Final Feasibility Report

Transaction Advisory Support for Planning of Scientific Solid Waste Management through Cluster Approach and Bid Process Management for selection of Developers & Operators

New Town, NDITA, Bidhannagar Municipal Corporation and few KMC wards adjoining to Bidhannagar MC (Cluster II)

Submitted to – State Urban Development Authority, Department of Urban Development & Municipal Affairs Government of West Bengal

Submitted by – PricewaterhouseCoopers Private Limited

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pwc

Abbreviations

Abbreviation	Paraphrase
AE	Assistant Engineer
BMC	Bidhannagar Municipal Corporation
BORRC	Bhattacharyya Orthopedics & Related Research Centre
C & T	Collection and Transportation
C&D	Construction & Demolition
C/N Ratio	Carbon Nitrogen Ratio
CAD	Computer Aided Design
CBD	Central Business Districts
CE	Chief Engineer
CEO	Chief Executive Officer
CMFA	Chief Municipal Finance Authority
CMLO	Chief Municipal Legal Officer
CPHEEO	Central Public Health and Environmental Engineering Organization
DG (S&D)	Director General (Sewage & Drainage)
DG (SWM)	Director General (Solid Waste Management)
DPR	Detailed Project Report
EE	Executive Engineer
FO	Finance Officer
GIS	Geographic Information System
GoWB	Government of West Bengal
HIDCO	The Housing Infrastructure Development Corporation
IRR	Internal Rate of Return
IS	Indian Standard
IT	Information Technology
ITES	Information Technology Enabled Services
KMA	Kolkata Metropolitan Area
KMC	Kolkata Municipal Corporation
LFG	Land Fill Gas
LOI	Letter Of Intent
MC	Municipal Corporation
MSWM	Municipal Solid Waste Management
NDITA	Nabadiganta Industrial Township Authority
NGO	Non-Governmental Organization
NGT	National Green Tribunal
NKDA	Newtown Kolkata Development Authority
NPV	Net Present Value
O&M	Operation & Maintenance

PCB	Pollution Control Board
PPP	Public Private Partnership
RDF	Refuse Derived Fuel
RfP	Request for Proposal
SHG	Self Help Group
Sq. Km	Square Kilometers
SUDA	State Urban Development Agency
SWM	Solid Waste Management
TA	Transaction Advisor
TBM	Temporary Bench Mark
UD & MA	Urban Development & Municipal Affairs
ULB	Urban Local Body
VTS	Vehicular Tracking System
WACC	Weighted Average Cost of Capital
WBPCB	West Bengal Pollution Control Board

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1. Executive Summary

Objective of the project: PwC was appointed as transaction advisors to SUDA for Cluster 2 ULBs, to provide proper guidance to the Urban Local Bodies of West Bengal on technical viability, and improving managerial, administrative and adequate institutional arrangement in this cluster. This project aims to study existing practices and gaps, if any, in terms of primary collection, secondary collection, treatment process and disposal in the particular ULBs, and recommend measures to improve synchronization between collection, storage & transportation of waste. To maximize efficiency and effectiveness of municipal management system in this cluster, it is necessary to address different dimensions of MSWM and devise cost-effective systems, which would be viable in the available socio-economic and politico-environmental setting, which forms the premise of our conceptual framework proposed in this report.

1.1. Approach

The current assignment for SUDA Cluster 2 covers the ULBs of Bidhannagar Municipal Corporation, Nabadiganta Industrial Township Authority (NDITA), New Kolkata Development Authority (NKDA) and three boroughs of Kolkata Municipal Corporation. The different important features, which were considered in detail for the same, are tabulated below:

Table 1 ULBs and important aspects covered in the study

ULBs	Area in Sq. km.	Wards/Boroughs	Waste Generated (TPD)
KMC	205	I, III, VII	667
BMC	60.5	All	610
NKDA	30	All	50
NDITA	1.74	All	27

During this project period, PwC has held extensive consultations with the ULBs in Cluster 2, State government officials at SUDA, Department of Environment, State Pollution Control Board as well as with technology suppliers, SWM execution agencies, IEC consultants, and similar individuals and agencies supporting ULBs in SWM activities. The current conceptual framework has been proposed based on our understanding of successes and limitations of various SWM management options in other ULBs across India, as well as our understanding of key considerations of Cluster 2 ULBs, state government stakeholders, private sector and communities at large. Some of the considerations for designing the concept for solid waste management of our study area are listed below:

- Design of a system that focuses on optimal minimization of waste going to landfills, in accordance with the requirements of the MSW regulation, which is to restrict landfilling to only inert, and rejects from waste processing that are not suitable for either recycling or processing.
- Compulsory segregation of waste at the source into wet & dry waste fractions to achieve maximum recovery of resources and taking into cognizance the existing practices followed by the ULBs to effectively link them with the proposed interventions like disposal of e-waste of e-recyclers, use of e-vehicles for C&T etc.
- Establishing an efficient door-to-door waste collection with maximum participation among the communities and the waste generators and increasing the efficiency through participation of NGOs etc. by studying models across the country for effective implementation.
- Reduction of manual handling of waste by automating the entire waste collection and transportation system to the maximum across the SWM value chain for effective reduction of informal group participation and associated fatalities.
- Prioritizing of "ease of access" to waste generators and handlers by provision of an effective and efficient waste collection system and appropriate transportation infrastructure such as providing one bin per km in densely populated areas.
- Daily transportation of waste to the processing & disposal facility and optimization of the same such as restricting one vehicle trip time to 6-8 hrs. Thus, increasing the life of vehicles

and reducing its O & M cost by effective overhauling of the existing transfer stations in the SWM value chain.

- Due consideration to environmental & social safeguards of NGT specifically pertaining to legacy waste and PCB siting norms for SLF design and compliance for obtaining the environmental clearance.
- Focusing on ULB specific proactive initiatives towards community participation through sustained IEC for awareness generation, behavior change, cooperation and compliance. For example – NDITA, KMC and NKDA have started IEC activities for effective segregation.
- Proposing a robust monitoring & tracking system of operations for real time analysis of data focusing on the integration of GIS, GPS, RFID/GPRS and MIS together into a platform. This will also include complain redressal mechanism focusing on addressing the same.

Key challenges identified:

1. Land for the proposed SLF site is not enough for implementation of the project as it falls less than 10 km from the airport, which makes it difficult to obtain the environmental clearance as per the PCB norms.
2. The land proposed for the SLF is spread over 20 acres which makes it difficult to accommodate inert inflow from all the four clusters for 20 years, based on PwC calculations the land required is in tune of 65 acres exclusively the SLF, however PwC proposes to use the 20 acres for purely processing of the incoming waste from decentralized units processed.

PwC has analyzed each cluster and has opted for an approach, which focuses on the concept of reducing the waste at each preceding level through decentralized processing of the SWM value chain, which effectively leads to a residual amount of waste flowing into the centralized processing center. The concept of a centralized and a decentralized system proposed for the entire cluster is tabulated below:

Figure 1 Various centralized and decentralized waste processing options

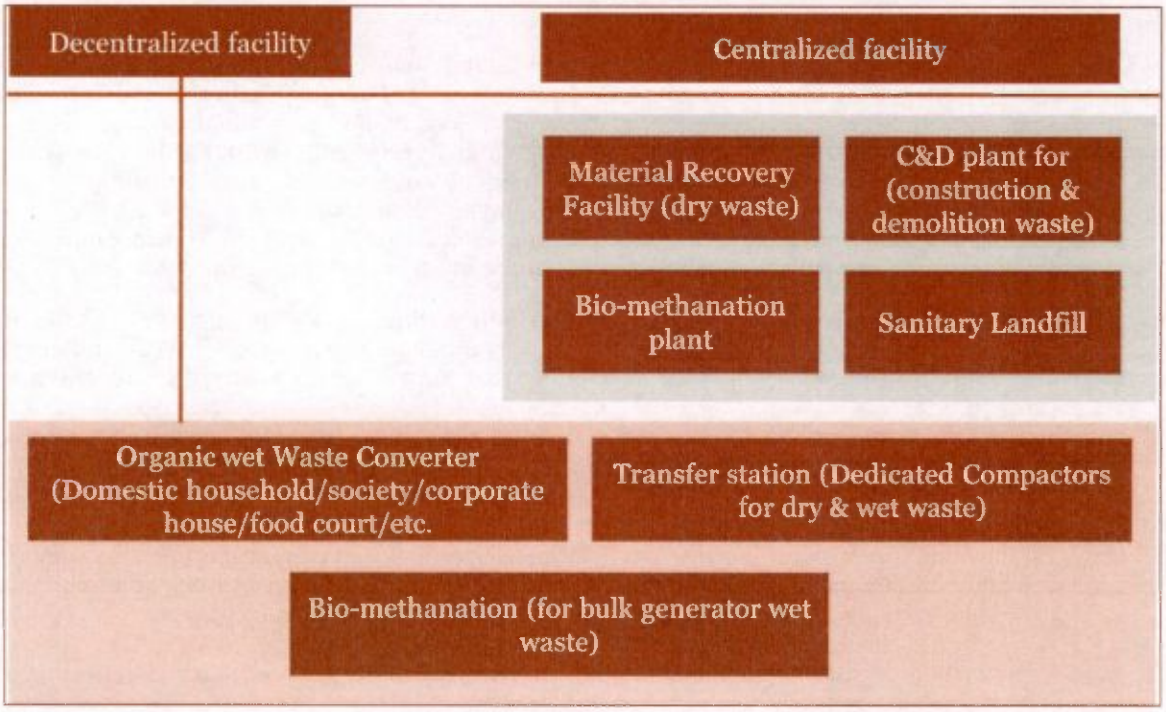

Table 2 Various components of the decentralized units

Decentralized system	
Component	**Rationale**
Organic Waste Treatment at Domestic Level	Households, societies, cooperatives and residential complexes generate substantial quantity of organic waste from domestic activities. The wet waste could be treated at the society premises by means of packaged compost plant or organic waste converter. The manure from those units could be used for gardening etc. within the premises. Such zero wet waste management initiative could be adopted at the housing level at different ULBs. In total, this intervention aims to reduce 20 TPD of waste from the total generated waste from source; In total 67 AOWCs of 300 kg/day have been proposed across the 4 ULBs, based on space availability. These may later be replicated by ULBs to scale-up decentralized operations to ensure larger proportions of organic waste being treated at community level.
Bio-methanation for bulk generators	Markets have been identified across the ULBs, and depending on availability of space near the markets, locations have been ascertained where biomethanation units may be placed to treat the incoming market waste within the ULB in a decentralized manner. The current intervention aims to process 25 TPD of waste from the total generated waste from market sources through decentralized biomethanation units. A total of 5 biomethanation units of 5TPD capacity each are proposed in Cluster 2, 4 units in BMC and 1 in NKDA. For ULBs such as KMC and NDITA where space availability is a constraint for setting up these units, a common biomethanation facility is being proposed at the centralized facility in HIDCO area to cater to the market waste from these congested places.
Decentralized Transfer Stations with MRF	All the ULBs currently use the transfer stations where the compactors have been placed, for compaction of the waste generated to minimize volumes and thus optimizing trips for waste transportation for disposal. However, currently most compactor stations are receiving mixed waste. Once source segregation is implemented, the current assets may be used as dedicated infrastructure separately for dry waste and wet waste

From selectively reducing the quantum of waste from decentralized system, we would achieve as much as possible of the total waste being generated in the cluster 2 ULBs, through decentralized systems within the ULBs close to their generation source. The remaining waste generated will be treated at the centralized facility located at the 20-acre land identified in HIDCO area. The centralized facility will comprise of the following components.

Table 3 Various components of the proposed centralized unit

Centralized system	
Component	**Rationale**
Location 1:	20-acre land in HIDCO area
Biomethanation (400 TPD) 4 units X 100 TPD	For market wastes from congested localities in cluster 2 ULBs where decentralized units are not feasible due to space constraints, a common biomethanation plant it proposed. This will also cater to balance source segregated wet waste from the ULBs which could not be treated in decentralized manner.
Material Recovery Facility (550 TPD)	The centralized MRF will cater to dry waste streams from cluster 2 ULBs, with an aim to further segregate incoming dry waste and manage them through a value chain-based approach.
C&D waste	Construction and demolition was generation taken place mainly due to

Centralized system	
management facility (400 TPD)	development of new areas, real estate market as well as while turning old properties for some new housing/ markets construction process. Construction & demolition waste from these four ULBs will be managed in a centralized facility, which will cater all different types of C&D wastes from those four ULBs, turning the waste into reusable construction and building materials. This intervention aims to process 250 TPD of waste from the total generated waste from source.
Location 2:	Proposed Disposal facility at Bhangor (tentatively indicated by SUDA)
Composting facility (500 TPD)	The project will involve 100% segregation of the waste primarily into two components – dry waste and wet waste. Decentralized facility will be designed for the wet waste generating from specific sources such as households, societies, complexes, bulk generators, big offices etc. There would be a number of other sources of generation of wet waste where decentralized facility may not be possible due to the less quantum of waste from individual units, such as – stand alone or individual households, commercial markets, small restaurants, and other domestic sources, park, gardens etc. In such cases, all those wet wastes would be brought to a centralized compost plant. This compost plant would be a centralized facility for all four ULBs. About 10 acre of land would be required for a compost plan of 500 TPD capacity.
Sanitary Landfill	The inert and rejects, generated from all centralized and decentralized facilities will be sent to the centralized secured landfill. This facility will cater all four ULBs. 432 TPD of inerts and rejects are estimated to be required to be disposed at this facility. About 65 acres of encumbrance-free and PCB compliant land would be required for the purpose of SLF.

Way forward:

- SUDA has already identified a prospective land parcel at Bhangor for creation of SLF for cluster 2 and other adjoining ULBs. SUDA and members of SWM task force to further take forward the acquisition process for thisland, as well as necessary permissions for intended landuse from concerned authorities.
- Consultation with technology providers, if necessary, may be organized to enable informed discussions around techno-commercial feasibility of SWM options
- Financial modelling, cost recovery plan etc. will be finalized based on completion of the above, and receiving concurrence from ULBs and SUDA

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2. Introduction

2.1. Project Background

2.1.1 General Background of SWM in India

Rapid urbanization in the last few decades has led to significant increase in municipal solid waste generation in India. Municipal Solid Waste Management (MSWM) has always been a great challenge for the urban local bodies (ULBs) in India. Public health, environment and quality of life in urban areas have a direct bearing on the efficiency with which the SWM service is provided by ULBs. In most cities of India, solid waste management is inefficient as systems adopted are primary, tools and equipment outdated, and inadequate & manpower productivity is low. A significant portion of the population does not have access to primary waste collection service and only 50 to 70% of waste collected is transported for disposal. Processing and treatment of waste is limited, and final disposal is in unscientific dumpsites, posing problems of ground and water contamination and air pollution.

2.1.2 General Background of SWM in West Bengal

There is a total of 125 ULBs within the State of West Bengal, of which seven are Municipal Corporations, while the remaining are large to small categories of municipalities.

As per the data obtained from the Urban Development and Municipal Affairs Department out of 125 ULBs only 108 have actually have prepared SLBs furnishing data focusing on the existing status for 2017-18 and targets for 2018-19 for SWM, Some of the areas (particularly Corporations) are also part of larger developmental areas, governed by the Development Authorities, constituted under the West Bengal Town and Country (Planning & Development) Act, 1979. State Government in its endeavor has taken several steps/initiatives for making all the cities clean, green and beautiful with special emphasis on management of solid wastes across all municipal towns of the State. All the ULBs have been provided with movable/ stationary compactors for proper transportation and subsequent primary management of solid wastes to the dumpsites. In some ULBs, battery operated hydraulic tippers have been provided for easy collection of waste from areas having narrow roads.

In addition to this, West Bengal has most municipal bodies regularly engaging in collection of waste from households, markets and sweep streets on a regular basis, most of the processes are not compliant to the rules. In addition, supplemental processes such as transport, treatment and disposal are taken up on a very ad-hoc basis waste is simply 'dumped' in an uninhabited or low-lying area in an unscientific manner. Such unorganized disposal of solid waste in the cities and towns of West Bengal poses considerable risk to natural resources, particularly ground water. West Bengal is also largely affected with arsenic contamination in ground water reserves, and leachate contamination from unscientific dumping poses risk to the reserves that are so far unaffected. Dumping of waste on riversides and other surface water streams also poses risk of leachate apart from chemical contamination of the water stream.

The waste stream indicates that there is significant inert waste that does not react with any known biological or naturally occurring agent, as well as large amount of compostable matter. Both streams offer considerable opportunities for economic activities such as filler material for construction, compost for soil remediation, wood substitutes (paddy husk) and in certain cases, feed stock for co-generation of electricity (e.g. sugarcane remnants and paddy husk). The second purpose of this strategy is to identify such opportunities and to suggest ways and means to capitalize upon them.

The overall management of solid waste generated from urban areas rests with municipal body but with a poor revenue base and managerial capabilities, municipal bodies treat this responsibility as an overhead and cost center as opposed to a business opportunity. Lack of active business opportunity, one that can be invested into not only by the municipality, but jointly and severally by private sector and community-based groups alike. At this time, it can be estimated that at least 50 to 60 per cent of the cost of solid waste management can be paid for by the products that emerge out of the waste collected and appropriately, which is not being tapped effectively across the state.

2.1.3 Conceptualizing of Cluster based SWM in the state

The State Government has started preparation of DPRs for Integrated Solid Waste Management of the municipal towns either in Stand-alone Mode or in Cluster Mode, considering the Components – i) Waste segregation at source in two separate litter bins for bio degradable & non-bio degradable waste, ii) Door-to-door collection of segregated waste, iii) Transportation of waste to dumping ground through compactor or other means, and iv) Segregation of Waste at Dumping Ground (if required) and Processing of Bio degradable Waste either to compost or energy. Special emphasis is being given on the sustainability of the projects by way of generating revenue through composting and energy (Bio-Gas or other form of fuel) generation from the Bio-degradable waste. Maintaining hygienic operational procedure in solid waste management and beautification of the dumping sites are also being taken care of. Over and above these, awareness campaign along with ICT-enabled interventions have been planned to trigger citizens' participation in these initiatives.

State Urban Development Agency (SUDA), Government of West Bengal has identified clusters comprising a number of municipalities to develop & implement a scientific and integrated municipal solid waste management system. In this DFR, the cluster mentioned below is the study area:

Cluster 2: New town, NDITA, Bidhannagar MC and Adjacent areas of Kolkata MC

2.1.4 Need for Transaction Advisory Services

The existing waste management system in this cluster has certain deficiencies in terms of primary collection, secondary collection, treatment process and disposal. The system lacks synchronization between collection, storage & transportation of waste. To maximize efficiency and effectiveness of municipal management system in this cluster, it is necessary to address different dimensions of MSWM and devise cost-effective systems which would be viable in the available socio-economic and politico-environmental setting.

Therefore, to provide proper guidance to the Urban Local Bodies of West Bengal on technical viability, and improving managerial, administrative and adequate institutional arrangement in this cluster, M/s PricewaterhouseCoopers Pvt. Ltd has been appointed for providing consultancy services as a Transaction Advisor for Solid Waste Management Project in the mentioned cluster.

2.2 Scope of Work for Transaction Advisory Services

The scope of work for PricewaterhouseCoopers Pvt. Ltd. to provide the Transaction Advisory services is as per the following:

- To coordinate with UD & MA Department, ULBs, development authorities and other concerned to identify and conceptualize/develop the SWM project
- To structure projects under PPP mode to enable recovery of the investments made in SWM projects through innovative business and commercial practices such as commercial sale of products, levy of user charges/ fee etc., as appropriate under the applicable laws.
- To suggest adoption of different best practices in other States
- To prepare feasibility report by incorporation of some of the aspects as listed below:
    - Concepts of Solid Waste Management of Government of West Bengal in the focus of latest Solid Waste Management Rules 2016
    - Optimum utilization of existing infrastructure of solid waste management in the ULBs
    - Optimum utilization of land for processing plant and sanitary landfill site clubbing ULBs in clusters to make the project financially feasible.
    - Collection and transportation of segregated waste has to be done case to case basis either by ULB or by private agency and the setting up & management of the processing plant and sanitary landfill site are to be done by the private concessioner using suitable and viable technology.

- Appropriate project structures
- Necessary clearances to be obtained from the West Bengal Pollution Control Board by the executing agency (TA consultant shall identify the list of clearances)
- Effective Operation & Management system to be established for at least 20 years
- Processing and disposal of the legacy waste and reclamation of land is to be ensured effectively
- Segregation of recyclable waste, bio-degradable waste, Refused Derived Fuel (RDF) and Construction & Demolition (C&D) waste are to be ensured effectively
- To prepare the scope of work as per the feedback of field inspection
- Propose effective and viable model of implementation on the basis of national and international best practices with a focus on most viable technology options and corresponding cost-benefit analysis to evolve a Zero Waste solution.
- Propose institutional structures required for implementation of projects and operation & maintenance thereof with private sector financing for the purpose of ensuring that the project is structured and executed in line with the specifications as stipulated in the Detailed Feasibility Report.
- Suggesting key performance indicators linked with payment schedule for evaluation of private agencies
- To prepare zero waste solution.

- To prepare bid documents (RfP, Concession Agreement etc.) and manage bid process till signing of Concession Agreement considering the above issues covered under feasibility study report.

3. Policy and Regulatory Framework

This section focuses on an insight of existing policies & regulatory framework, and its mandate on the context of an effective solid waste management system by extracting the relevant aspects from important regulations. The chapter also focuses on the interlinking of various existing policies of Government of India with the proposed ISWM structure envisaged in this detailed feasibility report.

3.1. MSW Rule 2000

The primary regulations relating to municipal SWM are the Municipal Solid Wastes (Management and Handling) Rules 2000 (MSW 2000 Rules), which apply to all municipal authorities responsible for the collection, segregation, storage, transportation, processing and disposal of MSW in India. Under the regulations, the Secretary is in charge of the Department of Urban Development of the concerned State and has overall responsibility for the enforcement of the rules within metropolitan cities. The Central Pollution Control Board (CPCB) and the State Boards or Committees also carry significant responsibilities. They are mandated to (i) monitor compliance with environmental standards for groundwater, ambient air, leachate, compost and gas emissions, (ii) Coordinate with other agencies, review SWM facility applications, (iii) issue authorization and compliance criteria, and (iv) in coordination with other agencies, review standards and guidelines, and compile monitoring data. Municipal authorities are mandated to implement the provisions of the rules, and to submit formal applications to their respective State Boards or Committees for the development of SWM facilities.

The Municipal Solid Waste (Management and Handling) Rules 2000 has specific directives to the Local Bodies, District Administrations and the Urban Development Departments of the State Governments for proper and scientific management of municipal solid waste. Under these rules, it is mandatory for all the urban local bodies to provide facilities for collection, transportation, treatment and disposal of municipal solid waste in a scientific and hygienic manner. The rules require the municipal authorities to adopt a suitable technology or combination of technologies so as to minimize the burden on landfill and that landfilling shall be restricted to non-biodegradable inert waste and other waste that are not suitable either for recycling or for biological processing. However, the MSWM Rules 2000 does not make any reference to the informal recycling sector.

3.2. Solid Waste Management Rule 2016

The MSWM Rules 2000 were amended and a Solid Waste Management Rules 2016 is now released. The SWM 2016 empowers the state to penalize municipal authorities who fail to discharge their obligatory duties in implementing MSWM Rules. The SWM Rules 2016 also fixes the responsibility of waste segregation on the waste generators and temporary storage of segregated wastes as per the recommendation of the Committee on 'National Sustainable Habitat Standards for Municipal Solid Waste Management'. The SWM Rules 2016 encourages the municipalities to adopt a 'Carrot and Stick' approach to ensure that the waste generator segregates waste.

The Central Public Health and Environmental Engineering Organization a department under the Ministry of Urban Development (MoUD) (now Ministry of Housing and Urban Affairs), Government of India developed in 2010 a Manual on Solid Waste Management. The manual aims at assisting the policy and decision makers, planner, managers and technical personnel involved in solid waste management activities, in safe and hygienic handling and disposal of municipal solid waste. The manual has been updated in 2014 based on the learnings in the implementation of the MSWM rules in the ULBs since 2000. The MoUD issued an advisory in October 2013 that built of the learnings on the implementation of the solid waste management services by various ULBs across the country.

3.2.1. Salient features of MSW Rules, 2016

These rules apply to every ULB, outgrowths in urban agglomerations, and the census towns, notified areas, notified industrial townships, areas under the control of Indian Railways, airports, airbases, ports and respective state government may notify harbours, defence establishments, special economic

zones, state and central government organizations, places of pilgrims, religious and historical importance as. The main highlights of the rule are described below:

- The waste generator should segregate and store the waste in three separate streams i.e. bio-degradable, non-biodegradable and domestic hazardous wastes
- Store construction and demolition waste separately.
- Prohibition on burn the waste by the waste generator.
- The waste generators shall pay user fee for solid waste management to the ULBs in the form of fees for rendering of services.
- All gated communities, institutions and RWAs shall ensure segregation of waste at source level, before primary collection or waste reaches the primary transfer station.

Key duties of the waste generators:

The waste generators are mandated with certain obligatory duties, which are enforceable by the ULBs in the form of byelaws, they are listed below:

- Segregate, store and handover separately the waste generated by them in three separate streams namely bio-degradable/wet waste, non-bio-degradable/dry waste and domestic hazardous wastes. All gated communities, institutions and RWAs shall ensure segregation of waste at source level
- Prohibition of the waste generator throw the waste generated by him/her/them on the street, open spaces, drain or water bodies; or burn the waste in open
- Mandating payment of user fee or charge or fines as may be specified in the bye-laws of the urban local bodies

The officials of ULBs or administrative bodies like Commissioner or Director of Municipal Administration are mandated some key duties focusing on the holistic management of MSW, the same are furnished below:

- Ensuring implementation of MSW rules by all urban local bodies falling under his/her control.
- Undertaking training and capacity building of urban local bodies for management of solid waste.
- Facilitating establishment of common regional sanitary landfill for a group of cities and towns falling within a radial distance of fifty kilometers or more from the regional facility on a cost sharing basis and ensure professional management of such sanitary landfills.

