DRAFT MASTER PLAN REPORT FOR SOLID WASTE COLLECTION AND DISPOSAL MANAGEMENT In GANGNI PAURASHAVA

Executive Summary

Gangni Paurashava is experiencing rapid urban growth, expanding commercial activity, and rising daily waste generation. Yet its existing solid waste management system remains limited, fragmented, and heavily dependent on manual collection from scattered roadside bins. The absence of proper coverage in peripheral wards, lack of segregation, an outdated direct-haul system, and operational inefficiencies have resulted in open dumping, drain blockage, environmental pollution, and increasing public-health risks.

This Solid Waste Management Masterplan provides a data-driven and spatially optimized roadmap to transform Gangni's waste system into a modern, efficient, and equitable municipal service. A detailed assessment of 265 existing waste bins reveals a strong concentration in central commercial wards but significant service gaps across Wards 01, 02, 03, 07, and southern Ward 09. GIS-based location-allocation analysis identifies 250 new bins to be placed strategically, focusing on unserved and underserved areas to ensure universal public access within the WHO-recommended 50–100 meters.

A major structural upgrade proposed in this Masterplan is the introduction of five Secondary Transfer Stations (STS). Network-based 500–1500–2500 meter service-area modeling confirms that these STSs together can effectively cover all nine wards. Transitioning from a direct-haul model to an STS-based system will reduce long travel distances for small collection vehicles, improve fuel efficiency, streamline operations, and create opportunities for partial segregation before final disposal.

To support sustainable collection and transportation, optimized routes were generated using the ArcGIS Vehicle Routing Problem (VRP) solver. Five operational routes have been defined, each assigned to a dedicated waste truck, ensuring full municipal coverage without route overlap. This modern routing approach reduces travel time, prevents redundant vehicle movement, and guarantees consistent waste evacuation from every ward.

The Masterplan also outlines an integrated pathway for long-term waste recovery. Recommendations include household-level segregation, community awareness campaigns, expansion of composting for organic waste, and piloting Refuse-Derived Fuel (RDF) technology for residual waste. These initiatives align with Bangladesh's Solid Waste Management Rules 2021 and the national 3R strategy, enabling Gangni to gradually shift toward a circular, resource-oriented waste system.

Institutional strengthening, financial planning, and stakeholder engagement are embedded throughout the plan, ensuring realistic implementation tailored to Gangni's administrative capacity. The proposed system is scalable, affordable, and capable of meeting both current and future waste-management demands of the municipality.

Overall, this Masterplan positions Gangni Paurashava to move from a scattered, reactive waste system to a structured, efficient, and environmentally responsible urban sanitation model. With phased execution and strong community participation, Gangni can achieve cleaner streets, improved public health, and a sustainable urban environment for its residents.

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Chapter 1: Introduction

1.1: Study Background

Gangni Paurashava is a small but growing municipal town in Meherpur District of Bangladesh, facing mounting challenges in managing its solid waste. With an estimated population of around thirty thousand residents, rapid urbanization and population growth are contributing to ever-increasing waste generation. However, the capacity to handle this waste has not kept pace. A significant portion of Gangni's garbage is never formally collected, mirroring the national situation where only about 45–50% of urban waste is picked up by municipal authorities while the rest is dumped on streets, open fields, or into waterways. In Gangni, uncollected refuse accumulates in drains, vacant lots, and roadside pits. There is currently no organized system of waste segregation at the source, so households and shops mix all kinds of waste together. This mixed trash often ends up in informal dumps or is thrown into nearby low-lying areas and riverbanks, creating eyesores and environmental hazards. For example, another Bangladeshi municipality (Habiganj) with a larger population but similar constraints had *no* designated dumping site, garbage was routinely being dumped on a riverbank and open roadside, leading to foul odors and pollution of water and air. Gangni faces analogous problems on a local scale: open dumping and burning of waste are common informal practices used by residents and municipal cleaners to cope with excess garbage. These practices have serious consequences – rotting waste clogs drains (exacerbating flooding in the monsoon), attracts disease vectors, and degrades the quality of life in the community. Environmental and public health concerns are rising as piles of uncollected waste emit foul smells and leachate, and the open burning of trash (a frequent sight in absence of proper disposal) releases harmful smoke.

Amid these growing concerns, there is a clear recognition that ad-hoc measures are no longer sufficient. Gangni Paurashava currently lacks an engineered landfill or sanitary disposal facility like most small municipalities, it relies on crude dumping grounds without any pollution control measures. The waste stream is dominated by organic matter (food scraps, vegetation, and other perishables), which decomposes rapidly in the tropical climate and can cause immediate nuisances if not managed. At the same time, use of plastic bags and packets is on the rise even in this small town, adding non-biodegradable litter to the streets and drains. Informal waste pickers do operate in Gangni to scavenge recyclable materials (plastics, metals, paper) from trash heaps, but there is no structured recycling program or organized composting of the abundant organic waste. In short, the town's solid waste management (SWM) system is rudimentary characterized by limited door-to-door collection in some wards, a few open collection points (bins or barrels) that often overflow, and ultimate disposal in unsanitary conditions. This situation is increasingly untenable given the municipality's development ambitions and the community's desire for a cleaner, healthier environment.

The rationale for preparing a structured Solid Waste Management Master Plan is compelling. Without a master plan, efforts to address Gangni's waste problems would remain piecemeal and reactive. A comprehensive master plan provides a *roadmap* to systematically improve SWM over the short, medium, and long term. It enables the Paurashava to assess the current situation in depth, identify specific gaps in service (e.g. neighborhoods with no collection, or lack of waste facilities), and plan out practical solutions suited to the local context. The master plan approach also ensures that future growth is taken into account

Gangni's population and commercial activity are expected to continue increasing, so the waste management system must be planned with tomorrow's needs in mind, not just today's. Furthermore, the Government of Bangladesh has recently strengthened its policy focus on solid waste management (through the National 3R Strategy and the Solid Waste Management Rules 2021, which introduce modern concepts like waste segregation and Extended Producer Responsibility). Preparing a master plan will help Gangni align with these national guidelines and access potential government support or funding. In summary, the SWM Master Plan is envisioned to be the blueprint for transforming Gangni's waste management moving from the current unsustainable practices to an organized, efficient system that protects public health and the environment. It will articulate clear strategies and investments needed to achieve a cleaner Gangni, and will serve as a tool for the Paurashava to coordinate efforts with stakeholders and justify resource allocation to this critical sector.

1.2: Objectives of the Solid Waste Management Master Plan

The Solid Waste Management Master Plan for Gangni Paurashava is driven by a set of well-defined objectives that address technical, operational, environmental, and policy aspects of waste management and to guide Gangni Paurashava toward a cleaner, healthier, and more sustainable waste management system. These objectives provide direction for all components of the plan:

- To assess the current state of solid waste generation, collection, transportation, and disposal in the municipality.
- To identify critical gaps and challenges in infrastructure, manpower, operations, and policy.
- To design a phased improvement plan covering short-term fixes and long-term structural upgrades.
- To promote community-based waste segregation, composting, and recycling practices.
- To propose institutional and financial models for sustaining the waste management system.
- To ensure that all proposed activities align with national environmental regulations and public health priorities.

Together, these objectives ensure that the master plan is **comprehensive** covering the physical infrastructure needs, the day-to-day service improvements, environmental protection goals, and the necessary policy and behavioral changes. They provide a checklist against which the success of the plan can eventually be measured. By meeting these objectives, Gangni Paurashava will be positioned to deliver a much-improved solid waste management service that is reliable, environmentally sound, and responsive to the community's needs.

1.3: Scope and Limitations of Study

The scope of work for the Gangni Solid Waste Management Master Plan outlines the major tasks and study components that will be undertaken. It defines *what* activities are included in developing the master plan from data collection and surveys to project design and stakeholder engagement. The following sub-sections describe each element of the scope:
This masterplan covers all major waste streams generated within Gangni Paurashava, including:

- Household/domestic waste
- Market and commercial waste
- Institutional and small-scale industrial waste
- Healthcare waste from clinics and diagnostic centers (non-hazardous)

It includes assessment of existing systems, design of interventions (collection, transfer, disposal, treatment), stakeholder mapping, cost estimation, and an implementation roadmap.

Limitations

- Liquid waste, faecal sludge, and industrial hazardous waste are excluded from this study.
- Detailed engineering designs, BOQs, and environmental impact assessments for specific infrastructure are outside the scope of this masterplan but may be recommended as follow-up actions.
- The plan is based on data collected within a defined timeframe; actual conditions may shift due to rapid urban or population changes. Regular revisions are recommended to keep the plan relevant.

1.3.1: Data Collection and Review

The first step of the master plan preparation is a thorough data collection and review of the current waste management situation in Gangni. This involves gathering both quantitative data and qualitative information. The study team will collect data on waste generation and composition – for example, measuring how much solid waste is produced per day in Gangni and breaking it down by source (households, markets, shops, clinics, etc.) and by type (organic waste, plastics, paper, glass, construction debris, etc.). Field measurements such as waste sampling and weighing will be conducted to establish accurate generation rates (e.g. kilograms per person per day) and to determine the typical composition of the waste stream in this municipality.

In addition to new measurements, the team will review existing records and documents. This includes any data the Paurashava has on waste collection (such as logbooks of waste vehicle trips or estimates of waste collected), past survey reports, and relevant studies (if any) done in Gangni or similar towns. They will inventory the current waste management facilities and resources: for instance, documenting how many waste collection bins exist and where, what vehicles and equipment the Paurashava uses (handcarts, rickshaw vans, trucks, etc.), the number of conservancy staff or waste workers employed, and the location and condition of the present dumping site. The data review will also cover demographic and urban profiles –

understanding Gangni's population distribution, density, and growth trends, since these factors influence waste generation and service demand.

Overall, this task creates the evidence base for the master plan. By collating all relevant data (waste quantities, infrastructure, human resources, budgets, etc.), the planners can accurately assess the baseline situation. Any critical data gaps identified during this stage will be noted and addressed through field surveys or estimates. This rigorous data collection and review ensures that subsequent planning is grounded in reality and tailored to Gangni's specific conditions, rather than on generic assumptions.

1.3.2: Survey and Mapping

To supplement the data collection, targeted surveys and mapping exercises will be carried out across Gangni Paurashava. These surveys are aimed at understanding community behavior, service coverage, and the flow of waste from source to disposal. One key activity is conducting household surveys – structured questionnaires administered to residents in different wards of Gangni. Through these surveys, the team will gather information on how households currently manage their waste (Do they receive door-to-door collection? Do they dump it in a particular spot? Do they practice any segregation or recycling on their own? How willing are they to participate in improved waste services or pay fees for better service?). The surveys will also capture public perceptions of the waste problem, such as areas they identify as "dirty" or urgent concerns like garbage clogging drains.

In parallel, the project will undertake field mapping of waste infrastructure and hotspots. Using Geographic Information System (GIS) tools, the locations of all existing waste bins, collection points, secondary transfer sites (if any), and the final dumpsite will be mapped. The collection routes taken by municipal waste collectors will be traced and mapped to visualize which areas are served and which are neglected. This waste flow mapping will illustrate how waste moves through the town – from generation points to collection and finally to disposal. It helps identify any bottlenecks or inefficiencies (for example, if certain neighborhoods are far from any collection point, or if collection routes are overlapping or leaving gaps).

Another aspect of this task is assessing the informal sector involvement in waste management. The team will identify and meet with local waste pickers, scrap dealers (locally known as kabadi traders), and any community-based organizations involved in cleanliness drives. The goal is to map out how recyclable materials are collected and traded informally in Gangni, and how organic wastes (like kitchen scraps) might be reused (some households may feed vegetable waste to livestock, for instance). Understanding the role of these informal systems is important, as the master plan can potentially build on or integrate them (for example, by supporting waste pickers to formalize recycling or including them in a future door-to-door collection scheme).

Through detailed surveys and mapping, the master plan team will obtain a spatial understanding of waste management in Gangni. They will produce maps – such as a base map of the town marked with waste service coverage, areas of heavy waste generation (e.g. the municipal market, bus stand, hospitals, etc.), and sites where waste is accumulating. These maps and survey findings will feed directly into identifying problems and designing targeted interventions for each part of the town.

