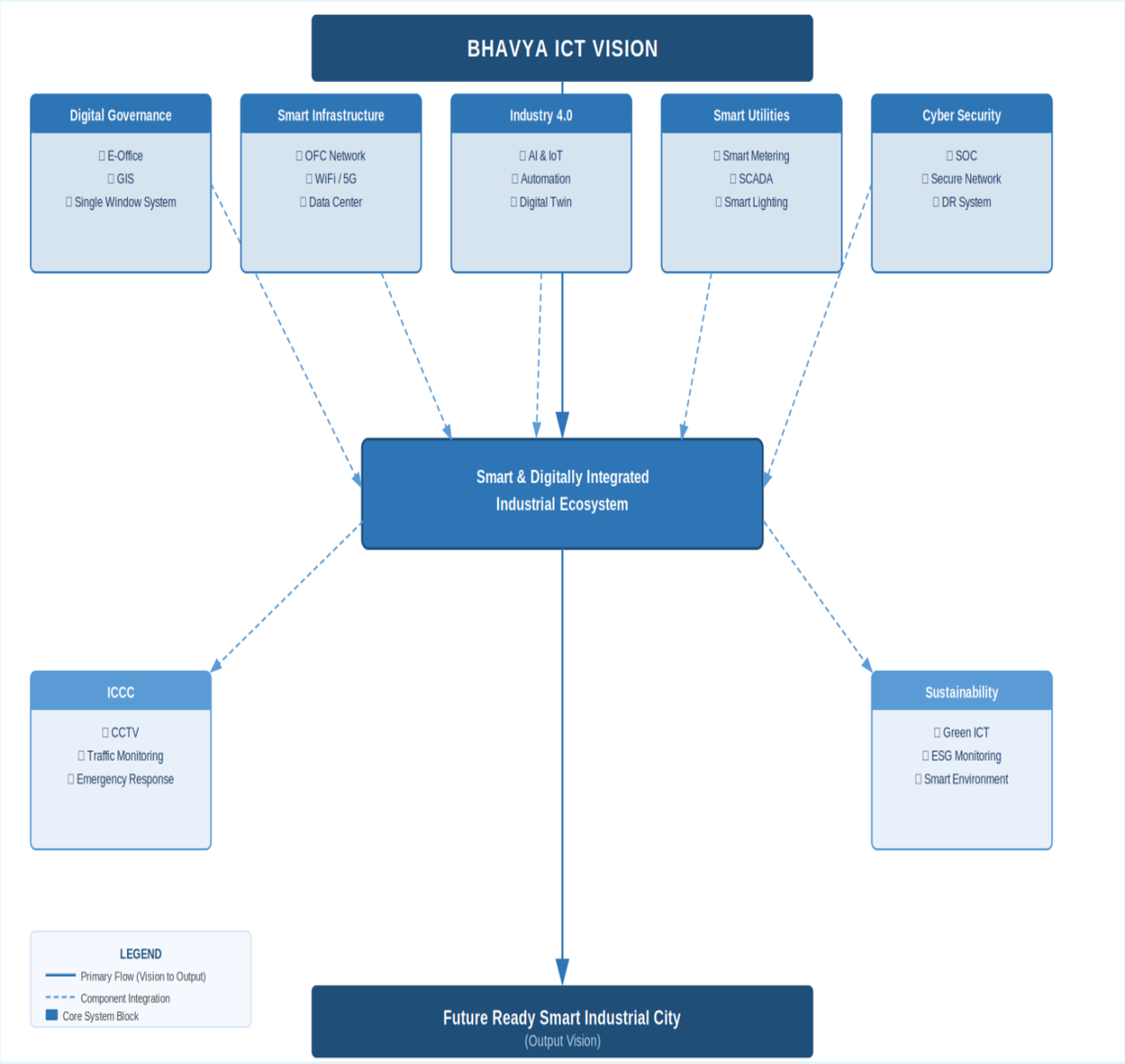


Figure 10.1: Integrated Block Diagram — Smart Industrial Ecosystem

10.3 ICT Master Planning Approach

The ICT Master Planning for the park adopts an integrated, layered approach aligned with the NICDC Smart Industrial Park Framework. The master plan is developed concurrently with the physical infrastructure master plan to ensure that ICT conduits, chambers, manholes, and passive infrastructure are embedded at the civil works stage, eliminating the cost and disruption of retrofitting.

The ICT Master Plan is structured around five functional layers: (i) Passive Infrastructure Layer comprising OFC ducts, chambers, and cabling pathways; (ii) Active Network Layer comprising switches, routers, and wireless systems; (iii) Application & Services Layer comprising ICCC, SCADA, BMS, and smart systems; (iv)

Data & Analytics Layer comprising the park data centre, AI platforms, and GIS; and (v) Cybersecurity & Governance Layer comprising perimeter security, SIEM, and policy enforcement.

The planning process integrates GIS-based zoning with utility corridor mapping under PM GatiShakti principles, ensuring that all ICT infrastructure is aligned with roads, storm-water drains, water supply, sewerage, power, and gas networks. Dedicated underground utility corridors (UUCs) accommodating HDPE ducts for OFC and power cabling shall be provided along all primary and secondary roads, enabling maintenance-free access through pre-installed draw-wires and junction chambers.

Scalability is a core design principle. The passive infrastructure shall be designed for at least 150% of initial active cable fill, and the data centre shall be planned for phased expansion from an initial 50 racks to 200 racks at full build-out. All active network equipment shall support hot-standby redundancy, and the ICCC platform shall be architected on a microservices-based, cloud-ready framework to accommodate future applications without system-wide replacement.

10.3.1 Zone-wise ICT Planning

The park shall be subdivided into functional zones including Core Industrial Zones (heavy and light manufacturing), a Business and Administration Zone, a Worker Amenity and Residential Zone, a Logistics and Warehousing Zone, a Green & Open Space Zone, and a Utility Zone. Each zone shall receive differentiated ICT provisioning based on bandwidth demand, criticality, and operational requirements, as summarised in the zone-wise connectivity matrix forming part of Annexure ICT-01.

10.4 Passive ICT Infrastructure

Passive ICT infrastructure constitutes the foundational layer of the park's digital ecosystem and shall be installed during civil construction to preclude the need for future road-cutting or retrofitting. All passive infrastructure shall be designed to a design life of minimum 30 years and shall comply with TIA-568-D, ISO/IEC 11801, and applicable BIS standards.

10.4.1 Optical Fibre Cable (OFC) Backbone

The OFC backbone shall form a ring-and-spur topology connecting all zones, nodes, and critical facilities within the park. The backbone shall utilize Single-Mode Optical Fibre conforming to ITU-T G.652.D specification with a minimum core count of 96 fibres per duct on primary backbone routes and 48 fibres on secondary distribution routes. The ring topology shall ensure path redundancy such that a single cable cut or node failure does not interrupt network services to any zone.

The total estimated backbone OFC route length for a park ranging from 100 to 1,000 acres shall be between 8 and 58 route kilometres, scaled proportionally to the final notified park area and internal road/zone layout. For planning and cost estimation purposes, a 500-acre reference case assumes approximately 28–32 route kilometres of backbone OFC route.

Each backbone node—typically co-located at street-level cabinets or sub-ICCC rooms—shall be equipped with 19-inch rack-mounted fibre distribution frames (FDFs) with pre-terminated LC/PC connectors for ease of patching and future reconfiguration. The OFC splicing shall be carried out using fusion splicing technology with average splice loss not exceeding 0.02 dB, tested and OTDR-documented for each fibre.

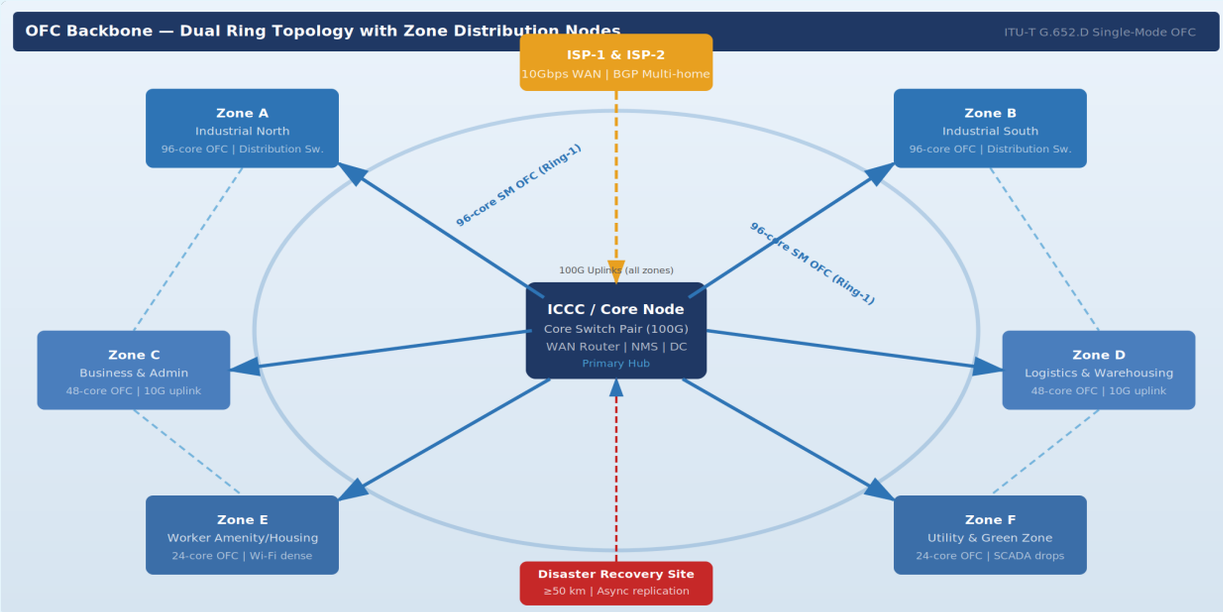


Figure 10.2: OFC Backbone Ring Topology — Zone Connectivity

Legend

■ Primary OFC Backbone (96-core SM)	■ Inter-Zone Ring Redundancy	■ WAN / ISP Uplink
■ DR Replication Link	■ Core / ICCC Node	■ Primary Zone Node
■ Secondary Zone Node	■	■

10.4.2 HDPE Duct Network

A comprehensive network of High-Density Polyethylene (HDPE) micro-duct and macro-duct pipes shall be installed along all primary and secondary roads within the park. The primary backbone ducts shall comprise a bank of 4×50mm HDPE ducts (2 active, 1 reserved, 1 for future) and 2×32mm micro-duct bundles for ICT services.

Secondary roads shall be served by 2×40mm HDPE ducts supplemented by 4×7mm micro-duct bundles for low-count service drops.

All HDPE ducts shall conform to IS 4984 and shall be furnished with internal silicon-coated liners and factory-installed pull-tapes to facilitate installation and future cable replacement without excavation. Duct route markers of UV-resistant HDPE shall be installed at every 50 metres and at each change of direction. All ducts shall be pressure-tested to 0.5 bar for 30 minutes prior to backfilling to certify integrity.

10.4.3 Telecom Chambers & Manholes

Pre-cast reinforced concrete (RCC) telecom inspection chambers conforming to TEC specifications shall be installed at maximum 50-metre intervals on backbone routes, at all route intersections, and at each plot service exit point. Chambers shall be of Type B (900mm × 600mm × 750mm) for secondary routes and Type D (1200mm × 900mm × 900mm) for backbone junctions. All chambers shall be fitted with anti-theft cast-iron frame and covers with appropriate load ratings (B125 for footpaths, D400 for carriageways) and tamper-proof bolt closure.

10.4.4 Structured Cabling within Common Facilities

Common area facilities including the Administration Building, ICCC, Employee Amenity Centre, Skill Development Centre, Convention Centre, and Security Cabins shall be wired with a structured cabling system conforming to ISO/IEC 11801 Class EA (Category 6A minimum). All horizontal cable runs shall not exceed 90 metres, with 10-metre patch cord allowance. Cable installation shall be carried out in dedicated cable trays (perforated steel, hot-dip galvanized) routed through false ceilings and service shafts, segregated from power cables with a minimum 300mm separation.

10.4.5 Underground Utility Corridor Integration

Wherever the master plan provides for a Common Utility Corridor (CUC) or Service Tunnel beneath primary roads, ICT HDPE duct banks shall be incorporated as a dedicated ICT compartment within the CUC cross-section, in accordance with the PM GatiShakti utility corridor standards. The CUC design shall allow for walk-in access for maintenance and cable pulling without excavation, significantly reducing long-term O&M costs. All ICT duct entries and exits from the CUC shall be protected with RCC end-caps and fire-rated sealing compounds at building penetrations.

10.5 Active ICT Infrastructure

The active ICT infrastructure shall constitute a carrier-grade, Software-Defined Networking (SDN) capable, multi-layer network supporting the park's internal operational networks, tenant connectivity, and smart system communications. The

network shall be designed with full redundancy at core and distribution layers and shall support IPv6 natively alongside IPv4 dual-stack operation.

10.5.1 Core Switching Layer

The park's network core shall be deployed at the ICCC facility and shall comprise a pair of fully redundant, chassis-based core switches operating in an active-active Virtual Switch Unit (VSU) or Stacked configuration. Core switches shall provide minimum 40G/100G uplink ports for inter-chassis links and 10G/25G downlinks to distribution switches. The core switching platform shall support full L3 routing with OSPF/BGP, MPLS, QoS with DiffServ, NetFlow/sFlow monitoring, and MACsec encryption on all trunk ports. Hardware-based Line Rate switching capacity shall not be less than 12.8 Tbps per chassis. A dedicated out-of-band (OOB) management network with console access to all active devices shall be provided.

10.5.2 Distribution Switching

Distribution switches shall be deployed at each zone-level ICT room or outdoor street cabinet (minimum one per 50-acre zone) and shall interconnect the core via dual uplinks on diverse OFC paths. Distribution switches shall operate at a minimum of 10G uplink capacity and provide 1G/2.5G access downlinks to access switches. All distribution switches shall support IEEE 802.1ag OAM for link fault management, Power over Ethernet Plus Plus (PoE++) delivery of up to 90W per port for powering IoT devices and smart poles, and VLAN segmentation aligned with the park's network segmentation architecture.

10.5.3 Routers & WAN Connectivity

A dedicated WAN router cluster at the ICCC shall manage external internet connectivity, State NIC network peering, and NICDC's central network interconnection. The park shall procure primary internet bandwidth from at least two diverse ISPs, with automatic failover configured through BGP multi-homing. Minimum contracted internet bandwidth shall be 10 Gbps (expandable to 100 Gbps) for initial phase, with a Service Level Agreement mandating 99.9% uptime. Additionally, a dedicated MPLS link to the NICDC central data centre and the nearest National Knowledge Network (NKN) PoP shall be provisioned.

10.5.4 Wi-Fi Infrastructure

The active wireless infrastructure shall deploy Wi-Fi 6E (IEEE 802.11ax) Access Points (APs) across all indoor common areas and outdoor zones. APs shall operate across 2.4 GHz, 5 GHz, and 6 GHz bands simultaneously, with individual AP throughput of not less than 3.5 Gbps. A cloud-managed or on-premise Wireless LAN Controller (WLC) shall provide centralized RF management, automatic channel optimization,

client steering, and integrated RADIUS-based user authentication. Outdoor APs shall be IP-67 rated and mounted on smart poles at 50–80 metre inter-AP spacing to ensure ubiquitous –65 dBm coverage. A minimum of 1,200 access points (scalable to 2,000+) shall be deployed at full park build-out.

10.5.5 Network Management System (NMS)

A comprehensive Network Management System shall be deployed at the ICCC for real-time visibility, fault management, configuration management, accounting, and performance monitoring (FCAPS) of all active ICT assets. The NMS shall support automated topology discovery, threshold-based alerting via email/SMS/push notifications, root-cause analysis, and SLA compliance dashboards. Integration with the ICCC's central monitoring platform shall be through standardized APIs (REST/GraphQL) to enable cross-domain correlation of network events with physical security and utility incidents.