The ULBs are mandated with some key duties and responsibilities for effective MSWM, they are listed below:

- Preparing a solid waste management plan as per State Policy and Strategy on Solid Waste Management within six months from the date of notification of state policy
- Framing byelaws, incorporating the provisions of these rules and ensure timely implementation.
- Prescribing and collecting user fee from waste generators.
- Developing infrastructure for segregation, collection, transportation, storage, processing and disposal of solid waste in their respective jurisdiction either at its own or through public private partnership mode.
- Providing easy access to waste pickers and recyclers for collection of segregated recyclable waste.
- Facilitating construction, operation and maintenance of solid waste processing facilities and associated infrastructure in house or with private sector participation using best-suited technologies.
- Undertaking in house or through any other authorized agency, construction, operation and maintenance of Sanitary landfill
- Making adequate provision of funds for capital investments as well as operation and maintenance of solid waste management services in the annual budget
- Closing down, remediate wherever feasible and cap the existing dumpsites, which are not engineered landfill sites as per the provision of these Rules

- Preparing and submitting annual report on the status of compliance of these rules during the calendar year on or before the 30th April of the succeeding year to the Commissioner or Director Municipal Administration
- Creating public awareness through Information, Education and Communication (IEC) campaign

The Operator of Solid Waste Processing and Treatment Facilities are mandated some key duties for effective and holistic processing of MSW, they are listed below:

- Identification and notification of land for setting up the solid waste processing and treatment facilities shall be the responsibility of the ULB. However, the criteria for setting up of solid waste processing and treatment facilities and key responsibilities of the operator in conjunction with the mandates as provided by the are as follows:
- Designing and set up the facility as per the technical guidelines issued by the Central Pollution Control Board in this regard from time to time and the manual of Central Public Health and Environmental Engineering Organization, New Delhi
- Obtaining the approval from the State Pollution Control Board or Pollution Control Committee
- Ensuring safe and environmentally sound operations of the solid waste processing and treatment facility and its closure and post closure phase as per the guidelines issued by Central Pollution Control Board from time to time and the Manual of Central Public Health and Environmental Engineering Organization, New Delhi.
- Submitting annual report in the prescribed form.

3.2.2. Compliance Schedules as per SWM Rules, 2016

The holistic areas of municipal solid waste management have been stipulated in four schedules.

- Schedule I stipulates deadlines for implementation of major action plan for successful implementation of SWM system for the city
- Schedule II stipulates specific action plan for MSW collection, segregation, storage, transportation, processing and disposal.
- Schedule III stipulates specification for landfill sites and
- Schedule IV stipulates standards for compost, leachates and incineration

Stipulations under schedule II covers major tasks from collection up to final disposal of MSW. This has major bearing on augmentation of financial resources, materialistic requirements and need for land area as well as governs the applicability of processing technologies. Some of the major aspects as per this schedule are described here. In the table below, the policy and regulatory framework for an integrated solid waste management system is furnished.

Table 4 Mandatory compliances for effective management of SWM

SN	Parameters	Compliance criteria
1.	Collection of municipal solid wastes	Littering of municipal solid waste shall be prohibited in cities, towns and in urban areas notified by the State Governments. To prohibit littering and facilitate compliance, the following steps shall be taken by the municipal authority, namely: - i. Organizing house-to-house collection of municipal solid wastes through any of the methods, like community bin collection (central bin), house-to-house collection, collection on regular pre-informed timings and scheduling by using bell ringing of musical vehicle (without exceeding permissible noise levels); ii. Devising collection of waste from slums and squatter areas or localities including hotels, restaurants, office complexes and commercial areas; iii. Wastes from slaughter houses, meat and fish markets, fruits and vegetable markets, which are biodegradable in nature, shall be managed to make use of such wastes;

		iv. Bio-medical wastes and industrial wastes shall not be mixed with municipal solid wastes and such wastes shall follow the rules separately specified for the purpose; v. Collected waste from residential and other areas shall be transferred to community bin by hand-driven containerized carts or other small vehicles; vi. Horticultural and construction or demolition wastes or debris shall be separately collected and disposed off following proper norms. Similarly, wastes generated at dairies shall be regulated in accordance with the State laws; vii. Waste (garbage, dry leaves) shall not be burnt; viii. Stray animals shall not be allowed to move around waste storage facilities or at any other place in the city or town and shall be managed in accordance with the State laws. ix. The municipal authority shall notify waste collection schedule and the likely method to be adopted for public benefit in a city or town. It shall be the responsibility of generator of wastes to avoid littering and ensure delivery of wastes in accordance with the collection and segregation system to be notified by the municipal authority as per para 1(2) of this Schedule.
2.	Segregation of municipal solid wastes	In order to encourage the citizens, municipal authority shall organize awareness programs for segregation of wastes and shall promote recycling or reuse of segregated materials. The municipal authority shall undertake phased program to ensure community participation in waste segregation. For this purpose, the municipal authorities with representatives of local resident welfare associations and non-governmental organizations shall arrange regular meetings at quarterly intervals.
3.	Storage of municipal solid wastes	Municipal authorities shall establish and maintain storage facilities in such a manner, as they do not create unhygienic and insanitary conditions around it. Following criteria shall be taken into account while establishing and maintaining storage facilities, namely: - i. Storage facilities shall be created and established by taking into account quantities of waste generation in a given area and the population densities. A storage facility shall be so placed that it is accessible to users; ii. Storage facilities to be set up by municipal authorities or any other agency shall be so designed that wastes stored are not exposed to open atmosphere and shall be aesthetically acceptable and user-friendly; iii. Storage facilities or 'bins shall have 'easy to operate' design for handling, transfer and transportation of waste. Bins for storage of bio-degradable wastes shall be painted green, those for storage of recyclable wastes shall be printed white and those for storage of other wastes shall be printed black; iv. Manual handling of waste shall be prohibited. If unavoidable due to constraints, manual handling shall be carried out under proper precaution with due care for safety of workers.
4.	Transportation of municipal solid wastes	Vehicles used for transportation of wastes shall be covered. Waste should not be visible to public, nor exposed to open environment preventing their scattering. The following criteria shall be met, namely: - The storage facilities set up by municipal authorities shall be daily attended for

		clearing of wastes. The bins or containers wherever placed shall be cleaned before they start overflowing; ▪ Transportation vehicles shall be so designed that multiple handling of wastes, prior to final disposal, is avoided.
5.	Processing of municipal solid wastes	Municipal authorities shall adopt suitable technology or combination of such technologies to make use of wastes so as to minimize burden on landfill. Following criteria shall be adopted, namely: - i. The biodegradable wastes shall be processed by composting, vermin composting, anaerobic digestion or any other appropriate biological processing for stabilization of wastes. It shall be ensured that compost or any other end product shall comply with standards as specified in **Schedule-IV;** ii. Mixed waste containing recoverable resources shall follow the route of recycling. Incineration with or without energy recovery including palletization can also be used for processing wastes in specific cases. Municipal authority or the operator of a facility wishing to use other state-of-the-art technologies shall approach the Central Pollution Control Board to get the standards laid down before applying for grant of authorization.
6.	Disposal of municipal solid wastes	Land filling shall be restricted to non-biodegradable, inert waste and other waste that are not suitable either for recycling or for biological processing. Land filling shall also be carried out for residues of waste processing facilities as well as pre-processing rejects from waste processing facilities. Land filling of mixed waste shall be avoided unless the same is found unsuitable for waste processing. Under unavoidable circumstances or till installation of alternate facilities, land-filling shall be done following proper norms. Landfill sites shall meet the specifications as given in Schedule –III.

3.2.3. Regulatory Aspects/Provision of MSW landfills

Under section 6 (3) of the MSW (M&H) Rules, 2016 State Pollution Control Board or Pollution Control Committee shall issue authorization in Form-III to the municipal authority or an operator of a facility within forty-five days stipulating compliance criteria and standards as specified in Schedule II, III and IV including such other conditions, as may be necessary. SPCBs/PCCs, after the receipt of application from the municipal authority or the operator of a facility including landfills, shall examine the proposal taking into consideration the views of other agencies like the State Urban Development department, the Town and Country Planning department, Airport or Air Base authority, the ground Water Board or any such other Agency prior to issuing the authorization.

Aspects pertaining to site selection are described below:

- Landfill identification to be done by 'Development Authorities' for the area falling under 'Development Authority', otherwise it shall be done by the concerned Municipal authority.
- The site selection to be done based on examination of environmental issues. The landfill site shall be planned and designed with proper documentation of a phased construction plan as well as a closure plan.
- The landfill facility shall be nearby a waste processing plant or an integral part of it. The landfill site shall be designed for 20-25 years.
- The proposed landfill site should be away from habitation clusters, forest areas, water bodies, monuments, national Parks, Wetlands and places of important cultural, historical or religious interest. In addition, approval shall be taken from the concerned authorities in case the landfill site is located within 20 km from the airport/airbase.

Aspects pertaining to facilities at site

- The landfill fencing with proper gate at entrance for monitoring incoming wastes/vehicles, to prevent entry of cattle, to keep record movement of vehicles and wastes, etc.
- Provision of weigh-bridge for assessing quantum of wastes
- Provision of drinking water, other sanitary facilities, and other safety measures including health check-up shall be provided to workers.

Aspects pertaining to water quality monitoring

Ground water quality monitoring within 50 m periphery of landfill site. In addition, ground water quality data to be generated before construction of landfill site for future reference.

Aspects pertaining to Ambient air quality monitoring

Installation of landfill gas control system including gas collection system shall be made at landfill site to minimize odor generation, prevent off-site migration of gases and to protect vegetation planted on rehabilitated landfill surface.

3.3. Environmental and climate change context overlapping with the MSWM

The Ministry of Environment, Forests and Climate Change (MoEFCC) and the pollution control boards: Central Pollution Control Board (CPCB) and State Pollution Control Boards (SPCBs) together form the regulatory and administrative core of the sector from the Environmental and Climate Change context. The related acts relevant to the MSWM are provided below:

The National Environment Policy, 2006 (NEP) is an attempt to strike a balance between improving quality of life, the finiteness of natural resources and social justice. The policy pinpoints amongst others, solid waste (industrial waste is the other one) as the main causes of soil pollution and provides an action plan for addressing the issue. The action plan suggests "strengthening the capacities of local bodies for segregation, recycling, and reuse of municipal solid wastes, recognizing inter-alia the positive impacts it may have on the welfare of safai-karamcharis (workers involved in the recycling sector), and setting up and operating sanitary landfills, in particular through competitive outsourcing of solid waste management services" and "giving legal recognition to, and strengthen the informal sector systems of collection and recycling of various materials, in particular enhance their access to institutional finance and relevant technologies."

The National Action Plan for Climate Change, 2008 (NAPCC) is categorised into eight Missions. One of the eight Missions is the 'National Mission on Sustainable Habitat'. A part of the National Mission on Sustainable Habitat is to address solid waste management to make it sustainable. The NAPCC stresses the provision in the NEP for giving legal recognition to the informal sector, which it recognises as the "backbone of India's highly effective recycling system". One of the guiding principles of the NAPCC is also "protecting the poor and vulnerable sections of society through an inclusive and sustainable development strategy, sensitive to climate change."

Some aspects of The Water (Prevention and Control of Pollution) Act, 1974 is important with regard to municipal solid waste management. Firstly, a consent from the state pollution control board for establishment of a sanitary landfill site and compost plant is essential and secondly, no water pollution should be caused by the leachate that is emitted by the sanitary landfill site or a compost plant. Additionally, the Water (Prevention and Control of Pollution) Cess Act, 1977 and amendments thereon makes provision for levying and collection of cess on water consumed for any processing, treatment and disposal of solid waste.

The Air (Prevention and Control of Pollution) Act, 1981 and amendments thereon mandates the need for obtaining consent from the State Pollution Control Board for establishment of the processing plants and disposal site and address environmental impacts caused by incineration plants, compost plants and landfill sites.

The Environmental (Protection) Act, 1986 and its subsequent notifications requires any municipal solid waste management project to conduct an environmental impact assessment and obtain approval for the Environment Impact Assessment and the Environmental Management Plan for the project.

The National Environmental Policy and National Action Plan for Climate Change are relevant in their recognition of the informal sector and the need for inclusive growth. The planning documents prepared by the Ministry of Urban Development in furtherance of these policies however have fallen short on this count. For example, the Plan for Implementation of National Mission on Sustainable Habitat (2011), the National Sustainable Habitat Standards for Municipal Solid Waste Management (Nov 2011) and the Guidance Note on Solid Waste Management at a Regional Level, all suggest public private partnerships and the use of technology, relegating to the side-lines the provisions relating to the informal sector. The lack of reference to the informal recycling sector in the MSWM Rules 2000 and 2013 is an indication of the low priority accorded to the informal sector in waste management by the executive government.

3.4. Swachh Bharat Mission& its overlapping mandates with SWM

Swachh Bharat Mission (SBM) was launched on 2nd of October 2014 with a vision to achieve a clean India as a tribute to the father of the nation, Mahatma Gandhi, on his 150th birth anniversary, in 2019. The Ministry of Urban Development (MoUD) is implementing SBM. Municipal Solid Waste Management (MSWM) a major component of the SBM (urban)- "refers to a systematic process that comprises of waste segregation and storage at source, primary collection, secondary storage, transportation, secondary segregation, resource recovery, processing, treatment, and final disposal of solid waste."

The activities associated with the management of MSW from the start of waste generation to final disposal can be grouped into the eight functional elements, which cover the entire SWM value chain, some of it is described below:

- Waste generation
- Waste storage at source
- Waste segregation
- Collection (primary and secondary)
- Transportation
- Processing and recycling
- Disposal of reject material
- Rehabilitation of the existing dumpsites to mitigate the pollution potential

3.5. Plastic Waste Management Rule 2016 and relevance to MSWM

The plastic waste management by the urban local bodies in their respective jurisdiction attempts to holistically capture the essence of the growing problem of plastic waste and its mandatory management: -

a. Plastic waste, which can be recycled, shall be channelized to registered plastic waste recycler and recycling of plastic shall conform to the Indian Standard: IS 14534:1998 titled as Guidelines for Recycling of Plastics, as amended from time to time.
b. Local bodies shall encourage the use of plastic waste (preferably the plastic waste which cannot be further recycled) for road construction as per Indian Road Congress guidelines or energy recovery or waste to oil etc. The standards and pollution control norms specified by the prescribed
c. Thermo-set plastic waste shall be processed and disposed off as per the guidelines issued from time to time by the Central Pollution Control Board notifications
d. The inert from recycling or processing facilities of plastic waste shall be disposed of in compliance with the Solid Waste Management Rules, 2000 or as amended from time to time based on government regulations and notifications.

The entire framework of rules and regulations is bound to be inefficient if the and the clauses, which mandate the responsibilities of the stakeholders, are being discussed below:

3.5.1. Responsibility of Local Body (Clause 6)

The ULB plays an important role in governing the urban landscape and has been given the mandate for the following, which covers the entire SWM value chain as mentioned below:

1. Every local body shall be responsible for development and setting up of infrastructure for segregation, collection, storage, transportation, processing and disposal of the plastic waste either on its own or by engaging agencies or producers.

2. The local body shall be responsible for setting up, operationalisation and co-ordination of the waste management system and for performing the associated functions, namely: -

    a. Ensuring segregation, collection, storage, transportation, processing and disposal of plastic waste.
    b. Ensuring that no damage is caused to the environment during this process;
    c. Ensuring channelization of recyclable plastic waste fraction to recyclers.
    d. Ensuring processing and disposal on non-recyclable fraction of plastic waste in accordance with the guidelines issued by the Central Pollution Control Board.
    e. Creating awareness among all stakeholders about their responsibilities.
    f. Engaging civil societies or groups working with waste pickers; and
    g. Ensuring that open burning of plastic waste does not take place.

3. The local body is responsible for setting up of a system for plastic waste management and shall seek assistance of producers and such system shall be set up within one year from the date of final publication of these rules in the Official Gazette of India from time to time.

4. The local body to frame byelaws incorporating the provisions of these rules for effective enforcement and compliance.

3.5.2. Responsibility of Waste Generator (Clause 8)

The waste generators are the prime stakeholders as they are responsible for releasing of waste into the environment, hence, it becomes imperative to manage the same, some of the responsibilities are described below:

1. The waste generator shall-

    a. Take steps to minimize generation of plastic waste and segregate plastic waste at source in accordance with the Solid Waste Management Rules, 2000 or as amended from time to time.
    b. Prohibit littering of the plastic waste and ensure segregated storage of waste at source and handover segregated waste to urban local body or gram panchayat or agencies appointed by them or registered waste pickers', registered recyclers or waste collection agencies;

2. All institutional generators of plastic waste, shall segregate and store the waste generated by them in accordance with the Municipal Solid Waste (Management and Handling) Rules, 2000 notified vide S.O. 908(E) dated the 25th September, 2000 under the Act or amendment from time to time and handover segregated wastes to authorized waste processing or disposal facilities or deposition centres either on its own or through the authorized waste collection agency.

3. All waste generators shall pay such user fee or charge as may be specified in the bye-laws of the local bodies for plastic waste management such as waste collection or operation of the facility thereof, etc.;

4. Every person responsible for organising an event in open space, which involves service of food stuff in plastic or multi-layered packaging shall segregate and manage the waste generated

during such events in accordance with the Municipal Solid Waste (Management and Handling) Rules, 2000 notified vide S.O. 908(E) dated the 25th September 2000 under the Act or amendment from time to time.

3.5.3. Responsibility of Producer (Clause 9)

The waste producers are the prime stakeholders as they are responsible for creation of plastic elements both single and multiple use plastic into the environment, hence, it becomes imperative to manage the same; some of the responsibilities are described below:

1. The producers, within a period of six months from the date of publication of these rules, shall work out modalities for either waste collection system based on extended producers' responsibility and involving State Urban Development Departments, individually or collectively, through their own distribution channel or through the local body concerned.

2. Primary responsibility for collection of used multi-layered plastic sachet or pouches or packaging is of producers, importers and brand owners who introduce the products in the market. They need to establish a system for collecting back the plastic waste generated due to their products. This plan of collection to be submitted to the State Pollution Control Board while applying for Consent to Establish or Operate or Renewal. The Brand Owners whose consent has been renewed before the notification of these rules shall submit such plan within one year from the date of notification of these rules and implement with two years thereafter.

3. Manufacture and use of non- recyclable multi-layered plastic if any should be phased out in two years' time.

4. Study area profile

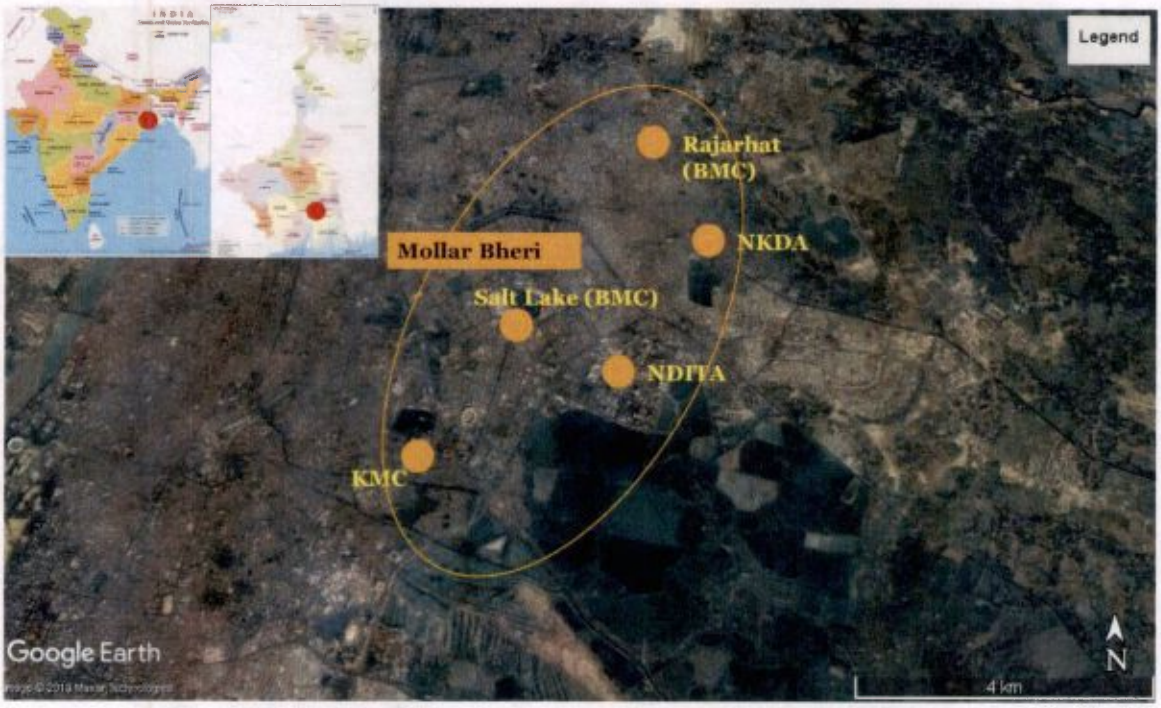
4.1. Reconnaissance survey of the study area

PwC study team has undertaken reconnaissance survey of the study area and obtained onsite information and understanding. Four ULBs, which have been considered in this cluster (Cluster II), are:

- New Town Kolkata Development Authority
- Nabadiganta Industrial Township Authority
- Bidhannagar Municipal Corporation and
- Adjacent areas/ wards of Kolkata MC

The relative location of the study area is show in the below satellite imagery:

Figure 2 Satellite Imagery of the project study area



Source – Google earth image of the towns and respective distances between them

Some of the information obtained and the general understanding of the same is described below:

4.1.1. Bidhannagar Municipal Corporation (BMC)

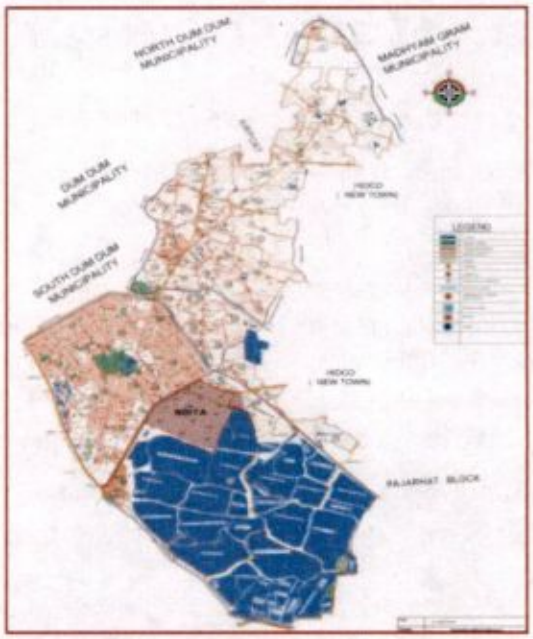
Bidhannagar is a satellite town located in the eastern edge of Kolkata. The township was earlier called Salt Lake but was later renamed to Bidhannagar. Bidhannagar is spread across an area of 60.5 Sq. Km which happens to be approximately 3.2% of the total Kolkata Metropolitan Area (KMA). BMC has 41 ward offices and one Head office.

Ward no's 1 to 26 fall under Rajarhat, ward no 29 to 40 falls under Bidhannagar. Wards no 27, 28, 35 and 36 are low population density wards and are mostly covered with water bodies.

Bidhannagar is surrounded by Madhyam Gram Municipality and North Dum Dum Municipality on the North side, Rajarhat Block on the South side, HIDCO on the East side and South Dum Dum Municipality on the West side. The study area map of the BMC has been shown in the adjoining figure.

The snapshot of Bidhannagar Municipal Corporation is presented in the following table, at a glance.

Figure 3 BMC Area



Source – Official website of BMC - www.bmcwbgov.in/

Table 5 Snapshot of BMC[1]

Demography	
Head Office	One (1)
Borough Office	Six (6)
Ward Office	Forty-One (41)
Geographical Area	60.5 Sq. Km. (Approximately) 3.2% of the Total Kolkata Metropolitan Area (KMA)
Number of Household	One Lakh Forty-Seven Thousand (1.47) Rajarhat – One Lakh Seventeen Thousand (1.17) Salt Lake – Twenty-Six Thousand (26,000) 14.34% of KMA Household 0.73% of the State Household
Establishment	
Year of Formation	18th June 2015
Board of Council Formation	16th October 2015
Periphery	
North	Madhyam Gram Municipality (Northern boundary of AN, AP and AQ Block of erstwhile Bidhannagar Municipality)
South	Rajarhat Block (Southern boundary of GM, GN & GP Block of erstwhile Bidhannagar Municipality)
East	HIDCO New Town (Eastern boundary of AQ Block running through the western boundary of Munsir Bheri of erstwhile Bidhannagar Municipality)
West	South Dum Dum Municipality (Eastern boundary of Salt Lake bypass of erstwhile Bidhannagar Municipality)
Administrative Jurisdiction	Bidhannagar Sub-division
District	North 24 Parganas
Police Jurisdiction	Bidhannagar City Police

[1] BMC website

4.1.2. New Town Kolkata Development Area (NKDA)

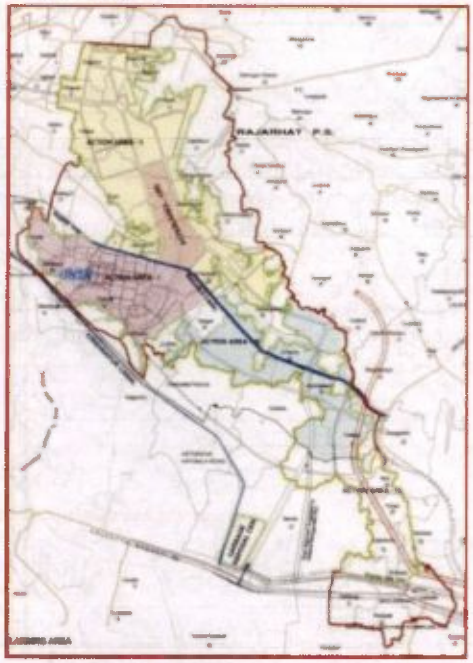
New Town is a fast-growing planned satellite city of North 24 Parganas district and an information technology cum residential hub, developed on the north-eastern fringes of Kolkata. The area mainly consisted of huge acres of cultivable lands and water bodies, which have been acquired and developed in a planned manner. NKDA has been constituted under the New Town Kolkata Development Authority Act, 2007. The primary aim of the act is to render various civic services and amenities within Newtown. The Act has come into effect since November 2008.