1.3.3: Solid Waste Management Improvement Projects

Based on the data and survey insights, the master plan will identify a set of priority improvement projects for Gangni's solid waste management system. This is a core part of the scope: formulating tangible solutions and interventions that the Paurashava can implement. The projects will cover the full cycle of waste management from collection to disposal. For example, one likely project is establishing an improved waste collection system – this could involve procuring new collection equipment (such as additional rickshaw-vans or a small dump truck), setting up a door-to-door collection scheme in all wards, and providing more communal bins in strategic locations. The plan will detail the design of such a project, including the number and type of vehicles needed, crew requirements, and routing plans.

Another key intervention will be the development of a waste disposal or processing facility. The master plan will examine options for a suitable disposal solution for Gangni: this might be the construction of a controlled landfill site on land identified by the municipality, possibly combined with a resource recovery facility (like a sorting center or a composting facility for organic waste). If a new site is needed, the plan will outline the criteria for site selection and the basic design (for instance, a small sanitary landfill cell with leachate control, or a fenced dumping yard with designated zones for composting). In case land acquisition for a landfill is challenging (a common issue in Bangladesh), the plan might propose interim solutions such as improving the existing dumpsite with some containment measures or exploring a shared regional landfill with nearby towns.

Additionally, specialized projects will be proposed to address gaps. This could include setting up a medical waste management system for clinics (if biomedical waste is currently mixed with municipal waste), introducing public awareness and cleanliness drives (as a "software" project to change behavior), and pilots for waste segregation (for example, selecting one neighborhood to pilot separating organic waste for composting with community participation). Infrastructure like public waste bins, covered storage sheds for collected waste, and personal protective equipment for workers are also part of the improvement measures.

For each identified project, the master plan will provide a concept design or description, justify why it is needed, and estimate the resources required (land, capital cost, operational cost). The plan will effectively create a portfolio of SWM projects – ranging from low-cost immediate fixes to larger investments – that together will upgrade Gangni's solid waste management. These projects will later be prioritized and phased (in Chapter 8 of the report), but in this scope section, all potential interventions are put on the table for consideration.

1.3.5: Complementary Programs

Technical fixes alone cannot solve solid waste problems; human behavior and community cooperation are just as important. Therefore, the master plan's scope includes designing complementary programs that will run in parallel with infrastructure improvements. One major complementary component is community awareness and public education. The plan will outline initiatives to educate the citizens of Gangni about proper waste practices – for example, campaigns to encourage households to store waste in bins with lids, not to litter in drains, and to cooperate with waste collectors by handing over trash at specified times. This could involve school programs (to teach students about the 3Rs: Reduce, Reuse, Recycle), distribution of

leaflets on waste segregation, and even door-to-door outreach in neighborhoods by volunteers or municipal staff.

Another complementary program is to foster behavioral change regarding waste segregation. The plan may propose a pilot program where households are given two bins (one for organic waste, one for others) and are encouraged through incentives or demonstrations to separate their waste. Community-based organizations and local influencers (such as imams of mosques or school teachers) might be engaged to spread messages on cleanliness and health impacts of waste mismanagement. The goal is to gradually instill a culture in which disposing of garbage properly is seen as everyone's responsibility.

Engaging the private sector and NGOs is also covered under complementary measures. The master plan will consider roles for private businesses in improving SWM, for instance, contracting a private company or youth cooperative to handle door-to-door collection under Paurashava supervision, or encouraging local entrepreneurs to start recycling ventures (perhaps a small-scale plastic recycling unit or a community compost sale program). It will also look at how NGOs or civil society groups can support, as NGOs often have experience in community mobilization and behavior change campaigns in Bangladesh.

Furthermore, the plan will propose incentive programs such as cleanest ward competitions, where communities that keep their area litter-free are recognized, or fee rebates for households that segregate waste properly. Another complementary aspect is improving the municipal complaint system so residents can report waste problems (like a missed pickup or an illegal dumpsite) and have them addressed quickly – these builds trust and participation.

In summary, this scope item ensures that alongside the "hardware" (trucks, bins, landfills), the "software" – i.e., human and social dimensions are addressed. The complementary programs are essential for making the technical solutions work effectively on the ground. By changing attitudes and involving citizens, these programs aim to make the improvements sustainable. After all, a clean Gangni cannot be achieved by the Paurashava alone; it requires broad public support, and that is what these programs seek to cultivate.

1.3.6: Legislative and Institutional Arrangements

An important component of the master plan is reviewing and strengthening the legislative and institutional framework for solid waste management in Gangni. This entails looking at the existing laws, regulations, and organizational setup that govern how waste services are delivered. At the local level, Gangni Paurashava likely has certain bylaws or regulations (under the Local Government (Pourashava) Act, 2009 and other relevant rules) that pertain to waste – for example, rules against littering, provisions for waste fee collection, or assigned duties of municipal staff. The master plan will review these local regulations to identify if they are adequate or need updates. For instance, the plan may recommend formulating a new municipal bylaw requiring every household and shop to use a covered bin and participate in waste segregation, with penalties for non-compliance, in line with the national Solid Waste Management Rules 2021 which call for mandatory source segregation and introduce concepts like EPR.

On the institutional side, the plan examines the roles and capacity of the Paurashava's departments involved in waste management. In Gangni, the conservancy section (or health section) of the municipality is typically

responsible for solid waste. The plan will assess whether this section has a clear structure and sufficient manpower. It will clarify roles such as who supervises the waste workers, how many sweepers or cleaners are assigned per ward, and what the responsibilities of Ward Councillors are in supporting waste management. If coordination issues exist say, between the municipal health section and the engineering section (for drain cleaning or waste vehicle maintenance) the plan will highlight the need for better inter-departmental collaboration.

The scope also includes exploring partnerships and institutional arrangements beyond the Paurashava. This could mean coordination with the Upazila administration or the Department of Environment on regulatory oversight (for example, ensuring that any new dumpsite complies with environmental clearance processes). It also could involve identifying opportunities for public-private partnerships (PPP) for instance, contracting out the operation of a compost plant to a private firm or engaging a local NGO to run community awareness activities on behalf of the Paurashava.

Another institutional aspect is capacity building. The master plan will outline needs for training municipal staff on modern waste management practices (like safe landfill operations, or bookkeeping for waste fee collection). It may recommend creating a dedicated position (e.g., a Waste Management Officer) within the municipality to champion the implementation of the plan.

By addressing legislative and institutional arrangements, the master plan ensures that there is a solid governance foundation for all technical interventions. Essentially, this task is about enabling the Paurashava to effectively implement and sustain the proposed waste management improvements through clear mandates, robust policies, and an empowered organization. Any gaps in the current framework will be met with recommendations whether it's drafting a new regulation, signing an MoU with another agency, or reorganizing the municipal waste management team to create an environment in which the master plan's initiatives can flourish.

1.3.7: Environmental Screening and Stakeholder Engagement

Solid waste management improvements go hand in hand with environmental considerations and community input. Therefore, the master plan's preparation includes a process of environmental screening as well as ongoing stakeholder engagement. Environmental screening means that the team will assess the potential environmental impacts of both the existing waste management practices and any proposed projects. For example, the current open dumping in Gangni might be causing leachate to seep into nearby soils or water – the plan will document these baseline environmental issues (perhaps through simple tests or observations of soil/water quality near the dumpsite, and noting any prevalent nuisances like smoke or pests). Then, for each major proposed project (say, developing a new landfill or a composting center), an initial environmental examination will be conducted. This involves identifying possible impacts (like odor, groundwater contamination, or attraction of vermin) and suggesting mitigation measures to incorporate in project design (such as lining a landfill and installing drainage to manage leachate, or planting a vegetation buffer around a waste site to reduce odor spread).

In essence, the plan will ensure that environmental safeguards are built into the recommendations, aligning with national environmental regulations and good practice. If any project appears to have significant adverse impacts, the plan will either propose alternatives or outline what further detailed environmental assessment will be needed before implementation.

Equally important is stakeholder engagement throughout the planning process. The master plan team will actively consult a broad range of stakeholders in Gangni. Key stakeholders include the municipal elected officials (the Mayor and Councillors), who will provide insights on political and community priorities and must ultimately approve the plan. The input of municipal staff and waste workers is vital – their practical experience can highlight issues that data might miss (such as specific local challenges in certain wards). The plan will likely convene meetings or focus groups with these staff to discuss problems and possible solutions.

Local community stakeholders are also engaged: this can include representatives from each ward (members of Ward Committees or citizen groups), market traders' associations, women's groups, and others. The planning team will hold community consultation meetings to share initial findings and listen to the community's concerns and suggestions. For example, residents may point out particular "black spots" where garbage is always dumped illegally, or they might express willingness to separate waste if the municipality provides multiple bins. Public feedback is invaluable to ensure the plan's proposals are socially acceptable and address real needs.

Furthermore, any relevant external stakeholders – such as the Department of Public Health Engineering (if they have projects in town), NGOs working in sanitation or environment, or neighboring local government bodies – may be consulted for coordination purposes. The engagement process will be documented, and the master plan will reflect the consensus and major concerns raised by stakeholders. By involving the community and stakeholders from the start, the plan builds local ownership. It also helps to pre-empt implementation issues – since stakeholders who have been heard and involved are more likely to support and cooperate with the plan's execution.

In summary, the environmental screening ensures the master plan is environmentally responsible, and stakeholder engagement ensures it is community-centered and realistic. Both elements are crucial for the long-term success and sustainability of the waste management improvements envisioned for Gangni.

1.4: Study Area

Gangni Paurashava is a small municipal town located in the southwest of Bangladesh, within Meherpur District of Khulna Division. It serves as the urban center of **Gangni Upazila**, which lies near the border with India's West Bengal statebio-protocol.org. Geographically, Gangni is situated roughly between the larger towns of Kushtia (to its northeast) and Meherpur Sadar (to its west), connected by a regional highway. The municipality covers an area of about **17 square kilometers**, encompassing portions of three rural *mouzas* (revenue villages). Administratively, Gangni Paurashava is subdivided into **9 wards** and **29 mahallas** (urban neighborhoods). It is bordered by Dhankhola Union on the north-west and by Roypur (Raypur) and Sholotaka Unions toward the east and south, delineating the limits of the town's expansionps.gangni.meherpur.gov.bd. The municipal boundary is relatively compact, but it also includes some semi-rural fringes, resulting in a mix of densely built-up areas and open lands within the official town limits.

The **settlement pattern** of Gangni reflects a transition from rural to urban land use. The town's core has grown around a traditional bazaar (market) area near the main road, where shops, marketplaces, and civic facilities (like the Paurashava office and Union Parishad complex) are concentrated. Here, plots are small and buildings are closely spaced, forming a dense urban fabric. Radiating out from this center, settlement becomes more dispersed: residential neighborhoods extend along the main roads and intersecting lanes, but between these clusters are patches of agricultural land and homesteads. Many households on the periphery still maintain kitchen gardens or even small crop fields, giving the outskirts a village-like character. This **linear-cum-clustered** settlement pattern with a dense town center and ribbon development along roads means some communities are relatively isolated by open fields. Such spatial layout poses challenges for infrastructure: providing utilities and waste collection to pockets of houses separated by farmland can be difficult. Moreover, Gangni's proximity to the international border (only a few kilometers away) and the presence of low-lying lands constrain outward growth in certain directions. For instance, to the west, expansion is limited by the Indian border, and to the south, there are floodplain wetlands. As a result, new housing tends to infill within the town or spread along existing road corridors. This organic growth, if unplanned, could lead to haphazard development; hence, understanding the settlement distribution is crucial for planning efficient solid waste services (like optimizing collection routes and locating waste facilities away from homes).

1.4.1 Land Use Composition

- **Residential Areas:** The dominant land use category, mostly concentrated in the central and southern parts, particularly around Wards 04, 05, 06, and 08. The built-up pattern shows dense settlements along major roads and mixed residential-commercial zones in the urban core.
- **Commercial Zones:** Linear commercial development follows the main road corridors crossing the municipality. The commercial belt is especially pronounced in Wards 04, 05, and 08, indicating a traditional bazaar or market-oriented urban morphology.
- **Agricultural Land:** Extensive agricultural tracts occupy the outer periphery, notably in Wards 01, 02, 03, 07, and 09. These green patches signify the transitional interface between the urban and rural landscape of Gangni.

- **Educational and Research Institutions:** Scattered across the municipality, with visible concentrations in the central zone, reflecting the presence of schools and colleges serving both urban and rural populations.
- **Community and Non-Government Services:** Distributed throughout, providing essential civic and social functions. Health facilities are smaller in number but are strategically positioned within the core urban wards.
- **Manufacturing and Processing Areas:** Small-scale industrial and service-related land uses are observed mainly in Wards 03 and 09, indicating the presence of workshops and cottage industries.
- **Waterbodies and Fallow Lands:** Numerous ponds and low-lying areas (shown in blue) intersperse the built-up zones, playing an ecological and drainage role within the Paurashava.
- **Road Network:** A well-defined road structure connects all wards, with the main arterial road traversing east–west through the central commercial strip. This network anchors the functional layout and accessibility of urban services.