10.6 Integrated Command & Control Centre (ICCC)

The Integrated Command & Control Centre (ICCC) shall serve as the operational nerve centre of the Smart Industrial Park, consolidating real-time data streams from all smart systems—surveillance, access control, utilities, environment, parking, smart poles, and building management—into a unified operational intelligence platform. The ICCC shall be housed in a purpose-built, environmentally controlled facility of approximately 2,000–3,000 sq.ft. within the Administration Complex, designed to operate 24 hours a day, 365 days a year, with a minimum staffing of six operators and one supervisor per shift.

10.6.1 Centralized Monitoring Platform

The ICCC platform shall be built on a microservices-based, API-first architecture to enable seamless integration with existing and future smart systems without vendor lock-in. The platform shall feature a unified Geographical Information System (GIS) interface enabling operators to visualize all park assets, alarms, and events on a geo-referenced park map. The platform shall support role-based access control (RBAC), audit logging of all operator actions, automated alarm correlation and prioritization, and escalation workflow management. The system shall maintain a minimum of 5 years of historical operational data on integrated storage with a 5-minute data granularity for all IoT telemetry streams.

10.6.2 Video Wall System

The ICCC operator hall shall be equipped with a high-resolution video wall comprising not less than 12 units of 55-inch narrow-bezel (≤1.7mm) LED-backlit or Direct View LED panels arranged in a 4×3 matrix configuration, delivering an aggregate resolution

of not less than 4K×2K. The video wall management system shall support real-time tiling of CCTV feeds, GIS maps, utility dashboards, and alarm panels, with drag-and-drop windowing capability from the operator workstations. The video wall shall be driven by a dedicated video wall processor with hardware-accelerated decoding supporting H.265 streams from all connected IP cameras simultaneously.

10.6.3 Emergency Response Integration

The ICCC shall serve as the primary Emergency Response Hub (ERH) for the park, maintaining direct communication links with the park's fire station, ambulance bay, police post, and the State Emergency Operations Centre (SEOC). Emergency protocols including fire evacuation, chemical spill, security breach, and natural disaster shall be encoded as Standard Operating Procedures (SOPs) within the ICCC platform, enabling one-click emergency activation, PA system broadcast, barrier-arm lifting at all entry gates, and automatic notification to allottee safety officers via mobile app. The ICCC shall maintain a UPS-backed emergency power supply ensuring continuous operation for a minimum of 4 hours in the event of total power failure.

10.7 Data Centre & Disaster Recovery Infrastructure

The park shall be served by a dedicated on-premise Data Centre (DC) designed and constructed to TIA-942 Tier III equivalent standards, offering concurrently maintainable power and cooling infrastructure with an annual uptime commitment of 99.982%. The DC shall be located within the Administration and ICCC Complex in a dedicated secure room of approximately 400–600 sq.m., with raised flooring, pre-action dry-pipe fire suppression, precision air conditioning, and 24×7 card-access security.

The initial DC build-out shall provision 50 standard 42U server racks at 10 kW average rack density, with the civil and power infrastructure pre-designed for horizontal expansion to 200 racks without structural modification. The DC power architecture shall follow a 2N UPS topology with static bypass, fed by dual independent LT panels from separate transformer feeders, supplemented by a dedicated DG set with Automatic Transfer Switch (ATS) for extended backup. Power Usage Effectiveness (PUE) shall be targeted at ≤1.4 through the deployment of hot-aisle/cold-aisle containment, free-cooling economizers, and variable-speed precision cooling units.

A geographically separated Disaster Recovery (DR) site shall be co-located at the NICDC Regional/National DC or at a Meity-empanelled third-party Tier III/IV data centre, located at a minimum distance of 50 km from the primary DC. Replication shall be achieved through synchronous/asynchronous OFC-connected links with Recovery Time Objective (RTO) of ≤4 hours and Recovery Point Objective (RPO) of ≤15 minutes for Tier 1 applications. Annual DR drills shall be mandated under the O&M SLA.

The DC shall serve as the hosting platform for all park ICT applications including the ICCC platform, SCADA servers, GIS, BMS, NMS, and tenant-facing portals. A co-location facility within the DC shall also be offered to tenant industries requiring on-premise server hosting, providing a managed, secure, and resilient alternative to independent server rooms within individual factory buildings.

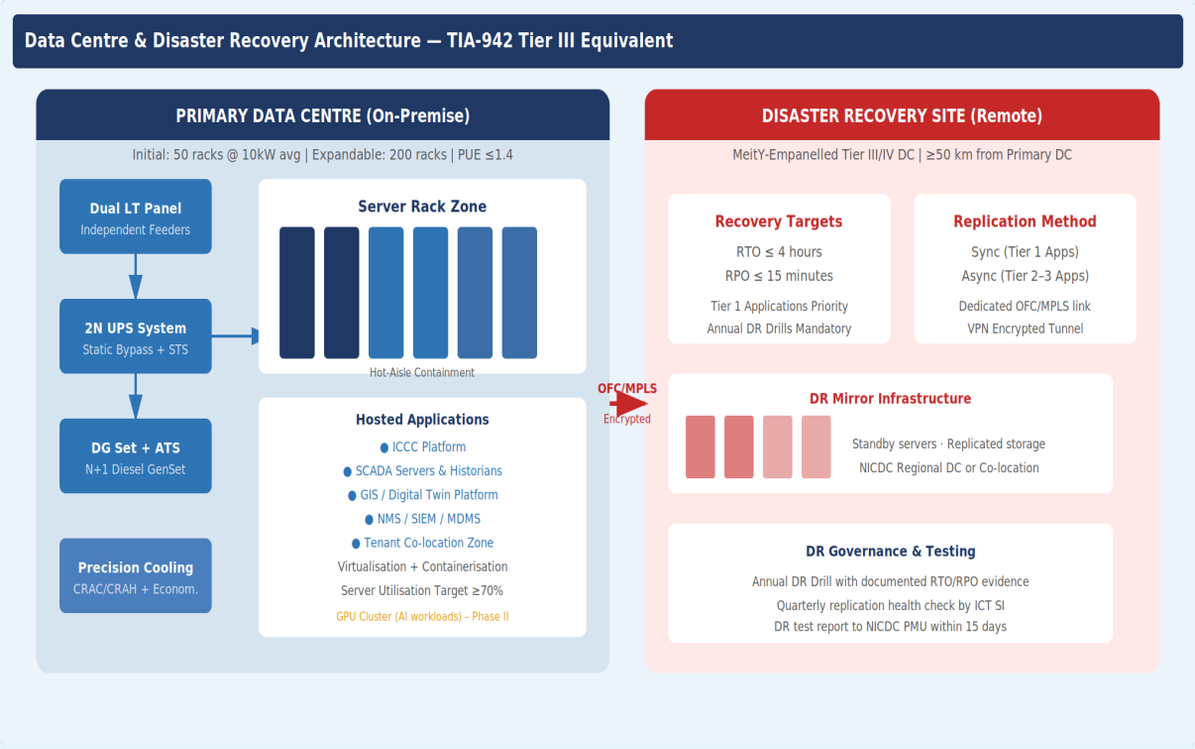


Figure 10.3: Data Centre & Disaster Recovery Architecture

Legend

■ Primary DC Core Systems	■ Power Infrastructure (2N)	■ Disaster Recovery Site
■ OFC/MPLS Replication Link (Encrypted)	■ Hosted Applications / DR Mirror	■

10.8 Smart Surveillance System

A comprehensive end-to-end IP Video Surveillance System (VSS) shall be deployed across the park to ensure perimeter security, internal monitoring, traffic management, and incident documentation. The system shall be designed as a scalable, edge-intelligent surveillance network capable of supporting a total of 2,000+ IP cameras at full park build-out, managed through a centralized Video Management Software (VMS) platform at the ICCC.

10.8.1 IP CCTV Cameras

Standard fixed surveillance cameras shall be deployed across all roads, common areas, utility zones, parking areas, and entry-exit points. Cameras shall conform to a minimum specification of 4MP (2688×1520) resolution, H.265+ compression, Wide Dynamic Range (WDR) of ≥120 dB, and integrated IR illumination effective to 50 metres. All outdoor cameras shall be rated IP-67/IK-10 and designed for an ambient operating temperature of -20°C to +60°C. Cameras shall be ONVIF Profile S and T compliant. PoE+ (IEEE 802.3at) powered cameras shall be preferred to minimize field cabling. The initial phase deployment shall encompass approximately 600 cameras.

10.8.2 PTZ Cameras

Pan-Tilt-Zoom (PTZ) cameras shall be installed at critical monitoring points including perimeter corners, main entry plazas, emergency assembly areas, and perimeter fence mid-points at intervals not exceeding 200 metres. PTZ cameras shall provide a minimum 36× optical zoom, 360° continuous rotation, auto-tracking capability with on-board deep learning object detection, and a minimum 4MP sensor at 30 fps. PTZ cameras shall be integrated with the VMS for preset positioning, patrol programming, and auto-response to alarm-triggered slewing.

10.8.3 Video Analytics Platform

A deep-learning Video Analytics Engine shall be deployed, integrated with the VMS, to process streams from all IP cameras in real time. The analytics platform shall support the following minimum algorithmic capabilities: perimeter intrusion detection, loitering detection, abandoned object detection, crowd density analysis, fire and smoke detection, wrong-way vehicle movement detection, and object counting. All analytics events shall be timestamped, geo-tagged, and logged in the ICCC event management system with camera snapshots and 30-second pre/post event video clips. The platform shall be GPU-accelerated and shall achieve a minimum of 95% detection accuracy under specified operating conditions as demonstrated during Factory Acceptance Testing (FAT).

10.8.4 Automatic Number Plate Recognition (ANPR)

ANPR cameras shall be installed at all park entry and exit lanes, internal checkpoint gates, and the logistics zone weighbridge approaches. ANPR cameras shall achieve a minimum 96% plate recognition accuracy under standard operating conditions including partial occlusion and adverse lighting, validated against a test dataset of 10,000 vehicle images. The ANPR system shall integrate with the park's Vehicle Access Management System to enable automatic permit verification, vehicle whitelist/blacklist management, and entry-exit time stamping for commercial vehicles.

ANPR data shall be retained for a minimum of 90 days and available for forensic retrieval.

10.9 Access Control & Visitor Management System

A multi-modal, technology-converged Access Control and Visitor Management System (ACVMS) shall be deployed to manage and control the movement of persons and vehicles across the park with precision, traceability, and real-time auditability. The ACVMS shall operate as an integrated module within the ICCC platform, providing a unified interface for access event management, visitor scheduling, and security exception handling.

10.9.1 RFID-based Access

Long-range Passive UHF RFID readers (ISO/IEC 18000-63 compliant) operating at 865–868 MHz (TRAI regulated band) shall be installed at vehicular entry lanes, warehouse dock doors, and internal checkpoint gates. RFID readers shall provide a read range of 3–8 metres at vehicle speeds up to 60 kmph, enabling non-stop transit verification for pre-authorized vehicles. All registered park vehicles—delivery trucks, staff vehicles, and service vehicles—shall be issued windshield-mount RFID tags with tamper-evident labels. RFID data shall integrate directly with the Vehicle Management and ANPR systems for dual-factor vehicle verification.

10.9.2 QR Code Integration

A digital visitor pass system based on time-bound, cryptographically signed QR codes shall be deployed for visitor access management. Visitors shall pre-register through the park's web/mobile portal, receive a one-time-use QR pass via email/SMS, and scan at entry QR readers for automatic gate authorization. QR passes shall encode visitor identity, host factory ID, permitted access zones, and valid time window, and shall be rendered invalid upon single use or time expiry. The system shall support bulk visit scheduling for contractors, auditors, and delegations.

10.9.3 Biometric Access Control

Biometric access terminals—integrating fingerprint (FAR ≤0.0001%, FRR ≤0.1%) and facial recognition capabilities—shall be deployed at all pedestrian entry points, ICCC access doors, Data Centre entry, and high-security utility control rooms. Facial recognition terminals shall operate on liveness-detection enabled algorithms to prevent spoofing, and shall function as a standalone mode with local database for 10,000 enrolled identities, synchronizing with the central access control server. The biometric system shall conform to FIDO2/WebAuthn standards and shall not store raw biometric data in transmittable form, in compliance with applicable data protection guidelines.

10.9.4 Turnstiles & Flap Barriers

Speed gates (bi-directional flap barriers) with integrated card reader and biometric terminal mounting provision shall be installed at all pedestrian entry vestibules, administration buildings, and common facility entrances. Turnstiles shall be full-height rotor-type at perimeter pedestrian gates for high-security sections, and waist-high retractable flap barriers at indoor facilities. All gates shall include ADA-compliant wide-lane provision, anti-tailgating sensors, and fire-safety mode enabling automatic free-egress upon fire alarm activation.

10.10 Smart Parking Management System

A sensor-based Smart Parking Management System (SPMS) shall be deployed across all designated parking areas within the park, including the Administration Complex car park, Employee Amenity Zone, Visitor Parking, and Heavy Vehicle Staging Yard, with an initial capacity provisioning of 2,000 car equivalent units (CEUs), scalable to 5,000 CEUs.

Individual parking bays shall be fitted with in-ground ultrasonic or magnetic parking sensors (IP-68 rated, 5-year maintenance-free battery life) transmitting bay occupancy status (available/occupied) via LoRaWAN or NB-IoT to the SPMS server. Dynamic Parking Guidance Signage (PGS)—LED variable message signs—shall be installed at all parking zone entry points and at internal junctions, displaying real-time available bay counts per zone. Integration with the ANPR system shall enable automatic vehicle-to-bay assignment tracking, enabling forensic retrieval of vehicle parking history.

A mobile application and web portal shall be provided for park users to view real-time parking availability, pre-book parking slots (for large events and delegations), and receive navigation to the nearest available bay. Integration with the park's Enterprise Resource Planning (ERP) portal shall enable parking charges to be automatically billed to allottee accounts based on vehicle type and duration. SPMS data shall feed the ICCC dashboard to enable real-time park-wide traffic flow management.

10.11 Smart Utility Metering & SCADA

The park shall be equipped with an Advanced Metering Infrastructure (AMI) system covering electricity, piped water, treated wastewater (for recycled water supply), and compressed air/gas, enabling automated billing, demand forecasting, and anomaly detection across all utility consumers—both common area and individual allottees.

Smart electricity meters conforming to IS 16444 (Part 1 & 2) and IS 15884 (for Net Metering enabled plots with rooftop solar) shall be installed at every allottee's incomer

switchgear location and at all common service connection points. Meters shall communicate via DLMS/COSEM protocol over RF Mesh or GPRS/NB-IoT to the central Meter Data Management System (MDMS). Tamper alarms, power quality event logging (harmonics, voltage sags, outages), and remote disconnection relay shall be standard meter features.

The Supervisory Control and Data Acquisition (SCADA) system shall provide centralized real-time monitoring and control of the park's utility networks including the 33/11 kV substation, Water Supply and Treatment Plants, Sewage Treatment Plant (STP), Effluent Treatment Plant (ETP), Storm-water Pumping Stations, and Gas Distribution Network. The SCADA platform shall conform to IEC 61850 (for electrical systems) and shall use IEC 62443 security architecture for OT network segregation. Historians shall log all process parameters at 1-minute intervals with 10-year data retention. All SCADA field RTUs and PLCs shall communicate via IEC 101/104 DNP3 or Modbus TCP/IP protocols over a dedicated, air-gapped OT communication network.