The main aim of creating this region was to reduce the increasing pressure of rapid urbanization and growing demand for housing and commercial spaces on the existing Central Business Districts (CBD) and to increase the house stock supply by creating new residential units.

The population under NKDA is 37000[2]. With the objective of developing an eco-friendly green dotted New Town, it was designed to develop the area in different phases. The area was initially divided into three Action Areas. Currently Action Area I, Action Area II and Action Area III come under the purview of NKDA, the rest of Newtown has been classified as Planning area.

The area spans across the Airport Police Station, Rajarhat Police Station and the Kolkata Leather Complex Police station. The map of new town development area is shown in the adjoining figure.

Figure 4 NKDA Area



Source – Official website of NKDA- https://www.nkdamar.org

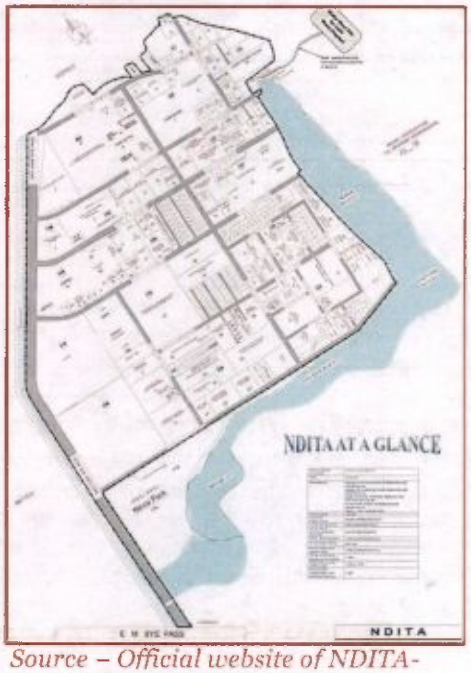
4.1.3. Nabadiganta Industrial Township Area (NDITA)

The Nabadiganta Industrial Township Authority came into existence in the year 2006. NDITA spans across 432 Acres of land in the Sector V area. Sector V was initially part of Bidhannagar Municipality, but due to the fast-paced growth of the region, BMC found it difficult to cater to the increasing demand for basic civil amenities. Hence, a township under Section 358A of the West Bengal Municipal Act, 1993 was formed with a view to provide proper infrastructural development required for setting up industries.

The Area under NDITA comprises of 432 acres which consists of a fixed population of approximately 900 people and a floating population of approximately 100000 people. The major establishments in that region consist of IT and ITES companies (206), Manufacturing companies (48), Banks, Hospitals and Telecom companies.

NDITA is surrounded by AN, AP and AQ blocks of BMC on the Northern side, by GN, GM and GP blocks of BMC on the southern side, by AQ block on the eastern side and by the Salt Lake By pass on the western side. The area under NDITA generates about 20MT of waste every day. The map of NDITA is shown in the adjoining figure.

Figure 5 NDITA Area



Source – Official website of NDITA-

[2] NKDA Website

4.1.4. KMC Wards adjacent to BMC

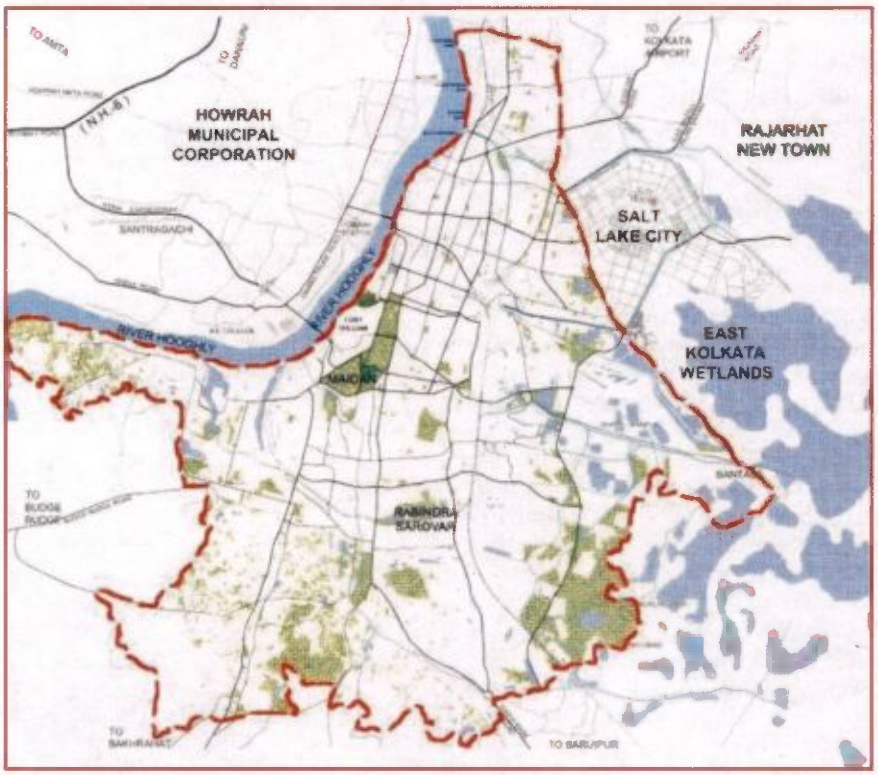
The Kolkata Municipal Corporation (KMC) covers an area of 205 Sq. Km and has to cater to the needs of approximately 1 Crore people which includes a fixed population of around 44 lakhs and a floating population of 60 nearly lakhs.

KMC generates around 4000-4500 MT of solid waste every day. The city is divided into 144 wards.

In this feasibility study, the assessment shall be undertaken to identify which wards of the KMC would be included in this study. This will be decided based upon the understanding of waste quantities from adjacent wards/ boroughs, infrastructure capacity, logistical planning etc. and discussions with the KMC officials. Below the KMC area map has been presented.

As per the discussion with the KMC officials it was decided to collaborate to find out the most appropriate wards which can cater to the waste character aligning itself with the choice of technology which will emerge from the feasibility phase.

Figure 6 KMC Area



Source:
https://www.researchgate.net/publication/319069015_Biodiversity_Accounting_of_Cities_A_case_study_of_Kolkata_India

4.1.5. Mollar Bheri disposal site

Mollar Bheri is the current unscientific disposal site, where all unprocessed fresh wastes from all locations under this study area (except KMC), are getting disposed off. The total land area of the disposal site is about 55 acres, out of which around 45% area is covered by accumulated garbage. Average height during the reconnaissance survey was observed visually as ~ 12 ft. Mostly compactors bring the waste to the disposal site, along with few numbers of open trucks etc. Two dedicated front-end loaders are available at the site to spread and level the fresh incoming waste after the disposal.

Mollar Bheri falls under two different Mouzas. Mouza – Dhapa Manpur Mouza and Mahisbathan Mouza. From verbal discussions with BC officials, it is understood that Dhapa Manpur mouza falls

under wetland (Kulipara, Durgabhasan, Gorumera etc.). However, Mahoshbathan mouza does not fall under wet land and it is primarily a "*Sali*" land (Boro paresh, chhoto paresh etc.)

A number of water bodies surrounds the site. On the northern side, Mollar Bheri is surrounded by a residential colony, slum area as well as high rises. IDL Aqua view residential complex is located within 1 km of vicinity. The other localities at Mollar Bheri periphery are Khasmahal and Sardarpara.

Figure 7 Satellite Imagery of the Disposal Site at Mollar Bheri

Source – Google Earth Based on reconnaissance survey by PwC

5. Current practices & situation analysis

In this chapter the present situation of solid waste management in the four project ULBs has been discussed in detail. Focus has been primarily made on the existing waste management strategy, collection process, processing & disposals (if any), and on ULBs' different initiatives towards waste handling practices. This analysis focuses on the, the existing gaps and overall deficiencies of the present system, major hotspot domains, and scope of interventions across all the ULBs under consideration.

For this purpose, PwC Team has undertaken reconnaissance surveys, site visits pertaining to coverage of various SWM assets etc. of the study area and carried out stakeholders' consultation to get access to all relevant information related to prevalent solid waste management system. The detailed outcome of the situation analysis is described in the subsequent section.

5.1. Bidhannagar Municipal Corporation Area

5.1.1. Primary Collection

As per the discussions with the officials, it is understood that, in Bidhannagar Municipal Corporation generates close to 508 TPD of waste. The BMC consist of two areas namely the Bidhannagar and the Rajarhat, which contribute around 610 TPD of waste altogether.

100% door to door collection of MSW is already in place. It takes place during 6-9 am in the morning. However, once the waste is collected, informal way of segregation happens by rag pickers for their own interest. For collection purpose, each ward has been given around 20-25 of vans, rickshaws and one auto tippers for collection and transfer to the compactors. BMC has both stationery and mobile compactors.

One of the common problems emanating from door to door collection was the common trend of the garbage collector to not visit all the floors of high-rise residential establishment. It was experienced by BMC that; early morning waste collection is not welcome by the residents. However, for waste collection after 9 am, most of the office dwellers keep their waste outside of their door, and stray dogs spread the same over. Therefore, rationalization of collection time is one of the important aspects.

Rajarhat area is a congested segment of BMC with narrow roads and unorganized drainage disposal mechanism. Therefore, proper movement of any waste collection vehicles within such roads and collection of waste is an issue. Baguihati market, Kestopur market, Jagatpur market, Narayanpur market, Kaikhali chiriya market, Maridhha market (ward no 14), Pramadgar market, Jangra bazaar etc. are some of the congested market, where waste management is a big challenge.

PwC team has visited few congested areas in Rajarhat zone. In ward no 18, 19, 21 wastes were seen to be deposited along Bagjola canal (example Udayan Polly). Team has also visited Jagatpur loknath market in ward no 20. In Santoshpolly area waste disposal on a piece of land was also observed. Collection of waste from all those congested markets is done by vans. BBI channel passes through this market, which leads to Bagjola canal. Huge quantities of waste from Jagatpur market is disposed in thischannel. During monsoon the situation becomes worst due to clogging and overflowing of the canal.

The above situation, which was observed during site visit at Rajarhat area could be a true representation of the main challenge of most of the areas in Rajarhat.

5.1.2. Secondary Transportation

In Rajarhat area, numerous open vats and disposal points were observed, from where refuse compactors take the waste to Mollar Bheri. The team observed the same near New Adarsha Polly (WN 21), Surangari Paskal etc. areas. In the BMC area, a reconnaissance survey has been undertaken in

ward no 2, 6, 13, 14, 18, 19, 20, 21, to obtain a representation understanding of the present SWM system in critical areas of BMC and also to assess the situation with its gaps.

It may be mentioned that ward no 1-27 the infrastructure etc. are catered by Rajarhat stockyard (starts from VIP flyover) and ward no 28-41, comes under BMC stockyard. There are two zones which are physically separated by Kestopur canal. Each borough has been given one back hoe loader for waste handling and management. Construction & Demolition waste, generated from BMC area, is directly sent to Mollar Bheri disposal site. In Bidhannagar Municipal Corporation, there are 27-28 open trucks carrying wastes to the disposal site.

PwC team has visited a no of portable compactor stations of BMC, such as – in wards no. 6 (near to Kaikhali mongolbari area, adjacent to airport boundary). Transfer stations are receiving mixed unsegregated waste into its compaction unit. Intermediate Processing and Open Dumping

PwC team has also visited a number of open community dumping points. One of such points is in ward no. 2 (217 bus stand, back side of Shalyen Bhattacharya hospital & BORRC). Waste is dumped in unscientific way and spread over the entire land, causing environmental and social nuisance to the community. Similar thing has been observed in ward no 12, backside of City Centre 2, where waste is dumped openly without any measure. In ward no 13 and near to Hatiyara South Road, the waste is being dumped in a land (near JP timber/Hela Battola & opposite to Bongiyo Gramin Biswas).

5.1.3. Street Sweeping Waste

Road sweeping is done in between 09:30-14:00 hrs. Ward-wise lanes are defined. Street sweeping wastes are put into the nearest vat or 1100 lit bins from where truck lifts the waste. Main road is cleaned by mechanical road sweeping machines. Main two issues, were identified by BMC officials, they are – 1) uncontrolled disposal of C&D waste and mixing of same with the street sweeping waste, and 2) Disposing of street dusting and waste, as it creates lot of fugitive emission while releasing from automatic sweeping machine.

5.1.4. Biomedical, Hazardous and E-waste Management

Biomedical waste from BMC area is taken care by SembRamky. They also take care of the waste generated by the IT sector and office premises generate e-waste and few hazardous wastes, which are brought to Mollar Bheri. Another two generators of hazardous waste are Saha Institute of Nuclear Physics and Bhaba Research institute. They burn their waste at their site, as BMC does not have any incinerators. Carcasses and waste from some small factories like chocolate, medicine etc. bury their waste under the ground.

5.1.5. Status of Overall Awareness towards Waste Management

Awareness towards waste management has been observed as one of the biggest concerns in the study area. From discussions with BMC officials, it is understood that to cater the storage of substantial waste generated from huge population, 660 lit community bins have been placed at different corners of the city. However, waste can be found spread almost everywhere, due to casual behavior of the citizens. Such cases have been observed in abundance in ward no 14.

NIMBY syndrome was also observed in some areas. Waste from BMC area is being disposed off to the open road adjacent to HIDCO land in New Town jurisdiction (outside of BMC area).

Due to behavioral practices, most of the drains in Rajarhat areas are choked with C&D waste, causing waterlogging problems.

As green waste generators, Bidhannagar has around 16 markets and Rajarhat has around 50 markets (vegetables, fruits, flesh etc.). 660 lit and 1100 lit compactor bins have been put in those areas. However, throwing of waste by roadside hawkers is one of the issues in those areas.

The drainage outfall of the adjoined area causes problem in Bidhannagar area, the existing 2m dia. drainage underground pipe is almost filled 1/3rd of its volume with cement slurry, pillows, bedding etc. However, BMC has Nallahman machine to clean drains from accumulated waste from time to time, which is not effective enough to mitigate the issues faced by BMC.

Habitation has been developed along Kestopur canal as well as along Bagjola canal. The team visiting the area found indiscriminate disposal of waste in the open despite of bins being placed alongside the Bagiola Canal. This can be directly attributed to the lack of civic awareness and behavioral issues towards sanitation and waste management. Therefore, from the above discussions, it is evident that proper IEC, awareness followed by enforcement will be one of the important aspects of the SWM system, both for the waste handlers as well as generators.

5.1.6. Initiatives by BMC

Presently collection and transportation, by and large are being managed by BMC themselves. If privatization happens in future, the option of absorption of BMC staff in the privatized system needs to be considered.

It was also understood that during FIFA 2017 under 17 World Cup, modern equipment, such as – last longing GI bins, RC or refuse compactors, tippers etc. were procured and presently in use.

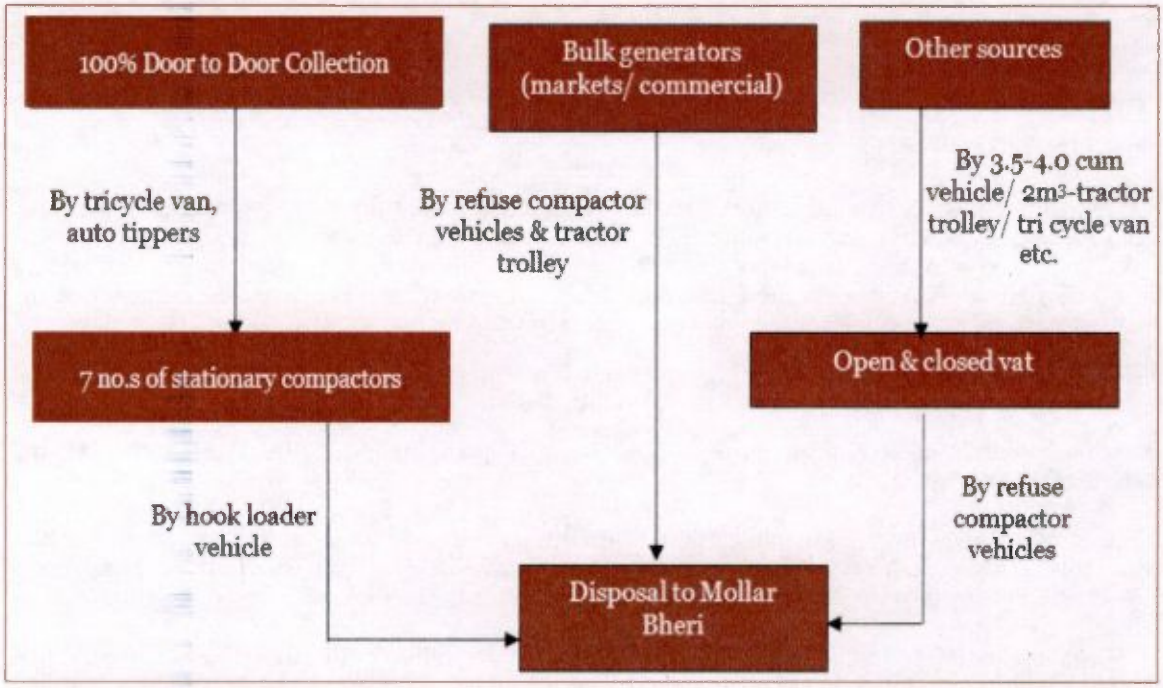
From the discussions with BMC officials, it was noted that a pilot project on composting has been planned from Coal India CSR fund. All PPEs were given by them to the labors, such as – color coded dress, gloves, gum boots, rain coats etc.

Under corporate CSR initiative (RS foundation, Swacch. etc.), different technology of waste treatment was tried, such as black hole technology etc. 2 TPD pilot compost plant for household waste has also been initiated by BMC.

BMC has 3 bigha of land near Rajarhat, which could be made available for the SWM project. Besides that, near to central park at pilot level secondary segregation of dry waste is also being practiced by BMC.

Salt Lake satellite town has been considered under NGT model town for implementation of scientific waste management system. Current waste management practices as a whole in BMC area is broadly presented in the figure below.

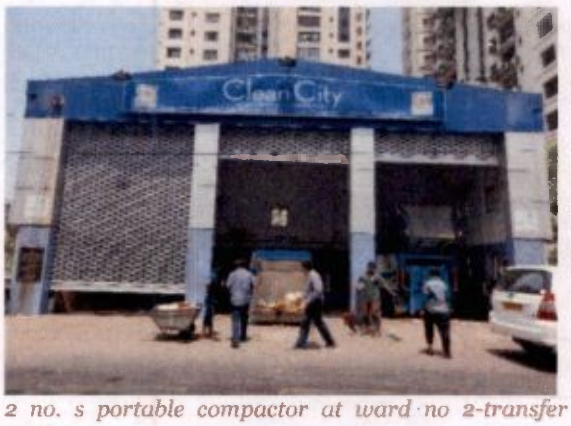
Figure 8 Flow chart of current waste management scenario in BMC



5.2. Kolkata Municipal Corporation area

PwC study team had selected borough no I, III, and VII in consultation with senior KMC officials and undertaken reconnaissance survey in few wards in those boroughs. Such wards are – ward no 31, 32, 33, 57, 66 etc. to understand the current situation and prevailing waste management practices. Besides this, the team had also discussed with senior officials of KMC in SWM department and obtain an overall scenario of the same. The understanding developed through above two modules, are being discussed below:

Figure 9 Existing Situation in ward no.32



2 no. s portable compactor at ward no 2-transfer station

Portable compactor under operation

Figure 10 Existing situation in ward no.33

Compactor station at ward no. 33

Garbage transported from households in a push cart and being loaded into the compactor

5.2.1. Source segregation and primary collection

The waste generation in KMC is about 670 TPD from these three wards. In ward no. 33(Borough III) & 64(Borough VI) source segregation is in practice. 100% collection & transportation exists as of now. As mentioned above, reconnaissance survey was undertaken in Ward no. 32 (along CIT road, Nazrul Islam Sarani), Ward no 31 (Maniktala Road and Narkeldanga), Ward no. 33 (Narkeldanga main road to Chawalpatti Road), Ward no. 57 (Chawalpatti road to metropolitan). In ward no. 33 (from Jora Mandir Bazaar to CIT road, which has lots of slums area with dense population).

At household level, waste is collected through pushcarts, tricycles and BOHT. Besides residential waste there is a substantial waste generation from different markets, foot paths, hawkers and street vendors. The disposal of waste is sometimes on street. Storage of waste in dustbins is not in practice in

all places and in such areas, generators throw waste on the road from their respective establishments (example Borough no. VII – New market, Lindsay Street, Chowranghee Road etc.).

In broad street, Bondale gate area, Topsia, Tiljala etc. area residents are not active on the morning time and do not want to hand over the waste to the collectors. As a result, most of the wastes are dropped on the road after the collection time. As per the discussions with Borough VII SWM officials, awareness is one of the biggest issues in implementation of proper waste management in their borough. Lot of tannery wastes, leather wastes, processed raw leathers etc. are also mixed with the MSW.

In KMC areas, out of all wards, there are only eight wards where source segregation is in place. Primary collection is done by handcart and auto tippers. Segregated dry waste is further goes through secondary segregation for different recycling revenue generating streams. For example, dry waste generated from Borough no. VII, taken to Dhapa check post for weighing and then further sent to PCB approved recyclers at Boral.

5.2.2. Secondary transportation to transfer stations

KMC has around 100 nos. of compactor stations (transfer stations). Out of those, the team visited few. At Bengal Chemical Compactor Station (ward no 32), which has three 9 MT compactors. In Ward no. 31 behind Beleghata hospital and near to Subhash Sarovar (Narkel Danga main road) two 9 MT compactors were seen to be present. All compactor stations mostly received mixed waste. Other observations from the team are as follows:

a. Filth around the compactor stations
b. Delay in lifting of the waste from the compactor stations
c. Inhibitions in operations – power failure, ROW, Lack of staff etc.
d. Community's reaction to the management of the compactor stations.

5.2.3. C&D and Other waste generation

From the discussions with the Assistant Director of Borough VII, PwC understood that many slums are being converted to real estate development, generating more C&D waste from those areas. Total C&D waste from KMC boroughs is estimated to be close to 133 TPD.

72-100 TPH C&D waste processing plant is proposed to be installed at Dhapa.

5.2.4. Treatment and disposal of waste

The KMC disposal site is located at Dhapa, which is about 35 hectares of land. Around 12 ha has been closed in the year 2008-09 and presently dumping is going on in 23 ha of active disposal area.

More than 90% of the waste is generated from KMC wards are getting disposed to Dhapa disposal site. On an average daily 4500 tons of waste is reaching to Dhapa landfill. This is mostly compacted and unsegregated waste (along with segregated green waste from eight of wards, where segregation is in place).

Dhapa disposal site is not only receiving the municipal solid waste from KMC areas, it also currently receives cesspool wastes, night soil, market wastes, slaughterhouse waste, drain silt, and landscaping waste.

However, the biomedical waste generating from KMC area is handed over to SembRamky, a private agency for effective disposal, which does not make it to Dhapa for disposal.

5.2.5. Initiative taken by KMC

The waste accumulation condition of Dhapa disposal site has reached beyond its capacity. From the discussions with stakeholders, it was understood that, for this particular reason provision of 20-acre land in HIDCO (near to Rosedale & Bagjola khal) was once made (much earlier to the conceptualization of this particular feasibility TA project) by KMC for setting up waste processing

facility there (dedicated waste quantity ~ around 540 TPD). And besides that, a provision of around another 35 acres of land was also identified at Rasapunjo (near Joka) for disposal of waste, generated from KMC area.

KMC, in 2018 had planned to set up crusher units at the dumping ground at Dhapa for the purpose of crushing chunks of C&D waste into fine grains, which can further be used in the construction of roads.

5.2.6. Concerns of stakeholders

The concern of 540 TPD waste (as discussed in previous section) has been suggested[3] to include as one of the parameters of this feasibility study. Based upon this, the feasibility study has been undertaken to assess the maximum feasible quantity that could be accommodated to this project from KMC area and mapping of its' associated KMC wards has been done accordingly.