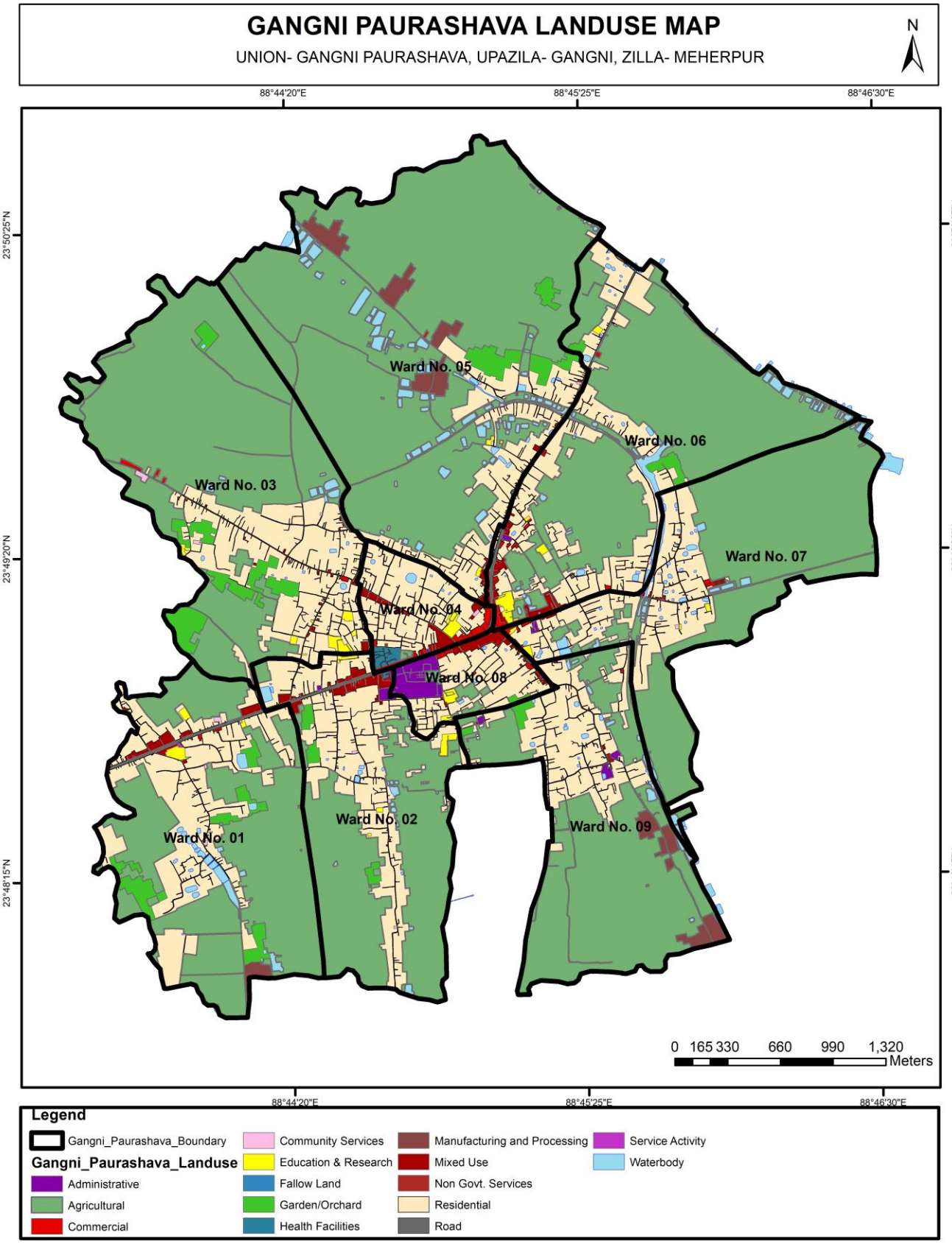

Figure 1: Land use Map of Gangni Paurashava

1.4.2 Waste Management Infrastructure

Gangni Paurashava's waste bin and route network reveals a developing yet functional municipal waste management system centered around structured collection routes and a designated dumping site. The integration of diverse bin types reflects an adaptive approach to urban waste handling.

Dumping Site & Fecal Sludge Treatment Plant (FSTP):

Located in the southwestern part of Ward No. 03, the site serves as the final disposal and treatment location for solid waste collected from the entire municipality.

Waste Bin Types and Distribution:

The municipality employs a combination of formal dustbins, informal bins, drum bins, and cement casting bins.

- **Formal Dustbins** are systematically placed along major roads and intersections in Wards 04, 05, 06, and 08, primarily the commercial and densely populated zones.
- **Informal Dustbins** appear in peripheral and low-density areas, showing community-driven or temporary waste storage spots.
- **Drum Bins** and **Cement Casting Bins** are scattered across inner neighborhoods, offering localized collection options.
- The **Municipal Wastebins** (marked with orange icons) dominate the central transport corridors.

Collection and Disposal Routes:

The solid black lines represent the disposal route plan, covering all major roads connecting to the central dumping site. These routes ensure efficient collection from each ward, especially the densely populated **Wards 04, 05, 06, and 08**, which generate the majority of municipal waste. The network's connectivity indicates a well-structured and accessible layout, minimizing travel distance for waste transport vehicles.

Functional Pattern and Spatial Analysis

The spatial pattern shows a **hub-and-spoke structure** where waste is collected from multiple decentralized bins toward a single treatment and dumping location in Ward 03.

- The **central corridor** (Wards 04–08) forms the operational core of waste management activities due to higher population, commercial activity, and institutional presence.
- The **outer wards (01, 02, 07, 09)** have fewer bins, reflecting their lower waste generation and semi-urban character.
- The road-based collection system demonstrates good coverage but would benefit from secondary collection points in peripheral wards to enhance efficiency.

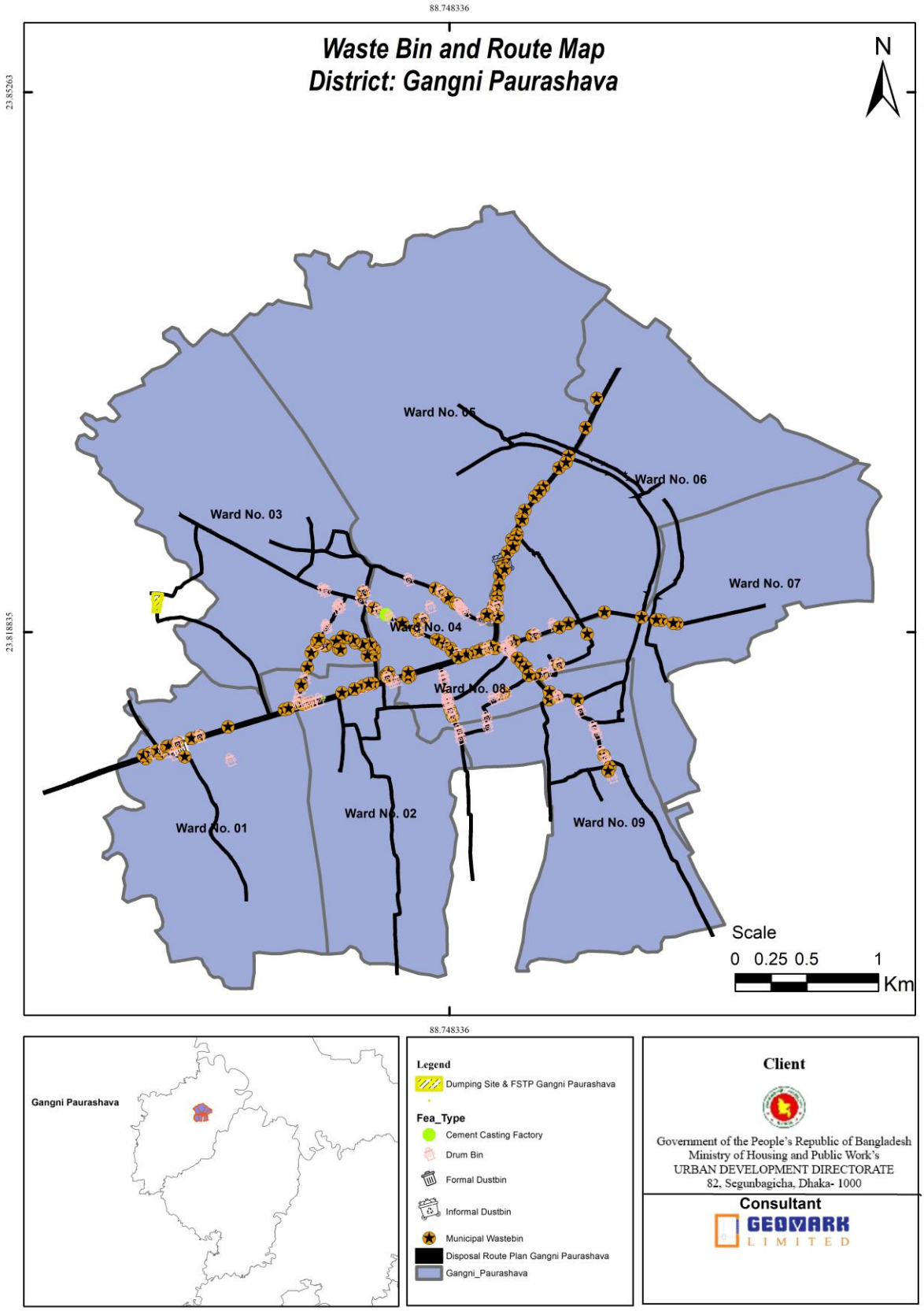

Figure 2: Existing Waste Management Infrastructures of Gangni Paurashava

However, expanding coverage to less-served wards and strengthening waste segregation and treatment at the source would further improve the sustainability of Gangni's urban sanitation framework.

Chapter 2: Literature Review

Chapter 3: Methodology & Approach of the Study

2.1 Defining Waste, Solid Waste and Municipal Waste

Waste is the spare things that we do not use. But there is a saying someone's waste is someone's raw materials and resources if used correctly and efficiently (Alam Safiqul, 2025).

Waste broadly includes any unwanted or discarded materials. **Solid waste** specifically refers to non-liquid waste from domestic, commercial, industrial or institutional sources (e.g. kitchen scraps, market waste, packaging, manufacturing by-products). **Municipal solid waste (MSW)** is the subset of solid waste collected by city corporations or municipalities from urban areas; it typically includes household and street sweepings along with some commercial waste. Haider & Riaz (2021) define solid waste management (SWM) as the planning, control and implementation of waste handling – from generation through collection, transfer, treatment and final disposal – in line with public health, environmental and engineering best practices. Municipal SWM is therefore the process by which a municipality organizes these activities within its jurisdiction. In Bangladesh, urban waste management is generally a municipal responsibility (city corporations or Paurashava handle MSW).

2.2 Classification of Solid Waste

Gangni's waste can be classified by material type, reflecting what actually appears on local streets and in bins:

- **Organic (Food and Market Waste):** This is by far the largest fraction. Household kitchen waste (vegetable peelings, leftovers, yard trimmings) and fresh-market scraps (fruit/vegetable peels, spoiled produce) dominate Gangni's MSW. National data suggest that organic "food" waste can be 70–80% of the municipal waste stream.
- **Plastics:** Plastic bags, packaging and bottles from shops and homes form a significant portion of the rest. In Bangladesh towns, plastics are often 5–10% of MSW. Gangni generates common plastics like grocery bags, food wrappers, and PET bottles.
- **Paper and Cardboard:** Newspapers, cardboard boxes and packaging make up a smaller share (typically 2–5%). These come from shops, offices and household waste.
- **Textiles:** Old clothing or rags enter the waste stream at perhaps 3–4%. Small amounts of cotton and synthetic cloth are discarded by households and tailors.
- **Metals and Glass:** Cans, tins, metal scraps (nails, pipes) and glass bottles are present in very small quantities. Local scrap dealers recover these; they are a minor fraction of volume.

- **Inert/Construction Debris:** Occasional building waste (broken bricks, concrete fragments) can appear during local construction or renovation, but this is not collected routinely by Gangni Paurashava.