10.12 Building Management System (BMS) Integration

The key common area buildings within the park—ICCC & Administration Building, Convention and Business Centre, Skill Development Centre, Employee Amenity Block, and the Data Centre facility—shall each be equipped with a Building Management System (BMS) conforming to BACnet/IP (ANSI/ASHRAE 135) or LonWorks protocols, enabling comprehensive automated management of HVAC, electrical, lighting, fire alarm, lifts, and water management subsystems within each facility.

The individual building BMS systems shall be integrated with the ICCC central platform through a BACnet/IP gateway or MODBUS TCP/IP middleware layer, enabling park operations staff to monitor aggregate energy consumption, occupancy, and fault alarms from all buildings through a single dashboard. AI-assisted energy optimization algorithms deployed at the BMS level shall automatically adjust HVAC setpoints, lighting levels, and equipment schedules based on occupancy sensor data and weather forecasts, targeting a minimum 20% reduction in common area energy consumption against baseline.

The Data Centre BMS shall maintain environmental parameters—temperature, humidity, differential pressure, and airflow—within ASHRAE TC 10.9 A1 class thresholds, with automatic failover to standby cooling units on threshold exceedance. All BMS alarms of Priority 1 (critical) and Priority 2 (urgent) shall be simultaneously transmitted to the ICCC operator console within 30 seconds of detection.

10.13 Environmental Monitoring System

A distributed Environmental Monitoring Network (EMN) shall be installed across the park to provide continuous, real-time measurement of ambient air quality, noise, and meteorological parameters, in compliance with CPCB's National Ambient Air Quality Monitoring Standards (NAAQMS) and applicable MoEF&CC Environmental Clearance conditions.

A minimum of four Continuous Ambient Air Quality Monitoring Stations (CAAQMS) shall be installed at strategic locations—windward and leeward of industrial zones, at the park boundary, and in the Worker Residential Zone—measuring PM2.5, PM10, SO2, NO2, CO, O3, VOCs, and Ammonia. Monitoring stations shall transmit real-time data to the ICCC and simultaneously to the State Pollution Control Board (SPCB) CAAQMS network portal as mandated by regulatory conditions.

Noise monitoring sensors shall be deployed at the park perimeter, sensitive receptor locations (residential/amenity zones), and major noise-generating industrial zones to provide real-time Leq (A-weighted equivalent noise level) data. The EMN shall integrate with the SCADA system to trigger automated source investigation workflows when ambient thresholds are breached, enabling compliance documentation without manual intervention.

A compact weather station (measuring wind speed/direction, temperature, relative humidity, rainfall, solar radiation, and atmospheric pressure) shall be installed atop the ICCC building, providing hyperlocal meteorological data to support stack emission dispersion modelling and emergency response planning.

10.14 Public Wi-Fi Infrastructure

In alignment with the PM-WANI (Prime Minister Wi-Fi Access Network Interface) framework, a park-wide Public Wi-Fi network shall be deployed to serve the connectivity needs of workers, visitors, contractors, and the public within common areas, amenity zones, food courts, and transit corridors. The Public Wi-Fi network shall be segregated from the park's private operational and tenant networks through dedicated VLANs and firewall policies, with no routing path between public and private network domains.

Public Wi-Fi access points—co-located on smart poles, building facades, and canopy structures—shall provide minimum 100 Mbps aggregate throughput per access point under full load. User authentication shall be via mobile OTP (one-time password) linked to Aadhaar-verified or VID-based identity, ensuring traceability while preserving user privacy as per Supreme Court guidelines on surveillance. Data retention of user

session logs shall comply with TRAI/DoT mandated requirements. A content filtering system shall block access to blacklisted URLs as per MeitY's prohibited content lists.

10.15 Cybersecurity Framework

The cybersecurity architecture for the park shall be founded on a Zero Trust Security Model, recognizing that threats may originate from both external and internal sources and that no device, user, or network segment shall be inherently trusted. The cybersecurity framework shall conform to ISO/IEC 27001:2022 (Information Security Management System), NIST Cybersecurity Framework (CSF) Version 2.0, CERT-In Guidelines for Critical Infrastructure Protection, and MeitY's Cloud Security Framework for government digital infrastructure.

Network segmentation shall form the first principle of the cybersecurity architecture. The park's networks shall be segregated into distinct security zones: (i) Operational Technology (OT) Network for SCADA, BMS, and smart metering; (ii) Information Technology (IT) Network for ICCC applications and data centre; (iii) Tenant Network for allottee connectivity; (iv) Surveillance Network for IP cameras and access control; and (v) Public Wi-Fi Network. Inter-zone traffic shall be controlled by next-generation firewalls (NGFWs) with application-layer inspection, intrusion prevention, and SSL decryption capabilities.

A Security Operations Centre (SOC) function—initially operated as a managed SOC service from a CERT-In empanelled vendor—shall deploy a Security Information and Event Management (SIEM) platform to aggregate and correlate logs from all ICT systems, firewalls, endpoints, and OT devices. The SIEM shall have pre-built detection rules for OT-specific attack patterns (ICS/SCADA threats) and shall generate alerts for anomalous behaviour within 5 minutes of event detection. An Endpoint Detection and Response (EDR) solution shall be deployed on all ICCC workstations, servers, and DC hosts.

All inter-system communications shall use TLS 1.3 minimum encryption. Privileged Access Management (PAM) shall be deployed for all administrator-level access to servers and network equipment, enforcing multi-factor authentication (MFA) and just-in-time access provisioning. Regular penetration testing (minimum bi-annually) by a CERT-In empanelled cybersecurity firm, and quarterly vulnerability assessments, shall be mandated under the O&M SLA. A cybersecurity incident response plan aligned with CERT-In's National Cyber Crisis Management Plan shall be tested through tabletop exercises annually.

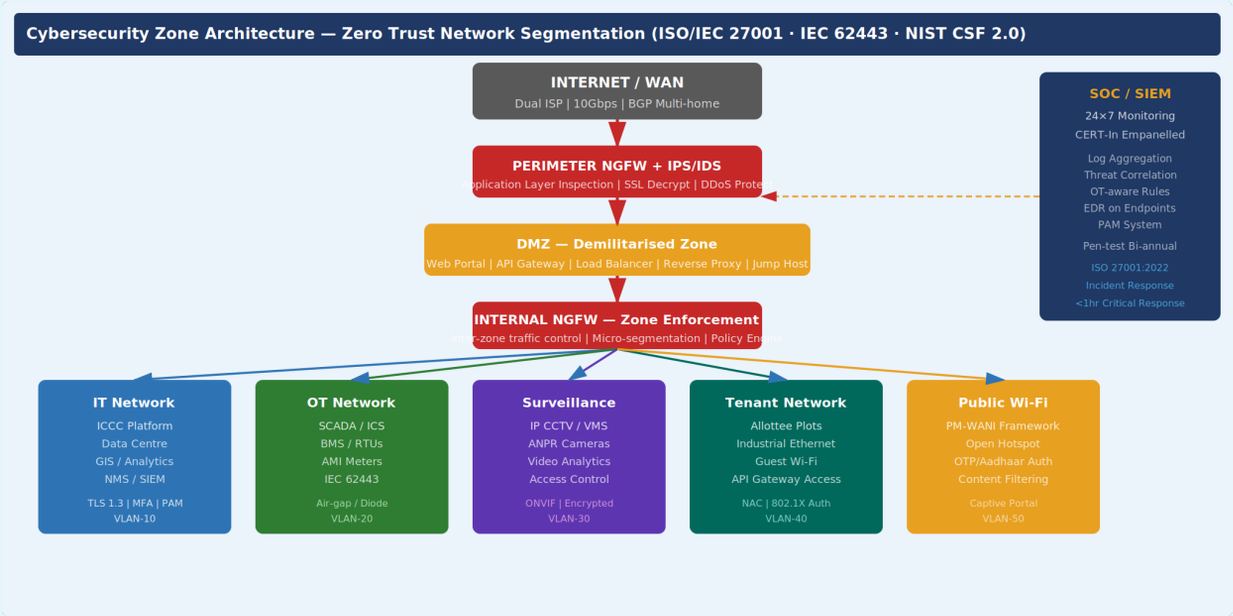


Figure 10.4: Cybersecurity Zone Architecture — Network Segmentation

Legend

■ NGFW / IPS – Enforcement Points	■ IT Network Zone (VLAN-10)	■ OT Network Zone – Air-gap (VLAN-20)
■ Surveillance Zone (VLAN-30)	■ Tenant Network Zone (VLAN-40)	■ Public Wi-Fi Zone (VLAN-50)

10.16 Smart Poles & IoT Infrastructure

Smart multifunctional poles shall be deployed along all primary and secondary roads, at pedestrian plazas, and at parking areas within the park at intervals of 30–50 metres (road type dependent). Each smart pole shall serve as a vertical utility spine, integrating multiple functions: LED street lighting, Wi-Fi 6E access point, surveillance camera (fixed), environmental sensor, digital display panel (select locations), EV charging point provision (fast & slow charging), and emergency SOS push-button intercom.

The smart pole design shall be structurally engineered to IS 2713 standards, fabricated in hot-dip galvanized steel with polyester powder coating, with a minimum design life of 25 years. An integrated pole controller module housed within the pole base compartment shall manage all connected devices, provide a PoE switch for camera and AP power, and communicate with the ICCC via OFC or LoRaWAN. The street lighting circuit shall be separately protected and independently controllable. Adaptive dimming of street lighting based on ambient luminance sensors shall be standard, targeting a minimum 40% energy savings over conventional non-controlled LED lighting.

An IoT sensor platform built on open-standard LPWAN protocols—LoRaWAN 1.0.4 (868 MHz) as the primary IoT backhaul and NB-IoT as secondary—shall be deployed park-wide to support a heterogeneous ecosystem of IoT devices. LoRaWAN network servers (compliant with LoRa Alliance specifications) shall be hosted at the ICCC DC, provisioned with a minimum of eight LoRaWAN gateways to ensure 99%+ park coverage at SF7. The IoT platform shall expose northbound APIs (MQTT, REST) for integration with the ICCC analytics engine and tenant IoT applications.

10.17 GIS & Digital Twin Readiness

A comprehensive Geographic Information System (GIS) platform shall be established as the geospatial backbone of the park's digital infrastructure management, asset registry, and operational dashboards. The GIS shall be developed on an open-standards platform (OGC WFS/WMS/WMTS compliant) and shall integrate all physical assets—roads, utilities, buildings, plots, smart poles, cameras, sensors, and green spaces—georeferenced to sub-metre accuracy using DGPS survey.

The GIS platform shall form the primary interface of the ICCC, enabling operators to spatially query, visualize, and respond to events. Asset management workflows—maintenance scheduling, fault resolution, and condition monitoring—shall be managed through the GIS-linked Asset Management System (AMS). All physical infrastructure as-built documentation shall be submitted in GIS-compatible formats (shapefile, GeoJSON, GeoPackage) and imported into the GIS database for perpetual record maintenance.

The park ICT design shall include provisions and specifications for a future Digital Twin platform, ensuring that from inception, all physical assets are assigned unique Asset IDs, BIM models are prepared to LOD 300 minimum (LOD 400 for key structures), and IoT sensor data streams are structured for ingestion into a 3D simulation environment. The Digital Twin shall replicate the park's physical environment in real-time, enabling scenario simulation for emergency response, infrastructure capacity planning, maintenance optimization, and investor onboarding. The Digital Twin platform shall conform to CityGML 3.0 and IFC 4.x standards for interoperability with national GIS databases under the PM GatiShakti NMP.

10.18 AI-based Analytics Readiness

The ICT architecture shall be designed with AI-readiness as a first-class design principle, ensuring that the data infrastructure, compute capacity, and application APIs are prepared to onboard AI and Machine Learning (ML) based analytics modules as the park matures. The Data Centre shall provision a dedicated GPU cluster rack

(expandable from initial 2×NVIDIA A100 equivalent to 8 GPUs) for hosting AI inference workloads.

In the initial operational phase, AI analytics shall be applied to the following high-priority use cases: (i) Video analytics for perimeter intrusion, fire/smoke detection, and crowd analysis as described in Section 10.3; (ii) Predictive maintenance of rotating equipment in utility plants through vibration, temperature, and current signature analysis; (iii) Energy demand forecasting and load optimization using SCADA and smart meter data; and (iv) Traffic flow prediction and smart parking optimization using vehicle count and occupancy data.

As the park's data ecosystem matures through Phase II and Phase III, additional AI modules shall be progressively onboarded including: anomaly detection in utility consumption patterns indicative of theft or leakage; AI-assisted emergency dispatch routing based on real-time traffic and incident location data; intelligent document processing for permit and NOC applications at the park administration portal; and supply chain visibility AI integrated with allottee ERP systems through secure API gateways.

10.19 Sustainability & Green ICT

The ICT infrastructure shall be planned and delivered in adherence to Green ICT principles, minimizing the environmental footprint of digital infrastructure while maximizing the operational sustainability contribution of smart systems across the park. Green ICT shall be integrated as a cross-cutting requirement across all ICT component specifications, procurement, and operational management.

The Data Centre shall target a Power Usage Effectiveness (PUE) of ≤1.4, consistent with globally recognized efficient data centre operations (ISO 30134 standard for DC energy metrics). This shall be achieved through hot-aisle/cold-aisle containment, variable-speed EC fans in precision cooling units, economizer-mode free cooling where ambient conditions permit, and right-sizing of UPS capacity for actual load with projected 80% maximum loading. DC server utilization rates shall be maintained above 70% through virtualization and containerization mandates.

All ICT equipment procured for the park—switches, routers, APs, servers, workstations, displays—shall carry a minimum 4-Star BEE energy efficiency rating or equivalent (Energy Star, 80 Plus Gold for power supplies). The smart street lighting system shall deliver a minimum 40% energy reduction versus baseline through LED technology and adaptive dimming. All ICT active equipment shall be RoHS compliant, and electronic waste management shall follow E-Waste (Management) Rules, 2022 through empanelled recyclers.

The ICCC platform shall include an ICT Carbon Footprint Dashboard, tracking energy consumption of all park ICT assets, their carbon equivalent emissions based on the applicable state grid emission factor, and progress against sustainability targets. This dashboard shall interface with the park's overall Environmental, Social, and Governance (ESG) Reporting System, enabling transparent disclosure to investors, regulatory authorities, and NICDC.

10.20 Standards & Compliance Framework

All ICT systems, equipment, and installations within the Smart Industrial Park shall conform to the applicable national and international standards, regulatory mandates, and Government of India policy frameworks. The following consolidated Standards and Compliance Matrix shall govern design, procurement, installation, testing, and operation of all ICT infrastructure components.

Table 10.1: Standards & Compliance Framework

Domain	Applicable Standards & Protocols
Network Infrastructure	TIA-568, ISO/IEC 11801, IEEE 802.3/802.11ax, ITU-T G.652.D
Data Centre	TIA-942 (Tier III equivalent), EN 50600, ASHRAE TC 10.9
Cybersecurity	ISO/IEC 27001:2022, NIST CSF 2.0, CERT-In Guidelines, MeitY Cloud Security Framework
Surveillance & ANPR	ONVIF Profile S/T/G, H.265/H.264 compression, IEC 62676
Smart Metering	IS 16444, IS 15884, DLMS/COSEM protocol, OpenADR 2.0
SCADA & Automation	IEC 61850, IEC 62443, DNP3, Modbus TCP/IP, OPC-UA
GIS & Digital Twin	OGC WFS/WMS/WMTS, CityGML 3.0, IFC 4.x, ISO 19100 series
Environmental Monitoring	IS 5182, CPCB NAAQMS guidelines, IEC 61724
Access Control	ISO/IEC 14443 (RFID), ISO 18092 (NFC), FIDO2/WebAuthn
Green ICT	ISO 30134 (PUE), Energy Star, BEE 5-Star for IT equipment, LEED v4.1

Compliance with the above standards shall be verified through a structured Testing & Commissioning (T&C) process comprising Factory Acceptance Testing (FAT) by NICDC-appointed PMC, Site Acceptance Testing (SAT) upon installation, and Integrated System Testing (IST) prior to ICCC go-live. All T&C documentation, including FAT/SAT/IST reports, OTDR test records, cable certification reports, and

penetration testing certificates, shall be submitted to NICDC as part of the As-Built documentation package.