Figure 11 Flow Chart of Current Waste Management Scenario in Selected Borough of KMC

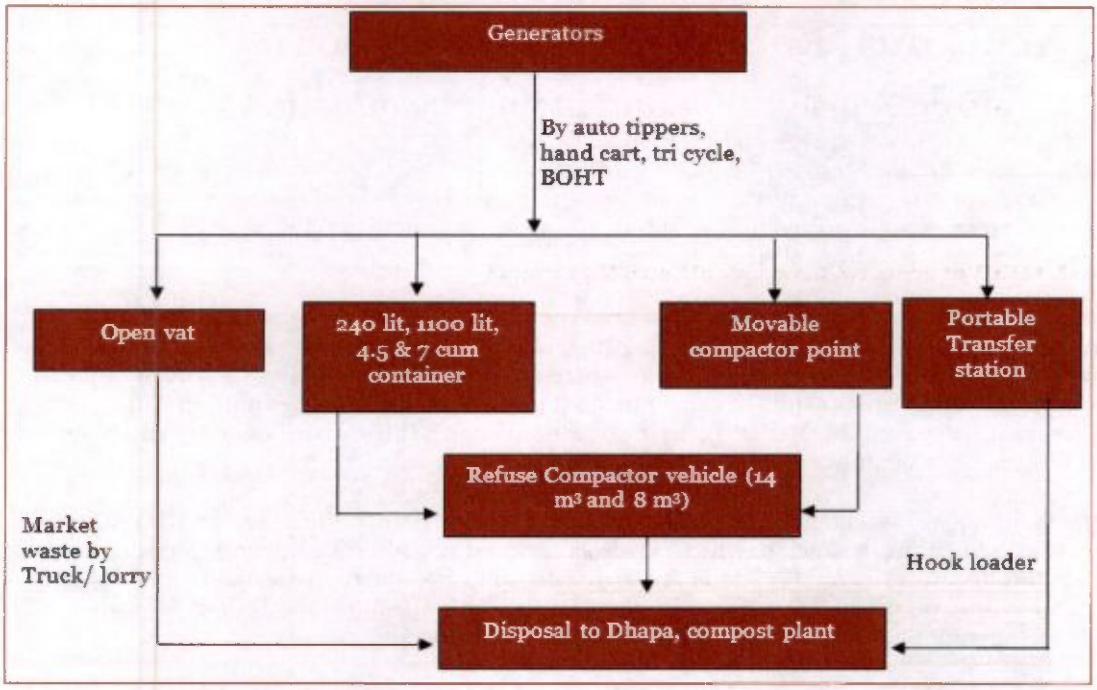


Figure 12 Existing Situation and key concerns in few representative wards of Kolkata Municipal Corporation Area- Borough-VII

Hydraulic BOHD used for primary collection of waste from Households

Water bodies adjacent to the open dumping at Topsia

[3]*Source: as per the discussions with DG(SWM), KMC*

Water bodies adjacent to the open dumping at Topsia

Vats with open dumping at Topsia

5.3. New Town Kolkata Development area

5.3.1. Source segregation and primary collection

NKDA generates around 50 TPD of waste. Since 2011 household level door to door collection is operational. As of now around 33161 nos. of households are covered under door to door collection. Two private agencies are involved in this system of waste collection. Up till February 2019 end mixed waste was being collected from all areas.

The objective of NKDA is to achieve 100% source segregation. However, as per the discussions with NKDA officials, they have a challenge of storing of segregated dry waste for further recycling. However, 5th March 2019 onwards, pilot level segregation has been initiated for 200 household & cooperatives in Action Area I. The segregated waste is kept within the premises until the lifting occurs, and later is disposed off to Mollar Bheri by means of one vehicle daily or every alternate day (depending upon the quantum of reject accumulated).

Segregated dry waste is taken to the 20-acre HIDCO land at Patharghata (near Lascar Hat) twice a day on Thursday and Saturday. Each day three vehicles are used (250-300 kg tippers) to transport them and then the dry waste is further manually segregated into 5/6 different waste streams, namely – metal, PET bottle, plastics, paper & boards, glass bottles, and others (wood, beddings, clothes etc.). Segregation operation takes place from 9 am to 5 pm by seven workers.

5.3.2. Secondary transportation and recycling

Although, segregation process is in place, it is being carried out at the pilot level and within a few areas. Largely the mixed waste is collected and transported from auto tippers to unload the waste into the 1100 lit compactor bins, which are kept at the following –

Table 6 Collection points in NKDA

#	Collection Points	#	Collection Points
1.	Near Water Tank No. 03	14.	Near Rabi Rasmi Housing; Street No. 306
2.	DLF Galleria	15.	Opp. To Near Unitech Gate -1
3.	Near Reliance Fresh	16.	Near Unitech Gate 1 Bus Stop
4.	Near Old Police Station	17.	In front of green field heights
5.	Tarulia R. R. Colony	18.	Balaka Housing
6.	In front of Pride Hotel	19.	Besides Tata Medical
7.	Opposite to Unitech Gate 2	20.	In front of OHIO Hospital
8.	Near Eco Space	21.	Near Uniworld Housing

9.	Near Bodoland House
10.	Near Axis Mall
11.	Near DLF 1 Gate No. 5
12.	Near Westin Hotel
13.	TCS Gitanjali Park

22.	Near Karigori Bhavan
23.	Near Down Town
24.	Shapoorji Bus Stand
25.	Inside Shapoorji Housing Complex

NKDA is in need of an agency for segregation of the dry waste and recovering utilization or reusable material from it through recycling process. In this context, a material recovery facility may be helpful, if initiated. However, NKDA do not have any dedicated and have not yet identified land to provide for waste management on similar lines.

From those twenty-six points, four 12 MT compactors take the waste to Mollar Bheri disposal ground.

5.3.3. Pilot scale initiatives on processing and treatment – key learnings

NKDA had initiated a pilot project in the market with 1 TPD of compost plant, accompanied with deodorizer. However, it did not work successfully due to odor issues. NKDA did not pursue the same further as the technology was not able to reduce the odor generated. Another semi-automatic machine was installed at CB community rooftop for the purpose of organic garden farming from green waste. It was accompanied with microbes' spray for 10 minutes and then shredding. The residential time of waste to manure was 20-22 days. However, this initiative was also not successful, as the system emits too much noise, while operational. NKDA did not follow up the same with effective understanding of the situation and it was understood that no IEC along with BCC was done to ensure continued operations.

5.3.4. Disposal system

Mixed waste collected from the twenty-six secondary collection areas are transported and disposed at the Mollar Bheri dumpsite without any treatment. Vehicle Tracking System

NKDA has installed Vehicle Tracking System (VTS) in all vehicles plying in the region for the purpose of collection of solid waste matter and sweeping roads.

5.3.5. Biomedical and Hazardous and C&D Waste Management

For biomedical and hazardous waste, respective institutions take care of their own waste.

A substantial amount of C&D waste is generated from this area, due to new development. Till date no proper C&D waste management is in place within the ULB jurisdiction, hence the quantification of the same is also lacking. In Eco park, objects from recycling of garments etc. has been initiated and is drawing attention from visitors.

5.3.6. Informal recycling sector

Engagement of informal sectors in waste recycling was observed at the immediate backside of City Centre 2. Here recyclable glass bottles are segregated and taken to Kalipur for selling by informal recycling sector, on their own without ULB's interventions.

5.3.7. IEC initiative

NKDA has recently initiated IEC activities on regular basis for source segregation in dual dustbins, as understood from their officials. From discussions, it was understood that the waste management in New town would need to be addressed in a different way as it is a small city, planned city and there is always a possibility of upgradation of the waste management system.

Figure 14 Flow Chart of Current Waste Management Scenario in NKDA

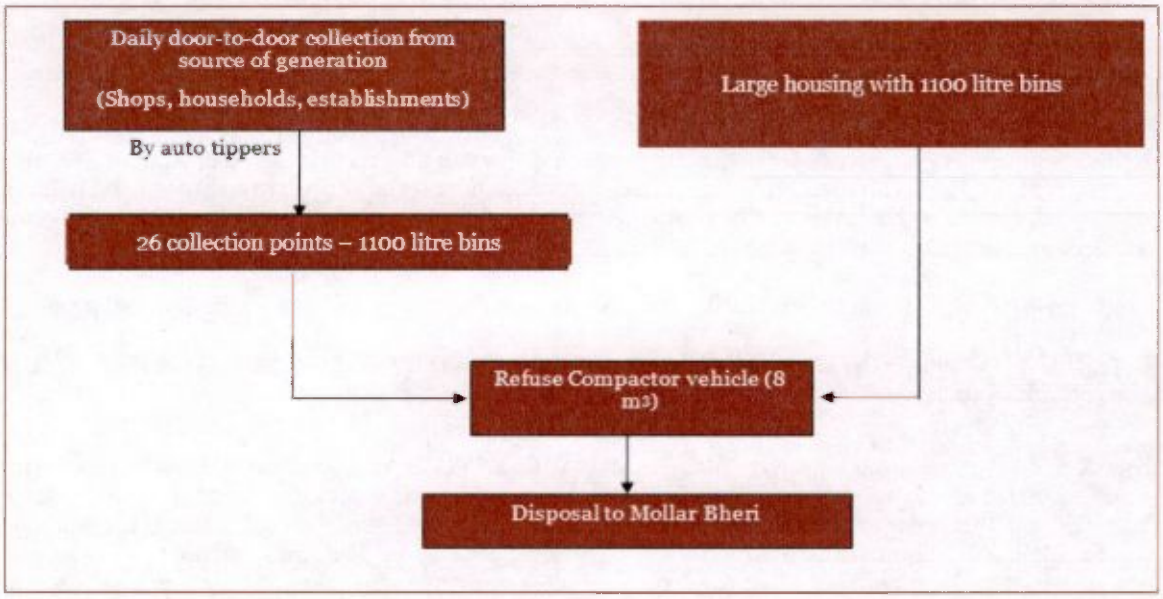


Figure 13 Waste Management Scenario in NKDA Area

Open roadside dumping on either side of the road at New town

Open roadside dumping near New town

Segregation centre at HIDCO 20-acre land

Recyclable items at segregation centre

5.4 Nabadiganta Industrial Township Area (NDITA)

5.4.1 Primary collection

In NDITA area, door-to-door waste collection of MSW is already in practice. NDITA is primarily a commercial establishment area, with comparatively less or no residential source of waste generation. The waste collection from those commercial establishments is mainly outsourced by NDITA (both manpower and primary equipment for collection & transportation). There are around 250 nos. of collection points. Currently source segregation has commenced at a pilot level and NDITA is looking to replicate the same across all the zones.

In addition to door to door collection, small bins will be placed at multiple locations in NDITA, which experience large footfalls like road side eateries, restaurants, shops. The garbage collected from those locations will be dumped into vans, which transport waste to the compactor stations. Also, roads are swept by workers mechanically on a daily basis.

The generation of waste is approximately 27 TPD. Storage of segregated waste will be one of the biggest challenges of NDITA, as per the discussions with the Chief Engineer of NDITA.

5.4.2 Secondary transportation

After primary collection, waste is brought to two compactor stations, from where it is sent to Mollar Bheri by means of hook loaders. The location of compactors is at – GN/28 near to Swastha Bhawan and AQ 13/2 (where there is a weighbridge in place). The outsourced agency is paid on tonnage basis after weighting the waste at weighbridge. As of now, it is understood that no KPI linked arrangement is in place with the agency.

5.4.3 E-waste management

Taking into account the presence of a large number of IT and ITES firms in Sector V, NDITA has introduced guidelines for collection and disposal of e-waste. A firm, which wants to dispose e-waste, has to inform NDITA, following which the authority will initiate a process to collect and dispose the waste matter. No e-waste is collected by the NDITA as of now and it is understood from discussions with NDITA that big corporate houses may be having some different arrangement for handling/ disposing off their e-waste through some other agencies. Most of the e-waste is sold to authorized recyclers by respective corporate houses, offices, IT establishment etc., as informed by NDITA.

5.4.4 Treatment and disposal

The waste generated from NDITA is currently disposed off to Mollar Bheri without any treatment. The total waste generation is about 27 TPD.

Disposal of unused fiber optical cable is a big challenge of NDITA. Substantial amount of unused cables is rejected on the roads or nearby open ground, which causes choking of drainage system, blocking of roads etc.

5.4.5 Initiative of NDITA on source segregation

It is understood from discussions that NDITA is in the process of initiating a very primary level segregation of waste into wet and dry at AQ 14/1. Wet waste would be sent to Mollar Bheri and dry waste will be segregated further for recyclables. NDITA has also undertaken several awareness campaigns in the form of workshops with representatives of the companies present in Sector V on how to segregate waste at the source. The following flowchart shows the existing waste management scenario in NDITA.

Figure 15 Flow Chart of Current Waste Management Scenario in NDITA

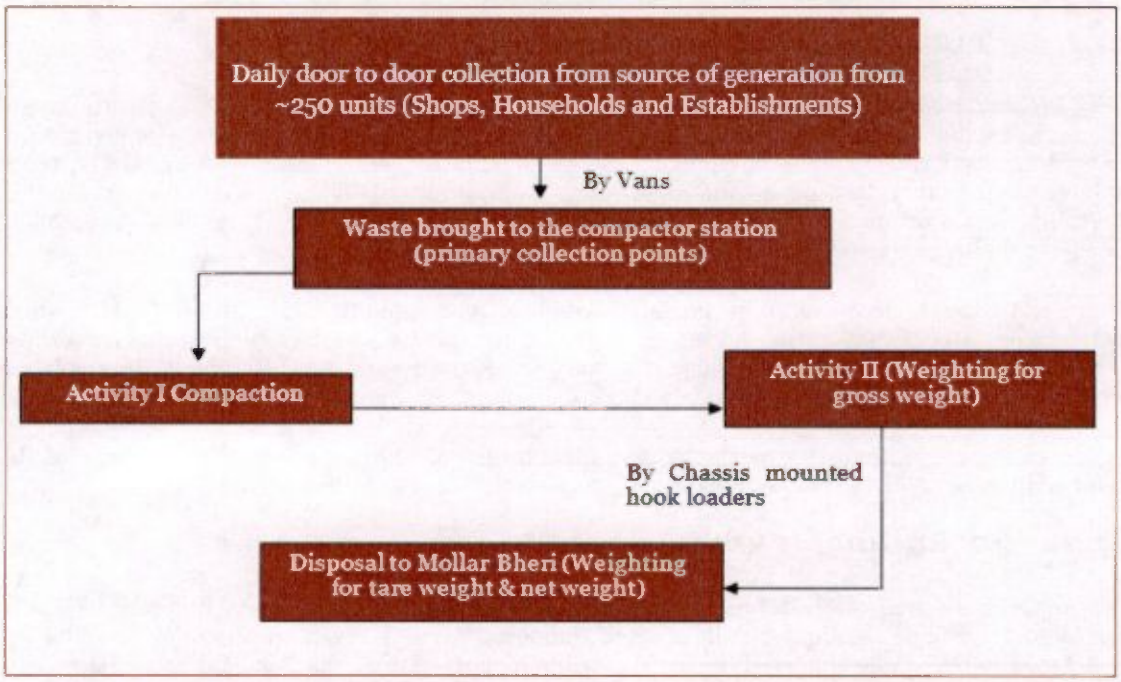


Figure 16 Waste Management Scenario in NDITA area

Automatic street sweeping machine at AQ-13

Compactor at GN 28

Dry waste collection point at AQ-14

Open dumping adjacent to AQ-14

5.5 Mollar Bheri waste disposal ground

As already discussed in previous chapters, Mollar Bheri site is extremely vulnerable to the environmental impacts due to this continuous dumping of untreated municipal solid waste and with the generated leachate eventually flowing into the adjacent wetland, thereby contaminating the ground water table below. The uncontrolled disposal at this site poses a potential threat due to release of leachate, landfill gas and suspended particulate matter. In addition to this, uncollected waste, which falls on the road during transportation, causes blockage in the drains adjacent to the disposal site. A number of water bodies and wet lands surround this site. There is also a high potential for real estate development and high-rise buildings, very close to the site (within 500 m distance).

The site area falls under East Kolkata Wetland, which has been declared as one of the Ramsar sites. The satellite image of the location of disposal site is presented in the following figure.

Figure 17 Satellite Imagery of the Disposal Site at Mollar Bheri

The specific situations associated with Mollar Bheri disposal site are being discussed in the following sections.

5.5.1. Groundwater Contamination

In absence of any liner at the bottom, the leachate percolated through the base of the dumpsite meets the groundwater making it contaminated. Besides this, there are a large number of wetlands adjacent to the dumping ground. The leachate from the site also contaminates both the groundwater and surface water. *Soil Contamination*

The current dumpsite is un-lined; the contaminant from waste and leachate is absorbed onto the underlying soil. Since it is an uncontrolled disposal site, the mixed waste contains different types of pollutants, which eventually have an impact on the soil.

5.5.2. Ambient Air Quality

The issue of ambient air quality of the Mollar Bheri dumpsite is twofold and are discussed below:

Greenhouse Gases

Since the dumpsite receives fresh untreated waste, anaerobic decomposition of the organic matter is a rampant phenomenon, which leads to release of methane gas, which is a potential greenhouse gas. It has many times more global warming potential than carbon dioxide. At the local level, due to release of methane gas, the adjoining settlements, and residential areas etc. experience obnoxious smell throughout the day and the surrounding area turns unhealthy.

Open Burning

In this dumpsite, open burning of waste has become a common practice. It releases toxic components such as furans, dioxins in the adjoining area, which has critical health impact for children and adults. However, we have found that the AQI levels for NO2, PM10, SO2 in Salt-lake was under 50 signifying the impact of the same has minimal heath impacts for the residing population; however, this does not signify promoting the existing practice of open burning at the dumpsite.

5.5.3. Social Impact and Health Hazard

Since the disposal site receives untreated unorganized mixed waste stream, there are biomedical, hazardous items within the accumulated waste in the dumping ground. Items like broken glass, blades, needles, explosive container, batteries, CRT, ULAB etc. pose risk of injury or chronic illness to the children and adult rag pickers who are associated with the garbage disposal site for their livelihood.

Rag Pickers Profile at Mollar Bheri

From the discussions with the local stakeholders and informal waste recycling sector at site, it was understood that more than 100 nos. of trips are made from different ULBs to Mollar bheri. More than 100 rag pickers work in this disposal site. Around 150 kg of recyclable items are segregated by each of them per week and sold to the recycling markets. Revenue generation per kg is approximately Rs 17-18/-However, the monthly income by rag pickers is limited to Rs 6000/- to 7000/-, comprising of 4-5 members of family. The rag pickers age profile is mixed They pick waste primarily from the vehicles containing fresh waste. Rag pickers are active at the disposal site between 9 am and 5 pm.

Linking of informal recycling sector to an organized waste collection taskforce system, could be considered as one of the soft components of the implementation strategy of this project.

Figure 18 Pictures of the disposal facility in Mollar Bheri

Entrance to disposal site

Waste lying at Mollar Bheri

Access through waste dump

Refuge compactor at disposal site

Rag picker consultation

Animals at disposal site

5.5.5 Key Issues with Mollar Bheri Disposal Site

Key Environmental Issues

Based on the stakeholder consultations done by PwC, some of the key issues can be effectively summarized below-

- Uncontrolled waste dumping. The nature of waste being dumped is untreated fresh waste
- The waste stream is of mixed type.
- No Compaction done, No Liner, or bund which shall contain the landfill, no leachate collection drains etc. Disposal is being done unscientifically.
- Contamination of soil, groundwater, ambient air quality
- Potential risk from hazardous and biomedical items within the garbage
- Fire at site due to uncontrolled open burning.
- Sliding of garbage heap due to instability
- Aesthetics and health impact to the neighborhood settlement due to odor and fumes from bio-degradation and open-burning.

Key Social Issues

Since the disposal site receives untreated unorganized mixed waste stream, there are biomedical, hazardous items within the accumulated waste in the dumping ground. Items like broken glass, blades, needles, etc. pose risk of injury or chronic illness to the children & adults rag pickers who are associated with the garbage disposal site for their livelihood.

During site visit and focus group discussions with the rag pickers, local people and site in-charge of Mollar Bheri disposal site, the following were the main observations:

- Death of animals due to accidental consumption of polythene spread all over is a common problem
- People face sleepless nights due to bad odor and smoke
- Individuals have bought residential flats near the disposal site due to urban growth in this area. However, they have voiced strong concerns with all concerned authorities and NGT for its scientific closure.
- It is further assumed that, the land value might increase in future after scientific closure of dumping ground which might lead to further urbanization

6. Gaps, scope and intervention areas

In previous chapter, the current waste management practices and the existing situation in all those four ULBs has been discussed. In this section analysis, interpretation, their gaps and areas of intervention etc. are being discussed, as it will pave the path for effective integration with the existing issues and effective pathways for seamless transition.

6.1. Gap Identification and Key Issues

6.1.1. Key Issues in four ULBs

In order to identify the gaps - review and appreciation of the prevailing guidelines and rules of MSW 2016 was done by PwC. Thereafter the comparison of existing practices against the standard practices has been assessed.

The inferences, arrived from such assessment and analysis, are being depicted in the following sections.

Table 7 Inferences of situation & gaps in present system- Bidhannagar Municipal Corporation (BMC)

SN	Head	Existing Practices in BMC	Identified Gaps and Issues
1	Source Segregation	• Rag-pickers & waste collectors informally segregate the waste to extract valuable materials from it	• Absence of 100% segregation at source in strategic organized way
2	Primary collection	• 100% door to door collection is in place (6-9 am) • Collection is done by van rickshaws and auto tippers	• Collection from high rise societies, due to mismatch of waste collection timing, stray animals spread waste within the premises • Challenges in primary collection in Rajarhat, due to narrow lanes
3	Secondary transportation	• Transfer stations are in place • Stationery & mobile compactors are used • 27-28 no. s of open trucks operational	• In transfer station and compactors, mixed waste is transferred for compaction • Many open vats in Rajarhat • Waste transportation in open trucks
4	Street sweeping	• Defined mechanism exists for street sweeping both by manual method and by automatic sweeping machine • Street sweeping waste is put inside 1000 lit roadside community bins	• Uncontrolled roadside disposal of C&D waste, mixed with MSW • Fugitive emission while unloading street sweeping waste from automatic road sweeping machine • Plastic waste disposal is one of the major challenges to handle
5	Processing & treatment	• Collected waste is eventually disposed off to Mollar Bheri without treatment	• Absence of any processing and treatment facilities (except few pilots under CSR fund)
6	Waste disposal	• There are a number of open dumping points within the city, where is disposed as per the convenience of the citizens	• Open and unscientific intermediate dumping points exists in almost all major locations within the city
7	Awareness level and common practices	• No dedicated and organized IEC activities • Real estate segment contributes significantly in illegal and unorganized disposal of C&D waste along the road • Uncontrolled behaviours of roadside hawker	• Waste spread over, due to behavioural pattern • NIMBY Syndrome due to scarcity of land • Blockage of drain due to choking due to SWM • Roadside green waste disposal in markets

		• Habitation encroachment along canals	• Throwing of waste in the stretch between two adjacent waste bins
8	Other Wastes management	• C&D waste is disposed off to Mollar Bheri by BMC • Biomedical, hazardous waste - taken care by generators	• No system in place for C&D waste management and mixed with MSW
9	Initiative taken	• Pilot composting project from Coal India CSR fund • Black hole technology was once tried under RS Foundation & Swachh CSR activities	• As of today, both the technologies have not been further implemented in commercial scale.

The inferences of situation & gaps in present system ~ Kolkata Municipal Corporation (KMC) is represented in the next page.

Table 8 Inferences of situation & gaps in present system ~ Kolkata Municipal Corporation (KMC)

SN	Head	Summary of Existing Practices in KMC	Identified Gaps and Issues
1	Source Segregation	• Source segregation is in place in only 8 nos. of the wards out of 144	• Absence of 100% segregation at source, through any strategic or organized way
2	Collection & transportation	• 100% door to door collection is in place (6-9 am) • Collection is done through push cart, tricycle and hand cart, BOHT • There are also refuse compactors which pick waste from road side bins (markets) • 240 lit road side bins transfer waste to the auto tippers • Around 102 nos. of compactor stations exist in the city	• All compactor stations receive mixed MSW along with landscaping waste • Mix match of timing of waste collection and residents' willingness to response to collectors • Tannery waste, leather wastes, processed 7 raw leathers etc. are also mixed with the MSW and disposed through open vats
3	Processing & treatment	• A compost plant exists in Dhapa, which caters to the green waste from 8 nos. of wards (500 TPD)	• Most of the waste is disposed unscientifically without any treatment (except 500 TPD) • No space in the form of land is available with KMC for processing
4	Waste disposal	• In Dhapa (total area 47 ha), active disposal area 35 ha • Compacted and mostly unsegregated waste (except from 8 nos of wards) disposal takes place in Dhapa	• No scientific disposal of waste, except daily cover on active cell • No engineered SLF present

5	Other Wastes management	• C&D waste is being generated from the slum wards, which are being turned to real estate development areas. • 72-100 TPH C&D waste is proposed to install at Dhapa. • Cesspool wastes, night soil, market wastes, slaughterhouse waste, drain silt, landscaping waste etc. all are disposed off to Dhapa • Biomedical waste is unscientifically disposed off to Howrah dumping ground.	• C&D waste is also mixed with MSW and is getting disposed off to Dhapa • All other types of waste except biomedical are disposed off to Dhapa.
6	Awareness	• Throwing of garbage on roadside • Non-cooperation of residents with the waste handlers	• Continuous long-term re-groups and IEC campaigns has been strongly necessitated
7	Initiative taken	• KMC has identified 20-acre land in HIDCO area to address around 540 TPD of waste for waste to energy plant • Provision of around another 35 acres of land was also identified at Rasapunjo (near to Joka) for disposal of waste • In 2018 KMC had planned to set up crusher units at the dumping ground at Dhapa	• KMC does not have any other alternative land for processing & treatment • C&D waste plant does not cater all waste generating from KMC areas

The inferences of situation & gaps in present system ~ NKDA is represented in the next page.