- **Hazardous/Medical Waste:** A small part of the waste is hazardous: used needles, bandages and pathology waste from the Upazila Health Complex and local clinics, plus containers of pesticides or solvents. These are a tiny fraction of the total but require special handling and should be kept separate from normal trash (see Section 2.8).

Overall, Gangni's waste profile – very high organic content with modest plastic and little else matches patterns seen in similar Bangladeshi towns.

2.3 Solid Waste Management (SWM) Practices in Gangni

2.4 Recycling and Composting in Gangni

Gangni already has an informal recycling network. Local scrap dealers (kabalis) routinely collect recyclables from households or purchase them from itinerant waste pickers. Plastic bags, bottles, cardboard and metal cans are separated and sold onward. Waste pickers on the streets recover glass and metal whenever possible. This informal system diverts some value from the waste stream, but it's haphazard and yields little public benefit. A more organized approach could help. For example, the municipality could place color-coded bins at the market for plastics and paper, which scrap dealers could empty on schedule.

The **composting potential** in Gangni is high. With most waste being biodegradable, community composting projects could flourish. Gangni's main market likely discards hundreds of kilograms of vegetable waste each day. If the Paurashava or a farmers' cooperative collected this material and composted it (using simple methods or small drums), they could produce organic fertilizer for local use. Such models have worked elsewhere: Bangladeshi NGOs like Waste Concern have shown that small neighborhood compost plants can safely turn wet waste into useful compost. Gangni's government could pilot a farm compost site, perhaps run jointly by market vendors, demonstrating how waste becomes an agricultural input. Over time, this would reduce the burden on the dumping ground and engage citizens in sustainable waste practices.

2.5 Hazardous Waste

Although relatively uncommon in quantity, hazardous wastes in Gangni pose serious risks if mishandled. Key sources include the Upazila Health Complex and private clinics (which generate medical waste such as needles, blood-stained gauze and surgical sharps) and small businesses (waste oil from auto shops, chemical solvents, fluorescent lamps). Farmers around Gangni may also bring empty pesticide containers into town as municipal garbage. These items must not mix with regular trash. For example, if sharp needles or infectious bandages end up in a mixed dump, they endanger waste handlers and scavengers. Likewise, toxic liquids or pesticide residues can contaminate soil and water. Studies in Bangladesh have found that waste workers at dumpsites suffer health problems from exposure to medical and chemical wastes. To protect public health, Gangni should require clinics to use puncture-proof sharps bins and arrange for safe disposal (ideally via the Upazila Health Complex's own waste system). Pesticide containers should be triple-

rinsed and kept separate; the municipality could work with agricultural extension services to collect these safely. In summary, recognizing these hazards and keeping such materials out of the open dump is essential to prevent injuries and pollution.

2.6 Legal Framework for SWM

Gangni's SWM is governed by a cascade of laws and rules. At the top are national policies and environmental laws:

- **Paurashava Act 2009** (updated municipal law) – charges municipalities with public health, conservancy and sanitation duties, which include solid waste collection and disposal.
- **Environment Conservation Act 1995 (amended)** – provides the basis for pollution control. Under this Act the government has promulgated specific rules on waste: the **Waste Management Rules 2021** (which cover SWM broadly), **Medical Waste Management Rules 2008**, and **Hazardous Waste Rules (Shipbreaking) 2011**.
- **Solid Waste Management Rules, 2021** – issued by the Ministry of LGRD/Environment, these rules mandate the 3R strategy (reduce/reuse/recycle) and even introduce Extended Producer Responsibility for plastics and packagingsdgs.un.org. The rules require municipalities to provide SWM services and encourage source-segregation and waste minimization.
- **Mandatory Jute Packaging Act 2010** – legally requires certain agricultural and food products to use jute (biodegradable) packaging, thereby reducing plastic bag use.
- **City Corporation Acts** similarly assign waste management duties to the larger city governments (though less relevant to a small pourashava like Gangni).
- **Local Bylaws:** Paurashavas often issue their own bye-laws (under the Paurashava Act) to regulate garbage collection, fees, and dumping sites.

Together, these laws form a framework: SWM is a municipal obligation by law, and national policies push 3R and safe disposal. (For example, the government specifically notes that Bangladesh's SWM Rules 2021 include provisions on waste segregation, recycling targets and accountability, and it was the first time Extended Producer Responsibility was included in Bangladeshi lawsdgs.un.org.) Gangni Paurashava must operate within this legal context, applying relevant sections (for instance, by requiring landlords to provide bins and paying user fees, enforcing no-dumping regulations, etc.).

Legally, Gangni Paurashava has clear authority and responsibilities. The Local Government (Paurashava) Act (2009) lists **waste removal and collection** as a mandatory municipal duty. Under this Act, Gangni's council can also levy sanitation fees (sometimes called "poura tax") on residents and businesses to pay for waste services. Nationally, Bangladesh has several regulations relevant to SWM. The Solid Waste Management Rules 2021, for example, require local governments to provide waste collection, encourage source segregation, and introduce extended-producer-responsibility for plastic and e-waste. There are also

general provisions under the Environment Conservation Act (1995) that classify certain medical and chemical wastes as hazardous.

In practice, however, Gangni's use of these legal powers is limited. The Paurashava has not yet passed strong local bylaws on waste or begun charging dedicated waste fees. Enforcement is weak: dumping fines exist on paper but are rarely imposed. Mandatory segregation rules (from 2021) are not enforced at the household level, so all waste is mixed in practice. In effect, while Gangni has the legal authority to manage SWM, the institutional capacity to enact and enforce rules is still lacking. This gap means many of the regulations designed to protect health and environment remain aspirations rather than realities.

Chapter 3: Present Situation of SWM in Gangni Paurashava

Consultants and survey teams had gone through a holistic approach with much deliberation, analyzed the main issues of the study background and identified the construction of the hypothesis to collect data from households, commercials, industries and medicals. Based on this analysis, the team had proposed a methodology for conducting the study, which covers the description of hypothesis, variables, study models, sampling methods, sample size, indicators for data collection, etc.

3.1 Existing Problems of Solid Waste Management in Gangni

- **Open dumping:** Residents commonly dispose of garbage in roadside drains, vacant lots or around open pits instead of sealed bins. These unsanitary dumps clog waterways and attract pests.

Figure 3: Open dumping place in Gangni

- **Insufficient bins:** Gangni has very few public trash bins. 250 Large roadside and institutional bins, 150 Additional allocated bins, Household-level bins cover only 15% (limited to some houses and schools). Thus, existing bins overflow daily, forcing people to leave trash beside them or on the street.

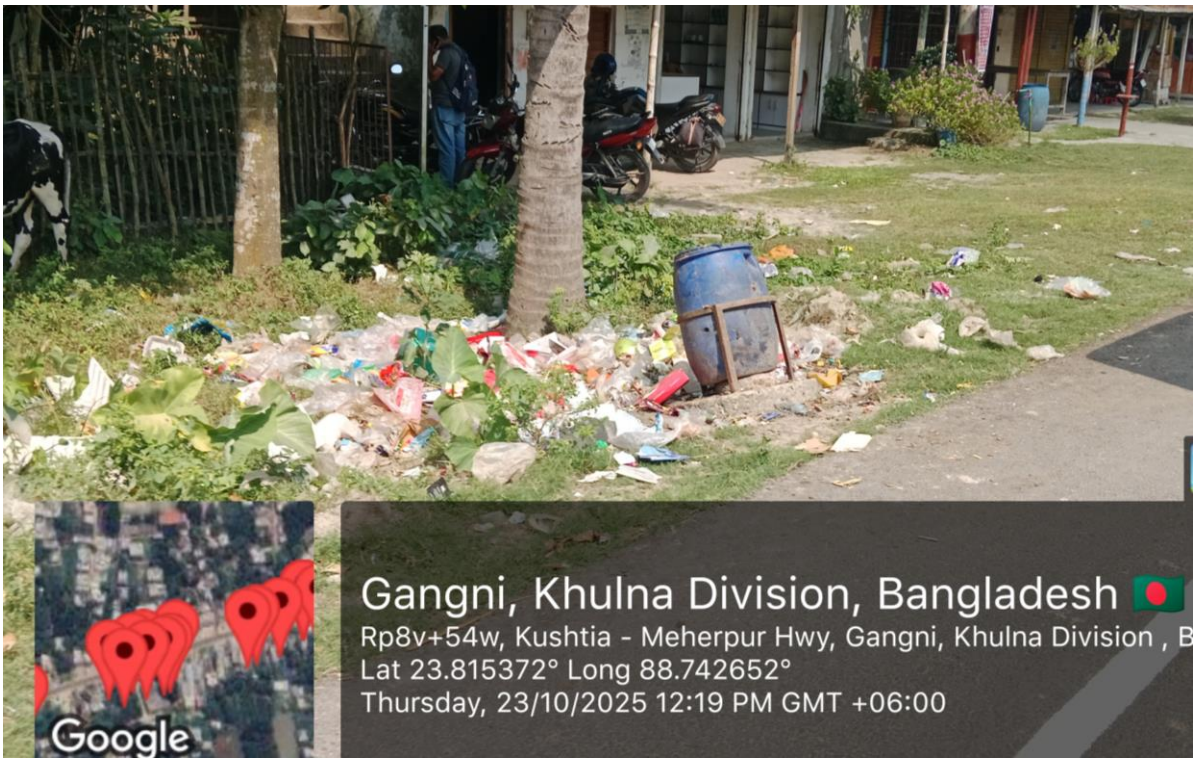

Figure 4: Trash overflow scenario in Gangni

- **Burning of garbage:** Especially during cooler months, households and vendors often burn mixed waste to clear it. This generates toxic smoke and pollutants.
- **Poor service coverage:** Collection routes miss many neighborhoods. Narrow or unpaved lanes are skipped, leaving areas of the town without service.
- **Limited equipment:** The Paurashava has only a few carts and 2 Trucks, 9 Vans, 5 Three-wheelers so it cannot run frequent pickups. No compactors or modern collection vehicles are available.
- **No segregation:** Households do not separate kitchen waste from recyclables. All materials go into a single pile, making recycling or composting difficult.
- **Funding and management gaps:** The Paurashava' s budget for SWM is small. Equipment is often in disrepair and personnel are few. Without more resources and trained staff, the system cannot improve.
- **Lack of public awareness:** Many people in Gangni are unaware of proper disposal methods or the impacts of littering. Throwing garbage on roads is still common practice.

Figure 5: Scenario of throwing garbage outside the bin in Gangni

- **Health hazards:** Waste workers and the public face risks from exposed trash (sharp objects, contaminated materials). Mosquitoes and rodents breed in stagnating garbage, spreading disease.

Figure 6: Potential Health Hazard in Gangni

These on-the-ground problems – open dumping, limited bins, waste burning, patchy coverage, and low awareness – combine to make solid waste a visible nuisance and health issue in Gangni. Addressing them will require targeted investments (more bins and vehicles), strict enforcement of sanitation rules, and education campaigns to change behavior.

3.1 Overall Waste Generation by Source in Gangni Paurashava

Gangni generates roughly 4.5–5 tons of municipal solid waste per day, about 2 t/d from households and 2.5 t/d from marketplaces – with a very high organic content. Field surveys indicate that 60–70% of this waste is biodegradable kitchen and market waste (e.g. food scraps, plant matter), similar to other small Bangladeshi towns.

Table 1: Composition of Household Waste

Waste Type	Estimated Share (%)	Typical Sources & Examples
Organic	60–70%	Kitchen scraps, vegetables, leaves, rice, fish bones
Inorganic (non-bio)	20–25%	Plastic, polythene, bottles, paper, textiles
Hazardous	2–3%	Batteries, expired medicines, mosquito coils
Sanitary/Liquid	5–10%	Wastewater from kitchens, toilets, wash areas

The remainder includes plastics, paper, textiles and other materials in small proportions. In practice there is almost no source segregation: mixed waste is disposed together. This reflects a national pattern where recent regulations (e.g. Solid Waste Management Rules 2021) do mandate household separation of waste, but implementation remains extremely weak. As a result, recyclables are not routinely separated and mixed wastes (often still wet) dominate the stream.