10.21 Implementation Phasing

The implementation of ICT infrastructure shall be phased to align with the civil infrastructure development schedule and to ensure that ICT systems are available for use at the time of first allottee handover. The phasing strategy ensures that core digital infrastructure—backbone OFC, ICCC, network, and security—is operational before the park opens for occupancy, with advanced smart systems and AI analytics platforms progressively deployed as the park reaches higher occupancy levels.

Table 10.2: Implementation Phasing

Phase	Scope of Work	Timeline	Key Deliverables
Phase I (Foundational)	OFC backbone, passive ducts, ICCC shell, core network, 50-node surveillance, smart entry gates, smart poles (Zones 1–3)	Months 1–18	Operational network; ICCC live; core surveillance & access control
Phase II (Operational)	Full surveillance coverage, SCADA integration, smart parking, BMS integration, public Wi-Fi, EMS dashboard, AI analytics module	Months 19–30	Full operational ICT; SCADA & BMS live; Public Wi-Fi activated
Phase III (Advanced / Future)	Digital Twin deployment, predictive AI analytics, 5G private network readiness, blockchain-based access, AR/VR ICCC integration	Months 31–48	Digital Twin operational; advanced analytics; 5G-ready infrastructure

Phase I implementation shall be the critical path for park operationalization. The ICCC must be commissioned at least 30 days prior to the first allottee handover to enable testing, staff training, and SOP validation. All passive OFC and HDPE duct infrastructure shall be installed and tested prior to road finalization to avoid post-construction excavation.

10.22 O&M Framework and Service Level Agreements

The Operations and Maintenance (O&M) of the park's ICT infrastructure shall be carried out under a comprehensive Managed Services Agreement (MSA) awarded to a qualified ICT System Integrator through a competitive tendering process by NICDC or the park's Special Purpose Vehicle (SPV). The MSA shall be structured as a 5-year contract (extendable by 3+2 years) with clearly defined Service Level Agreements (SLAs), Key Performance Indicators (KPIs), & a financial penalty framework for non-performance.

The O&M service scope shall encompass preventive maintenance (quarterly for passive infrastructure, monthly for active systems), corrective maintenance, software patch management, annual cybersecurity audits, staff training, end-user helpdesk support (16×5 minimum, 24×7 for critical systems), spare management with critical spares on-site, and annual SLA compliance reporting to NICDC.

Table 10.3: O&M Framework and Service Level Agreements

Service Parameter	Performance Benchmark	Penalty (per incident)	Measurement Frequency
Core Network Uptime	99.9% per quarter	0.5% of quarterly AMC charge	Real-time monitoring
ICCC System Availability	99.5% per month	0.25% of monthly O&M charge	Monthly
CCTV Uptime (operational cameras)	≥ 95% at all times	₹500 per camera/day below threshold	Weekly audit
ANPR System Accuracy	≥ 95% recognition rate	0.1% of monthly charge per 1% deviation	Monthly
Cybersecurity Incident Response	Critical: < 1 hr; High: < 4 hrs	As per SLA schedule	Per incident
Smart Metering Data Accuracy	± 0.5% tolerance	Penalty as per AMC terms	Quarterly calibration
Helpdesk Response (ICT faults)	Priority 1: < 2 hrs; P2: < 8 hrs	Escalation to NICDC PMU	Per ticket
SCADA System Availability	99.5% per month	0.25% of monthly AMC	Monthly

The O&M contractor shall maintain a dedicated on-site team comprising a minimum of: 1 ICT Site Manager, 2 Network Engineers, 2 CCTV/Security System Technicians, 1 Cybersecurity Analyst (remote SOC from empanelled CERT-In vendor), and 1 Data Centre Operations Specialist. Key personnel qualifications and experience requirements shall be specified in the MSA RFP and shall be verified prior to contract award.

CHAPTER 11

PROJECT FINANCING & IMPLEMENTATION

11.1 Implementation Strategy & Execution Framework

The implementation and phasing of a master plan involve a strategic approach to execute its objectives and projects over a designated timeline. For an industrial park, this process includes integrating governance mechanisms such as Special Purpose Vehicles (SPVs) or Industrial Area Development Authorities (IADA) with the overall master plan and ensuring compliance with state and national legal frameworks.

11.2 Implementation Mechanisms & Phasing

Implementation of various proposals and identified projects requires a thorough assessment and step-by-step approach. Phasing breaks down the park's implementation into manageable segments, prioritizing infrastructure projects based on urgency, market demand, and investment attractions. The development is typically organized into short-term, medium-term, and long-term phases to align with the financial capacity and land absorption rates.

Table 11.1: Implementation Mechanisms for Industrial Parks

Implementation Mechanism	Industrial Planning Application
Micro-level / Block Plans	Delineating development schemes for specific industrial blocks, allowing for flexible plot amalgamation or subdivision based on tenant requirements.
Development Regulations	Utilizing customized Building Byelaws and Zoning Regulations (e.g., separating Red/Orange industries from green zones) to regulate safe development.
Governance & Policy	Establishing an Industrial Area Development Authority (IADA) or SPV and integrating approvals via online single-window clearance systems. Indicative compliance/clearances generally required for Industrial Parks is placed at **Annexure-1**.
Development Projects	Executing anchor infrastructure projects first, such as trunk roads, Common Effluent Treatment Plants (CETPs), and multi-modal logistics hubs.

Table 11.2: Base Factors for Development Phasing

Base Factor	Strategic Focus for Industrial Phasing
Economic Potential & Investment	Prioritize areas with high economic potential, immediate availability of developable land, and maximum investment attraction (e.g., plots closest to National Highways).
Infrastructure Deficiencies	Focus initial phases on establishing critical utilities (water, power, sewerage) that are essential for the operation of early anchor tenants.
Workforce & Social Factors	Phase in worker housing, healthcare, and skill development centres in tandem with industrial cluster operationalization to support the "walk-to-work" concept.

11.3 Cost Estimates, Revenue Generation and Funding Mechanism

To ensure financial sustainability and promote economic growth, the identified proposals must be costed out accurately, with inflation rates considered over the phased timeline. Rates for any pending land acquisition must be calculated in accordance with the relevant state policies, Schedule of Rates (SORs), and prevailing market rates, rates shall be considered based on the royalties on the basis of government orders.

Table 11.3: Cost Components and Revenue Sources for Funding

Financial Component	Elements / Sources
Cost Estimates for Infrastructure Projects	Capital expenditures (CAPEX) for Water treatment plants, Water supply networks, Sewage treatment plants, Stormwater drains, Solid waste treatment, Electrical substations, and Telecom networks.
Revenues from Authority's Own Resources	Generating returns through the sale of plots, sale of purchasable FSI, development charges, and user charges for common utilities (e.g., CETP, water).
Funding from State & Central Govt.	Leveraging state equity (in the form of land), central grants/equity (e.g., NICDC), and funding from missions like AMRUT or PMAY.
Leveraging External Funding & Partnerships	Low-interest loans from organizations like HUDCO, World Bank, JICA, ADB, Joint Ventures, and Public-Private Partnerships (PPP) for specialized facilities.

11.4 Project Cost Estimates

The creation and development of trunk infrastructure in an industrial park shall be taken up at an estimated cost. Along with the estimated civil construction cost, it will include contingencies, escalations, construction supervision charges, applicable administrative charges, quality control charges, construction safety charges and interests during construction period. The above mentioned will have to be factored in the calculation of the overall project cost. Based on the implementation schedule of planned construction packages, the phasing of expenditure and the sources of funds will be derived.

A broad framework for costing of aforementioned components is provided in the table below:

Table 11.4: Project Cost Estimates (CAPEX)

Sr. No.	Description	UOM	Qty / Capacities	**Cost (₹ Crore)**
(1)	**(2)**	**(3)**	**(4)**	**(5)**
A.	**Core infrastructure**			
1	Site Development	acres		

2	Compound Wall / Fencing	KM		
3	Roads including street furniture, sidewalks & cross drainage	KM		
3.1	*Arterial Road- 45m ROW*	*KM*		
3.2	*Sub Arterial Road- 30m ROW*	*KM*		
3.3	*Collector Road- 24m ROW*	*KM*		
3.4	*Local Streets- 18m/12m ROW*	*KM*		
4	Minor/Major Bridges	Nos		
5	Storm Water drain including outfalls	KM		
6	Potable Water network including Firefighting system, Rising main, storages and associated pumping, SCADA	KM		
7	Recycle Water Supply network storages and associated pumping, SCADA	KM		
8	Sewage Network	KM		
9	Industrial Effluent collection network	KM		
10	Main Receiving Substation (MRSS) incl. civil works	Nos		
10.1	*Main Receiving Substation (MRSS) with SCADA*	MVA & KV		
10.2	*Associated Civil works*	LS		
11	Zonal Substations (ZSS) incl. civil works	Nos		
11.1	*Zonal Substations (ZSS) with SCADA*	KVA/KV		
11.2	*Associated Civil works*	LS		
12	Power Distribution system (cabling, RMUs, streetlights for roads and common areas etc.)	LS		
13	Utility Ducts / Trench for cables	KM		
14	Water Treatment Plant	MLD		
15	Common Effluent Treatment Plant (in ZLD if applicable)	MLD		
16	Sewage Treatment Plant	MLD		
17	Solid Waste Management	TPD		
18	Information and Communication Technology incl. security infrastructure	LS		
19	ICCC cum Admin Building	Sq mtr		
20	Entrance Plaza / gates	LS		
21	Area Landscaping	Sq mtr		
22	Any other item (misc.)	LS		
	Sub Total (A)			
B	**Value-added infrastructure**			
1	Renewable energy	KW		
2	Built to Suit facilities (BTS)	Sq mtr		
3	Ready Built Factories (RBF)	Sq mtr		
4	Storage and warehousing facilities	Sq mtr		

5	Common Facilities like R&D centres and testing labs, Weighbridge, Tool room etc)	Sq mtr		
	Sub Total (B)			
C	**Social Infrastructure (preferably on PPP basis)**			
1	SAFE worker housing	Sq mtr		
2	On-site day care facilities including health services	LS		
3	Skill Development Centre	Sq mtr		
	Sub Total (C)			
D	**External Infrastructure**			
1	Access road from site to nearest NH or SH	KM		
2	Power transmission line from nearest substation	KM		
3	Water supply pipeline from nearest source / reservoir	KM		
4	Gas supply pipeline from nearest source	KM		
	Sub Total (D)			
E	**Sub-Total (A+B+C+D) Project Construction Cost**			
F	GST @ 18% on Sub-Total (E)	%		
G	**Project Construction Cost including GST (E+F)**			
H	**Soft Costs (over sub-total G)**			
1	Contingencies on Project Construction Cost on (G)	%		
2	Escalation on Project Construction Cost on (G)	%		
3	Construction supervision on Project Construction Cost on (E)	%		
4	Administrative charges on Project Construction Cost on (E)	%		
5	Quality control charges on Project Construction Cost on (E)	%		
6	Construction safety on Project Construction Cost on (E)	%		
7	Any other mandatory charges applicable in the state	%		
	Sub-Total Other Costs (H)			
	Total Infrastructure Cost (G+H)			

Note: Capacities / Qty / Area/ Length of each infrastructure component shall mandatorily be mentioned under column 4.

II O&M Charges (OPEX) in % of CAPEX (G) and in Rs. (Crores).

11.4.1 Financial Analysis

An initial financial analysis of an industrial park is essential to assess its economic viability and long-term sustainability. While capital and operational costs—such as land, infrastructure, utilities, and maintenance—can be reasonably estimated, revenue projections are more uncertain as they depend on land uptake, user demand, pricing mechanisms, and policy support. Although industrial parks require significant upfront investment, efficient planning, modern infrastructure, and technology-enabled management can improve operational efficiency, enhance investor attractiveness, and generate sustainable long-term returns.

11.4.1.1 Financial Structuring and Viability Assessment

This chapter presents a BHAVYA-aligned financial framework for development of an industrial park through a Special Purpose Vehicle (SPV). All figures are indicative placeholders and should be replaced with project-specific DPR estimates, State policy rates, approved financing terms and supporting documents before submission.

Objective of the Financial Chapter

- Estimate the total project cost in a manner consistent with BHAVYA DPR template, including land cost / valuation, eligible infrastructure components, taxes, contingencies, escalation, supervision, O&M and external infrastructure, wherever applicable.
- Define the means of finance, including State / State Nodal Agency/CPSEs equity through land, Central assistance, approved debt where applicable, private developer equity where applicable, and internal accruals from land monetisation.
- Demonstrate compliance with BHAVYA funding caps, release pre-conditions, fund utilization restrictions, convergence principles and non-duplication of funding.
- Set out revenue assumptions, O&M recovery framework, O&M Corpus Fund, financial viability indicators, sensitivity cases, and approval / monitoring dashboards required for appraisal.

11.4.1.2 BHAVYA-aligned Financial Architecture

The financial architecture should be structured around BHAVYA requirements rather than a generic financing model. The SPV should function as the accountable entity for planning, procurement, execution, land allotment, O&M and financial sustainability.

Table 11.5 Bhavya aligned financial architecture

Parameter	BHAVYA-aligned approach	Responsibility / source	Financial implication
(1)	*(2)*	*(3)*	*(4)*
Land	Minimum eligible land to be encumbrance-free and transferred to SPV as prescribed. Land transferred to the SPV is treated as equity contribution.	State / UT Government, State Nodal Agency, CPSE or Private Developer, as applicable	Land value forms part of shareholder contribution; transfer of land is a precondition for fund release.
Eligible infrastructure	Core, value-added, social and external infrastructure as approved in DPR and permitted under BHAVYA.	SPV through EPC mode for core infrastructure; PPP may be used for appropriate value-added / social components	Only approved eligible components can be financed from BHAVYA funds.
Central assistance	Provided through NICDIT as equity and, where specifically approved, debt; NICDIT equity not to exceed 50% of paid-up equity capital.	Government of India through NICDIT	Subject to funding cap, land value linkage, tranche conditions and NLSC approval.
External infrastructure	Last-mile Road, power, water and gas connectivity may be included	State / UT Government / Private Developer	Up to 25% of approved funding may be allocated for external

	subject to BHAVYA limits.	with SPV coordination	infrastructure and limited to 25% of external infrastructure cost.
O&M	Dedicated O&M framework through user charges, PPP, other sustainable mechanisms and optional O&M Corpus Fund.	SPV / facility manager / PPP partner	Up to 5% of gross allotment premium may be set aside in a separate escrow account as O&M Corpus Fund.

11.4.1.3 Project Cost Framework under BHAVYA

The DPR should present project cost under separate heads for eligible, ineligible and externally funded / converged components. This segregation is necessary because BHAVYA assistance can be used only for approved components and cannot be used for expressly ineligible cost heads.