Table 9 Inferences of situation & gaps in present system - New Town Kolkata Development Authority (NKDA)

SN	Head	Summary of Existing Practices in NKDA	Identified Gaps and Issues
1	Source Segregation	• 5th March 2019 onwards, pilot level segregation has been initiated for 200 household & cooperatives in Action Area I	• Storage of segregated waste is a challenge for the ULB
2	Primary collection	• Household level door to door collection is in place through third party engagement	• NA
3	Secondary transportation	• Segregated dry waste is taken to 20-acre HIDCO land for further segregation • Auto tipper (4 nos.) are used to transport wet waste into 1100 lit compactor bins	• NA
4	Processing, treatment	• From dry waste, manual separation of recyclable material is done at HIDCO land	• No scientific process or treatment facility or recycling facility is available

5	Waste disposal	• Segregated wet waste disposed off to Mollar Bheri by refused compactor (4 nos. 12 MT) • Dry rejects from segregated waste transported to Mollar Bheri in open vehicle	• No scientific landfill • Use of open vehicle for disposal
6	Awareness level and common practices	• IEC activities on regular basis for source segregation	• NA
7	Other Wastes management	• For biomedical and hazardous waste, respective institutions take care of their own waste	• Need of C&D waste treatment facility has been necessitated.
8	Initiative taken	• A pilot project in the market with 1 TPD of compost plant, accompanied with deodorizer. • Semi-automatic machine was installed at CB community roof top for the purpose of organic garden farming • Vehicle Tracking System (VTS)	• Odour issue from the compost plant • Sound issue from organic roof top farming

Table 10 Inferences of situation & gaps in present system - Nabadiganta Industrial Development Authority (NDITA)

SN	Head	Summary of Existing Practices in NDITA	Identified Gaps and Issues
1	Source Segregation	• NDITA is on the process of initiating primary level source segregation in AQ 14/1 block	• No full-fledged source segregation as exists as of now.
2	Primary collection	• Door to door waste collection of MSW is already in practice • Community bins in large footfall areas, eateries, shop and commercial areas.	• In primary collection, mixed waste is collected
3	Community bins in large footfall areas, eateries, shop and commercial areas.	• Auto tippers are used to transport waste to two compactor stations	• No dedicated compactors for wet and dry waste, as there no source segregation
4	Secondary transportation	• Mechanical road sweepers are operational	• NA
5	Street sweeping	• Waste management in NDITA area outsourced to a private agency	• No processing or treatment is in place • No KPI defined to the agency and commercial term is based upon waste tonnage disposed per day.

6	Processing & treatment	• Compactors take waste to the Mollar Bheri disposal facility	• No scientific disposal of waste • Disposal of unused fibre optical cable is one of the biggest issues
7	No KPIsare defined to the agency and commercial term is based upon waste tonnage disposed per day.	• Several workshops and awareness campaigns with representatives from sector 5 companies for waste segregation	• NA
8	Waste disposal	• E-waste handling is taken care by individual corporate houses	• E-waste generation is substantial in this region. NDITA is yet to implement the guideline of e-waste disposal and its implementation • Unused and damaged fibre optical cables (cut pieces) are one of the biggest challenges to dispose in the ULB

6.2. Scoping and Intervention Areas

6.2.1. Interventions in the four ULBs

Based upon the analysis made in the previous section, the scoping of the feasibility study vis-à-vis intervention areas of the project have been identified and are being furnished below:

- Source segregation of wastes into two waste streams – 1) green organic food waste or wet waste and 2) other mixed waste or dry waste
- 100% collection of waste from residential (door-to-door), commercial, institutional and other areas.
- Rationalization of door to door waste collection timing with three bin system
- Rationalization of street sweeping mechanism, collection & disposal
- Special attention to primary collection from the areas with narrow lanes
- Feasibility of converting the city into bin-less city and use of refuse compactors, compatible with duel 1100 lit bins
- Feasibility of setting up or augmentation of transfer station with compactors
  1. *to identify location/ area of new transfer stations, if needed*
  2. *Converting open disposal site to transfer stations*
  3. *Converting mixed waste receiving compactors to segregated compactors*
- Waste transportation in closed vehicle with route optimization
- ICT based tracking mechanism for collection & transportation system
- Feasibility of setting up Processing and treatment facility for green waste
  1. *Regional treatment facility (compost plant) for the cluster*
  2. *Community level treatment of waste within the generation premises*
  3. *Option of treatment of green market waste with energy recovery mechanism (Bio-methanation)*
- Feasibility of setting up Material Recovery Facility (MRF) for mixed dry waste and recycling of utilizable material from the waste
- Formulation of rigorous IEC program and training modules
- Planning, design & development of scientific landfill
- Other waste (E-waste, biomedical, hazardous etc.) waste management
- Development of KPIs based waste management system with defined service level

While implementing the above-mentioned interventions, the following primary criteria have been kept in consideration as a part of sustainable and scientific waste management solution:

- Integration of existing infrastructure & investment made into the proposed system
- Synchronization of existing master plan or any future schemes into the proposed system
- Optimization of land utilization (minimum disposal)
- Reduction of manual handling
- Compliance of Rules, environmental & social safeguards
- Technological flexibility and options

6.2.2. Interventions at Mollar Bheri & Reclamation

In view of the above discussions, it can be concluded that, the current disposal site at Mollar Bheri is under environmental threat both physically and socially.

Moreover, the dumping is being carried out without any compaction of waste at site. The bulk density of the waste, lying at the site is very low. It indicates that, in future due to absence of any in-situ compaction, the dumpsite would be entirely accumulated by garbage disposal. Therefore, it has been necessitated to reclaim the land prior to its closure and the need of systematically shifting & relocating of scattered waste from the dumpsite, to a single place in an optimized manner has been envisaged.

In view of this, it is intended to reclaim maximum land out of this disposal site. As an alternative to this site, planning for an engineered sanitary landfill for the processed waste needs to be done prior to the closure for effective intervention. Furthermore, future interventions around this area need to clearly consider the areas where development is strictly regulated under Ramsar convention protected area. Following map shows areas in East Kolkata wetlands that are protected under Ramsar convention.

Figure 19 Moujas under the East Kolkata Wetlands

Source – Official Website of EKWMW - http://ekwma.in/ek/maps-2/

7. Model case studies and suitable technology options

Based on our understanding of the various models prevalent in the area of study, we have identified the best practices from across the country for exploring the replicability of the same in the context of the present cluster. Understanding the key-takeaways from the same would help the authority in understanding various models for effective administration. For detailed context, please refer to ***Annexure A.2.***

7.1 Key takeaways from model cities

Table 11 Key take away from model cities

City	Key Takeaways
Pune[4]	• Door-to-Door collection is undertaken by an NGO called SwaCH, following which gate collection is done from households through Ghantagadis, which start collection from 6:30 AM onwards and have separate partitions for dry and wet waste. However, the level of segregation is only 50%. The Ghantagadis transport the waste to transfer stations where the waste is compacted and sent to respective processing sites using bulk refuse carriers. • Apart from this, there are households that process waste at their complexes itself. More than 10000 households have installed vermicomposting arrays at their buildings itself, PMC has offered a property tax rebate to all those households. • Moreover, PMC has prepared an action plan for involving the citizens in the SWM value chain. As part of the IEC activities, PMC has planned outreach programs through special groups like schools & colleges, Corporates, Lions and Rotary Clubs and SHGs. It has also planned to conduct ward level rallies, exhibitions to generate awareness on a door-to-door basis.
Varanasi[5]	• Sweepers', appointed by VMC, engages in primary collection or door-to-door collection of MSW and carrying it to the nearest collection points (called as depots or community bins), which are then directly hauled by the collection vehicle from the collection points to the disposal site. VMC has provided 26 depots for the temporary storage of MSW, which are scattered throughout the city. • Previously, waste used to get deposited in the area near Varuna tributary of river Ganges and Ramnagar dumping grounds. However, MSW is presently sent to waste treatment plant at Karsana and Bhavaniya where it is disposed by scientifically and in well-designed engineered manner. • About 15% (80 tons) of compost is produced from an average of 500-600 metric tons of waste processed every day in waste treatment plant, which is sold to the locals at Rs.1000 per tons.
Indore[6]	• In Indore, waste is generated in segregated form as domestic, semi bulk and bulk generators and is collected in segregated form by partitioned tippers from domestic generators. • The tippers have a predefined collection route (monitored by a GPS enabled tracking system) and on completing their collection routes, move to their designated GTS and offload their waste in the designated compactor. The compactor compresses the waste and it is loaded on the hook loader to be transported to the central processing plant. • To strengthen and reduce the cost of the Secondary Collection and Transportation System, IMC has constructed eight ultra-modern transfer stations of three types of models such as Ramp based static GTS, portable Compactors based GTS and semi portable Compactors based GTS installed by Hyva and TPS at different locations
Delhi[7]	• As per information provided by MCD, there are two waste collection systems running in Delhi. Under one system, collection is done through formal sector by the municipal staff or by an authorized party or private concessionaire. Under the other, the informal sector is responsible for door-to-door collection of garbage, which is further transported to dhalaos after the waste picker takes up the recyclable fraction. The informal sector is integrated into the collection systems by an informal contractor. • MSW is collected daily from storage /receptacles /collection centers/ (dhalaos/dustbins/) existing at different places in all statutory bodies of Delhi. This MSW does not include segregated waste picked up by waste pickers / kabariwala at the doorstep and Collection Centers. This waste generated by the citizens is deposited in the receptacles either by the citizens themselves or through private waste pickers and the same is taken to various facilities for processing/disposal.
Greater Mumbai	• The Municipal Corporation of Greater Mumbai (MCGM) is formally responsible for the management of waste in the city. The prevailing approach has been one of collection and disposal that is, garbage is collected from communities by the municipal authorities and disposed off at the three main dumping sites that are currently servicing the city. • Garbage collectors employed by various housing societies manually collect the waste generated at the household level and dump it in the garbage bin at specified street corners. There are around 5,800 community bins in the city. In case of South Mumbai, trucks collect garbage from the garbage bins and transport it to a transfer station which is located in Mahalakshmi. A separate transport is arranged for transferring the garbage from Mahalakshmi to the northern part of Mumbai where the dumping grounds are situated. From all other parts of the city, garbage is sent directly to the dumping grounds. Nearly 95% of the waste generated in the city is disposed off in this manner.[8] • Notably, MCGM, under one of its IT initiatives started ICT enabled waste management project called GPS based Vehicle Tracking and Monitoring System (VTMS). The system is a web based automatic vehicle tracking and telemetric fleet management incorporating Global Positioning System (GPS), combined with GPRS/GSM and digital map technology.[9]
Ahmedabad[10]	• AMC has identified more than 934 locations as waste collection points, where 1051 closed body M.S. Community storage bins have been provided for waste collection. These containers are lifted minimum once in a day and if required, then twice a day and carried to the disposal site.

4 NIMBY, Not In My Backyard, 2016
5 Municipal solid waste management in Varanasi, India, 2018.
6 https://www.smartcityindore.org/solid-waste/
7 A study on management of municipal solid waste in Delhi, 2016.
8 http://www.mumbaidp24seven.in/reference/solidwaste.pdf
9 Waste Management in India - Shifting Gears, March 2017.
10 Solid Waste Management: A Case Study of Ahmedabad, 2016.

	• The Municipality has developed a fully mechanized transportation system that ensures handling of waste only once. Furthermore, AMC has also outsourced the secondary waste transportation system & ensure timely & efficient removal of waste from its collection point. • Notably, AMC introduced a new concept of Door/Gate to Dump since July 2009, in which the AMC appointed contractor to collect waste from residential units in the morning hours and from commercial units in the evening in closed Hydraulic Euro III vehicles. The waste from these vehicles is transferred to transfer stations from each ward to the treatment plants.
Mysore[11]	• MCC carries out door-to-door collection of solid waste from all the 65 wards within its limit. Out of which, 62 wards are handled by Outsourced labors and three wards are handled by federation of Mysore City Wards Parliament. • Presently, the wastes generated from households are not segregated at source; hence, the City Corporation has begun distributing bins to the households to segregate dry waste and wet waste at homes (Green bins for wet waste and Red bins for dry waste). The MCC plans to collect the plastic wastes separately once in a week from every households which would reduce their burden of segregation. • For waste treatment and landfilling, a 200-ton capacity compost plant located near Vidyaranyapuram was established in 2001 under ADB project & is outsourced to M/s IL & FS Company. To reduce the smell, a barricade of about 26 Ft has been erected around the compost plant. To avoid accidental burning of waste the accumulated waste of about 4 lakhs cum is capped. 6700 saplings are planted around entire sewage farm to reduce the smell emanating from the compost plant. • For reusing waste, Mysore City Corporation and Mysore Pinjarapole Society has jointly implemented the Solid and Liquid Resource Management Project for the production and sale of Eco- friendly Vessel Washing Powder and Eco- friendly Toilet/ Floor Cleaning Powder from Citrus fruit peels, cow dung ash, Shikakai and soap nut and Cattle Dung & Urine related products (Panchagavyam and Amritpani).
Shimla[12]	• Shimla Environment, Heritage Conservation and Beautification (SEHB) Society is responsible for the door-to-door collection from households under the supervision of Commissioner (President) and Corporation Health Officer (Member Secretary). The society has provided two colored bins – yellow and green to households/ commercial establishments/ institutions, etc. for primary storage and segregation of garbage. • The frequency of clearing of these bins varies from daily, alternate day, twice a week or even once a week depending on the area. These concrete bins and dumper containers are positioned at convenient locations for the residents to access and dispose their waste in an appropriate manner. MCS efforts to extend 100% ward level door-to-door garbage collection are supported by declaring the ward as dumper free. • Transportation of waste from the secondary collection points to the treatment plant and landfill is the operated and managed by MC Shimla. The entire city's waste is collected and transported through 40 different vehicles with varying capacities.
Agartala[13]	• AMC has provided proper storage bins or centers that are stationed at different location of the city, which is widely used for throwing wastes of nearby localities. NGOs are involved in collection process, as in every ward one NGO is involved for collection of waste. • Around 500 medium and large size bins/containers are placed in different parts of city mainly in the major market areas, roads and commercial areas etc. Waste transportation vehicles further collect these wastes to the disposal site. • AMC is spreading awareness among common people for extending cooperation towards AMC for Sweeping, Cleaning, and lifting the waste for door-to-door waste collection. The intervention focuses on changing the attitude of common people so that the people may stop throwing wastes on roads, drains, or water bodies and will use the dustbin or container provided by AMC and co-operate the staffs/NGOs during collection of wastes. • Notably, Bio-Medical wastes is being collected almost from all the Government and private medical establishments on daily basis as per guideline given by Government of India rule 1998(Biomedical waste handling rule 1998) and sent for incineration in the Diesel, which is located at "Hapania area".
Surat	• Waste collection efficiency in Surat has improved from 40 per cent in 1995 to 97 per cent currently, while the house-to-house collection coverage has improved to 92 per cent. Around 1,570 metric tons (MT) of waste is collected in the city every day. SMC has also introduced an Anudan Scheme under which it pays residential societies to collect their waste and clean their premises. SMC generates its revenue for waste management from lease rent and user charges.[14] • Notably, as part of the Smart City Mission, the Surat Municipal Corporation (SMC) had proposed installation of 75 underground garbage bins across the city last year of which 43 have been installed in public areas. A total of R 456 crore was spent by the SMC to install the bins. All the bins are equipped with two compartments – one for the general public to discard their litter and the other one for municipal workers who collect waste from that area. To ensure efficient waste segregation, the bins are further divided into dry and wet waste. The size of the underground dustbin is 3 cubic meters and each bin can hold up to 1.5 tons of garbage.[15]

11 Assessment of Municipal Solid Waste Management in Mysore City, 2014.

12 Municipal Solid Waste Management Plan for Municipal Corporation Shimla, 2012.

13 Trends of Urban Solid Waste Management in Agartala City, Tripura, India, 2014.

14 Waste smart cities: A survey by the Centre for Science and Environment shows how Indian cities are turning over a new leaf in solid waste management, 2016. (DownToEarth)

15 Surat Smart City.

7.2 Suitable technology options

This section assesses different technologies across the cities and tries to encapsulate all the parameters as deemed in alignment with the current project. We have tried to capture the same in the form of a table, which is furnished below. This table essentially furnished the technologies which are applicable to this project context and which are finally proposed for cluster II project. However, the detailed overview of all technologies has been discussed in this chapter, after this table. For detailed context, please refer to ***Annexure A.2***.

Table 12 Final technology selection based on model cities case reviews

#	Technology name	Technology type	Waste type	Applicability	Case study cities	Key features and benefit	Capex and Opex in Lakhs	Land required	By products to generate revenue	Implementation model	Assessment in cluster II Project and consideration
1	Waste to Energy	Bio-methanation	Organic wet waste	Bulk generators	Solapur, Varanasi, Pali hill, Indore	1 TPD decentralized to 300 TPD centralized plant; no odor, customized size, pathogen free compost, captive power generation	Capex Min – 15 (0.50 TPD) Max – 9000 (300 TPD) Opex Min – 1.90 (0.50 TPD) Max – 90 (300 TPD)	Min – 370 m2 (0.50 TPD) Max – 37000 m2 (300 TPD)	The technology is not fully explored, though it has a potential to generate energy as well as digested sludge manure. PPAs can be signed	PC/Service contract	Technology reviewed and both the centralized & decentralized options have been considered for the proposed project at pilot scale at the beginning, which can be replicated upon successful implementation.
2	Automatic Organic waste converter	Composting process	Organic wet waste	Community, residential society level	Sawantwadi Municipal Council, Mumbai	50 kg/day to 500 kg/day range	Capex Min – 13 (1 TPD) Max –53 (5 TPD) Opex Min – 2 (1 TPD) Max -10 (5 TPD)	Min – 1.85 m2 (1TPD) Max - 7.45 m2 (5 TPD)	Quality compost compliant with has a good market.	EPC/Service contract	Technology reviewed and proposed for pilot scale installation.
3	MRF	Vibrator, magnetic separator, air classifier, conveyor belt picking etc.	Mixed dry waste after primary segregation	Centralized level	Indore	Modular system, expandable capacity, recycling of dry utilizable components, engagement of rag pickers through an organized manner	Capex Min –40(20 TPD) Max –80 (50 TPD) Opex Min – 6 (20 TPD) Max -15 (50 TPD) INR 3 lakhs per ton of waste	Min – 200 m2 (20 TPD) Max – 6000 m2 (50 TPD)	Different streams of recyclable materials like plastic PETs, Paper, Textile etc.	EPC/Service contract/ULBs can do it themselves too	Reviewed and proposed for centralized facility for cluster II project

4	C&D Waste treatment plant	Segregation, screening, crushing (primary and secondary), dust removal, sand washing	All types of construction & demolition waste - wood, bricks, concrete, metal, roofing shingles, card board etc.	Real estate industry within urban periphery, old building demolition, road construction and repair	Burari, New Delhi	Expandable capacity as per requirement, recycling of C&D material and turning into secondary construction material	Capex Min – 200 (300 TPD) Max –750 (500 TPD and above) Opex Min – 20 (300 TPD) Max -50 (500 TPD and above) INR 3 lakhs per ton of waste	Min – 6000 m2 (300 TPD) Max – 12000 m2 (500 TPD and above)	By-products like tiles, aggregate and silt which can be sold to real estate players as inputs for development. Paver blocks, tiles, hollow blocks/bricks, pre-fabricated structures like frames, manhole covers, benches	PPP/Service contract	Technology reviewed and proposed for centralized system
5	Landfill Mining	Bioremediation into inert and combustibles	Legacy waste	Old unscientific disposal site	Vijayawada (2,50,000 MT), Nagpur (10,00,000 MT) Vadodara (3,00,000 - 2,00,000, m^3), Kumbakonam (2,00,000, m^3), Jeonju (933.773, m^3)	Land can be reclaimed, no leachate and GHG generation, minimal or no monitoring	Depending upon the bid parameter of the private operator the cost revolves around Rs. 600-700/ton of waste.	Depends on the land parcel of the ULB	NA	Service Contract/Management Contract	Technology reviewed and proposed for reclamation of Mollar Bheri
6	Secured Landfill	Engineered sanitary landfill with liner, leachate, gas collection system etc.	Inert	Fresh waste after processing and treatment	Multiple cities	Stopping unscientific disposal of fresh waste and thereby avoiding ground waste, soil, surface water, air, aesthetic etc., all kind of environmental & social hazard.	Capex Min – 100 Max - 1400 Opex Min – 12 Max -30 INR 650 per ton of waste	Depends on the land parcel of the ULB	NA	PPP/Service contract	Proposed for 5 years cell, with a provision for 20 years accumulation'

8. Demand assessment

This chapter will discuss the generation of waste from four project ULBs under consideration for the assignment and their different waste streams (as per their disposal pathways). For this purpose, population projection exercise has been done, these projections should prove to be useful for the policy planners and the municipal authorities to develop infrastructure for sustainable development of the city. Appreciation of the population growth shall have direct bearing on the waste generation and to have sustainable development plans of solid waste management inclusive of equipment and manpower across the SWM lifecycle.

8.1. Population projection

8.1.1. Population data consideration

Population projections are usually done by different methods, but the common aspect across all of them is the, population of the base census year, which in this case 2011 has been considered. It may be mentioned that several sources of population have been examined by the consultants' team, such as –

a. Population from secondary data (internet etc.), ULB websites
b. Population figure, received from the respective ULBs
c. Population figure from census, Govt. of India.

For design purpose, the population obtained from Census 2011 has been considered for the scheme and the respective population of the individual wards under the ULBs (for KMC & BMC) has been considered. For NDITA, we understood based on stakeholder consultations that most of the population is floating population and the ULB has very limited. For NKDA area, population figure has been obtained as per the land use of development plans or respective action areas demarcated by them.

8.1.2. Population projections

Projection of the population requires, several alternative mathematical projections methods such as – arithmetic progression method, incremental increase method, geometrical progression method, decadal methods etc. have been adopted and used. The average population obtained from all those methods has been applied to project the population for the project horizon. A snapshot of the various methods and the formulae along with the integration with the target years has been tabulated below:

Table 13 Population projection methods

SN	Methods	Formula Used	Years & Populations		
			2020	2030	2040
1	AP	P = P (2011) + nX	*Output*	*Output*	*Output*
2	GP	P = P (2011) x (1+r)^n]	*Output*	*Output*	*Output*
3	Incremental	P = P (2011) +nX+n(n+1)Y))	*Output*	*Output*	*Output*
4	Decadal	P = P (2011) x [1 + (nU_{av})]	*Output*	*Output*	*Output*
5	Average				

Where, X - Population increment, Y - Incremental increment, N - No of decades, r - Geometric mean, Uav - Average growth

8.1.3. Projection horizon

The projection of population has been done for a horizon of 20 years keeping in mind that the construction and operationalization of the scheme may take another one year from now to complete. Hence the project initiation year has been considered as 2020, intermediate year (or short term) as

2030 & final year (or long term) as 2040. The population projection has been done up till the year 2040. In sections below, the individual projection of each ULBs are being furnished.

8.2. Projected population

8.2.1. Population projection –BMC

BMC consists of Bidhannagar or Salt-lake model city and Rajarhat town. The census population of 2001 and 2011 has been considered for population projection and the growth rate of the area over these two consecutive decades have been calculated.

Table 14 Growth rate of BMC

Year	2011	2001	Growth rate (%)
Bidhannagar	2,31,263	160000	44.54%
Rajarhat	4,00,844	270000	48.46%
Total	**6,32,107**	**430000**	47.00%

Source – Projected from Census 2011 data

Based upon the growth rate the population projection has been done for all the wards of BMC for the period for 2020, 2030, and 2040.

Table 15 Population projection for BMC

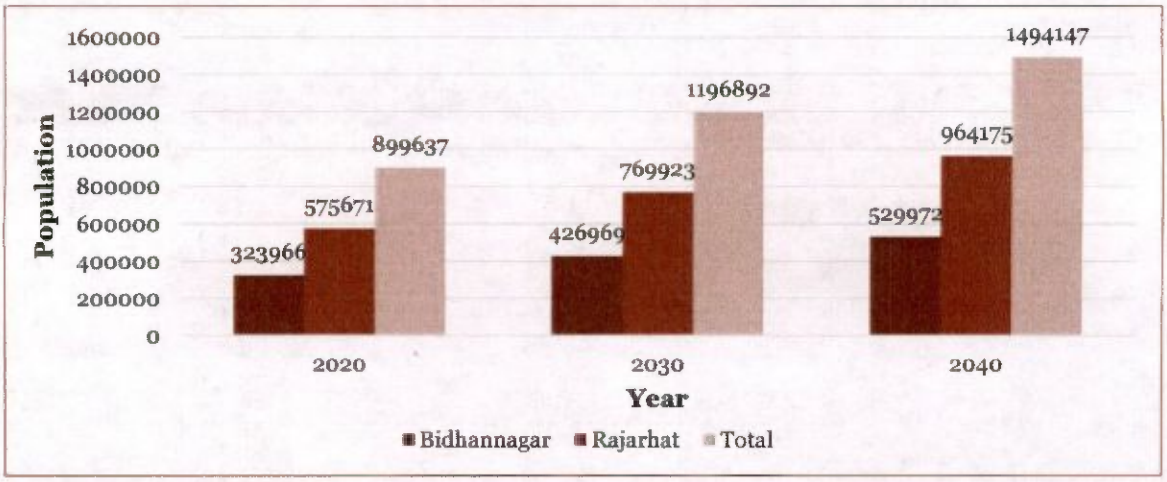
Location	Ward No.	Population Projection		
		2020	2030	2040
Rajarhat	1	18172	24303	30435
	2	21782	29132	36482
	3	22237	29741	37245
	4	21878	29261	36643
	5	21343	28544	35746
	6	24146	32294	40441
	7	24541	32822	41103
	8	18611	24891	31171
	9	24205	32372	40540
	10	21200	28354	35508
	11	18353	24545	30738
	12	28727	38421	48114
	13	27259	36458	45656
	14	18974	25377	31780
	15	18113	24225	30336
	16	24489	32753	41016
	17	23649	31629	39609
	18	17877	23910	29942
	19	18295	24468	30642
	20	30132	40299	50467
	21	22790	30480	38171
	22	26290	35161	44033
	23	16715	22356	27996
	24	23312	31178	39044
	25	21633	28932	36232
	26	20948	28016	35085
Bidhannagar	27	22062	29077	36091
	28	26824	35352	43880
	29	19753	26034	32314

	30	18645	24574	30502
	31	21243	27997	34750
	32	18905	24915	30926
	33	19248	25367	31487
	34	21324	28104	34883
	35	17484	23043	28602
	36	21654	28539	35424
	37	24392	32147	39902
	38	23927	31534	39141
	39	22765	30003	37241
	40	19661	25912	32163
	41	26080	34372	42663
	Grand Total	**899637**	**1196892**	**1494147**

Source – Projected from Census 2011 data

The graphical representation of the population projected for the period of 2020, 2030, and 2040 is given below.