Table 2: Waste Generation by Source in Gangni Paurashava

Waste Source	Estimated Daily Generation (tons/day)	Notes
Households	2.0	Mostly organic waste
Marketplaces	2.5	Includes vegetable, fish, meat waste
Industrial Areas	0.0	No industrial waste reported
Agricultural Waste	Mixed with other waste	Not separately recorded
Roads/Drains	Occasionally collected	Much of it ends up in canals via drains

3.2 Waste collection and transportation

Gangni's collection system is basic and under-resourced. A limited number of roadside bins or drums are scattered in main streets and markets, but many neighborhoods lack any covered container. Households and shopkeepers typically bring waste bags to the nearest public bin or pile them by the roadside at predetermined collection points. Municipal staff then use a small fleet of open trucks and vans to gather the waste by hand. (Exact numbers are not large – the town reportedly operates only a few collection vehicles, several of which are old and sometimes out of service.) Formal collection covers perhaps only 40–50% of the total waste, consistent with national averages. The rest of the refuse is often left on site, dumped in vacant lots or drains, or burned in situ. There are **no secondary transfer stations** in Gangni; garbage is loaded into trucks directly at the collection points and hauled straight to the disposal site. This limited infrastructure – few bins, a handful of ageing trucks, and no intermediate transfer point – makes the collection service unreliable and spatially patchy.

3.2.1 Primary Collection of Solid Waste

Primary collection in Gangni involves the gathering of waste from roadside drums or informal piles placed by households, markets, and shops. Currently:

- Collection is done manually by municipal workers.

- Waste is gathered using open-bed trucks (2–3 operational), three-wheelers, and vans.
- Households dispose of waste in roadside drums or in open spaces; only about 15% have access to any kind of bin.
- There is **no formal door-to-door collection** or household bin distribution yet, although future plans suggest a 3-bin system (biodegradable, non-biodegradable, and medical).

Public participation is weak. The absence of educational campaigns and bin infrastructure further reduces efficiency. Organic and inorganic wastes are collected together, limiting any scope for processing or recycling downstream.

3.1.2 Secondary Transfer Station (STS)

Currently, Gangni Paurashava has **no Secondary Transfer Station (STS)** infrastructure.

- All waste collected from roadsides is directly hauled to the final disposal site at Morghati.
- This direct haul system is inefficient, especially for distant or densely populated wards.
- The absence of an STS means longer haul times, more wear on limited vehicles, and operational delays.
- The Masterplan identifies the need for one or more STSs to serve as consolidation points, reduce fuel costs, and streamline waste flow.

Implementing STSs could significantly improve route efficiency, allow for partial sorting, and reduce strain on the existing collection fleet.

3.3 Waste treatment and disposal

Gangni currently **lacks an engineered landfill** or modern disposal facility. The town uses an open dumpsite on its fringe (location: on low-lying municipal land north of the urban area) where garbage is heaped and periodically covered. This site has no liner or leachate controls, mirroring the situation in most Bangladeshi towns. As part of the Masterplan, a new landfill is planned at [proposed site on the southeast outskirts] with basic sanitary design (separate cell, minimal lining). Details such as capacity and design are not yet finalized, but the move to a dedicated waste cell should reduce open dumping.

In addition, a **Fecal Sludge Treatment Plant (FSTP)** is under construction to handle septage from on-site latrines and septic tanks. The FSTP (located at [komalapur site or other identified site]) is designed to treat municipal sewage sludge; its capacity is sized to Gangni's population (on the order of several hundred cubic meters per day). Construction is underway (estimated ~50–60% complete), with commissioning expected in the next 1–2 years. Once operational, the FSTP will provide biological treatment for sewage solids, producing treated effluent and compost; however, its success will depend on keeping solid waste and non-septic effluent out of the system.

3.4 Existing infrastructure and facilities

The town's waste infrastructure is modest. **Collection vehicles:** Gangni has only a few open-bed trucks or vans (some 2–4 units) for waste pickup. Many of these are over 10 years old, with mechanical issues and limited hauling capacity. No separate vehicles exist for recyclable materials. **Bins and drums:** Public waste bins are scarce and unevenly distributed. A survey found roadside drums only in the busiest markets and central wards; most residential streets have none. Without secondary sorting stations, recyclables are left mixed with trash. **Wastewater/drainage:** There is no integrated sewer system; liquid waste from sinks and drains flows into open channels or rivers. Gangni's stormwater drainage is limited to a few natural khals (canals) and some uncovered drains. Crucially, the solid waste and drainage systems are not linked: garbage is not generally conveyed by drains, but indiscriminate dumping has blocked many small khals. During rains, plastic and organic waste commonly clog the drainage network, worsening urban flooding.

Public toilets exist in major markets and the bus terminal, but there is no formal city-wide septic suction service; septage is manually emptied (often unsafely) until the FSTP comes online.

Table 3: Existing Waste Collection Infrastructure

Component	Quantity/Status	Remarks
Municipal Garbage Trucks	5 total (3 operational)	2 of 2–2.5 tons, 1 of 1.5 tons
Covered Vans	7 (not in use)	Functional but not deployed
Three-Wheelers & Vans	14 approx.	Used in narrow lanes
Roadside Bins/Drums	Limited, sparse distribution	Only in key market/central areas
Secondary Transfer Stations	None	Direct dumping from drums to disposal site
FSTP (under construction)	~50–60% complete	Planned for septage treatment
Landfill (planned)	Basic layout, site identified	No engineered cell built yet

3.5 Community behavior and institutional constraints

Residents generally show limited awareness of formal waste separation. In focus-group feedback, many villagers noted that no color-coded bins or bags were provided, and that neither households nor shops segregated their rubbish. In line with national trends, garbage is often thrown into street drains or open areas rather than deposited in bins. This communal behavior – together with low public awareness – contributes to littering and drain blockage. The local population has requested improvements: suggestions include provision of household bins, community composting training, and stricter enforcement against dumping.

On the municipal side, Gangni's Paurashava is constrained by budget and manpower. Waste management falls under the Public Health Engineer and a few sanitary inspectors, but there is no full-time waste department. Officials acknowledge the need for more vehicles, bins, and personal protective equipment. Funding is tight and solid waste is one of many competing priorities. Coordination between drainage maintenance and waste collection is weak, so clogged drains often go unaddressed. In sum, institutional capacity is limited by lack of equipment (trucks, bins, segregation tools) and weak public outreach – reflecting a common situation where national rules on 3R (reduce-reuse-recycle) have outpaced local implementation.

Table 4: Key Institutional and Community Challenges

Category	Description
Public Awareness	Low; no color-coded bins, source separation not practiced
Community Behavior	Common dumping in drains or roadsides; little compliance with proper disposal norms
Institutional Limitations	Few dedicated staff; no formal waste management department
Budget Constraints	Funding shortfalls affect operations and equipment procurement
Infrastructure Gaps	No transfer stations, few bins, aging trucks, no medical waste treatment machinery
Drainage-Waste Linkage	Poor coordination; solid waste regularly clogs stormwater drains

3.6 Stakeholders of Solid Waste Management of Gangni Paurashava

The effectiveness of solid waste management (SWM) in Gangni Paurashava depends on the coordination and contribution of multiple stakeholder groups. Each plays a distinct role across various stages of the waste management chain from generation to final disposal.

Table 5: Stakeholders of Solid Waste Management of Gangni Paurashava

Stakeholder Group	Role in SWM
Municipality (Pourashava)	Core responsibility for collection, transportation, and disposal
Public Health Engineering Dept.	Technical support for drainage and sanitation
Households	Primary waste generators; minimal source segregation
Shopkeepers & Market Vendors	Contribute significantly to daily waste, especially organic
Van Drivers & Sweepers	Frontline collection and street cleaning
NGOs (e.g., Basha Foundation)	Limited-scale involvement in awareness and waste handling
Donors (e.g., ADB, WB)	Infrastructure funding support (vehicles, drainage)

3.7 Existing Bins Coverage in Gangni Paurashava

Gangni Paurashava currently operates **265 public waste bins**, distributed across the nine wards in varying densities. The service-area coverage map (50 m, 75 m, and 100 m buffers) shows that these bins provide reasonably good accessibility in the central commercial belt but leave substantial gaps in peripheral and semi-urban neighborhoods.

The largest concentration of the 265 bins is found across Wards **04, 05, 06, and 08**, which collectively form the municipality's commercial and institutional core. In these wards, the 50–100-meter coverage rings from individual bins overlap extensively, creating a continuous service zone where nearly every household or shop can access a bin within a short walking distance. This dense clustering reflects the municipality's focus on high-waste-generating zones—markets, transport corridors, schools, and business areas—where daily waste production is significantly higher.

However, despite having 265 bins overall, the map clearly reveals **coverage inequity**. Wards **01, 02, 03, 07, and the southern portions of Ward 09** have visibly fewer bins. Their settlements fall largely outside the 100-meter service buffers. These underserved zones include low-income colonies, scattered homesteads, mixed agricultural–residential patches, and unplanned horizontal expansions along narrow lanes. Residents in these areas often resort to:

- informal roadside dumping,
- using vacant plots or canal edges as disposal points, and
- throwing waste into drains due to the absence of nearby bins.

This mismatch between bin distribution and settlement density reduces collection efficiency. Collection vans frequently encounter small, unorganized waste piles rather than formal bin points, resulting in longer route times and mixed waste that is harder to process later.

Even with a total stock of **265 bins**, the current spatial pattern is *center-heavy but perimeter-weak*. The central wards enjoy strong spatial coverage, while peripheral wards still lack an adequate number of formal disposal points. These gaps align with the municipality's earlier pattern of placing bins mainly on accessible paved roads, leaving narrow or semi-rural lanes unserved.

In essence, the existing 265-bin network performs well in the urban core but fails to ensure municipality-wide access. The findings highlight the need for a rebalanced bin placement strategy—redistributing or adding bins in outer wards, introducing community-level drums where road width is limited, and integrating bin placement with future route optimization and door-to-door collection plans. Strengthening coverage in these underserved areas will be critical for reducing informal dumping, protecting drainage lines from blockage, and moving Gangni toward a more equitable and efficient solid waste management system.

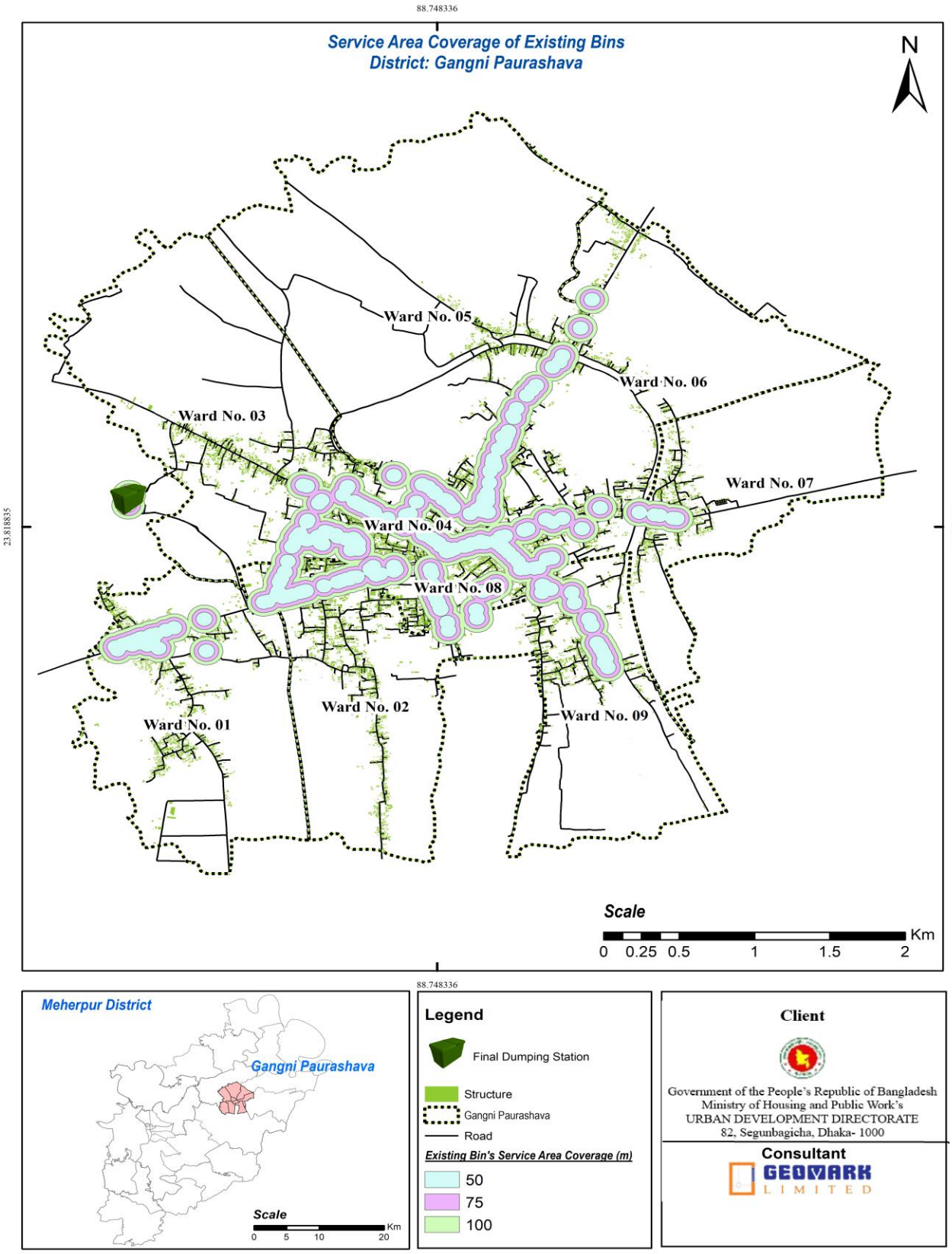

Figure 7: Service Area Coverage of Existing Bins

Chapter 4: Proposal of Future Waste Management Initiatives

4.1 Physical Initiatives to tackle waste management challenges

4.1.1 Bin Placement for the easy access for the public use

Gangni's waste collection currently lacks sufficient public bin infrastructure, especially in residential neighborhoods and low-income areas. Only a limited number of large roadside drums exist in central wards and markets, leading to widespread open dumping in areas where formal collection points are missing. To address this, the Paurashava proposes:

- **Strategic placement of durable public bins** at high-traffic locations such as ward junctions, bus terminals, and marketplaces to ensure cleaner public spaces and reduce indiscriminate dumping.
- **Deployment of community collection drums** in slum settlements and peripheral wards where door-to-door collection is unfeasible due to narrow lanes or scattered dwellings.
- **Use of standard-design bins** that are compatible with existing collection vehicles and can be easily relocated or replaced when needed.

While a 3-bin system has been recommended by the district administration, the current Masterplan recognizes that **practical segregation at the household level is not yet feasible** due to low awareness, inconsistent collection, and lack of enforcement. Therefore, **waste will continue to be collected in mixed form** and transported to the disposal site. To compensate, **segregation will be carried out at the landfill zone**, where organic, recyclable, and hazardous materials will be separated manually or mechanically prior to final processing or burial. The bin placement initiative thus serves as a logistical improvement for cleaner public spaces—not as a primary tool for waste sorting at the source.

This approach balances operational realities with incremental improvements, laying the groundwork for future adoption of source segregation once infrastructure and public behavior have matured.

Applying the **WHO standard** of one bin every 50–100 meters, combined with a location-allocation analysis, the Masterplan identifies **250 new bin** locations that directly target both unserved and underserved neighborhoods of Gangni Paurashava. The model prioritizes zones where bin access was previously absent or insufficient, ensuring that residents no longer need to rely on open dumping or distant disposal points. By strategically expanding coverage into these critical gaps, the Paurashava can improve daily waste-collection efficiency, reduce environmental nuisance, and move toward a more equitable and accessible urban waste-management system.

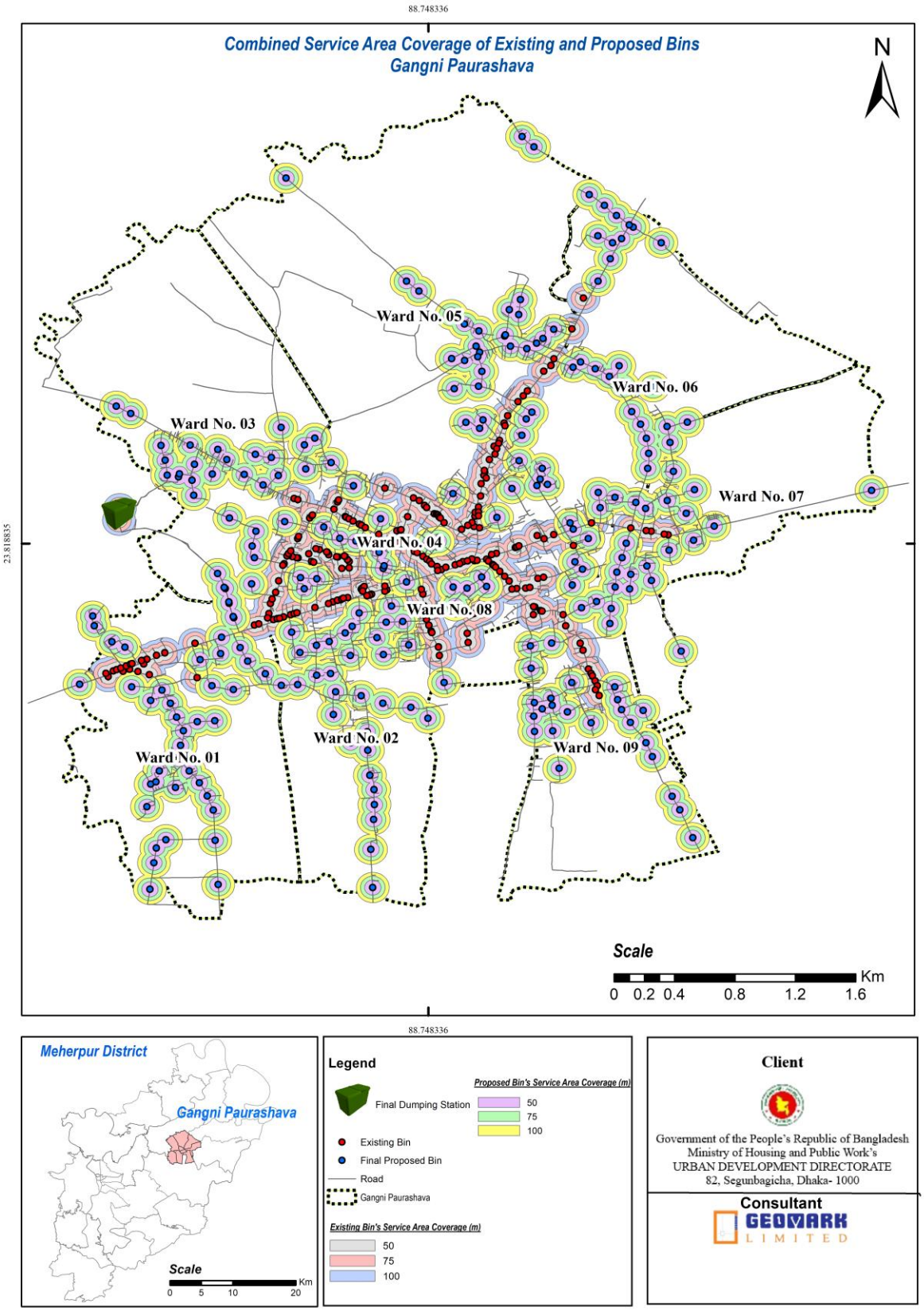

Figure 8: Bin assignment for the underserved and unserved areas

Table 3: Ward Based Proposed Bin

Ward No.	Bin Number
1	39
2	32
3	38
4	11
5	30
6	40
7	22
8	9
9	29

4.1.2 Proposal for a Secondary Transfer Station (STS)

Currently, all municipal waste in Gangni is collected manually from roadside drums and transported directly to the disposal site at Morghati. The absence of a Secondary Transfer Station (STS) leads to:

- Long-haul trips for collection vehicles,
- Inefficient fuel use,
- Higher vehicle wear and tear, and
- Reduced coverage in outlying wards.

To streamline operations, a dedicated **five Secondary Transfer Stations (STS)** across Gangni Paurashava represents a major structural improvement in municipal waste logistics. At present, waste collected from roadside bins and drums must be transported directly to the final disposal site at Morghati using small vans, three-wheelers, and manual carts. This one-stage system results in long haul distances, high fuel costs, operational inefficiency, and reduced service coverage. In line with global best practices and **WHO recommendations**, small primary-collection vehicles should not travel long distances to disposal sites; instead, waste should be consolidated at strategically located STSs before being transferred by larger trucks. WHO notes that secondary transfer points reduce travel time and support more reliable daily collection in urban areas.

To determine the most suitable locations for STSs, a detailed **service-area analysis was conducted using the New Service Area Tool under the ArcGIS Network Analyst extension**. This tool allowed accurate modelling of accessibility along the real road network rather than simple Euclidean buffers. Three service-distances: **500 m, 1500 m, and 2500 m**, were selected based on **WHO** guidance and international benchmarks for waste transport efficiency. The resulting map provides a clear picture of how the five proposed STSs collectively extend coverage across all nine wards that will serve as a consolidation point for primary collection loads,

- Enable intermediate sorting and temporary storage,
- Facilitate scheduled transfer using larger capacity trucks to the final landfill.

This step is crucial for reducing operational delays, increasing route efficiency, and enabling partial separation of waste streams before final disposal.

4.1.2.1 Service Area Coverage – Proposed STS

The map illustrates three service-distance categories generated from the network model:

1. 0–500 m Catchment (Light Yellow)

This zone includes areas that can reach an STS within 500 meters of road distance.

- It reflects the **primary collection efficiency zone**, where pushcarts, rickshaw vans, handcarts, and small three-wheelers can reach the STS with minimal effort.

- According to WHO's urban waste logistics guidance, primary collection becomes inefficient beyond **300–500 m**, as manual transport becomes physically burdensome and time-consuming.
- In Gangni, this band mostly covers the dense inner cores of Wards 04, 05, 06, and 08 where settlement density and waste generation are highest.

2. 501–1500 m Catchment (Light Green)

This middle-distance service area represents neighborhoods requiring moderate travel distance by waste vehicles.

- WHO indicates that **feeder routes** and semi-mechanized vehicles maintain efficiency up to about **1–1.5 km** before needing a consolidation point.
- This zone covers large sections of Wards 01, 02, 03, 06, 08, and 09—ensuring that even moderately distant households and commercial strips can feed waste into the nearest STS smoothly.

3. 1501–2500 m Catchment (Blue Zone)

The outer band shows the **extended service reach** of each STS.

- WHO notes that secondary transport remains efficient up to **2–3 km** if waste is first consolidated at a local STS instead of being hauled directly to a landfill.
- These zones cover fringe and semi-urban areas in Wards 01, 03, 07, and 09—places previously underserved due to long distances to Morghati disposal site.

The **five STS locations** have been placed in such a way that their network-based service areas together cover the entire Paurashava boundary. Overlaps between STS service zones demonstrate redundancy and reliability, ensuring that if access to one STS is blocked or crowded, an alternative exists within a reasonable distance. The STS in Ward 03 serves the western expansion areas, the STS in Ward 01 covers southern peri-urban zones, and the STS near Wards 06 and 07 extends coverage toward the eastern and northeast growth corridors. The central STS near Ward 08 acts as a **hub** supporting the busiest commercial and institutional core.