Table 11.6: Project cost framework under BHAVYA

Cost head	Treatment under BHAVYA	Remarks
(1)	*(2)*	*(3)*
Land acquisition / land development cost	Not admissible for Scheme funding; land transferred to SPV is treated as equity contribution.	Show separately as State / private developer / CPSE contribution and support valuation basis.
Core infrastructure	Eligible, if approved in DPR.	Internal roads, underground utilities, storm water drainage, streetlights, landscaping, CETP, WTP, STP, SWM, ICT, security

		infrastructure, administrative block and fire safety systems.
Value-added infrastructure	Eligible, if approved in DPR.	Built-to-suit facilities, warehousing, sector-specific support infrastructure, R&D / testing / training centres and renewable energy infrastructure; PPP preferred where suitable.
Social infrastructure	Eligible, preferably on PPP basis.	S.A.F.E worker housing, common facility centres, day care / health services and skill development centre.
External infrastructure	Eligible within specified limits.	Last-mile link road, power transmission line, water pipeline and gas connectivity from nearest source; balance funding commitment to be shown.
Preliminary / pre-operative expenses, IDC, working capital, vehicles, royalty, commissioning fees	Not admissible for Scheme funding.	To be funded from other sources, if required; avoid including in BHAVYA funding claim.
Taxes, contingencies, escalation, supervision, QA/QC, safety	May be included only if part of approved eligible components and DPR cost estimates.	Show assumptions clearly and reconcile with package estimates and tender benchmarks.

11.4.1.4 Land Valuation and Equity Contribution

Land-related treatment should be aligned with BHAVYA land ownership, transfer and valuation framework. The financial model should not treat land as a reimbursable Scheme-funded item.

Table 11.7: Land Valuation and Financial treatment model

Land source / mode	Valuation basis	Financial model treatment
(1)	*(2)*	*(3)*
Land pooling / aggregation / town planning	Higher of applicable circle rate / DLC or fair market value of reconstituted and serviced parcels determined by valuation committee.	Recognize as equity contribution of the concerned shareholder after transfer to SPV.
Land acquisition by State / UT Government	Compensation paid or payable under applicable law, including statutory interest under LARR Act, 2013, excluding specified premiums, charges, subsequent enhanced compensation, stamp duty / registration and borrowing costs.	Recognize as State equity, subject to documentation and transfer to SPV.
Private developer contribution	Higher of applicable circle rate / DLC or fair market value determined by prescribed valuation committee.	Treat primarily as private developer equity in project-specific SPV; shareholding to reflect valued contribution.
Transfer timeline and condition precedent	Ownership of land to be transferred to SPV within the stipulated period after project approval; 90% encumbrance-free land required for Tranche I.	Fund release cannot be assumed unless land transfer and other preconditions are met.

11.4.1.5 Means of Finance and Funding Limits

The means of finance should be structured to comply with BHAVYA funding framework, while ensuring that the SPV remains financially sustainable during implementation and post-completion operations.

Table 11.8: Means of Financing

Source of finance	Permissible / indicative treatment	Key control point
(1)	*(2)*	*(3)*
State / State Nodal Agency equity	Primarily through transfer of project land to SPV; additional cash support may be provided for external infrastructure, viability support or non-funded components.	Land must be encumbrance-free and valued in accordance with BHAVYA.
NICDIT / Central assistance	Equity contribution and, where specifically approved, debt; linked to value of land transferred and capped at 50% of paid-up equity capital.	For ordinary public projects, maximum assistance up to Rs. 1 crore per acre, subject to approval.
Private developer contribution	Land and/or cash equity in project-specific SPV, where applicable.	For private developer collaboration, assistance is equity only and limited to Rs. 50 lakh per acre or 50% of infrastructure cost, whichever is lower.
Debt / project borrowing	May be considered only where specifically approved and where cash flows can service debt.	Debt assumptions should not dilute BHAVYA conditions or create encumbrance inconsistent with reserved matters.
Internal accruals	Receipts from land allotment / lease, user charges, maintenance charges and other SPV revenues.	Treat conservatively; link to demand validation, allotment schedule and escrow / O&M arrangements.

Convergence / other schemes	Permitted for components not funded or partially funded under BHAVYA.	No double financing of the same component; identify convergence at DPR stage.

11.4.1.6 Tranche-wise Release of Funds and Drawdown Plan

The annual cash-flow projections shall be provided and should be aligned with BHAVYA milestone-linked release schedule. The model should not assume upfront receipt of full Central assistance.

Table 11.9: Tranche wise fund release

Tranche	Percentage	Key pre-conditions / milestones to be reflected in financial model
(1)	*(2)*	*(3)*
Tranche I - Part A	30%	Approval by NLSC; transfer of 90% encumbrance-free land to SPV; delegation of development / planning powers for single-window clearance; allocation of power and water by State / UT Government.
Tranche I - Part B	10%	Environmental clearance obtained and commencement of work.
Tranche II	40%	Utilisation of 75% of first tranche; proportionate physical progress; land allotment to at least two manufacturing units with required investment commitment. Remaining 10% land transfer should be completed before this release.
Tranche III - Part A	10%	Utilisation of 90% of first and second tranches; proportionate physical progress; completion of external infrastructure components; commencement of construction of at least two independent manufacturing facilities.
Tranche III - Part B	10%	Certification for final completion.

The cash-flow model should map project expenditure, State / private contribution, NICDIT assistance, debt drawl, internal accruals and O&M corpus creation year-wise.

Funding approved under the Scheme should not be revised at any stage; therefore, cost escalation and under-recovery risks should be handled through contingencies, value engineering and committed non-Scheme funding sources.

11.4.1.7 Revenue, Land Monetisation and O&M Corpus Strategy

Project revenues should be modelled through a transparent land allotment / lease policy, user charges, maintenance charges and other receipts. The pricing framework should support investor affordability while ensuring project sustainability.

Table 11.10: Revenue approach

Revenue / reserve item	BHAVYA-aligned approach	Financial model requirement
(1)	*(2)*	*(3)*
Industrial land allotment / lease	Primary revenue stream from saleable / leasable plots; allotment to be transparent and non-discriminatory.	Area, rate, escalation, absorption schedule, receivable cycle and GST / tax treatment to be separately shown.
Anchor investor / self-allotment	Where private developer acts as anchor investor, self-allotment up to 25% of developed land may be permitted, subject to scheme conditions.	Pricing should be transparent and not more favourable than terms available to other allottees.
Commercial / amenity / mixed-use receipts	May support overall financial sustainability subject to approved master plan and land policy.	Show separately from industrial revenue; avoid cross-subsidy assumptions unless approved.
User charges and maintenance charges	To fund operation, maintenance and management of assets created under the Scheme.	Charges should be enforceable under allotment / lease terms and reviewed periodically.

O&M Corpus Fund	SPV may set aside up to 5% of gross allotment premium in a separate escrow account.	Use only for first five-year operational deficit, including utilities, maintenance, security, housekeeping and replacement of short-life assets, with SPV Board approval.
Surplus and reserves	Surplus after five years from O&M Corpus may be transferred to SPV general reserves.	Define reserve policy, renewal fund and periodic maintenance provisions.

11.4.1.8 Key Financial and Operational Assumptions

Table 11.11: Key Financial and Operation Assumptions

Assumption category	BHAVYA-aligned assumption	Rationale / note
(1)	*(2)*	*(3)*
Appraisal period	30 years or as appropriate for DPR, with construction, ramp-up, operations and renewal cycles.	Should capture land absorption, O&M, periodic maintenance and debt service, if any.
Implementation period	24 months for approved development works; longer period for 500-1000 acre parks may be considered by NLSC based on justified requirements.	Model milestones should match approved implementation schedule.
Cost escalation	Base costs to be supported by DPR quantities, SOR / market benchmarks and tender package estimates; escalation to be tested as sensitivity.	Funding is not revised after approval.

Demand and absorption	Based on demand validation, competing park vacancy and sectoral ecosystem analysis.	Land monetisation should be stress-tested for slower absorption.
Power and water	Availability of uninterrupted power and assured water supply should be confirmed as per projected demand.	Important for eligibility / evaluation and investor readiness.
O&M recovery	Through user charges, PPP models or other sustainable mechanisms, supported by O&M Corpus where applicable.	Prevents deterioration of assets and SPV operating deficits.
Digital systems	Single-window, e-land management, utilities and compliance mapping should be reflected wherever relevant.	Supports operational readiness and evaluation scoring.

11.4.1.9 Financial Analysis and Viability Indicators

The DPR should present a complete financial assessment, including capital cost, funding, revenues, expenditure, depreciation, O&M plan and key financial indicators. Since BHAVYA is an infrastructure-enabling scheme, viability assessment should demonstrate financial discipline, sustainability and investor affordability, not merely commercial return maximisation.

Table 11.12: Financial Analysis and Scheme Interpretation

Indicator / test	Base case	Downside case	Management interpretation
(1)	*(2)*	*(3)*	*(4)*
Funding compliance	Central assistance within applicable per-acre and equity caps.	Funding gap due to cost overrun or ineligible costs.	Identify non-Scheme funding and avoid assuming revised BHAVYA assistance.
Land valuation adequacy	Land value supports proposed equity structure.	Land valuation lower than	May reduce permissible GoI

		expected or transfer delayed.	equity / delay tranche release.
Project IRR / cash surplus	Positive project cash flow over appraisal period.	Lower land prices / slower absorption.	Assess sustainability of SPV, not only accounting surplus.
Debt service ability	DSCR acceptable if debt is proposed.	Delayed revenue and higher interest burden.	Limit debt unless clearly serviceable from project cash flows.
O&M recovery	Full recovery through user charges and corpus support.	Partial recovery or delayed collections.	Strengthen enforceability of O&M charges and ring-fence corpus.
Investor affordability	Land pricing aligned to target sectors and market benchmarks.	Pricing too high for demand or too low for recovery.	Balance competitiveness with lifecycle cost recovery.

11.4.1.10 Convergence and Non-duplication of Funding

The SPV, State / UT Government and implementing agencies may leverage relevant Central and State Government schemes for components not funded or only partly funded under BHAVYA. The DPR should identify convergence areas such as external infrastructure, last-mile connectivity, utilities, logistics infrastructure, skill development, renewable energy, water management, waste treatment and testing / laboratory facilities. The financial model should include safeguards to ensure that the same component is not funded twice.

Table 11.13: Convergence and Non-Duplication

Component / area	Potential convergence route	Control required
(1)	*(2)*	*(3)*
External infrastructure balance cost	State budget, State schemes, line departments, PM Gati Shakti-	SSA to include mandatory commitment

	aligned works or private developer contribution.	for balance funding where required.
Skill ecosystem / training	State skill missions, Central skill schemes, industry partnerships or PPP.	Clearly separate capital cost, operating support and partner contribution.
Renewable energy / sustainability	Renewable energy schemes, DISCOM / open access frameworks, PPP models.	Avoid double counting of renewable infrastructure funded under BHAVYA.
Testing labs / common facilities	Relevant sectoral schemes, industry associations, PPP models.	Show component owner, capex source and user-charge model.
Worker housing / social infrastructure	PPP, State housing schemes, employer participation.	Land, construction and O&M responsibilities to be documented.

11.4.1.11 Financial Risks and Mitigation Measures

Table 11.14: Financial Risks and mitigation

Risk	Financial impact	BHAVYA-aligned mitigation
(1)	*(2)*	*(3)*
Delay in land transfer / encumbrance clearance	Defers tranche release, construction and investor allotment.	Ensure 90% encumbrance-free possession at application stage; complete transfer to SPV within stipulated timeline.
Ineligible cost included in funding claim	Creates funding gap or rejection during appraisal.	Segregate eligible, ineligible and converged components in DPR and financial model.
External infrastructure not funded / delayed	Affects investor readiness and tranche conditions.	Include SSA commitment and convergence plan; document State responsibility and timelines.
Cost escalation after approval	Funding approved under Scheme will not be revised.	Use updated SOR, tender benchmarks, contingencies, value

		engineering and non-Scheme funding buffer.
Slow land absorption	Reduces internal accruals and weakens debt service / O&M recovery.	Anchor investor strategy, sector targeting, flexible plot sizes and phased pricing.
O&M under-recovery	Creates asset deterioration and SPV operating deficit.	Notify enforceable user charges, maintain O&M Corpus in escrow and ring-fence maintenance collections.
Double financing / audit objection	Risk of fund recovery or non-compliance.	Maintain component-wise funding register, separate accounts for BHAVYA funds and asset register under GFR principles.

11.4.1.12 Approval, Monitoring and Compliance Dashboard

The NLSC shall consider approval of the project cost, eligible components, funding structure, SPV implementation arrangements, land transfer, delegation of powers, external infrastructure commitments, tranche schedule and monitoring framework based on the inputs provided in the DPR. The financial model should be updated at DPR finalisation, tender award, construction commencement, major variation approval, tranche release, land monetisation review and O&M review. **(Annexure 5)**

Table 11.15: Monitoring Metrics

Monitoring area	Metric	Frequency	Escalation trigger
(1)	***(2)***	***(3)***	**(4)**
Cost	Approved cost vs actual / tendered cost; eligible vs ineligible component reconciliation.	Monthly / quarterly	Package-level variation above approved tolerance or ineligible

			expenditure detected.
Funding	Equity received, NICDIT assistance released, debt drawn, cash balance and utilisation certificates.	Monthly	Utilisation below tranche requirement or cash runway below 3 months.
Land	Land transferred to SPV, encumbrance status, valuation documentation and allotment progress.	Monthly / quarterly	Land transfer milestone missed or allotment below approved plan.
Tranche compliance	Milestones achieved, EC status, work commencement, utilisation, physical progress and manufacturing-unit commitments.	At each tranche	Any precondition not satisfied before drawdown.
Revenue	Allotment premium, lease receipts, receivables, maintenance charges and O&M corpus balance.	Monthly / quarterly	Receipts below base case by more than 20% or O&M reserve below threshold.
Assets and audit	Asset register, separate BHAVYA accounts, audit observations and public disclosure status.	Quarterly / annual	Diversion, encumbrance or non-approved use of Scheme-funded assets.

11.4.1.13 Indicative approval items

- Approval of total project cost with clear segregation of land, eligible infrastructure, ineligible costs, external infrastructure, taxes, contingencies, O&M and convergence components.
- Approval of equity contribution by participating entities, including recognition of land as equity contribution after valuation and transfer to SPV.

- Approval of financial assistance within applicable caps and release linked to BHAVYA milestones.
- Approval of EPC package structure for core infrastructure and PPP / partnership approach for value-added and social infrastructure, where applicable.
- Approval of land monetisation policy, pricing framework, user charges, O&M Corpus Fund, escrow arrangements and asset management responsibilities.
- Approval of monitoring dashboard, reporting format, utilisation certificate mechanism, audit process and asset register requirements.

Note: All figures and assumptions in this chapter are indicative. Replace them with project-specific DPR estimates, valuation reports, State policy rates, approved financing terms, market assessment, tax assumptions and signed support / shareholder documents before submission under BHAVYA.