Figure 20 Graphical representation of BMC population projection



Source – Projected from Census 2011 data

Note: In line with the discussion with the officials of BMC, it has been understood that the floating population plays an important role to influence the waste generation of the study area. However, in absence of any authenticated data or study report on the same, we have considered 20% escalation of waste generation in BMC owing to the contribution of floating population for 2020. Accordingly, for 2030 and 2040, we have considered 30% and 40% respectively as a floating population factor for future waste projection.

8.2.2. Population projection – KMC

Three boroughs (I, III and VII) comprising 27 wards of Kolkata Municipal Corporation have been considered and included in this cluster project based on the consultations and project level interactions. The population projection of whole KMC is presented in the tables below:

Table 16 Census population data for the whole of KMC

Census Year	Population	Increment X	Incremental Increment, Y	Rate of Increment
1961	2927298			
1971	3148746	221448		0.076
1981	3305006	156260	-65188	0.050
1991	4399819	1094813	938553	0.331

2001	45728976	41329157	40234344	9.393
2011	4496694	-41232282	-82561439	-0.902
Average		313879	-10363433	1.790
Geometric mean				0.108

Source – Projected from Census 2011 data

Table 17 Population projection data of whole KMC

Year	2020	2030	2040
AP	4695998	4917446	5138894
GP	4931829	5464869	6055522
Decadal	4934104	5420114	5906125
Average	**4853977**	**5267476**	**5700180**

Source – Projected from Census 2011 data

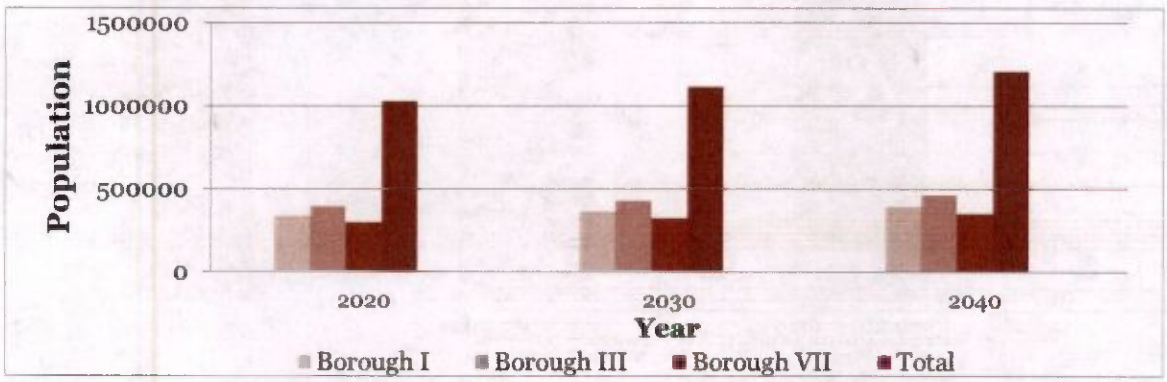
The graphical representation of the projected population for the period of 2020, 2030, and 2040 is given below.

Table 18 Population Projection Data of Three Boroughs of KMC

Boroughs	2020	2030	2040
Borough I	334695	363206	393043
Borough III	394668	428289	463471
Borough VII	298567	324002	350617
Total	**1027930**	**1115497**	**1207131**

Source – Projected from Census 2011 data

Figure 21Graphical representation of KMC population projection



Source – Projected from Census 2011 data

8.2.3. Population projection - NKDA

NKDA is a new entity and has been formed within last 10 years of time span, hence no decadal census data was available for this particular ULB as a reference. However, for the population projection purpose, urban growth rate trend of Kolkata Metropolitan City and its peripheral area, has been considered. Based upon this, the population projection for three action areas has been done. The base population is considered as of 2019, as per the data provided by NKDA during our interactions with the concerned officials.

Table 19 Base Population Data of NKDA (2019)

Area Details	Land-use	Type	Population
Action Area I	Residential	Individual plots, cooperatives & bulk plots	13826
		RR Plot	563
Total Action Area I			***14389***
Action Area	Residential	All plots	10466

II		RR Plot	234
Total Action Area II			***10700***
Action Area III	Residential	All plots	11455
Total Action Area III			***11455***
Total Residential Population (Action Area I+II+III)			**36544**
Floating population	Non-residential		70000

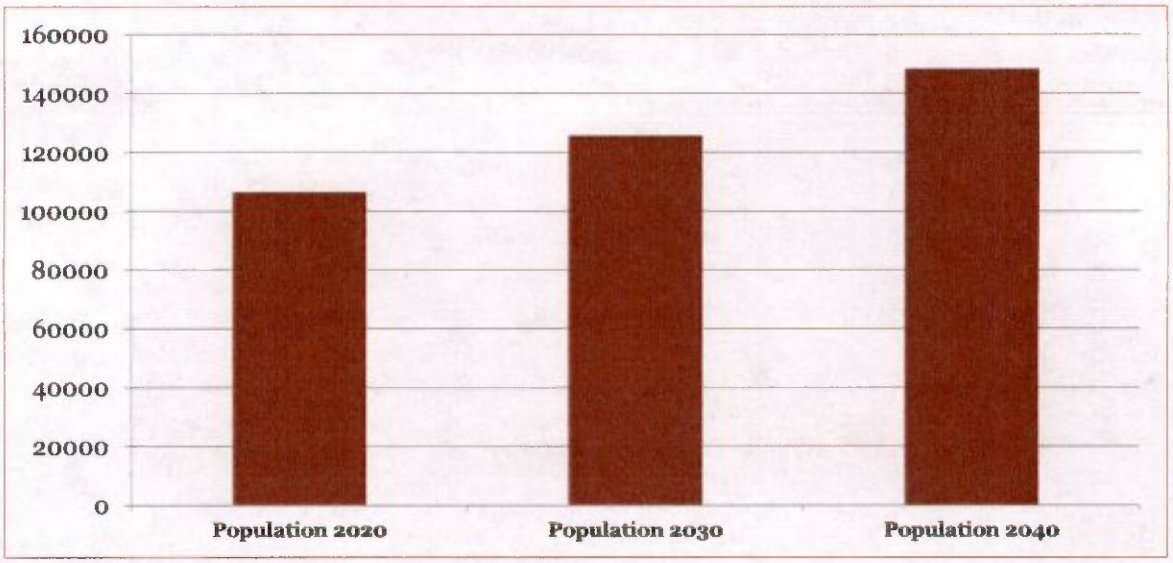
Source – Data provided by NKDA

Table 20 Population Projection Data of NKDA

SN	Head	Value	Basis
1	Growth rate	18%	Urban township growth rate of Kolkata
2	Population 2020	106544	Calculated
3	Population 2030	125722	Calculated
4	Population 2040	148352	Calculated

Source – Projected from data provided by NKDA

Figure 22 Graphical representation of NKDA population projection



Source – Projected from NKDA data

8.2.4. Population projection - NDITA

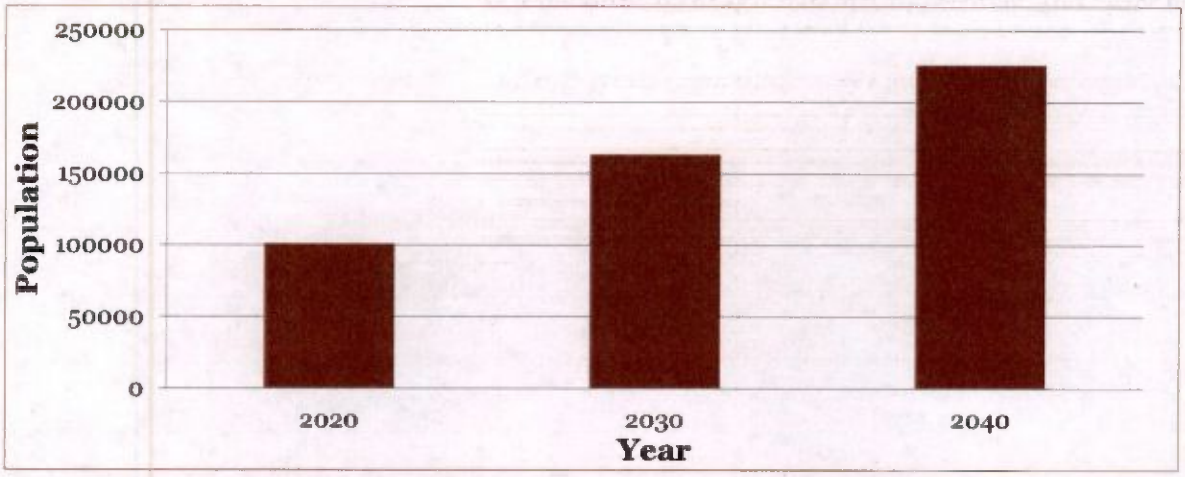
NDITA is an IT Hub and it majorly caters floating population only, with very nominal number of residential populations. The population projection for this ULB is given in the table below.

Table 21 Population Projection Data of NDITA

Population Projection	Population	Basis
Floating population (2019)	100000	NDITA
Residential population	900	
Population 2020	100900	
Population 2039	226000	NDITA website
Population 2040	226000	Considered
Population 2030	163450	Calculated

Source – Projected from data provided by NDITA

Figure 23 Graphical representation of NDITA population projection



Source – Projected from data provided by NDITA

8.2.5. Summary of Population projection

The summary of population projection of all four ULBs are presented below:

Table 22 Population projection summary

SN	ULBs	2020	2030	2040
1	BMC	899637	1196892	1494147
2	KMC	1027930	1115497	1207131
3	NKDA	106544	125722	148352
4	NDITA	100900	163450	226000
5	**Total**	**2135011**	**2601561**	**3075630**

8.3. Waste Quantification

Waste quantification analysis has been carried out, mostly considering the per capita generation factor for each of the ULBs. Per capita generation for respective ULBs has been achieved by deriving per capita waste generation factor from the current waste generation data, as provided by respective ULBs has been considered in conjunction with the present population.

The quantification of waste for four ULBs is furnished below:

8.3.1. Waste quantification for BMC

The ward-wise waste generation and projection for BMC is furnished below. The waste generation factor for BMC has been calculated as 0.564 kg/capita/day.

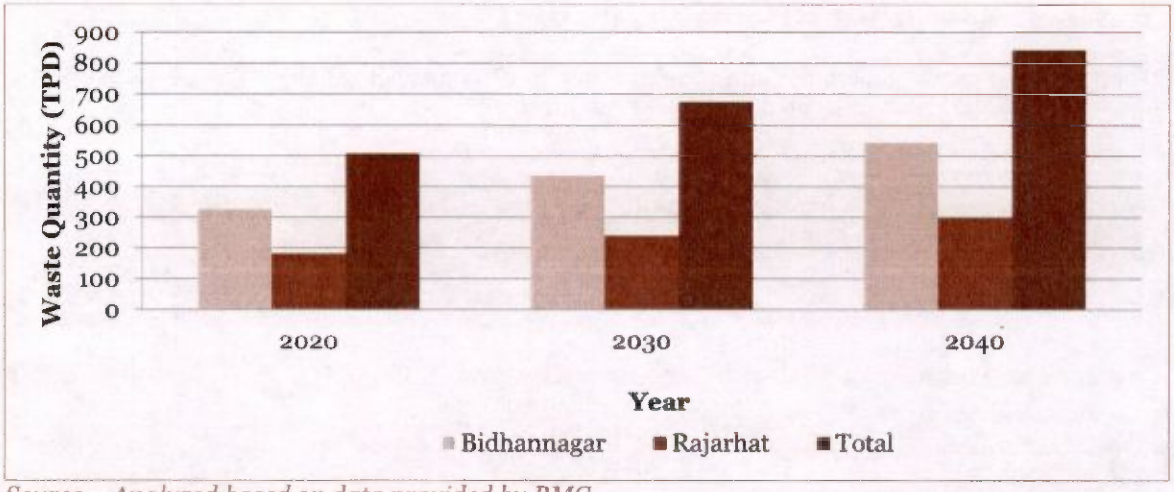
Table 23 Ward-wise Waste Generation of BMC

Location	Ward No.	Waste Projection (TPD)		
		2020	2030	2040
Rajarhat	1	10	14	17
	2	12	16	21
	3	13	17	21
	4	12	17	21
	5	12	16	20
	6	14	18	23
	7	14	19	23
	8	11	14	18

	9	14	18	23
	10	12	16	20
	11	10	14	17
	12	16	22	27
	13	15	21	26
	14	11	14	18
	15	10	14	17
	16	14	18	23
	17	13	18	22
	18	10	14	17
	19	10	14	17
	20	17	23	28
	21	13	17	22
	22	15	20	25
	23	9	13	16
	24	13	18	22
	25	12	16	20
	26	12	16	20
Bidhannagar	27	12	16	20
	28	15	20	25
	29	11	15	18
	30	11	14	17
	31	12	16	20
	32	11	14	17
	33	11	14	18
	34	12	16	20
	35	10	13	16
	36	12	16	20
	37	14	18	23
	38	14	18	22
	39	13	17	21
	40	11	15	18
	41	15	19	24
	Total	**508**	**676**	**844**

Source – Analysed based on data provided by BMC

Figure 24 Graphical Representation of Year-wise Waste Generation of BMC



Source – Analyzed based on data provided by BMC

The summary of the same is presented in the table below.

Table 24 Summary of waste generation of BMC (incorporating contribution of floating population)

Area	Waste Projection (TPD)		
	2020	2030	2040
Bidhannagar	325	435	544
Rajarhat	183	241	299
Total	**508**	**676**	**844**
Design Waste quantity after considering floating population)	**610**	**879**	**1181**

Source – Analyzed based on data provided by BMC

8.3.2. Waste quantification for KMC

Borough no. I, III, and VII have been considered for this project and accordingly the waste generation of those wards is being furnished below.

Table 25Present (2019) Waste Generation of KMC (selected Borough)

Ward No	Borough	Average waste disposal at Dhapa (2019), TPD, KMC data	Borough-wise Total (TPD)
1	I	18.63	189.82
2		39.02	
3		16.59	
4		9.79	
5		38.48	
6		32.26	
7		11.48	
8		7.91	
9		15.66	
13	III	33.99	309.38
14		48.28	
29		44.86	
30		19.34	
31		45	
32		73.36	
33		21.07	
34		21.01	
35		2.47	
56	VII	17.18	167.5
57		24.37	
58		43.81	
59		39.34	
63		42.8	
64		Data not available	
65		Data not available	
66		Data not available	
67		Data not available	

Source – Analyzed based on data provided by KMC

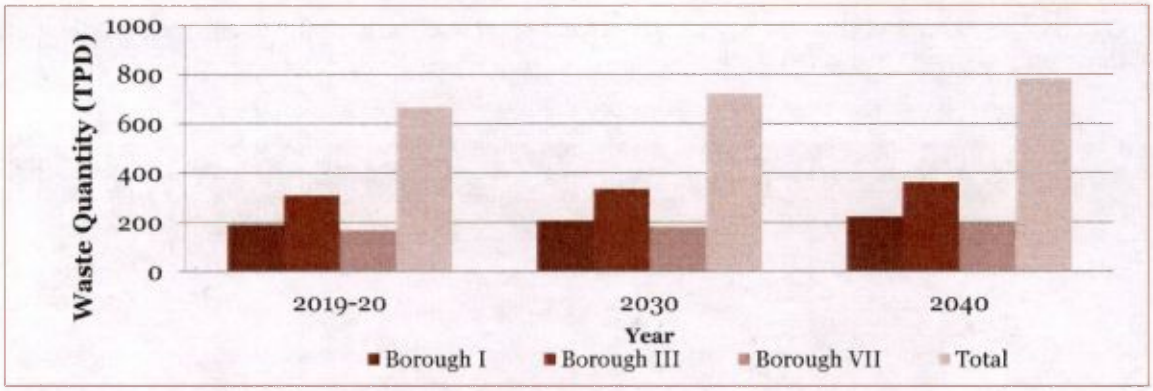
The waste generation factor for Borough I, III and VII has been found as 0.567 kg/capita/day, 0.784 kg/capita/day, 0.561 kg/capita/day respectively. This factor has been applied for these three boroughs to calculate the waste generation for 2030 and 2040. The results of the same are furnished below:

Table 26 Waste Quantification of KMC (selected Borough)

Boroughs	2019-20	2030	2040
Borough I	190	206	223
Borough III	309	336	363
Borough VII	168	182	197
Total	**667**	**723**	**783**

Source – Analyzed based on data provided by KMC

Figure 25Graphical Representation of Year-wise waste generation of KMC



Source – Analyzed based on data provided by KMC

8.3.3. Waste quantification for NKDA

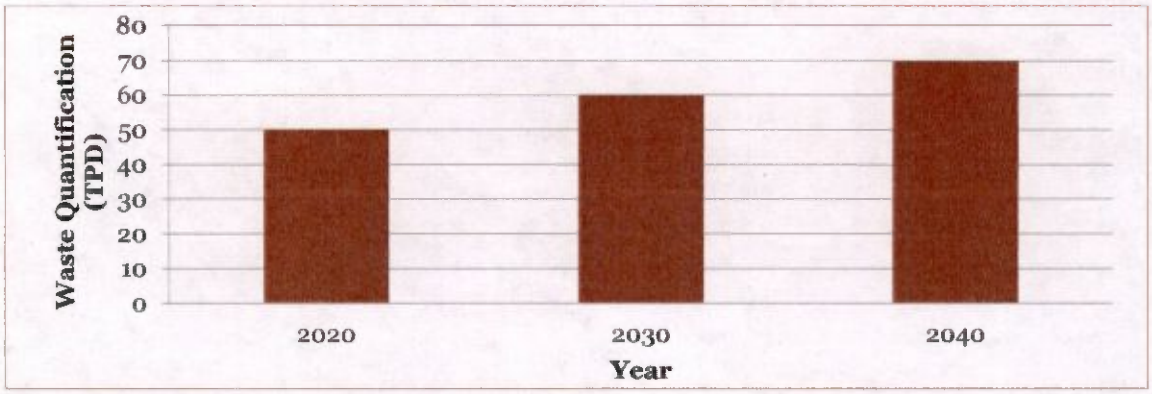
The waste quantification data of NKDA is presented in the table below as well through graphical representation based on the same principles followed for the other ULBs in the study area:

Table 27 Waste Quantification of NKDA

SN	Year	Waste (TPD)
1	2020	50.17
2	2030	60
3	2040	70

Source – Projected based on data provided by NKDA

Figure 26 Graphical representation of year-wise waste generation of NKDA



Source – Projected based on data provided by NKDA

8.3.4. Waste quantification for NDITA

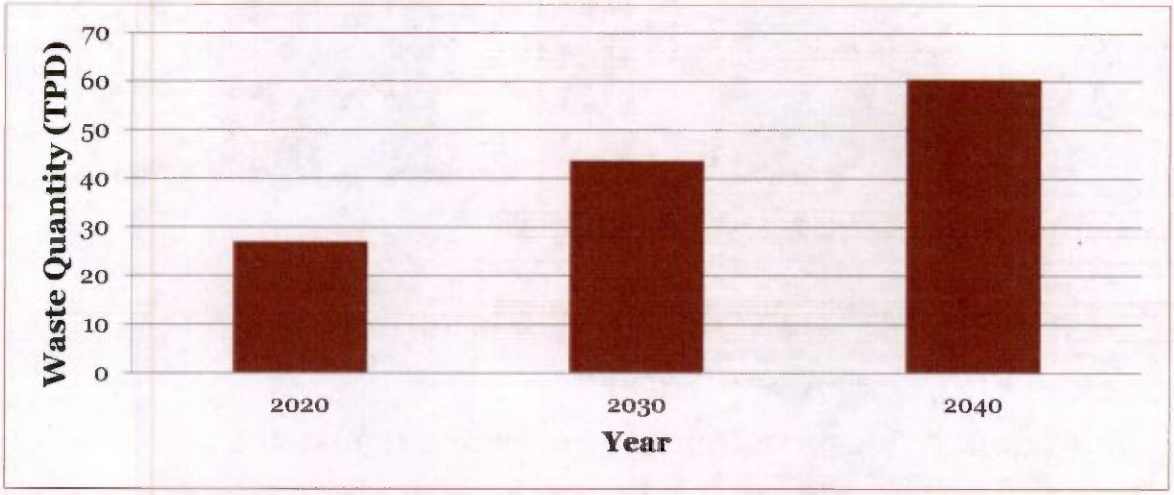
The waste quantification data of NDITA is presented in the table below as well through graphical representation:

Table 28 Waste Quantification of NDITA

SN	Year	Waste (TPD)
1	2020	27
2	2030	44
3	2040	60

Source – Analyzed based on data provided by NDITA

Figure 27 Graphical representation of year-wise waste generation of NDITA



Source – Projected based on data provided by NDITA

8.3.5. Summary of waste projection for all ULBs

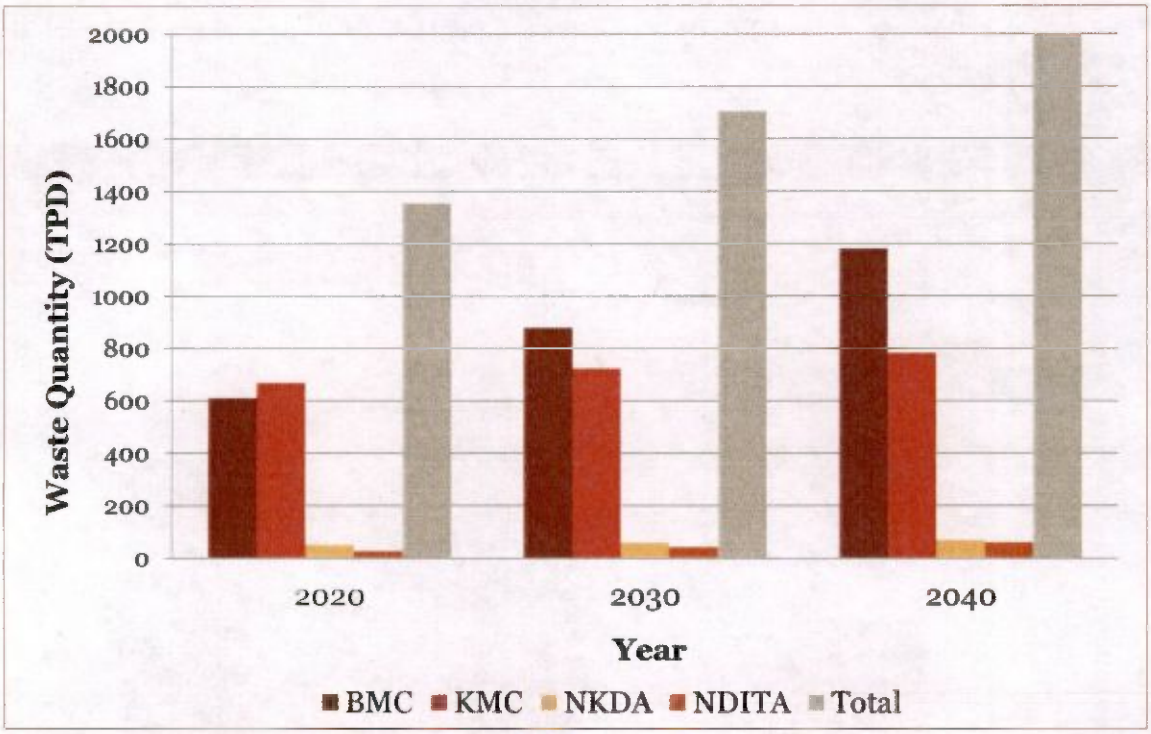
The summary table and its graphical representation of waste quantification for all ULBs is presented below:

Table 29 Summary Table of Waste Quantification of all ULBs

SN	ULBs	Waste (TPD)		
		2020	2030	2040
1	BMC	610	879	1181
2	KMC	667	723	783
3	NKDA	50.17	60	70
4	NDITA	27	44	60
5	**Total**	**1353**	**1705**	**2094**

Source – Projected from data provided by ULBs

Figure 28 Graphical representation of year-wise waste generation in all ULBs



Source – Projected from data provided by ULBs

8.3.6. Construction & Demolition waste from all ULBs

During our discussions with the authorities we found that there is very little scope for quantification of Construction & Demolition (C&D) waste through primary survey across all the ULBs in the study area, therefore an established method of quantification of C&D waste has been adopted and used for calculation of the same. To assess the plant capacity and the area requirement, C&D waste generation has been considered as 20-25% of the total waste generation (additionally). Hence, the tentative estimated quantity of C&D waste generation from all four ULBs is furnished in the following table:

Table 30 C&D waste generation from all ULBs

SN	ULBs	C&D Waste (TPD)		
		2020	2030	2040
1	BMC	122	176	236
2	KMC	133	145	157
3	NKDA	10	12	14
4	NDITA	5	9	12
5	**Total**	**270**	**342**	**419**

Source – Analyzed based on data provided by ULBs

9. Surveys and Investigations

Baseline survey has been conducted for the purpose of the feasibility study. The survey included topographical survey, geotechnical survey, waste characterization survey and water quality analysis survey. They detail of the surveys and investigations are being discussed in the below sections:

All testing reports and investigations have been done by the laboratories, accredited by NABL, Govt of India.