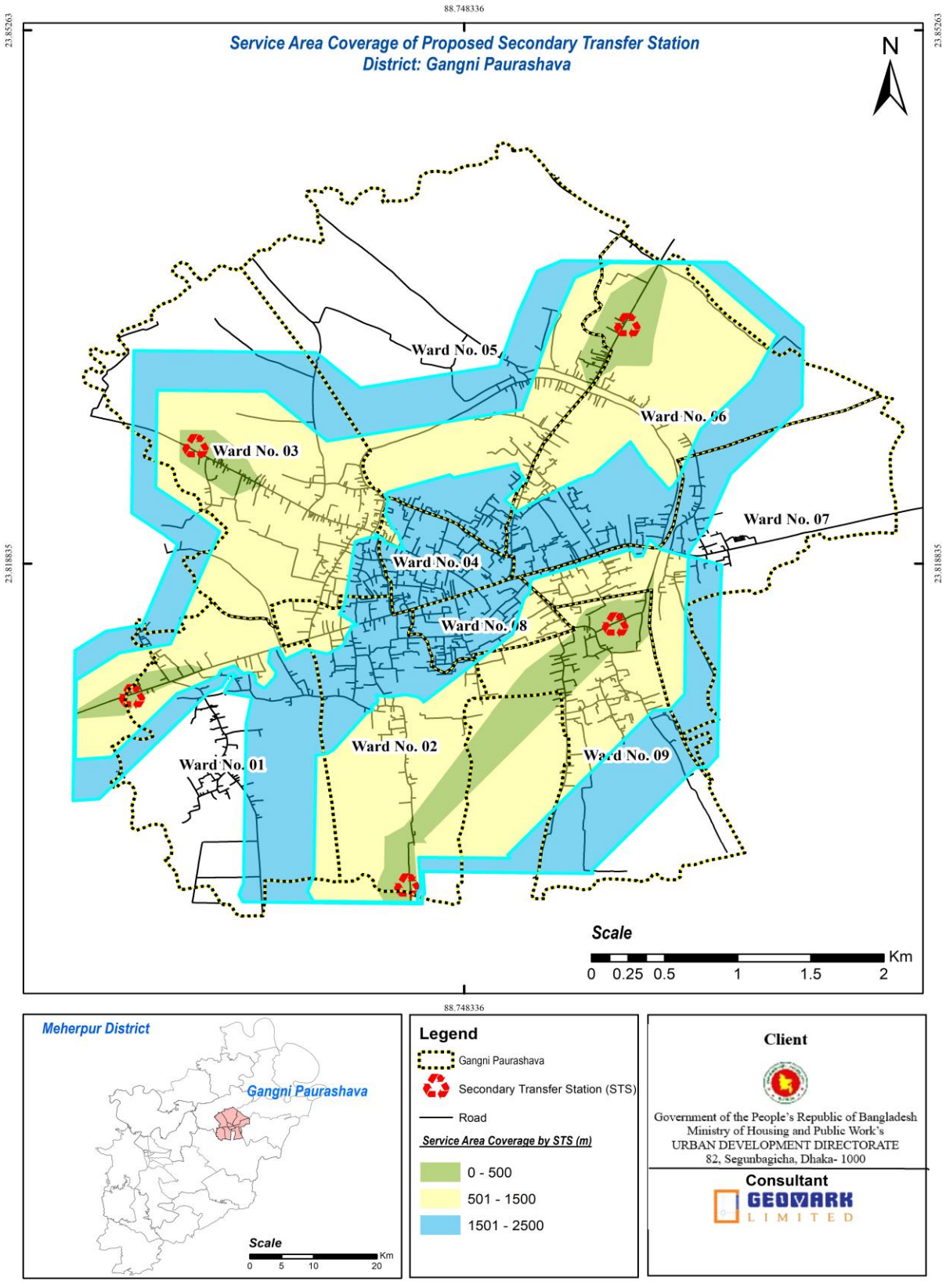

Figure 9: Service Area Coverage of Proposed STSs

Purpose & Benefits of Introducing 5 STSs

1. Reducing Long-Haul Trips

Currently, all waste is directly hauled to Morghati disposal site, multiplying travel time and fuel consumption. Network analysis clearly shows that large parts of the town lie more than 2 km away—well beyond practical direct-haul limits.

2. Improving Efficiency and Fuel Use

WHO stresses that STS systems significantly reduce transport cost by minimizing the distance small vehicles must travel before offloading waste and returning to their routes.

3. Extending Service Coverage to Outer Wards

Peripheral wards—previously underserved due to distance—now fall inside the 500–2500 m network catchments, ensuring citywide waste access.

4. Strengthening Waste Segregation & Interim Storage

Each STS will allow:

- temporary storage,
- initial sorting,
- separation of recyclables and organics,
- and safe handling of municipal waste before final transport.

5. Supporting Scheduled Bulk Transfer

With STSs functioning as consolidation nodes, larger trucks can transport waste to Morghati on fixed schedules—consistent with WHO's recommended multi-tier collection model.

4.1.3 Procurement and Use of Covered Trucks

Currently, Gangni Municipality relies on a limited fleet of uncovered open-bed trucks and three-wheelers for waste collection and transport. Although 7 covered vans are technically functional, they remain unused, primarily due to operational issues such as lack of trained drivers, inadequate route planning, or administrative constraints.

To address this, the following actions are proposed:

- Immediate deployment of the 7 existing covered vans by resolving logistical and staffing gaps. These vehicles can be prioritized for waste transport in densely populated or sensitive areas (e.g. near schools, markets, and health centers) where hygiene and odor control are critical.
- Development of standard operating procedures (SOPs) for the regular use and maintenance of these vans.
- Training programs for drivers and waste handlers focused on handling covered vehicles and minimizing in-transit waste spillage.
- Long-term procurement of additional hydraulic compactor trucks, especially for high-volume waste zones, to replace aging uncovered trucks and improve waste handling efficiency.

Activating the idle covered vans will significantly enhance transportation hygiene, reduce roadside litter during hauling, and align with national standards on secure waste movement. It's a low-cost, high-impact improvement that can be implemented rapidly with minimal capital investment.

4.1.3 Arrangement for Segregation in Landfill Zone

Currently, waste disposal at Morghati occurs without segregation organic, inorganic, and hazardous materials are dumped together, undermining the environmental viability of the landfill and limiting future resource recovery options.

To address this, the following measures are proposed within the landfill zone:

- Construction of **segregation sheds** where waste can be manually sorted before final burial.
- Installation of **sorting platforms** with conveyor systems for separating recyclables from organic waste.
- Designation of specific cells within the landfill for different waste streams (organic, medical, plastic).
- Allocation of space for **future composting units** or small-scale Material Recovery Facilities (MRFs).

Integrating these features within the landfill compound will support both immediate operational improvements and long-term sustainability through potential reuse, composting, or recycling initiatives.

4.2 Action Plan for Sustainable Solid Waste Management in Gangni Paurashava

Gangni Paurashava faces the same waste-management pressures as other rapidly urbanizing areas of Bangladesh: rising waste volumes (now ~25–30 thousand tonnes per day nationally) with only a fraction collected by municipal services. In fact, Bangladesh's urban authorities formally collect only about 45–50% of generated waste. The remainder is often dumped in drains, open fields or waterways, causing flooding, pollution and public-health hazards. Moreover, studies find that ~82% of households dispose of all waste (organic, recyclable, and other) together, with virtually no source segregation. This integrated plan aims to close these gaps in Gangni by

- Expanding collection coverage
- Instituting source-separated pickup
- Building community awareness
- Piloting refuse-derived fuel (RDF) processing
- Securing sustainable financing, and
- Creating a clear waste-flow pathway. The goal is to transform Gangni' s system into an inclusive, circular model (similar to Waste Concern's Integrated Resource Recovery Center concept where 85–90% of waste can become resources).

4.2.1 Expand Collection Coverage and Infrastructure

Currently Gangni's outskirts and low-access areas are under-served. Many neighborhoods lack any formal collection, so waste accumulates in yards, drains or open dumps. To achieve **universal coverage** the municipality will:

- **Deploy additional vehicles:** Allocate dedicated 3-wheel tricycles and compact trucks to new wards and remote zones. Assign these vehicles to collect both household and market waste so no area is missed.
- **Optimize routes and schedules:** Develop ward-level schedules and GPS-assisted route plans to avoid overlaps and gaps. For example, GIS-based optimization (as used successfully in other Bangladeshi cities) can minimize travel time and ensure regular service.
- **Formalize collection service:** Contract or hire waste collectors for all zones. (Experience from Dhaka shows formalizing collectors under city oversight improves accountability.) The goal is that every street is reached daily or every few days.

Improving coverage will dramatically reduce illegal dumping in waterways and open spaces, directly addressing public-health and flood risks.

4.2.2 Implement Segregated Collection at Source

Gangni will shift to **source-separated** collection for major waste streams. Under this system:

- **Waste categories:** Households and institutions will separate *organic/food waste* (kitchen scraps, market leftovers, garden clippings) from *dry recyclables* (plastics, paper, metals) and *other waste* (textiles, small refuse).

- **Color-coded containers:** The municipality will distribute labeled bins or polybags (by color or symbol) for each category. For example, green bags for organic waste, blue for recyclables, etc. The first batch of containers/bags will be provided **free** as an incentive, following models in other Asian cities. This encourages compliance and clean sorting from the start.
- **Mandated by law:** This supports Bangladesh's 2021 Solid Waste Management Rules, which now require mandatory household segregation. Publicizing this regulation will reinforce the program.

By standardizing packaging and separation at the source, collection crews can handle waste more efficiently and direct each stream to the proper process. For example, clean organic material can go straight to composters, while mixed loads go to RDF. Community surveys show that without incentives or guidance, over 80% of residents mix all waste; providing the right tools and education is critical to change behavior.

4.2.3 Community Awareness and Environmental Education

Long-term success depends on public buy-in. Gangni will launch a multi-pronged education campaign to teach why proper waste management matters. Key activities include:

- **School Programs:** Integrate waste management and "3R" (Reduce, Reuse, Recycle) concepts into the local school curriculum. Organize student-led clean-up drives, poster competitions, and assemblies. Young people are effective messengers; empowering schools creates sustainability and peer influence.
- **Ward-level Focus Groups (FGDs):** Convene focus-group discussions in each ward with residents, business owners, and community leaders. In these sessions facilitators will explain the *environmental and health hazards* of poor waste practices (e.g., blocked drains causing urban flooding, decaying garbage emitting methane gas). Discussions will cover how diseases (dengue, cholera) spread from open waste, and teach practical 3R techniques. Participants learn their role in a cleaner Gangni, fostering civic responsibility.

These outreach efforts target the low awareness that studies identify as a major barrier. Without continuous education and incentives, households rarely segregate waste. By making the issues relatable (through school events and local dialogues), Gangni aims to change habits.

4.2.4 Resource Recovery: Composting and RDF Technology

The plan emphasizes turning waste into value, in line adding **5R** with Bangladesh's national **3R strategy**. Organic waste (the majority of Bangladeshi MSW) will be diverted to **composting**. A corner of the landfill site can host a simple compost facility (or community barrel composter sites), turning food scraps and yard waste into fertilizer for local farmers. This reduces landfill volume and cuts methane emissions.

For the non-organic, non-recyclable fraction, Gangni proposes to pilot a small **Refuse-Derived Fuel (RDF)** unit. In this process, shredded residual waste (mixed plastics, paper, light fabrics) is dried and pressed into fuel pellets. These RDF pellets can be used by nearby industries (e.g. brick kilns or cement factories) as a substitute for coal. Waste Concern's research indicates RDF made from plastics and paper can replace coal in kilns. Gangni would seek a partnership (possibly with Waste Concern or a private firm) to design and operate the RDF system under national guidelines.

Key aspects for the RDF component:

- **Supply:** Non-recyclable community and commercial waste is routed to the RDF plant instead of landfill. Agreements (MoUs) with local businesses and institutions ensure a steady waste stream.
- **Processing:** The plant will sort and shred the waste, remove inert materials, then pelletize the combustible fraction. (This is similar to MBT plants used internationally.)
- **End use:** The resulting fuel pellets, having a high calorific value, would be sold to energy-intensive consumers. For instance, the Bangladesh cement industry is already exploring RDF use to reduce coal dependency.
- **Economic viability:** Revenue comes from RDF sales and tipping fees charged to waste generators. Costs include machinery (shredders, dryers, pelletizers), labor, and utilities. A detailed business analysis (CAPEX/OPEX) will be conducted to ensure the plant's sustainability.

The RDF project must follow strict environmental controls. Any facility will adhere to DoE emission standards and operate under Waste Management Rules. By adopting proven technology (e.g. proven plastic-to-fuel incinerators) and conducting regular monitoring, Gangni can harness its waste for energy while minimizing pollution.

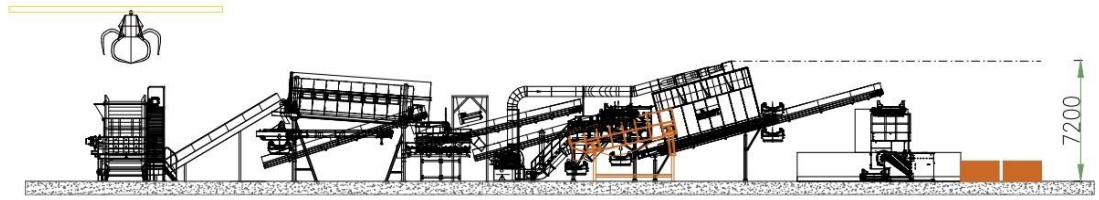

Table 4: Process of Waste Recycling

4.2.5 Route Proposal for the Waste Collection Trucks

The proposed waste collection routing system for Gangni Paurashava has been developed using the **New Vehicle Routing Problem (VRP) solver** within ArcGIS Network Analyst. Unlike simple service-area models, the VRP tool optimizes actual collection routes based on multiple real-world constraints—travel time, road network geometry, turning rules, vehicle capacity, and depot (STS) locations. As a result, the routes shown on the map represent the most efficient, implementable collection paths for municipal waste trucks and small primary collection vehicles.