Annexure 1

Sr. No.	Nature of Compliances/Clearances
Pre-Operative **Registrations**	
1	Incorporation of Company
2	Registration of Permanent Account Number (PAN)
3	Registration of Tax Account Number (TAN)
4	Registration under Goods and Service Tax (GST)
5	Registration under Industrial Enterprises Memorandum – Part-I
6	Registration under Import Export Code
7	Registration under Profession Tax Enrolment Certificate for Company
8	Registration under Profession Tax (EC) for Directors of Company
9	Possession Letter for Acquisition of Land
10	Stamp Duty Exemption for Registration of Land
11	Registration under Maharashtra Pollution Control Board (MPCB) Consent to Establish
12	Registration as Principal Employer under Contract Labour Act
13	Registration under Building and Other Construction Works
14	Registration of Lease Deed of Land
15	Temporary Electricity Connection
16	Temporary Water Connection
17	Trees Cutting Permission
18	Building Plan Approval and Fire No Objection Certificate
19	Registration under Employee State Insurance Corporation (ESIC)
20	Registration under Provident Fund (PF)
21	NOC from Airport Authority
22	Preliminary Layout Drawing Approval and license for Storage of Gases
23	Factory layout plan approval, 1948
24	Registration under Payment of Gratuity Act, 1972
Post Construction/Operative Registrations	
25	Registration with Common Hazardous Waste Treatment, Storage & Disposal Facility (CHWTSDF)
26	Registration of Centralised/Common Effluent Treatment Plant at AURIC
27	Consent to operate (CTO) & Authorization to store Hazardous waste
28	Fire No Objection Certificate

29	Building Completion Certificate and all other related clearances required
30	NOC from Collector Office for Storage of Gases
31	NOC from Superintendent of Police for Storage of Gases
32	NOC from Deputy Superintendent of Police for Storage of Gases
33	NOC from Jurisdictional Police Station for Storage of Gases
34	NOC from Regional Fire Officer for Storage of Gases
35	NOC from Sub Divisional Office for Storage of Gases
36	NOC from Town Planning Authority for Storage of Gases
37	Final Approval from PESO for Nitrogen and Gases
38	Approval for utilisation of Natural Gas through Pipeline
39	Factories License
40	Registration of Occupation under Factories Act
41	Registration of Establishment under the Interstate Migrant Workmen Act, 1979
42	Employer Registration under the respective states and Other Manual Workers Act, 1969
43	Registration under Industrial Enterprises Memorandum – Part-B
44	New Power Connection for Industrial Use
45	Permanent water connection
46	Registration under private Security Guards Act 1981
47	Permission for Boiler
48	Solvent License, if req.
49	Obtain Registration as Manufacturer under Legal Metrology Act
50	Stamping & Calibration of Machinery from Legal Metrology
51	Layout Approval for Diesel Generator sets (if applicable)
52	Registration of Diesel Generator Sets (if applicable)
53	Permission for charging Diesel Generator Sets for more than 250 KVA (if applicable)
54	Permission for erection of lift
55	License to operate lift
56	Boiler Erection certificate
57	Renewal of Registration as Principal Employer under Contract Labour Act
58	Application for Lower Income Tax Rate for Company
59	Obtaining Eligibility Certificate from Directorate of Industries under Package Scheme of Incentives - 2019
60	Electricity Duty Exemption

ANNEXURE 2

Environment & Sustainability framework for Industrial Parks under BHAVYA scheme

In addition to periodic statutory compliance being carried out by the SPV. The adoption of the environment & sustainability rating system would further help SPVs / industries to strengthen their commitment towards environment safeguards and improve their performance to meet sustainable standards.

Further the Industrial rating framework would enable SPVs to ensure compliance with the statutory obligation and assess performance of industrial park (IP) / individual industries during construction as well as operational stage.

(a) Sustainability rating in Indian scenario

In September, 2025, Industrial Park Rating System (IPRS) 3.0 was announced by GoI. The IPRS is being developed through Department for Promotion of Industry and Internal Trade (DPIIT) with support from the Asian Development Bank (ADB).

It is being conceptualized to enhance the transparency, competitiveness, and investment attractiveness of India's industrial ecosystems by benchmarking industrial parks.

(b) Environment & Sustainability framework

Sustainability, environmental awareness, renewable resource management, etc plays a vital role in sustainable lifestyle. With the global carbon emissions rising day by day, it is essential to move towards reduction of environmental footprints. Govt of India has already committed to achieve the Net Zero emission target by year 2070.

Environment & Sustainability framework (ESF) for projects proposed to be developed under BHAVYA scheme has been developed in-house by NICDC, considering statutory conditions imposed in Environmental Clearance (EC) by the MoEF&CC & SEIAA, social safeguards, internal infrastructure, public health, monitoring & surveillance, Net zero / innovation initiatives, labour compliance & proposed key pillars under Industrial Park Rating System (IPRS) and UNIDO's Eco Industrial Park framework etc. The Environment & sustainability framework has been conceptualized on *fourteen evaluation indicators* to have coverage of the Industrial Park in a holistic manner.

SPVs are expected to adopt the best practices as prescribed in the Environment & Sustainability framework and assess performance of respective industrial park through evaluation indicators. The ESF rating programme is aimed at creating a green industry landscape in industrial parks being developed under BHAVYA scheme. The SPVs / Industries are expected to further perform better than the compliance of statutory obligation and set higher goals for adoption of innovative techniques & consistent improvement.

The ESF rating system has been designed to evaluate the participating Industrial parks based on their overall performance, environmental safeguards and assess whether the entities have made efforts to perform better than the prescribed standards. Besides the above, parameters such as efficiency in terms of use of natural resources, waste management, performance of the industrial parks on the social & public health aspects etc are important part of the rating system for a holistic evaluation of the overall performance of Industrial parks.

ESF rating is the "*first of its kind rating system for Industrial parks*" which provides a holistic framework, which evaluates industrial parks on the environmental friendliness of their activities using a life cycle approach. Implementation of the ESF rating may provide leadership and guidance to SPVs / Industries on sustainable operations.

The Environment & Sustainability framework comprises of following indicators.

(i) Evaluation Indicators:

Evaluation Indicator 1	**Environmental Planning & site selection.**
Evaluation Indicator 2	Statutory compliance & Environmental Safeguards.
Evaluation Indicator 3	Energy conservation.
Evaluation Indicator 4	Water quality monitoring & preservation.
Evaluation Indicator 5	Solid waste disposal.
Evaluation Indicator 6	Air & Noise monitoring.
Evaluation Indicator 7	Social Infrastructure & Safeguards.

Evaluation Indicator 8	Grievance redressal / Tenant outreach & dialogue.
Evaluation Indicator 9	Labour rights & compliance.
Evaluation Indicator 10	Gender equality.
Evaluation Indicator 11	Public Health.
Evaluation Indicator 12	Net Zero / Innovation initiatives.
Evaluation Indicator 13	Monitoring & surveillance.
Evaluation Indicator 14	Internal Infrastructure.

The indicator / assessment parameters are aimed to ensure sustainable implementation of the industrial parks. The framework would enable a tool for measuring statutory, environmental & sustainability safeguards, social safeguards, internal infrastructure implementation etc. Further, the framework would encourage competitiveness among SPVs / industries, and enable to rate the industrial parks by their best practices, and also to receive feedback from stakeholders.

In the form of a prescribed framework, these *14 indicators* have to be assessed through parameter of total of *68 questions*. The weightage of the assessment framework is prescribed for total *500 marks*, having *score methodology of 5 to maximum 10 score* based on the nature of the parameter. Documentation required to assess the prescribed parameters has been mentioned in the framework.

(ii) Rating of Industrial Parks

The industrial parks shall be rated as per following categories;

(a) Leaders – high performing industrial parks securing more than 80 % score.
(b) Challengers- growing industrial parks securing 60 % score
(c) Aspirers – Industrial parks secured above 40 % score.

(iii) <u>Implementation Process</u>

For implementation of ESF at respective industrial parks, the SPVs will conduct an annual rating / annual audit through prescribed indicator / parameter. The ESF rating will be carried out by a *<u>three-member committee</u>*, comprising officials from SPV, PMNC & EPC contractor in consultation with NICDC. Based on requirement, the SPV may

also opt for approved EIA consultants, Govt Environmental Institutions, State Industries Association, Confederation of Indian Industries (CII) etc.

Benefits of ESF rating system:

Adoption of ESF rating system addresses statutory obligation of the SPVs, energy efficiency, water conservation, renewable energy, waste management, internal infrastructure etc. Some of the major benefits are highlighted below:

a. Enable SPVs to track compliance of industrial parks through standardised framework.
b. Initiatives beyond compliance & provide scope for innovation & improvement.
c. Provide an opportunity to the SPVs for a green corporate image for meeting performance beyond regulations and compliances.
d. Overall natural resource conservation & management.
e. Monitor development of Internal infrastructure etc.

Industrial Park Environment & Sustainability framework (1/11)

Indicator	Assessment Parameter	Documentation Required	Scoring Methodology (maximum 10)
Environmental Planning / Site selection	**Alternative site selection / Land suitability analysis / due diligence carried out by the State Govt / SPV** for the **Industrial Park (IP).**	Copy of report / GIS study / due diligence study / URDPFI guidelines etc	5 if suitable study carried out ; else, 0.
	Whether Industrial Park / Master Plan notification of IP done by the State Govt / SPV	Copy of notification.	10 if IP & Master Plan are notified, 5 if either IP or Master Plan is notified ; else 0.
	Does **Special Planning Rights** entrusted to the SPV	Copy of notification.	5 if notified; else 0
	Did **Industrial Park zoning** for **Red / Orange / Green / White Category Industries** delineated in layout / master plan	Copy of approved layout / master plan.	10 if zoning activity carried out ; else 0.
	Are existing Industries at IP **meet siting criteria prescribed by State Pollution Control Board (SPCB)**	Copy of prescribed siting criteria / Consent to Establish (CTE) / Consent to Operate (CTO) issued by SPCB.	10 if siting guidelines / CTE / CTO issued ; else 0.
	Flood Plain Zoning done for IP	Technical guidelines on Flood Plain Zoning by MoJS.	5 if Flood plain mapping / stream analysis done; else 0.
	Seismic zone mapping done for IP	Seismic zone guideline by BIS / NDMA etc.	5 if Seismic zone mapping one; else 0.
	Eco Sensitive Area (ESA) excluded / included in IP	Approved master plan, Change in Land use notification etc. Copy of ESA notified by MoEF&CC .	5 if Eco Sensitive Area excluded for development of IP ; else 0.

Industrial Park Environment & Sustainability framework (2/11)

Indicator	Assessment Parameter	Documentation Required	Scoring Methodology (maximum 10)
Statutory compliance & Environment Safeguards	Does the SPV / individual Industries **submitting statutory compliance** regularly **to MoEF&CC & SPCB**	Acknowledge copy of compliance report submitted for last 1 year certified by the SPV / Industries concerned.	10 if compliances submitted; else, 0.
	Does **individual units obtained CTE / CTO and all extant permits** before starting operations	Copy of CTE / CTO / Approvals	10 if permits obtained; else, 0.
	Has **Environmental Management cell constituted** at SPV ?	Copy of establishment of EC cell	10 if EC cell constituted ; else 0
	Are site specific **biodiversity conservation & mitigation plan prepared / implemented** within the IP ?	Biodiversity conservation plan, implementation records etc.	10 if required biodiversity measures are limplemented, 3 if its under preparation; else 0.
	Are compensatory afforestation & **green belt is being** maintained in compliance with applicable regulations and guidelines?	Approved Master Plan of the park delineating green area provision, initiative for green area development etc	10 if green area development has complied with applicable regulations and guidelines, 3-5 if proposal has initiated ; else 0.
	Are existing **water bodies retained / rejuvenated** as per policy specifications?	Approved master plan, evidence of implemented protection works etc.	10 if protection measures implemented as per policy, 3 if its under process; else 0.

Industrial Park Environment & Sustainability framework (3/11)

Indicator	Assessment Parameter	Documentation Required	Scoring Methodology (maximum 10)
Statutory compliance & Environment Safeguards	Does the IP carried out **self annual audit & third party audit** ? And recommendations of audit has been implemented at site.	Copy of audit report and compliance taken by the SPV of last 1 year.	10 if audits are carried out, 3-5 if action has been initiated ; else 0.
	Does SPV / Individual Industries has **well laid Environmental Policy** and implementing policy provisions	Copy of policy and details of policy provisions implemented at site.	10 if policy adopted ; else 0
	Does SPV / Individual industries earmarked **funds for Environmental Management Plan (EMP) / Corporate Environment Responsibility (CER)**.	Details of annual expenditure against EMP & CER etc	10 if SPV incurred expenditure, 2 if budgetary provision has been made and action initiated; else 0.
	Are site **specific EMP / Disaster Management Plan (DMP) / Hazard identification & Risk Assessment (HIRA)** plan prepared / being implemented at IP.	Copy of EMP / DMP / HIRA along with details of implementation of the same.	10 if EMP , DMP & HIRA prepared (for each report 3 marks) and being implemented, 3-5 if initiatives has been taken; else 0.
	Are **Project information sign board, layout** of Industrial Park installed at IP	Photographic / documentary evidence , field observation findings.	5 if sign board / layout installed; else 0.
	Are **copy of EC letters, Labour Licence & permits etc adequately displayed** at project site / SPVs website / circulated to concerned stakeholders.	Photographic / documentary evidence , filed observation findings.	5 if approvals , permits etc. suitably displayed ;else 0.

Industrial Park Environment & Sustainability framework (4/11)

Indicator	Assessment Parameter	Documentation Required	Scoring Methodology (maximum 10)
Statutory compliance & Environment Safeguards	Has Site **Safety, Health & Environment (SHE) / Grievance redressal cell (GRC)** constituted by the SPV / Industries & meeting held regularly.	Copy of establishment of SHE committee / GRC along with MoM & attendance sheet of meetings held.	10 if committees has been constituted and monthly meeting is held ; else 0.
Energy conservation	Does the IP utilize **renewable energy as minimum 5-10 % of total power demand of IP** ?	Details of installation of renewable energy sources , Self certified monthly energy bills issued by the Discom (past 1 year) which show credit of renewable energy as a line item	10 if 5-10 % of total power demand is met / proposed through renewable energy.
	Does the IP promote **use of EV , Solar energy equipment's, energy efficient fixtures etc.**	Self certified report , documentary proof, site inspection	10 if SPV / is promoting use of renewable energy sources; else 0.
	Does the park have **green building certifications (GRIHA rating**)?	Self-certified documentation by park manager providing evidence of park's green building certification	10 if ≥1 building certified LEED/IGBC Gold or higher or similar; else 0.
Water quality monitoring & Preservation	Does the IP has **confirmed allocation of surface water resources** ?	Approval of surface water allocation with the source of supply	5 if surface water sources are utilized; else 0.
	Does the park have facilities for **rainwater harvesting (RWH)** ?	Self-certified photos of rainwater harvesting systems (recharging pit, trench) or details on rainwater harvesting utilization levels on-site.	5 if RWH supplying ≥25% annual water demand, 2 if action has been initiated; else 0.

Industrial Park Environment & Sustainability framework (5/11)

Indicator	Assessment Parameter	Documentation Required	Scoring Methodology (maximum 10)
Water quality monitoring & Preservation	Are **stormwater drainage** conduits/basin/pond created across park?	Self-certified photos of covered stormwater drains/outfalls with embankment/protection, or evidence of a functional rainwater harvesting system	5 if drainage system is functional across at least 90% of the IP, 2 if ts under construction ;else 0.
	Does the IP **prohibit extraction of ground water** for use by industries?	Self-certification along with applicable official orders, notification, or circular on the prohibition of groundwater extraction for industrial use	5 if there is no water extraction; else 0.
	Are CETP / STP installed at IP & Zero Liquid discharge (ZLD) adopted and / or treated industrial effluent / sewage is being utilized within IP.	Details of CETP / STP installation / proof of ZLD adoption and treated effluent utilization proof.	10 if CETP & STP installed / ZLD adopted and treated effluent utilized, 5 if either CETP / STP installed, 2 if action initiated; else 0.
	Is **efforts taken to reduce water demand** during construction / operation stage.	Details of water saving techniques	5 if water saving techniques is practised, 2 if action has been initiated;else 0.
	Are **Water quality / effluent monitoring** carried out as per prescribed norms.	Documentary evidence of monitoring reports and acknowledgement of receipt at statutory authorities	5 if monitoring carried out as per prescribed provisions, 2 if action initiated;else 0.