9.1. Waste characterization survey

9.1.1. Stages of sampling

Waste characterization survey has been done to assess the physical composition and chemical characteristics of waste. Waste sampling has been divided into two different stages within the site. The numbers of the collected samples and their respective points are as follows –

a. Random waste sample received at Mollar Bheri, coming within a transportation vehicle
b. Waste sample collected from the site (legacy waste)

9.1.2. Collection of samples

For collection of waste from transportation vehicles initially 50 kg or more sample was taken during the beginning, middle and last stages of the waste discharge. Thereafter they were mixed thoroughly for several times. After obtaining a homogeneous waste, 5 kg of composite sample was taken into the bag and marked properly. Samples were collected from the disposal site as well and were flattened and quardrisected into four equal parts. From the four equal parts, two diagonal parts were taken out. The same procedure was followed for a number of times until the weight of each homogenous sample weighed as 5 kg. A schematic diagram for collection of samples is given in the below **Figure**.

Figure 29 Quarter conning method of sampling to be adopted

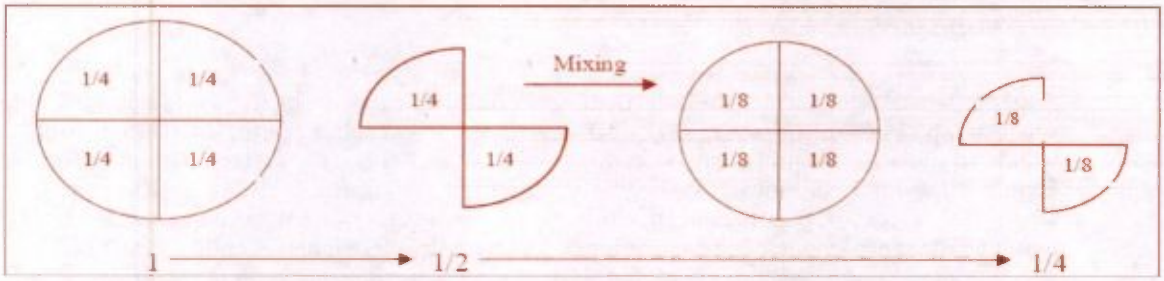


Figure 30 Legacy waste sampling

Figure 31 Fresh Waste Sampling

9.1.3. Preparation of samples

The crude solid waste sample as such was not ready for analysis. So, a representative homogeneous sample has been prepared as per IS:9234. According to IS:9234 the three basic operations required to prepare the sample are given below.

a. **Drying:** Oven has been used for drying the sample. Moisture content of the crude sample has been determined during drying process at 70-75° C.

b. **Grinding or Pulverizing:** Before grinding, the segregation of various inert materials like glass, ceramics, metals, stones etc, have been done. The remaining material has been ground and sieved to form a homogenous powder, which has been used for further analysis.

c. **Mixing:** A flow chart of the sample preparation and analysis is already given previously.

9.1.4. Analysis of samples

Once the sampling process was done, the samples were taken to the laboratory and analysed for following physical and chemical parameters –

Physical Parameters	Chemical Parameters
Density (ton/m³)	Moisture content (%)
Cloths	Organic carbon
Organic content	C/N ratio
Paper	Calorific value, kCal/kg
Plastics	
Polyethylene	
Rubber, Leather	
Wood	
Ash and fine earths	

Physical Analysis

a. **Segregation:** Segregation of waste materials has been carried out as per IS: 9235. Crude waste samples constitute wide range of materials viz. Paper, glass, ceramics, leather, rubber, wood, stone, soil, plastics, leaves, cotton, clothes, feathers, hair, ferrous and non-ferrous metals. Glass and ceramics have been separated out by sieving. Plastics, leathers, rubber, wood, stones, leaves, papers, cotton, clothes, non-ferrous metals have been separated out by handpicking. Ferrous metals have been removed by a strong magnet. Weight of each material has been taken. The separated materials have been further segregated into organic and inorganic portion. The organic portion consists mainly of paper, rubber, plastics, wood, textiles, hair, feathers, cork, leather, vegetable materials, soil etc. This organic portion has been taken for further analysis on percentage/wt. basis.

b. **Moisture Contents:** Industrial oven has been used for drying the sample. The moisture content of the sample has been determined by keeping the sample in the oven for 24 hrs. by maintaining the temperature between 70-75°C because the sample contain the combustible materials (as per IS: 9235 drying may be generally done at 105°C but in case of combustibles the temperature shall be 70-75°C). The process of heating, cooling, and weighing has been repeated till constant wt. of the dried sample obtained. Moisture content has been calculated as the percentage of the original mass.

Chemical Characterization

a. **Phosphorous:** Phosphorus was analyzed by Stannous Chloride Reduction method where a blue color is produced by the reduction of phosphomolybdic acid with freshly prepared

stannous chloride solution. .1.0 gm. of the ground sample has been taken in a 500ml conical flask and 200 ml of the .002N sulphuric acid has been added and shake for half an hour. After that suspension has been filtered through whatman No. 50 filter paper to get a clear solution. 10 ml of the filtered sample has been taken in the volumetric flask of capacity 100ml. 2 ml of ammonium molybdate and 5 drops of stannous chloride solution has been added and make up to the mark using distilled water. A blue color has been appeared. Optical density of the blue sample has been taken at 690nm using a blank of distilled water with same amount of chemicals. Concentration of the phosphate has been calculated with the help of standard curve.

b. **Carbon:** Carbon content of the ground representative sample has been analyzed as per IS:10158, carbon has been determined gravimetrically after burning the sample in presence of oxygen and the carbon dioxide formed has been estimated as sodium carbonate. The combustion has been carried out in a 1 m long tube with 40 mm OD. The apparatus used is carbon hydrogen train.

c. **Calorific Value:** Calorific value of the sample has been analyzed as per the IS:1350 (Part II). Bomb Calorimeter has been used to measure the amount of heat generated when matter is burnt in a sealed chamber (Bomb) in an atmosphere of pure oxygen gas. For the analysis of the calorific value of the ground sample firstly the water equivalent of the calorimeter assembly has been calculated using the standard benzoic acid of calorific value 6319 Cal/gm.

Waste characterization has been done based upon their physical and chemical characteristics. A comparative analysis has been made to understand the quality of waste and quantity of different parameters of the waste. The observed physicochemical characteristic of waste, changes of properties being discussed below.

Results of Sampling:

Physical Parameters

Sl. No.	Particulars	Waste from incoming truck	Legacy waste
1.	Bulk Density (Ton/M^3)	0.496	0.9975
2.	Moisture content (%)	28.42	21.93

Chemical Parameters

Sl. No.	Particulars	Waste from incoming truck	Legacy waste
1.	Organic Content (%)	24.98	6.29
2.	Calorific Value (kcal/kg)	1174	Nil
3.	C/N Ratio	25.36	20.0

Physical Composition

S.L. No	Fresh waste sample from the incoming truck	Composition	Percentage (Individual)	Total Percentage
1	Organic Waste			
i)		Food	Nil	
ii)		Food Waste	29.99	
iii)		Vegetable Waste	69.25	
iv)		Fruits	Nil	
v)		Garden waste	0.76	
vi)		Yard and Park waste	Nil	
		Partially decomposed organic waste	Nil	

2.	Recyclable Broken Color Glass			Nil
3.	Recyclable Plastic			0.24
4.	Polyethene			12.76
5.	Metals			Nil
6.	Papers			Nil
7.	Cardboard			Nil
8.	Thermocols			Nil
9.	E-Waste			Nil
10.	Stone			Nil
11.	Aggregate (Inert material)			Nil
12.	Rubber			Nil

SL.no.	Old legacy waste sample from the disposal site	Composition	Percentage (Individual)	Total Percentage
1.	Organic Waste		Nil	
i)		Food		
ii)		Food Waste	Nil	
iii)		Vegetable Waste	Nil	
iv)		Fruits	Nil	
v)		Garden waste	Nil	
vi)		Yard and Park waste	Nil	
		Partially decomposed organic waste	29.64	
2.	Recyclable Broken Color Glass			Nil
3.	Recyclable Plastic			Nil
4.	Polythenes			2.89
5.	Metals			Nil
6.	Papers			Nil
7.	Cardboard			Nil
8.	Thermocols			Nil
9.	E-Waste			Nil
10.	Stone			34.82
11.	Aggregate (Inert material)			32.65
12.	Rubber			Nil

9.2. Geotechnical survey

9.2.1. Survey approach &methodology

Geotechnical survey has been done to investigate the soil characteristics of the site for the proposed facility (HIDCO 20-acre land) as well as existing disposal site at Mollar Bheri. Two bore wells points have been identified at the site. Soil samples were explored and analysed for Atterberg limits, grain size distribution, bearing capacity etc. The ground water table was noted during the geotechnical exploration.

The approach of geotechnical investigation was as per the following:

- Identification and selection of the area for geotechnical survey
- Installation of Piezometric wells
- Collection of split spoon samples for laboratory testing

Figure 32Soil sampling at HIDCO

- Performing certain in-situ testing of soils – standard and dynamic cone penetration test, permeability test
- Collection of ground water samples for laboratory testing
- Collection of core recovery and analysis of strata
- Results and Interpretation.

9.2.2. Survey parameters

Following tables depict the parameters for the survey conducted.

Table 31 Details of the parameter for Geotechnical Investigation

SN	Item Description
1	Conducting Standard Penetration Test in the bore holes within the virgin soil strata at 1.5 m interval or at every change of strata whichever is earlier, up to rock bottom/ 10 m depth, whichever comes earlier as per IS: 2131-1981 (and collection of undisturbed soils samples from boreholes for other laboratory tests).
2	Depth of bedrock
3	Conducting the following properties on selected soil samples: -
a)	Physical characteristics of soil type and strata, grainsize distribution
b)	Atterburg's limits
c)	Sieve analysis
d)	Hydrometer analysis.
e)	Tri-axial shear test.
f)	Density and moisture content
g)	Sheer tests and consolidation tests
h)	Chemical analysis – sulphate, chloride, pH for ground water
i)	Chemical analysis – sulphate, chloride, pH for soil
j)	Soil bearing capacity
4.	Depth of Ground Water

9.2.3. Results and analysis

The depth of water table was found at 3.3m and 6m for Mollar Bheri and HIDCO 20-acre land side respectively. The results and analysis of the bore log of two sites are being discussed below:

Table 32 Bore lab data of Geotechnical Investigation at Mollar Bheri

Date (dd / mm)	Depth (m)		Length (m)	Nature of Sampling	SPT : No. of blows					Description
	From	To			0-15 cm	15-30 cm	30-45 cm	45-60 cm	N' Value	
12.05.19	0.50			D						Top soil filled with soil roots, organic matter , plastic, brickbats, kankars etc.
	1.00			D						
										1.20m
	1.50	2.10	0.60	P	2	2	3	3	5	Firm greyish clayey silt with brown spot and sand mixed.
	3.00	3.45	0.45	U						
										3.80m
	4.50	5.10	0.60	P	8	12	17	20	29	
	6.00	6.60	0.60	P	9	14	21	22	35	
	7.50	8.10	0.60	P	11	18	24	24	42	.Medium dense to dense whitish grey silty fine to medium sand with mica.
12.05.19	9.50	10.10	0.60	P	13	21	26	28	47	
	10.10	(Termination Depth)								
Abbreviations: U-Undisturbed Sample D-Disturbed Sample P-Standard Penetration Test										

Table 33 Bore lab data of Geotechnical Investigation at 20-acre HIDCO Land

Date (dd / mm)	Depth (m)		Length (m)	Nature of Sampling	SPT : No. of blows					Description
	From	To			0-15 cm	15-30 cm	30-45 cm	45-60 cm	N Value	
13.05.19	0.50			D						
	1.00			D						
	1.50	1.95	0.45	D						Top soil filled with soil roots, organic matter , plastic, brickbats, kankars etc.
	3.00	3.45	0.45	D						
	4.50	4.95	0.45	D						
	6.00	6.60	0.60	P	3	3	4	4	7	6.10m
	7.50	7.95	0.45	U						
13.05.19	9.50	10.10	0.60	P	1	1	2	1	3	Very soft to firm greyish silty clay with decomposed woods.
	10.10	(Termination Depth)								

Abbreviations: U-Undisturbed Sample D-Disturbed Sample P-Standard Penetration Test

Table 35 Geotechnical Investigation results at 20-acre HIDCO Land

Layer Details				Average Field N-Value	Bulk Density (t/m3)	Liquid Limit (%)	Plasticity Index (%)	Shear strength Parameters
Stratum No.	Description	Depth below EGL (m)						
		From	To					
I	Top soil filled with soil roots, organic matter , plastic, brickbats, kankars etc.	0.00	6.10	-	-	-	-	-
II	Very soft to firm greyish silty clay with decomposed woods.	6.10	10.10	2 to 7	1.72	48.2	24.4	C= 2.6 t/m^2, ϕ =0 deg

* Suggested

Table 34 Geotechnical Investigation results at Mollar Bheri

Layer Details				Average Field N-Value	Bulk Density (t/m3)	Liquid Limit (%)	Plasticity Index (%)	Shear strength Parameters
Stratum No.	Description	Depth below EGL (m)						
		From	To					
I	Top soil filled with soil roots, organic matter , plastic, brickbats, kankars etc.	0.00	1.20	-	-	-	-	-
II	Firm greyish clayey silt with brown spot and sand mixed.	1.20	3.80	5	1.89	45.4	21.3	C= 3.1 t/m^2, ϕ =0 deg
III	.Medium dense to dense whitish grey silty fine to medium sand with mica.	3.80	10.10	29 to 47	1.90*	Non- Plastic		C= 0 t/m^2, ϕ =30 to 32*deg

* Suggested

Figure 33 Soil sampling for Geotechnical and Topographical Survey at Mollar Bheri

9.3. Topographical survey

9.3.1. Scope of work

The scope for topographical survey at site is as per the following:

1. Complete topographical survey with spot levels and preparation of contour plan with 0.5 m interval.
2. Level survey with spot level grid of 10 m x 10 m.
3. Setting up temporary bench mark (TBM).
4. Setting up a local coordinate system with respect to the magnetic North for future identification or reference frame.
5. Actual Mean Sea Level of the Temporary bench mark established in the site
6. Topographical map - two hardcopies in A0 size and one electronic copy in AUTOCAD Format showing main features of the site and adjoining areas.
   Main features include:
   - Key map
   - Total Site boundary and survey area boundary
   - Water bodies nearby/ adjacent to the site
   - Existing drains/ Nallahs
   - Roads inside and outside of the site, access road
   - Electric poles & cables
   - Water pipe lines
   - Nearby houses/ settlements/ permanent structures
   - Leachate pit/ water accumulated within the landfill site
   - And any other important physical features

In the drawing, the total area of the site, which was surveyed, as well as waste confined area has been mentioned separately. The volume of accumulated waste has also been assessed.

9.3.2. Results and output

From the topographic survey, the total area of the disposal has been obtained as 24.72 acre. The topographical survey output and the contour map is attached to this section.

9.4. Water quality analysis survey

Water sampling has been done to determine the existing quality of water around the project area and also to assess the impact from the proposed project. Grab sampling was done in the month of May 2019. Samples for chemical analysis were collected in polyethylene carbuoys. Samples for DO analysis were collected in the glass bottle of capacity 300ml and the DO was fixed on site using KI and $MnSO_4$. Selected physico-chemical parameters have been analyzed for projecting the existing water quality status in the study area.

Sampling has been done following standard guidelines for physical, chemical and bacteriological parameters. Analysis has been following methods prescribed in "Standard Methods for the Examination of Water and Wastewater (20th Edition)". Samples were collected from ground water sources and tube wells located in the vicinity of project site. The below table gives the result of analysis.

Table 36 Standard methods of analysis for different parameters of ground & surface water

SN	Parameters	Brief Outline of the Methods of Analysis
1	pH	**Electrometric method** - The pH value is determined by measurement of the electromotive force of a cell consisting of an indicator electrode immersed in the test solution and the reference electrode. The electromotive force is measured with a pH meter.
2	Conductivity	Conductivity is directly measured by using Conductivity Meter in unit of milli mho/cm.
3	Turbidity	**Nephelometric method (by Turbidity meter)** - It is based on the comparison of the intensity of light scattered by the sample under defined conditions with the intensity of light scattered by a standard reference suspension under the same conditions. The higher the intensity of scattered light, the higher the turbidity.
4	Color	**Visual comparison method** - Color is measured by visual comparison of the sample with platinum-cobalt standards. One unit of color is that produced by 1 mg of platinum/litre in the form of chloroplatinate ion.
5	Dissolved oxygen (DO)	**Iodometric method** - The dissolved oxygen in the sample oxidized Manganous hydroxide to Manganic hydroxide which in turn oxidizes iodide to free iodide in an acid medium. The iodine liberated is determined by titration.
6	Biochemical Oxygen Demand (BOD)	**Incubation and Iodometric method** - The method consists of filling with sample to overflowing, an airtight bottle of the specified size and incubating it at the specified temperature for 5 day. DO is measured initially and after incubation and the BOD is computed from the difference between initial and final DO.
7	Chemical Oxygen Demand (COD)	**Open Reflux method** - Sample is refluxed in strongly acid solution with a known excess of potassium dichromate. After digestion, the remaining unreduced potassium dichromate is titrated with ferrous ammonium sulphate to determine the amount of potassium dichromate consumed and the oxidizable organic matter is calculated in terms of oxygen equivalent.
8	Total Dissolved Solids (TDS)	**Gravimetric method** - The sample is filtered, and the filtrate evaporated in a platinum crucible on stream bath. The residue after evaporation is dried to constant mass at 103- 105 ° C.
9	Total Hardness	**EDTA Titrimetric method** - Ethylenediaminetetraacetic acid and its sodium salts form a chelated soluble complex when added to a solution of certain metal cations. If a small amount of a dye such as Erichrome Black T is added to an aqueous solution containing calcium and magnesium ions at a pH of 10, the solution becomes wine red. If EDTA is added as a titrant, the

SN	Parameters	Brief Outline of the Methods of Analysis
		calcium and magnesium will be complexed the solution turns from wine red to blue, marking the end point of the titration.
10	Total alkalinity	**Titration method** - Total Alkalinity of the water sample is analyzed by titrating the sample with 0.02 N Sulphuric Acid using Methyl Orange Indicator.
11	Sulphate	**Gravimetric method** - Sulphate is precipitated in Hydrochloric Acid medium as Barium Sulphate by the addition of Barium Chloride Solution. The precipitation is carried out near boiling temperature and after a period of digestion, the precipitate is filtered, washed with water until free of chlorides, ignited or dried and weighed as Barium Sulphate ($BaSO_4$).
12	Phosphate	**Stannous Chloride method** - Molybdate reagent is added in the sample to form Molybdophosphoric acid which is further reduced by addition of stannous chloride to intensely colored molybdenum blue. The intensity of this color is measured by taking absorbance of this solution at 670 Nm and compare with a calibration graph using a distilled water blank.
13	Fluoride	**SPADNS method** - SPADNS calorimetric method is based on the reaction between Fluoride & Zirconium dye lake. Fluorides react with the dye lake, dissociating a portion of it in to a colorless complex anion (ZrF_6^{2-}) and the dye. As the amount of Fluoride increases, the color produced becomes progressively higher. Absorbance of the color is determined by using spectrophotometer at a wavelength of 510 nm.
14	Nitrate	**Reduction method** - Nitrate present in wastewater is converted to ammonium ion by Reduction method, using a strong alkali. Ammonium ion is decomposed to produce ammonia, which is distilled and absorbed in an acid medium and excess acid is back titrated.
15	Chloride	**Argentometric method** - Adjust the pH of the sample between 7-10. Sample is titrated with standard $AgNO_3$ using Potassium Chromate indicator. Silver Chloride is precipitated before red silver chromate is formed.
16	Phenolic compounds	**Bromate Bromide method** - Phenolic Compounds are isolated from wastewater by distillation under acidic conditions. Distilled phenol treated with Standard bromate – bromide solution and then treated with Potassium Iodide. Liberated Iodine is titrated with standard thiosulphate using starch indicator.
17	Cyanide	**Titrimetric methodology** - Sample is distilled in alkaline media. The cyanide ion in the alkaline distillate is titrated with standard silver nitrate to form the soluble cyanide complex, as soon as all cyanide ions has been complexed and a small excess of silver ions has been added the excess silver ions is detected by the silver sensitive p-dimethylaminobenzalrhodamine which immediately turns from a yellow to a salmon color.
18	Sodium & Potassium	**Flame photometer method** - Flame photometer is first calibrated with standard solution of Sodium and Potassium and after that Sodium & Potassium are analyzed in the sample. The principle of flame photometer is based on the fact that when a metallic salt solution is drawn in to a non-luminous flame, the emitted characteristics wavelengths can be isolated and detected with a suitable detector.
19	Iron	**Phenanthroline method** - Iron is brought into solution, reduced to the ferrous state by boiling with acid and hydroxylamine and treated with 1,10 phenanthroline at pH 3.2 to 3.3. Three molecules of phenanthroline chelate each atom of ferrous iron to form an orange-red complex. The absorbance of the colored solution is measured at 510 nm.

SN	Parameters	Brief Outline of the Methods of Analysis
20	Chrome	**Colorimetric method** - Sample is digested with a sulphuric -nitric acid mixture and then oxidize with Potassium Permanganate. After that sample is allow to react with Diphenylcarbazide to form a complex with chrome of pink color whose absorbance has been taken at 540 nm.
21	As, Cd, Cu, Pb, Hg, Ni, B and Zn:	These are analyzed by Atomic Absorption Spectrophotometer.