The proposed waste transportation system divides Gangni Paurashava into five service routes, each assigned to a single truck operating between designated Secondary Transfer Stations (STS) and the Final Dumping Station (FDS). The routes are structured to ensure that all wards receive uninterrupted waste evacuation support on a daily basis.

Route 1: This route serves the southern part of the Paurashava, primarily covering **Ward No. 01 and Ward No. 02**. Waste collected at the STS located in the southern zone is transported directly to the FDS following the major access roads. This route ensures efficient coverage of the peripheral settlements that are far from the central urban area.

Route 2: Route 2 connects the central and eastern urban blocks. It covers significant portions of **Ward No. 04, Ward No. 08, and Ward No. 09**. Waste accumulated at the central STS points is evacuated through the main urban corridors, ensuring uninterrupted movement despite dense commercial activities.

Route 3: This route links the western STS with the central disposal network. It primarily serves **Ward No. 03 and Ward No. 04**. The route provides an important connection for waste generated in the western residential clusters, enabling timely transportation to the final disposal site.

Route 4: Route 4 is a shorter service corridor focused on **Ward No. 03**, particularly the dense residential neighborhood adjacent to the western STS. It functions as a supplementary transport line to manage the comparatively higher waste volume generated in this ward.

Route 5: Route 5 serves the northern and northeastern portion of the municipality, covering **Ward No. 05, Ward No. 06, and Ward No. 07**. Waste from these wards is collected at the nearest STS and transported along the main arterial road toward the FDS. This route secures proper connectivity for the wards that are spatially farther from the disposal site.

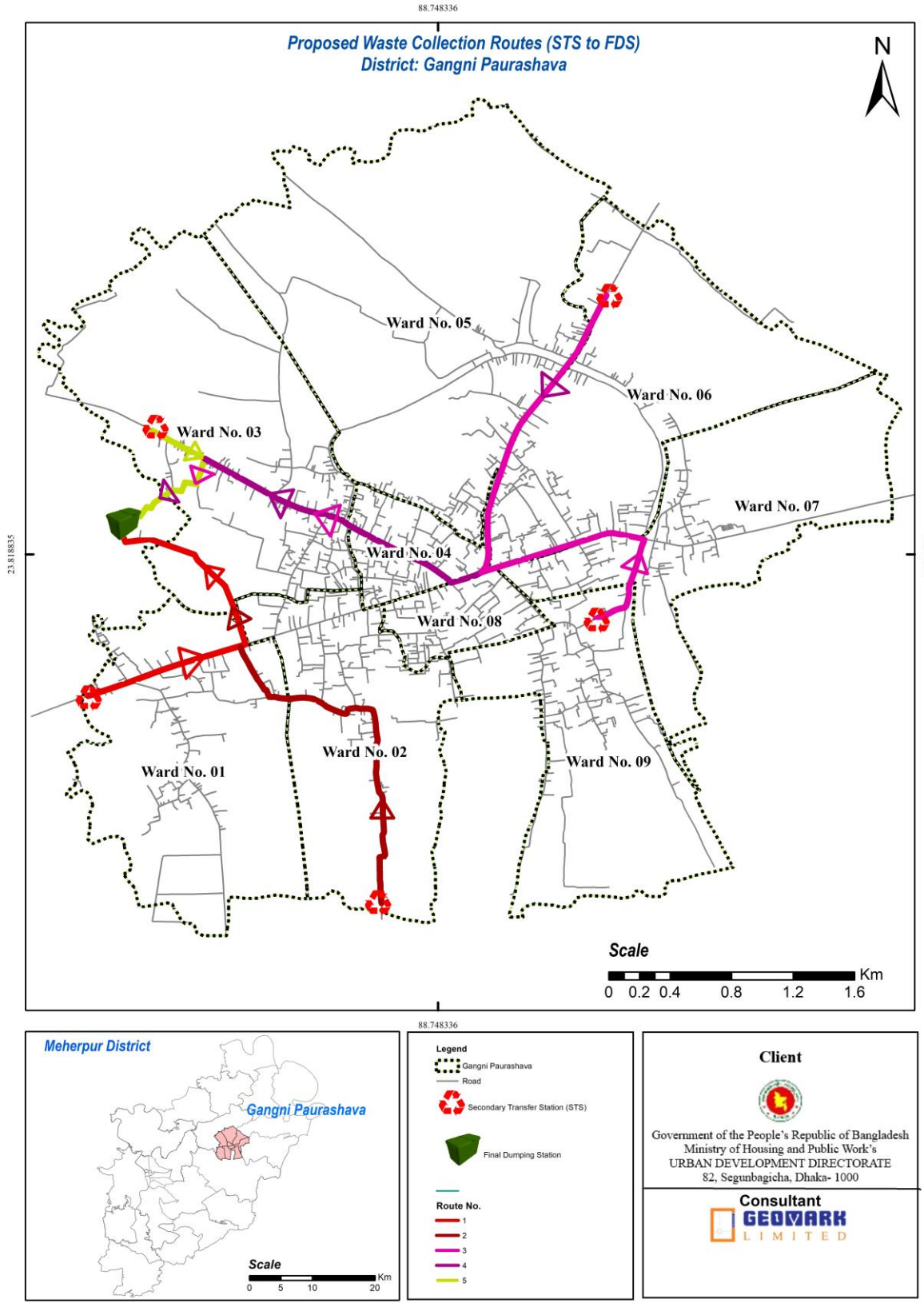

Figure 10: Proposed Waste Collection Route

4.2.5.3 Operational Benefits of the VRP-Based Route System

1. Minimizes Travel Time & Fuel

The VRP solver mathematically minimizes

✓ total distance,

✓ number of vehicle-hours, and

✓ total operating cost.

This significantly improves fuel efficiency and fleet productivity.

2. Reduces Overlap Between Trucks

Manual routing often creates redundant paths. The VRP automatically eliminates route overlap, ensuring that two vehicles do not cover the same street segment unless necessary.

3. Ensures Full Coverage

The model guarantees that every defined service point is visited—critical for equal service distribution across all nine wards.

4. Supports Daily Scheduling

VRP incorporates time-window logic. Even if the municipality later sets preferred collection hours, the VRP-based system can accommodate those constraints.

5. Aligns With STS-Based Collection Strategy

The routing structure validates the introduction of the 5 STSs by creating efficient waste flows from: **Household → Local Loop → Feeder Route → STS → Bulk Transport → Final Dumping Site**

4.2.6 Sustainable Financing and Governance

Financing this integrated system requires multiple sources:

- **Household collection fee:** Residents will pay a modest monthly fee for curbside pickup. For context, Dhaka city residents currently pay about Tk 100–300 (≈US$1–3) per household per month. Gangni can set an affordable rate (e.g. Tk 50–100) to cover part of operational costs. This user charge encourages households to value the service and helps fund collection staff and trucks.
- **Tipping fees:** A small fee at the landfill/RDF delivery point will be charged to commercial and institutional generators, aligning costs with waste quantity.
- **Government support:** National or district grants/subsidies can underwrite large capital expenses (e.g. vehicles, compost or RDF equipment, bins). The LGED and environment grants could fund the startup costs, as done in similar projects.
- **Public–Private Partnership (PPP):** The RDF plant (and possibly collection services) can be structured as a PPP. In this model, the municipality provides the land or facilities and regulatory support, while a private operator invests in and manages the plant. The private partner recoups

investment through future RDF sales. Such a PPP can speed deployment of technology without straining city finances.

- **Informal sector integration:** Local recyclers and waste-pickers will be integrated into the system. Sorted recyclable materials from Gangni can be sold to these entrepreneurs (who already recover 15–20% of recyclables informally). Organic waste could be partly managed by farmers or cooperatives (e.g. small farms buying compost). The plan encourages sharing a portion of profits or returns with these community stakeholders, creating incentives to keep waste streams clean.

Municipal governance will shift from service provider to coordinator/regulator. Gangni's role will be to allocate routes and waste streams, enforce segregation rules, collect fees, and monitor service contracts. As one study recommends, local government should **"strengthen policy enforcement, integrate the informal sector, and increase financial commitment"** in waste management. Gangni will implement such a framework, ensuring transparent budgeting (aiming beyond the current <1% of budgets for waste) and robust oversight of private contractors.

4.2.7 Integrated Waste Management Flow

A clear operational pathway will guide waste from generation to recovery. In practice, the flow will be:

- **Generation:** Segregated waste is placed at source by households, markets and institutions (organic vs. recyclables vs. residual).
- **Collection:** Dedicated vehicles (vans, tricycles) collect segregated streams according to a schedule. Organic bins and dry recyclables are picked up on different circuits.
- **Centralized Sorting Hub:** All collected material is brought to a central site (the municipal landfill or transfer station). Here, any mixed loads are manually sorted: organics are separated from plastics, metals, etc. The site will have designated areas for composting and material recovery.
- **Resource Streams:**
  - *Organics* go to the composting plant or community compost pits, turning into fertilizer.
  - *Recyclables* (paper, metal, certain plastics) are baled or crushed and sold to certified recyclers.
  - *Residuals* (non-recyclable plastics/textiles/paper) go to the RDF processing unit. If needed, very inert waste is landfilled.
- **Energy/Fuel Output:** The RDF unit processes residue into pellets, which are then shipped to industrial users (e.g. brick or cement factories) to be used as alternative fuel.
- **Monitoring and Feedback:** Throughout this chain, municipal officers monitor quantities at each stage. Data on waste volumes and compositions will be tracked to continuously improve operations.
- This integrated approach embodies principles of **circular economy**. According to Waste Concern's model, an IRRC (integrated resource recovery center) can convert **85–90% of incoming waste** into useful products (compost, biogas, recyclables, RDF). By following these best practices, Gangni will drastically reduce landfill disposal. As an example, countries with advanced systems recycle or recover most waste (Germany: >67% recovery) and incinerate the rest for energy (Japan: ~80% energy recovery). Gangni's plan is a scaled-down version of these integrated systems, suitable for a small municipality.

Chapter 5: Conclusion

Gangni Paurashava is at a critical turning point in its urban development trajectory. The assessment carried out in this Solid Waste Management Masterplan reveals a system that has been functioning under severe limitations—insufficient bin coverage, a one-stage direct-haul collection model, lack of segregation, aging vehicles, informal dumping practices, and wide service gaps across peripheral wards. These challenges are not unique to Gangni; they mirror the structural constraints of many small municipalities in Bangladesh. However, Gangni's compact urban form, engaged local community, and emerging institutional capacity create a strong foundation for systemic improvement.

The comprehensive spatial analysis conducted through GIS, service-area modeling, and network-based routing has clarified the municipality's most pressing needs and the most cost-effective pathways for intervention. The introduction of strategically placed public bins—prioritizing unserved and underserved neighborhoods—will significantly reduce informal dumping and improve public hygiene. The proposal for five well-distributed Secondary Transfer Stations marks a transition from an inefficient direct-haul system to a modern, multi-tier collection and transport framework. This approach aligns with WHO recommendations and global good practices, ensuring that primary collection vehicles operate within feasible distances and larger trucks handle long-haul movement to the disposal site.

Alongside physical improvements, the Masterplan outlines a broader strategy for institutional strengthening, community engagement, and resource recovery. The recommendations for source segregation, composting, and RDF processing reflect a gradual shift toward a circular waste-management model where waste is treated as a recoverable resource rather than a nuisance. Moreover, the optimized vehicle routes generated through ArcGIS Network Analyst provide a practical, implementable framework that ensures full municipal coverage while minimizing travel time, fuel use, and operational overlap.

This Masterplan does not claim to solve every challenge at once. Instead, it offers a phased, realistic roadmap tailored to Gangni's capacity, budget, and urban growth trends. Its success will require coordinated action—municipal leadership committed to enforcement and investment, community participation in responsible disposal practices, and consistent support from national agencies and development partners. The implementation of the proposed interventions, supported by clear operational guidelines and incremental capacity building, will enable Gangni Paurashava to deliver cleaner streets, healthier neighborhoods, and a more resilient urban environment.

In sum, the Solid Waste Management Masterplan provides Gangni with a structured, data-driven strategy to transition from an outdated, fragmented system to an efficient, equitable, and future-ready waste management framework. With sustained commitment and phased execution, Gangni can emerge as a model small town demonstrating how even limited-resource municipalities can achieve sustainable urban sanitation and environmental stewardship.