Industrial Park Environment & Sustainability framework (6/11)

Indicator	Assessment Parameter	Documentation Required	Scoring Methodology (maximum 10)
Solid Waste disposal	Does the park provide **solid waste collection with segregation at source, disposal** as per extant rules. Does IP has on site treatment facility?	Self-certified contracts, work orders, photos, waste management plan, or evidence of a functioning solid waste management facility within IP	10 if ≥70% segregation rate and ≥80% of waste recycled, 2 if action has been initiated ; else 0.
	Does disposal of **hazardous solid waste carried out as per norms? Hazardous disposal facility or MoU with approved** third-party handlers.	Documentary evidence of MoU with hazardous waste management facility, Self-certified contracts, work orders, photos, waste management plan.	5 if fully compliant with State Pollution Control Board hazardous waste norms and no violations reported in a period of 12 months, 2 if action has been initiated ; else 0.
	Does the industrial park have an **operational collection center for E-waste and Battery waste disposal ?**	Self-certified agreements, licenses, inventory & tracking logs, or evidence of a functioning operational center for e-waste	5 if fully compliant with State Pollution Control Board e-waste & battery waste norms and no violations reported in a period of 12 months, 2 if action has been initiated ; else 0
	Does **Muck generated during construction suitably disposed. Construction & demolition waste management facility** identified.	Self certified pictures / documentary evidence of muck disposal. Copy of MoU for C&D Waste disposal.	5 if C&D waste suitably disposed, 2 if action has been initiated; else 0.

Industrial Park Environment & Sustainability framework (7/11)

Indicator	Assessment Parameter	Documentation Required	Scoring Methodology (maximum 10)
Air & Noise monitoring	Are **ambient air quality monitoring system** installed within IP ? Whether Monitoring data submitted to regulatory authorities.	Documentary / photographic evidence of ambient air monitoring station and monitoring reports submitted to regulatory bodies.	5 if compliance made as per statutory provisions ;else 0.
	Does **DG sets installed** are being operated in conformity to State Pollution Control Board's provisions ?	Documentary evidence of permission for DG operations.	5 if DG operation is in conformity to SPCB; else 0.
	Vehicle associated with construction / operation activities have valid **Pollution Under Control (PUC)** certificate ?	Documentary evidence of PUC certificates.	5 if construction vehicles meet PUC norms; else 0.
	Are **Noise monitoring system** installed within IP ? Whether Monitoring data submitted to regulatory authorities?	Documentary / photographic evidence of noise monitoring system and monitoring reports submitted to regulatory bodies.	5 if compliance made as per statutory provisions ;else 0.

Industrial Park Environment & Sustainability framework (8/11)

Indicator	Assessment Parameter	Documentation Required	Scoring Methodology (maximum 10)
Social Infrastructure & safeguards	Are **medical facilities** (Dispensary / Ambulance / First Aid facility / oxygen support / Qualified Doctor, para medical staff , first aid trainer) available within the IP?	Self attested compliance documents including staff rosters or timesheets demonstrating facilities & healthcare staff presence	10 if healthcare facility staffed with qualified doctor and staff ≥8 hrs/day ;else 0.
	Are **drinking water facility for workers / visitors** available within IP **?**	Self attested details of drinking water facility within IP.	5 if any drinking water facility provided, 2 if action has been initiated ; else 0.
	Does Industrial **worker housing / working women hostels** provided to industrial workers & staff	Housing capacity statement with workforce headcount in the period	5 if housing provide basic facilities and standard for living in 100% of housing; else 0.
	Is there a **public transport system** for workforce movement for nearest town / nearby settlement , market from the IP ?	Self-certified copy of office orders issued by SPV / IP or authorized agency confirming operation of public transport services.	5 if functional public transport facility is located and operational within 1km waling distance of the IP; else 0
	Is **canteen facility** on subsidised rate available within IP for workers?	Self-certified copies of details of canteen facility along with photographs.	5 if canteen is available ‘ else 0
	Is **rest room** for workers provided within IP ?	Self-certified copies of details of rest room facility along with photographs.	5 if rest room is available ‘ else 0

Industrial Park Environment & Sustainability framework (9/11)

Indicator	Assessment Parameter	Documentation Required	Scoring Methodology (maximum 10)
Social Infrastructure & Safeguards	Are **community facilities** like creche, baby feeding lounges, toilets / washroom for workers available & maintained?	List of community facilities with maintenance log book showing quarterly maintenance for the past year	5 if community facilities are provided and maintained over the last year; else 0.
Grievance redressal / Tenant Outreach & Dialogue	Is a system in place to collect **Public / tenant suggestions / complaints** regularly?	Self attested details, MoM, registers and records showing tenant / public feedback in past 1 year.	5 if feedback collected once in a month ; else 0.
	Is **Grievance redressal cell (GRC)** operational at IP?	Attested and dated grievance register/log for the last year with records of grievances raised, actions taken, and closure dates	5 if ≥90% grievances resolved within 30 days; else 0.
Labor Rights & Compliance	Is **compliance of Labour Licence provisions. submitted** annually?	Latest annual labour compliance audit report.	5 if annual compliance submitted and no non compliance reported else 0.
Gender Equality	Provisions made by the SPV to promote **women workforce** through tenant ?	Attested HR headcount by gender for the last year	5 if ≥2 incentives created by park for tenant to include women workforce; else 0.
	Is **gender-inclusive infrastructure** (e.g. restrooms, separate toilet / washroom for females safety features) available?	Records showing availability of gender-inclusive infrastructure in Industrial Park buildings, specifying percentage of buildings with such facilities	5 if gender-inclusive facilities are available in ≥75% of park buildings; else 0.

Industrial Park Environment & Sustainability framework (10/11)

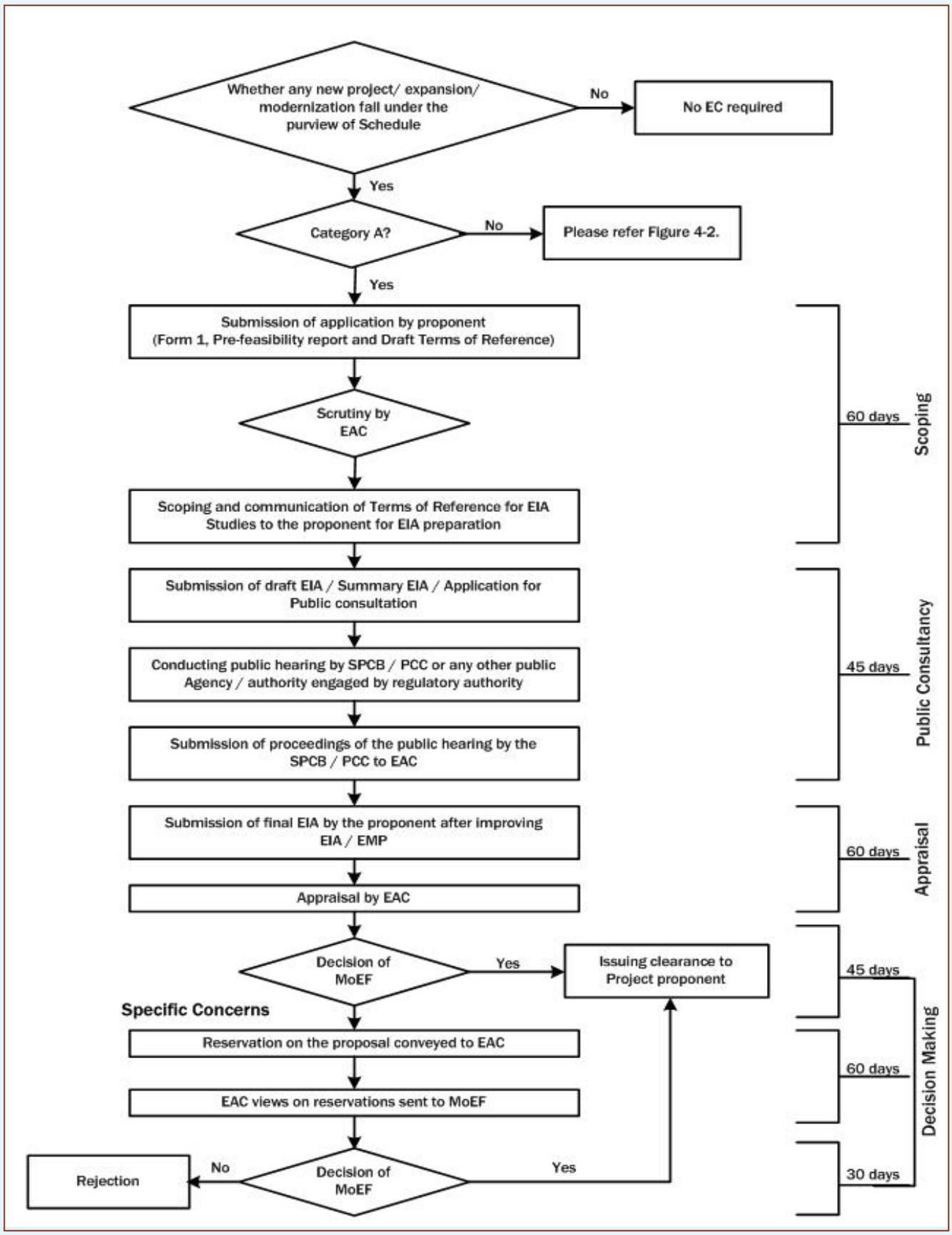
Indicator	Assessment Parameter	Documentation Required	Scoring Methodology (maximum 10)
Public Health	Whether **Personal Protective Equipment (PPE) kit** provided to all construction workers.	Register / Log book with proof of issuance of PPE kit.	10 if PPE kits provided to all; else 0.
	Are **Health Check up camps for workers** conducted regularly within the park?	Details of camps held with attendance records.	5 if min 1 session per quarter; else 0.
	Are **mobile toilets** facilities provided ?	Certified copy of List & location of mobile toilet	5 if mobile toilets provided; else 0.
	Are **recreational** facilities provided at site ?	Details of recreation facilities, photograph etc	5 if recreation facilities provided; else 0.
Net Zero / Innovation initiatives	Target by SPV / Industries **to reduce Green House Gas (GHG) emissions** ?	Copy of policy / MoU etc	10 if any strategy finalised to reduce GHG , 2 if initiatives taken ; Else 0.
	Whether **energy efficiency certifications (BEE) implemented**	Bureau of Energy Efficiency (BEE) certification copy	10 if ≥50% buildings are BEE certified, 2 if initiatives taken ; else 0.
	Use of **sustainable construction materials** (e.g OPC cement , AAC block) used within IP	Details of sustainable construction materials use such as Fly Ash, reuse materials etc.	5 if sustainable materials utilized at site; else 0.
	Initiative by the SPV / Industries on **future technology**, R&D	Documentary evidence of such initiatives.	5 if at least 25 % of Industries taken any initiates on future technology or R &D ; else 0.
	Green supply chain	Details regarding lower environmental impact at vendor premises, lower waste / effluent disposal, procurement of products with lower environmental impact etc.	5 if at least 25 % of Industries taken any initiates on green supply chain; else 0.

Industrial Park Environment & Sustainability framework (11/11)

Indicator	Assessment Parameter	Documentation Required	Scoring Methodology (maximum 10)
Monitoring & surveillance	Is an **Integrated Command and Control Centre** (ICCC) surveillance system functional?	Report for the past 12 months showing operational hours and real-time event logs documenting alerts	5 if ICCC was operational at least 75% of the time over the last 12 months and real-time alerts were consistently logged; else 0.
Internal Infrastructure	Does the IP provide **solid waste / effluent collection at plot level?**	Details of waste disposal / effluent treatment at park level,	5 if it's as per actual demand during the assessment period; else 0
	Does the IP **have dedicated parking facility during construction & operation phase**.	Approved layout with clear delineation of parking.	5 if dedicated parking provision has been made; else 0.
	Does the IP **have commercial / public and semi public facility** ?	Approved layout with clear delineation of parking.	5 if provision of commercial & PSP facility has been made; else 0.
	Does the park has **provision of emergency assembly area, emergency siren and evacuation routes** ?	Approved layout delineating emergency assembly area, emergency siren and evacuation routes.	5 if provision of emergency assembly area, siren has been made; else 0.
	Are suitable **entry & exit gate , boundary pillars** provided at IP.	Approved layout delineating entry / exit gate and boundary , photograph etc	5 if gate and boundary pillar provided; else 0.
	Is there provision of **Helipad** within IP (in case no Helipad / Airport is within 50 km)	Approved layout delineating location of Helipad / Office order etc	5 if Helipad provided; else 0.
	Is there provision **of police check post, integrated security system/ police patrolling** in IP	Approved layout security provision/ Office order etc	5 if security arrangement provided; else 0.

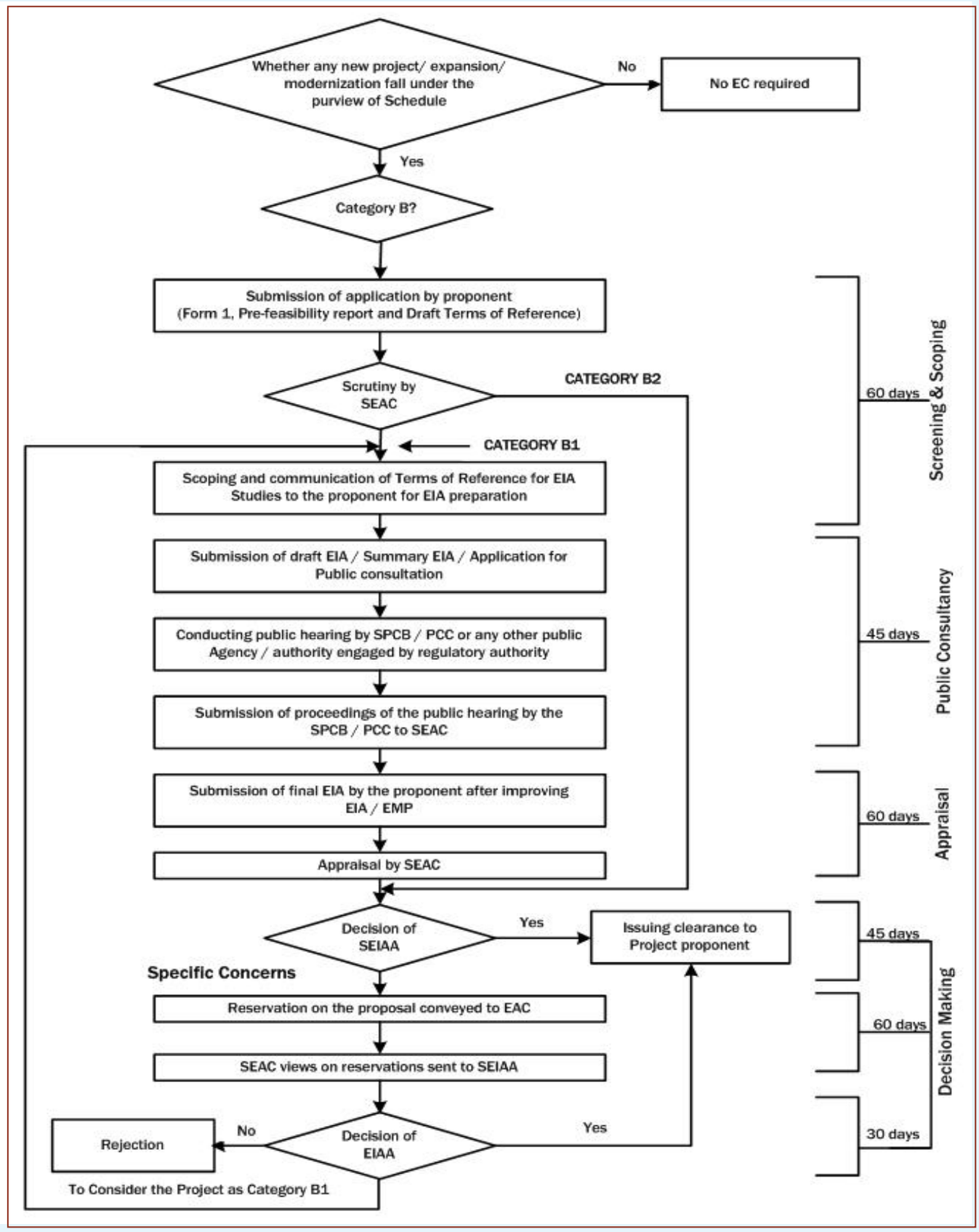
Annexure 3

Work flow of Environmental Clearance for Category A projects



Annexure 4

Work flow of Environmental Clearance for Category B projects



BHAVYA — Financial Model Template

Annexure 5

Bharat Audyogik Vikas Yojna (DPIIT) — 30-Year Project Bankability Model

Project Name	
Sponsoring Agency / SPV	
State / UT	
Park Type (Greenfield / Brownfield)	
Implementation Mode (State / CPSE / Private)	
Park Size (acres) — from Cost Summary Sheet 1!C18	
Model Currency	INR Crore
Model Horizon	30 Years (operating)
Discount Rate / WACC (%) — see Sheet 1	
Construction Period	3 Years (Tranche I + II + III)
Operations Begin (calendar year)	
Author / Consultant	
Authorised Signatory	
DPR Version & Date	

Purpose & Conventions

This model operationalises the BHAVYA Guidelines' Financial Analysis requirements

- Revenue model with allotment premium, lease rentals, maintenance charges, and user charges.
- 30-year P&L, Cash Flow, Project IRR, Equity IRR, NPV, DSCR profile, and Payback.
- Mandatory O&M Corpus Fund per Guidelines Para 7.9 (5% of gross allotment premium, escrowed, restricted drawdown).
- 40:40:20 tranche release per Guidelines Para 9.6 — released against milestone preconditions.
- Sensitivity analysis: absorption rate ±20%, cost overrun ±15%, plot premium ±10%.

Conventions: Yellow-fill cells with blue text are inputs. Black text = formulas. Green text = links to other sheets. All amounts in ₹ Crore unless stated. Years are operating years (Y1–Y30); construction (Years –2 to 0) is summarised in Sheet 3 CAPEX Schedule.

Workflow: 1) Fill Sheet 1 Assumptions → 2) Verify CAPEX Sheet 3 matches Cost Summary Worksheet → 3) Confirm

1. Assumptions

Single source of truth for all model inputs. Yellow cells require input; everything downstream flows from here.

A. Project Scale		
Park area for funding (acres)		*From Cost Summary Sheet 1!C18*
Net developable plot area (% of gross)	60.0%	*Typical 55–65% after roads/utilities/buffers/social*
Net plot area (acres)	-	*Auto-calculated*
Net plot area (sq.m)	-	*1 acre = 4,046.86 sq.m*

B. Cost Base		
Total infrastructure cost — from Cost Summary 8.E12 (₹ Cr)		*Link manually or enter*
Scheme funding requested (₹ Cr)		*From Cost Summary 8.E16; ≤ 1 cr/acre cap*
State 75% external infra share (₹ Cr)		*From Cost Summary 5.I11*
Land value / SPV equity (₹ Cr)		*From Cost Summary 1.C32*
Promoter / State contribution (₹ Cr)		*Balancing item, includes cash + land*
Debt (₹ Cr)	-	*Typically 0 — Scheme is equity-only per Para 9.1*
Interest rate on debt (%)	9.0%	*If any debt taken*
Construction period (years)	3	*Para 10.2 — 24 months extendable*

C. Revenue Drivers		
Plot allotment price (₹ Lakh/acre)		*Should cover infra+land+10–15% margin*
Lease tenure (years)	99	*Typically 99-year lease*
Absorption — Year 1 (% of net plot)	15.0%	*Typical first-year uptake*
Absorption — Year 2 (% of net plot)	25.0%	
Absorption — Year 3 (% of net plot)	25.0%	
Absorption — Year 4 (% of net plot)	20.0%	
Absorption — Year 5 (% of net plot)	10.0%	
Absorption — Year 6+ (% of net plot)	5.0%	*Residual annual uptake until 100%*
Maintenance charge (₹/sq.m/month)	10	*Recurring charge on allotted land*
Common area user charges (₹ Cr/year, escalated)	1.00	*Park-level CETP/STP/SWM user charges*
Revenue escalation (% p.a.)	5.0%	*5% pa typical*

D. OPEX Drivers		
Manpower cost — Year 1 (₹ Cr/year)	1.50	*Park admin, security, O&M staff*
Power & water for common areas (₹ Cr/year)	1.20	
Repairs & maintenance (% of CAPEX/year)	1.5%	*1.5% of CAPEX/year typical*
CETP/STP/SWM consumables (₹ Cr/year)	0.80	
ICT AMC + cybersecurity SOC (₹ Cr/year)	0.60	*Per Ch 10 SLA*
Insurance + statutory + audit (₹ Cr/year)	0.40	
Other admin & contingency (₹ Cr/year)	0.30	
OPEX escalation (% p.a.)	6.0%	*6% pa typical (slightly above revenue)*

E. O&M Corpus Fund (Para 7.9)		
Escrow % of gross allotment premium	5.0%	*Mandatory 5% per Para 7.9*
Corpus drawdown — start year	6	*Year from which corpus can supplement OPEX*

F. Discount & Tax		
Discount rate / WACC (%)	10.0%	*10% typical for PSU/government projects*
Effective tax rate (%)	25.2%	*Base corporate 22% + cess + surcharge*
Depreciation rate on CAPEX (straight-line, %)	4.0%	*25-year asset life*

G. Sensitivity Variables (active scenario)		
Absorption multiplier (1.0 = base; ±0.20)	100.0%	*1.0=base; 0.8=low; 1.2=high — see Sheet 9*
Cost overrun multiplier (1.0 = base; ±0.15)	100.0%	*1.0=base; 1.15=high; 0.85=low*
Premium multiplier (1.0 = base; ±0.10)	100.0%	*1.0=base; 0.9=low; 1.1=high*

Above Mentioned Values Are Indicative In Nature

2. Revenue Model

Allotment premium, lease, maintenance, user charges over 30-year operating horizon

	Y1	Y2	Y3	Y4	Y5	Y6	n^{th} Year
Plot Absorption (% of net plot)	15.0%	25.0%	25.0%	20.0%	10.0%	5.0%	-
Cumulative Allocation (%)	15.0%	40.0%	65.0%	85.0%	95.0%	100.0%	100.0%
Acres allotted (annual)	-	-	-	-	-	-	-
Acres allotted (cumulative)	-	-	-	-	-	-	-
Revenue Streams (₹ Cr)							
Allotment Premium (one-time)	-	-	-	-	-	-	-
Maintenance Charges	-	-	-	-	-	-	-
User Charges (CETP/STP/SWM)	0.15	0.42	0.72	0.98	1.15	1.28	1.34
Annual Lease Rental (nominal 1%)	-	-	-	-	-	-	-
TOTAL REVENUE (₹ Cr)	**0.15**	**0.42**	**0.72**	**0.98**	**1.15**	**1.28**	**1.34**

3. CAPEX Schedule

Construction-period deployment (Y-2, Y-1, Y0) and depreciation across operating years

	Y1	Y2	Y3	Y4	Y5	Y6	n^{th} Year
CAPEX Deployment by Source (₹ Cr)							
Scheme funding (Tranche I) — 40%	-	-	-	-	-	-	-
Scheme funding (Tranche II) — 40%	-	-	-	-	-	-	-
Scheme funding (Tranche III) — 20%	-	-	-	-	-	-	-
Promoter / State equity (cash + land)	0.05	-	-	-	-	-	-
Debt (if any)	-	-	-	-	-	-	-
State 75% External (off-Scheme — for reference)	1.00	-	-	-	-	-	-
TOTAL CAPEX deployed in Y1 (one-time)	**0.05**	**-**	**-**	**-**	**-**	**-**	**-**
Depreciation Schedule (₹ Cr)							
CAPEX base (cumulative)	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Annual depreciation (SL)	-	-	-	-	-	-	-
Accumulated depreciation	-	-	-	-	-	-	-
Net Block (CAPEX - accumulated depr)	0.05	0.05	0.05	0.05	0.05	0.05	0.05

4. OPEX Schedule

Annual operating expenses, escalated

	Y1	Y2	Y3	Y4	Y5	Y6	n^{th} Year
Manpower	-	-	-	-	-	-	-
Power & water (common areas)	-	-	-	-	-	-	-
Repairs & maintenance (% of CAPEX)	-	-	-	-	-	-	-
CETP/STP/SWM consumables	-	-	-	-	-	-	-
ICT AMC + cybersecurity SOC	-	-	-	-	-	-	-
Insurance + statutory + audit	-	-	-	-	-	-	-
Other admin & contingency	-	-	-	-	-	-	-
TOTAL OPEX (₹ Cr)	**-**	**-**	**-**	**-**	**-**	**-**	**-**

Above Mentioned Values Are Indicative In Nature

5. O&M Corpus Fund — 5% Escrow per Guidelines Para 7.9

Mandatory escrow of 5% of gross allotment premium; restricted drawdown after Year 5; supports O&M sustainability post-tranche-release period.

	Y1	Y2	Y3	Y4	Y5	Y6	nth Year
Annual Allotment Premium (₹ Cr) — from Sheet 2	-	-	-	-	-	-	-
Escrow contribution (5% of premium)	-	-	-	-	-	-	-
Drawdown (if year ≥ start year and OPEX > Revenue ex-premium)	-	-	-	-	-	-	-
Opening balance	-	-	-	-	-	-	-
Closing balance (in escrow)	**-**	**-**	**-**	**-**	**-**	**-**	**-**

Note (Guidelines Para 7.9): The O&M Corpus is held in a separate escrow account, deposited at the time of allotment, with drawdown only on Board approval (with DPIIT nominee concurrence). Permitted drawdown applications: O&M of CETP/STP/SWM, internal roads, streetlights, security, short-life asset replacement. Any unutilised balance at end of 5 years (from Operationalization) is transferred to general reserves.

6. Profit & Loss Statement (30-Year)

₹ Crore. Standard P&L flow with depreciation, interest, tax.

	Y1	Y2	Y3	Y4	Y5	Y6	nth Year
Total Revenue	1.00	-	-	-	-	-	-
(-) Operating Expenses (OPEX)	-	-	-	-	-	-	-
EBITDA	**1.00**	**-**	**-**	**-**	**-**	**-**	**-**
(-) Depreciation	-	-	-	-	-	-	-
(-) Interest on Debt	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Profit Before Tax (PBT)	**0.95**	**(0.05)**	**(0.05)**	**(0.05)**	**(0.05)**	**(0.05)**	**(0.05)**
(-) Tax	-	-	-	-	-	-	-
Profit After Tax (PAT)	**0.95**	**(0.05)**	**(0.05)**	**(0.05)**	**(0.05)**	**(0.05)**	**(0.05)**
Cumulative PAT	0.95	0.90	0.85	0.80	0.75	0.70	0.65

7. Cash Flow Statement (30-Year)

Operating CF + Investing CF + Financing CF. Project IRR computed on Net CF before financing.

	Y1	Y2	Y3	Y4	Y5	Y6	nth Year
Operating Cash Flow							
EBITDA (from P&L)	-	-	-	-	-	-	-
(-) Tax paid	-	-	-	-	-	-	-
Net Cash from Operations	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Investing Cash Flow							
(-) CAPEX (Y1 only)	-	-	-	-	-	-	-
Net Cash Flow (pre-financing)	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Cumulative Net Cash Flow	-	-	-	-	-	-	-
DSCR (EBITDA / [Interest + Principal])	-	-	-	-	-	-	-

Above Mentioned Values Are Indicative In Nature

8. Project Returns — IRR / NPV / DSCR / Payback

Key bankability metrics

Project IRR		*Internal rate of return on pre-financing project cash flows over 30 years.*
Project NPV @ WACC (₹ Cr)	(67.20)	*NPV at WACC = ('1. Assumptions'!C48). NPV > 0 indicates value creation; NPV < 0 indicates the project doesn't meet the cost of capital.*
Equity IRR (proxy)		*Same as Project IRR for an equity-only project (Para 9.1).*
Simple Payback (years)		*Year in which cumulative net cash flow first turns non-negative.*
Avg DSCR (Years 6–25)	n/a (no debt)	*Average Debt Service Coverage Ratio in steady-state operating years (Y6–Y25). Should be ≥ 1.25.*
Per-acre infra cost (₹ Lakh/acre)		*Total infra cost per acre. Compare against indicative ₹/acre benchmarks (NICDC portfolio).*

Indicative Bankability Thresholds	
Project IRR	≥ 10–12% for PSU/govt-led parks; ≥ 14% for private-led
Project NPV @ WACC	Should be > 0
Avg DSCR (when debt present)	≥ 1.25
Simple Payback	≤ 15 years
Per-acre infra cost	≤ ₹1 Cr/acre (State/CPSE) or ₹50 Lakh/acre (Private)

(helper) IRR cash flows	*Year 0*	*Year 1*	*Year 2*	*Year 3*	*Year 4*	*Year 5*	*Year 6*	*n^{th} year*
Pre-financing CF (₹ Cr)	-	(4.65)	(4.67)	(4.68)	(4.73)	(4.91)	(5.15)	(5.47)

9. Sensitivity Analysis

Change the sensitivity multipliers in Sheet 1 to view IRR/NPV under different scenarios. The table below provides reference matrix.

A. Current Scenario (drives Sheet 1 multipliers)	
Absorption multiplier	100.0%
Cost overrun multiplier	100.0%
Premium multiplier	100.0%
Current Project IRR	
Current Project NPV (₹ Cr)	(67.20)

B. Sensitivity Reference Table — enter manually for each scenario

Scenario	Absorption	Cost	Premium	Project IRR	Project NPV (₹ Cr)
Base Case	100.0%	100.0%	100.0%		
Downside (absorption -20%)	80.0%	100.0%	100.0%		
Downside (cost +15%)	100.0%	115.0%	100.0%		
Downside (premium -10%)	100.0%	100.0%	90.0%		
Stress (all three downside)	80.0%	115.0%	90.0%		
Upside (absorption +20%)	120.0%	100.0%	100.0%		
Upside (premium +10%)	100.0%	100.0%	110.0%		
Best Case (all three upside)	120.0%	85.0%	110.0%		

Workflow: Set Sheet 1 multipliers to the scenario values shown in columns C–E, then copy the resulting IRR / NPV from Sheet 8 into columns F–G of this table. Repeat for each scenario row. (Data Tables / Solver can automate this in Excel desktop.)

Above Mentioned Values Are Indicative In Nature

10. Tranche Drawdown vs Milestones

Per Guidelines Para 9.6 — 40:40:20 release linked to milestone preconditions. This sheet mirrors Cost Summary Sheet 7 and reconciles to financial model cash flow.

Tranche	Description / Milestone	% Share	Amount (₹ Cr)	Linked to Model Year	Cumulative %	Cumulative (₹ Cr)
I-a	Approval by NLSC + Land transfer (90% encumbrance-free) + Delegation of powers + Power/Water allocation	30.0%	-	Year 1	30.0%	-
I-b	EC obtained + Commencement of work	10.0%	-	Year 1	40.0%	-
II	Utilisation of 75% Tranche I + Physical progress + Allotment to ≥2 manufacturing units	40.0%	-	Year 2	80.0%	-
III-a	Utilisation of 90% T1+T2 + Physical progress	10.0%	-	Year 3	90.0%	-
III-b	External infra complete + 2 units in construction + Final completion certificate	10.0%	-	Year 3	100.0%	-
	Total	**100.0%**	**-**			

CRITICAL CHECK: Total in row 11 must equal Scheme Funding requested in Sheet 1 ('1. Assumptions'!C13 reference). Tranche I (50% combined = I-a 30% + I-b 10% per guidelines) and Tranche II (40%) and Tranche III (20% combined) sum to 100%. Note that Para 9.6 uses 40:40:20 as the top-level ratio, but the milestone breakdown in I-a/I-b/III-a/III-b is a refinement we adopt for cash-flow planning.

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