Results

Chemical Report (Ground Water)

Sl. NO.	Name of Parameters	Test Methods	Bore well
			Date of Collection 27.05.2019
1	Temperature °C	APHA 22nd EDN 2550	31.5
2	Turbidity (NTU)	IS 3025 (P-10), R.A. 2006	<1.0
3	Dissolved Oxygen, mg/l	APHA, 22nd EDN,4500 O_C	6
4	Colour, (Cobalt units)	APHA 2120 B, 22nd EDN	<1.0
5	Taste	IS 3025 (P-07), R.A. 1984	Agreeable
6	pH Value	IS 3025 (P-11), R.A. 2009	7.28
7	Alkalinity as $CaCO_3$ mg/l	IS 3025 (P-23), R.A. 2014	378
8	Total Hardness as $CaCO_3$,mg/l	IS 3025 (P-21), R.A. 2006	604
9	Iron as Fe, mg/l	APHA 22nd EDN 3111 B	0.432
10	Chloride as Cl mg/l	IS 3025 (P-32), R.A. 2009	326
11	Residual Free Chlorine, mg/l	IS 3025 (P-26), R.A. 2009	NIL
12	Total Dissolved Solids, mg/l	IS 3025 (P-16), R.A. 2006	910
13	Bio Chemical Oxygen Demand 3 Days at 27° C (mg/l)	IS 3025 Part 44,1993, RA 1999	<3.0
14	Chemical Oxygen Demand mg/l	APHA 22nd EDN 5220 B	23
15	Calcium as Ca mg/l	APHA 22nd EDN 3500 Ca B	152
16	Magnesium as Mg, mg/l	APHA 22nd EDN 3500 Mg B	54.43
17	Sulphate as SO4, mg/l	APHA 22nd EDN 4500 SO4 E	13.872
18	Cadmium as Cd, mg/l	APHA 22nd EDN 3111 B & C	<0.003
19	Arsenic as As, mg/l	APHA 22nd EDN 3120 B	<0.01
20	Lead as Pb mg/l	APHA 22nd EDN 3111 B & C	<0.01
21	Total Chromium as Cr+6, mg/l	APHA 22nd EDN 3500 B	<0.05
22	Phenolic Compounds as C_6H_5OH, mg/l	APHA 22nd EDN 5530 D	0.05
23	Oil & Grease mg/l	IS 3025 (P-39), R.A. 2009	0.54
24	Phosphate as PO4-P mg/l	APHA 22nd EDN 4500 P-C	0.268
25	Potassium as K, mg/l	APHA 22nd EDN 3500 K, B	8
26	Sodium as Na, mg/l	APHA 22nd EDN 3500 Na, B	168
27	Total Suspended Solids, mg/l	IS 3025 (P-17), 1984 R.A. 2012	5
28	Nitrate as NO3 mg/l	APHA 22nd EDN 4500 NO3 - B	0.258

Chemical Report (Surface Water)

Sl. No.	Name of Parameters	Test Method	Surface Water (Pond Water) Date of Collection 27.05.2019
1	Temperature °C	APHA 22nd EDN 2550	32.7
2	Turbidity (NTU)	IS 3025 (P-10), R.A. 2006	30
3	Dissolved Oxygen, mg/l	APHA, 22nd EDN,4500 O_C	3.8
4	Colour, (Cobalt units)	APHA 2120 B, 22nd EDN	63
5	Taste	IS 3025 (P-07), R.A. 1984	Bitter
6	pH Value	IS 3025 (P-11), R.A. 2009	8.9
7	Alkalinity as CaCO3 mg/l	IS 3025 (P-23), R.A. 2014	170
8	Total Hardness as $CaCO_3$, mg/l	IS 3025 (P-21), R.A. 2006	240
9	Iron as Fe, mg/l	APHA 22nd EDN 3111 B	0.52
10	Chloride as Cl, mg/l	IS 3025 (P-32), R.A. 2009	220
11	Residual Free Chlorine, mg/l	IS 3025 (P-26), R.A. 2009	NIL
12	Total Dissolved Solids, mg/l	IS 3025 (P-16), R.A. 2006	591
13	Bio Chemical Oxygen Demand 3 Days at 27° C (mg/l)	IS 3025 Part 44,1993, RA 1999	16
14	Chemical Oxygen Demand mg/l	APHA 22nd EDN 5220 B	94
15	Calcium as Ca mg/l	APHA 22nd EDN 3500 Ca B	43
16	Magnesium as Mg, mg/l	APHA 22nd EDN 3500 Mg B	32.07
17	Sulphate as SO4, mg/l	APHA 22nd EDN 4500 SO4 E	56.362
18	Cadmium as Cd, mg/l	APHA 22nd EDN 3111 B & C	<0.003
19	Arsenic as As, mg/l	APHA 22nd EDN 3120 B	<0.01
20	Lead as Pb mg/l	APHA 22nd EDN 3111 B & C	<0.01
21	Total Chromium as Cr+6, mg/l	APHA 22nd EDN 3500 B	<0.05
22	Phenolic Compounds as C6H5OH, mg/l	APHA 22nd EDN 5530 D	0.08
23	Oil & Grease mg/l	IS 3025 (P-39), R.A. 2009	0.92
24	Phosphate as PO4-P mg/l	APHA 22nd EDN 4500 P-C	4.32
25	Potassium as K, mg/l	APHA 22nd EDN 3500 K, B	58
26	Sodium as Na, mg/l	APHA 22nd EDN 3500 Na, B	117
27	Total Suspended Solids, mg/l	IS 3025 (P-17), 1984 R.A. 2012	96
28	Nitrate as NO3 mg/l	APHA 22nd EDN 4500 NO3 - B	11.9

Bacteriological test result (Ground water)

Sl. NO.	Name of Parameters	Test Methods	Result Bore well Water Date of Collection 27.05.2019
1	2	3	4
1	Coliform /100 ml	IS :1622-81	1000/100 ml
2	Fecal Coliform/100 ml	IS: 1622-81	200/100 ml

Bacteriological test result (Surface water)

Sl. NO.	Name of Parameters	Test Methods	Result
			Surface Water (Pond Water) Date of Collection 27.05.2019
1	2	3	4
1	Coliform /100 ml	IS :1622-81	9000/100 ml
2	Faecal Coliform/100 ml	IS: 1622-81	3000/100 ml

10. Project concept and planning model

This chapter focuses on the project concept, basic considerations while finalization of the approach and the methodology of the project. Since all the ULBs have different waste characteristics followed by different demographics and presence of different nature of commercial, residential and institutional units, the primary considerations for the planning model of each ULB has to be customized as per the need and the same is being furnished below:

10.1. Primary considerations

Formulizing the project planning and design philosophy invariably requires understanding the parameters, which can create an impact if analyzed effectively, we based on our experience have shortlisted the following important criteria or approaches on priority to evolve an optimum solution-

- Integration of existing infrastructure into the proposed system
- Synchronization of existing pilot scheme or planning of interlinking/replication into the proposed system
- Optimization of land utilization (minimum disposal)
- Reduction of manual handling
- Compliance of latest Rules, environmental & social safeguards
- Technological flexibility and exploring options for adoption
- Defined performance parameters performance monitoring
- Robust monitoring & tracking system of operations for real time analysis of data.

A robust MSW management system requires an ULB to take proactive initiatives towards community participation through sustained IEC for awareness generation, behavior change, cooperation and compliance. The 'NIMBY Syndrome' (Not in My Back Yard) in particular affects continuation of solid waste treatment and disposal sites and to that effect, the ULB needs to have effective communication and build partnerships and offer some incentives to the affected community.

Some of the considerations have been made for designing the concept for solid waste management of our study area:

- Compulsory segregation of waste at the source into wet & dry waste fractions to achieve maximum recovery of resources
- Design of the system in accordance with the requirements of the MSW regulation which is to provide treatment and disposal facilities for MSW and restrict landfilling to only inert and rejects from waste processing that are not suitable for either recycling or processing.
- Establishing an efficient door-to-door waste collection with maximum participation among the communities and the waste generators
- 100% collection and transportation of the waste generated
- Reduction of manual handling of waste by automating the entire waste collection and transportation system to the maximum.
- Priority is given to "ease of access" to waste generators and handlers by provision of an effective and efficient waste collection system and appropriate transportation infrastructure such as providing one bin per km in densely populated areas
- Daily transportation of waste to the processing & disposal facility and optimization of the same such as restricting one vehicle trip time to 6-8 hrs. thus, increasing the life of vehicles and reducing its O & M cost.
- Effective monitoring system in place to ensure the sustainability of the proposed system.

10.2. Centralized and Decentralized system

In an urban set up like Kolkata Metropolitan Area, waste management is a challenge due to land constraint. Besides land - transportation, waste handling manpower & infrastructure on regional basis involve a huge capital investment and time as well. Trials have been made to address the waste at the source of generation and thereby reducing the load on the entire value chain. In line with these constraints, while developing the project concept and model for the present cluster project, a review and appreciation of centralized versus decentralized system has been undertaken to appreciate the usability of both the forms given below-

Table 37 Centralized vs Decentralized system

Centralized System	Decentralized System
• **Best when there is unavailability of land near the source of waste generation** • **NIMBY syndrome - Local level resistance** • **Large economies of scale** • **Waste characteristics - large cities with higher % of combustibles warrants setting up of large / centralised facilities.**	• Land within the locality of waste generation is available • Abundance of labour required for preliminary sorting • High organic content of waste is pre-requisite. • Cheaper technology with low O&M • Established markets for compost/biogas • Low on risks and hazards

Benefit of decentralized system

- Reduces O&M cost on waste transportation in a large city where the transportation distance of waste is substantial
- Promotes segregation of waste at source
- Simple technology like composting and bio-methanation, requires semi-skilled staff, translating to cheaper personnel costs.
- Cheaper technology
- Inclusive projects – Protects and promotes livelihood opportunities
- Smaller project areas -Better monitoring on a real time basis.
- Reduces landfilling cost.

Under this context, the present project concept has been developed with a blend of both centralized and decentralized systems. The objective is to reduce the volume of waste through decentralized manner at each level of the SWM value chain and thereby attaining a minimum land requirement for centralized treatment and disposal facilities leading to overall economies of scale at the operational level.

Centralized and Decentralized system will comprise of the following sub components–

10.2.1. Decentralized system

Based upon the nature and quantum of waste decentralized waste management system may be proposed. Some of the interventions are as per the following:

Organic Waste Treatment at Domestic Level

Households, societies, cooperatives and residential complexes generate substantial quantity of organic waste from domestic activities. The wet waste could be treated at the society premises by means of packaged compost plant or organic waste converter. The manure from those units could be used for gardening etc. within the premises. Such zero wet waste management initiative could be adopted at the housing level at different ULBs.

Bio-methanation for Bulk Generators

Bidhannagar has around 16 markets and Rajarhat has around 50 markets, in addition to this the overall cluster has a large presence of un-notified markets, which generate close to 0.5-1 TPD of market waste, these organic green wastes can be processed through biomethanation. Similarly, NKDA and other ULBs which have markets and adjacent space to place (around 500 sqm for 5 TPD units) decentralized biomethanation units may be considered for decentralized processing of market waste at source.

Decentralized Transfer Stations with MRF

All the ULBs currently use the transfer stations where the compactors have been placed, for compaction of the waste generated to minimize volumes and thus optimizing trips for waste transportation for disposal. However, currently most compactor stations are receiving mixed waste. Once source segregation is implemented, the current assets may be used as MRF centers to allow segregation of the dry waste, and thereafter compaction of segregated waste.

10.2.2. Centralized facility

Centralized system will be adopted for the following components, to be placed in 2 locations:

Location 1: 20-acre land in HIDCO area

Biomethanation (400 TPD)

For market wastes from congested localities in cluster 2 ULBs where decentralized units are not feasible due to space constraints, a common biomethanation plant it proposed. This will also cater to balance source segregated wet waste from the ULBs which could not be treated in decentralized manner. 4 nos. of 100 TPD Modular unit would be installed on modular basis.

Material Recovery Facility (MRF)

The centralized MRF will cater to dry waste streams from cluster 2 ULBs, with an aim to further segregate incoming dry waste and manage them through a value chain-based approach.

Construction & Demolition Waste Management Facility

Construction and demolition were generation taken place mainly due to development of new areas, real estate market as well as while turning old properties for some new housing/ markets construction process. Construction & demolition waste from these four ULBs will be managed in a centralized facility, which will cater all different types of C&D wastes from those four ULBs, turning the waste into reusable construction and building materials.

Location 2: Centralized disposal site (proposed at Bhangor)

Composting Facility

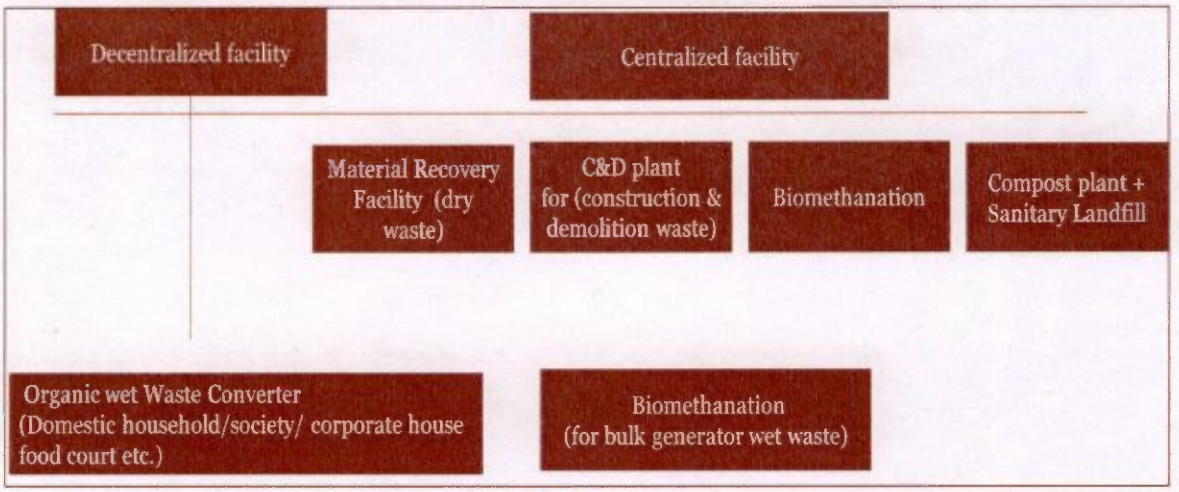
The project will involve 100% segregation of the waste primarily into two components – dry waste and wet waste. Decentralized facility will be designed for the wet waste generating from specific sources such as households, societies, complexes, bulk generators, big offices etc. There would be a number of other sources of generation of wet waste where decentralized facility may not be possible due to the less quantum of waste from individual units, such as – stand alone or individual households, commercial markets, small restaurants, and other domestic sources, park, gardens etc. In such cases, all those wet wastes would be brought to a centralized compost plant. This compost plant would be a centralized facility for all four ULBs.

Sanitary Landfill Facility

The inert and rejects, generated from all centralized and decentralized facilities will be sent to the centralized secured landfill. This facility will cater all four ULBs. 432 TPD of inert and rejects are estimated to be required to be disposed at this facility. About 65 acres of encumbrance-free and PCB compliant land would be required for the purpose of SLF.

In the following sections, individual waste management models (collection, transportation, processing, treatment & disposal) of each of four ULBs are being discussed. The concept flow is presented in the diagram below:

Figure 34 System Optimization with Centralized/ Decentralized Combination



10.3. Conceptual planning &models of facilities in each ULB

This section will discuss the various models of the SWM plan for individual ULBs and the integration of the same holistically into the centralized system.

10.3.1. Concept plan &solution model for KMC

KMC boroughs have mixed generation pattern of waste and a diversified land use. Therefore, collection and transportation along with treatment from 3 boroughs of KMC have different pathways.

From residential areas & institutional areas (old office areas) which are located in congested locations, waste will be collected by means of LCV, BOHD, tri cycle etc. in a segregated manner (dual compartment). The waste will be sent to transfer stations for compaction. The compacted waste will be then be taken to Dhapa compost plant (for wet) and MRF facility for dry waste. For collection from congested slum areas, tri cycle, 1 MT BOHD etc. vehicle will be used.

The C&D waste generated will be sent to the centralized proposed C&D waste treatment facility. Figure below depicts the proposed model:

Figure 35 SWM Solution model for KMC

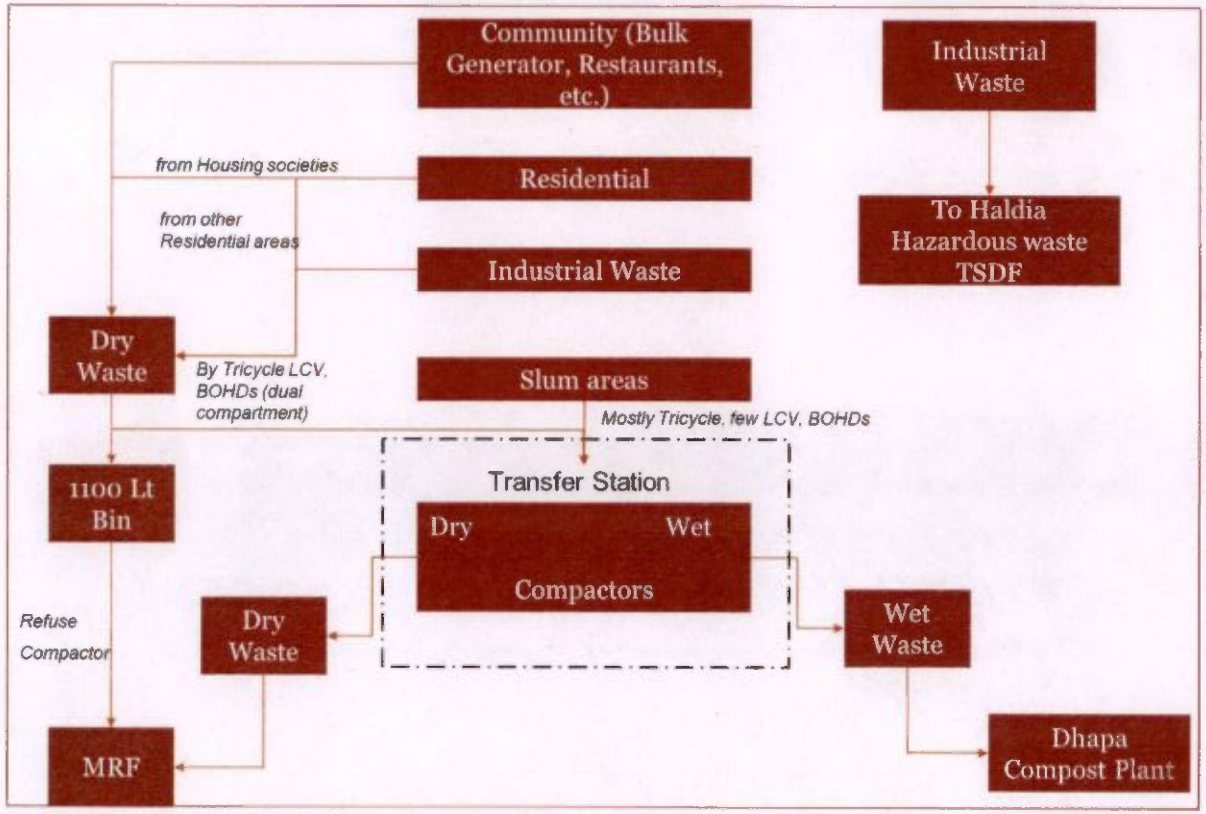


Figure 36 SWM Solution model for KMC - Mass balance

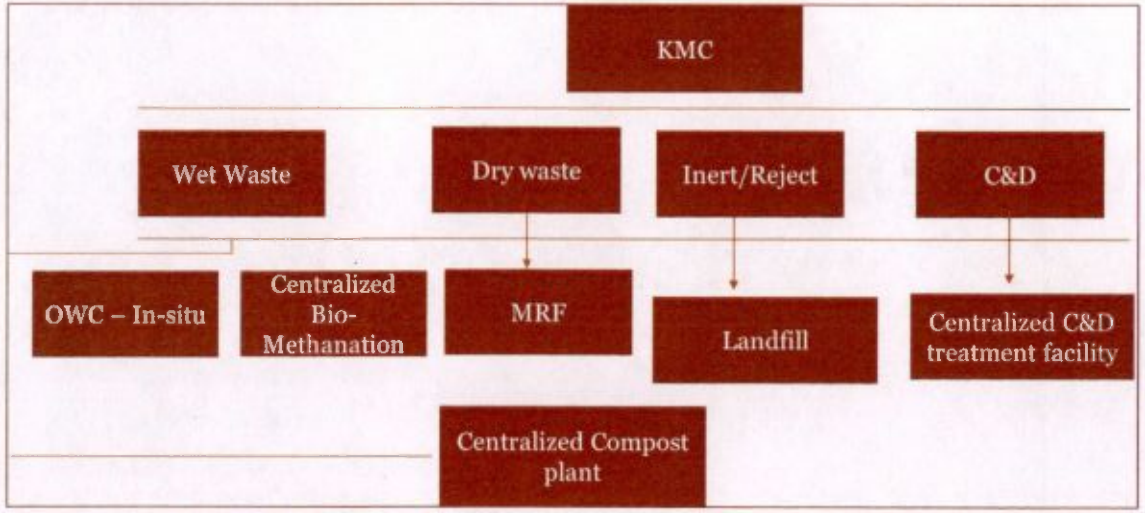


Table 38 Mass Balance for KMC

Decentralized System						**Sharing of Centralized System by ULBs (20 years planning)**				
5 TPD biomethanation Plant for bulk generators			**In situ automatic organic waste composter (300 kg/day)**			**MRF**	**C&D**	**Biomethanation**	**Composting**	**SLF (TPD)**
Location	**Nos**	**Total TPD**	**Location**	**Nos**	**Total TPD**	**At 20-acre Patharghata site**			**At Bhangor**	
			WN 32 - CIT road, Nazrul Islam Sarani area	5	1.5					
			WN 31 - Maniktala Road	5	1.5					
			WN 33 - Locality along Narkeldanga main road	5	1.5					
			WN 57 - Chawal Patti to metropolitan area	5	1.5					
			Broad street	5	1.5					
			Tiljala sibtala area	4	1.2					
NA	0	**0**		**29**	**8.7**	**214**	**157**	**250**	**113**	**182**

10.3.2. Concept Plan & Solution Model for BMC

BMC has a mixed land use and waste generation pattern. It has residential societies, abashans, big complexes, general residential areas, old residential areas, congested localities, bulk vending zones & markets, and commercial complexes. As it has multidimensional waste generation pattern, the collection, transportation treatment & disposal strategies are also different within its jurisdiction.

Organic green waste from bog houses, complexes, abashans etc. will be in situ treated by organic composter and dry waste will be brought to the MRF facility by means of refuse compactors. From bulk markets, sabzi bazaar and commercial areas green waste will be sent to the Biomethanation plant by means of bulk waste carrying vehicles (or tractor trolleys). The dry waste from markets and other residential areas will be sent to the transfer station and from there the compacted dry waste will be sent to the material recovery facility. The wet waste from different scattered residential locations will be collected by means of tri-cycles, LCV and will be sent to the transfer stations, from where they will be sent to the centralized processing facility. Figure below depicts the model:

Figure 37 SWM solution model for BMC

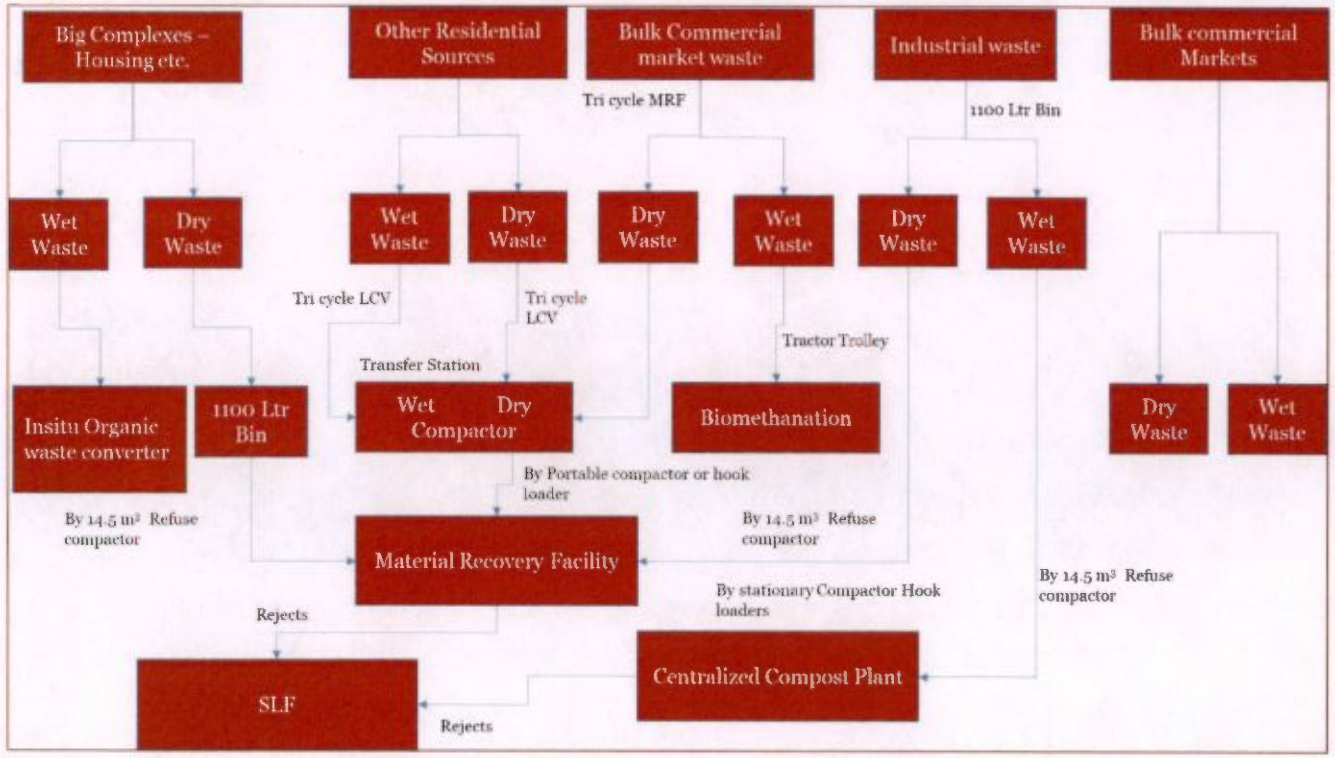


Figure 38 SWM solution model for BMC - Mass balance

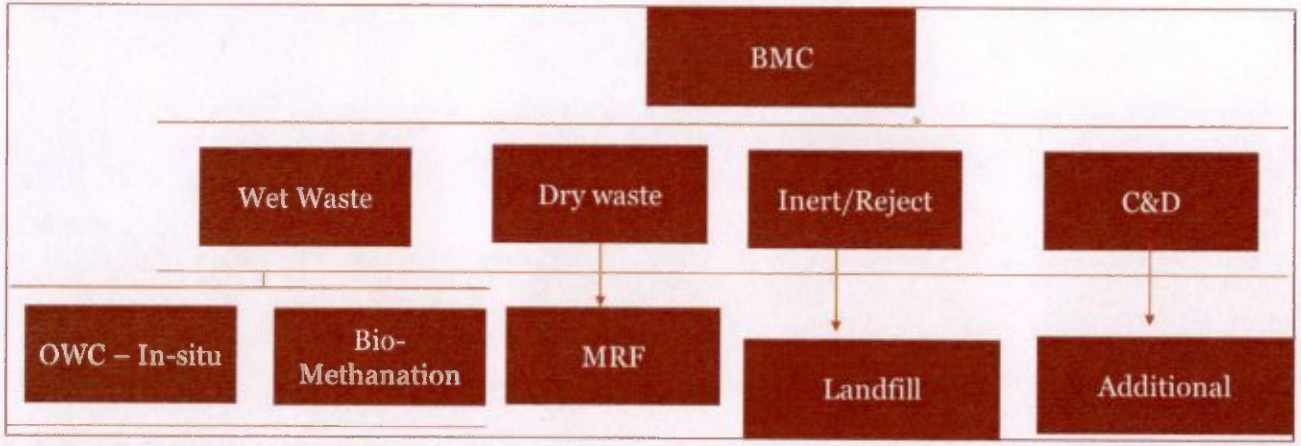


Table 39 Mass Balance for BMC

Decentralized System						**Sharing of Centralized System by ULBs (20 years planning)**				
5 TPD biomethanation Plant for bulk generators			**In situ automatic organic waste composter (300 kg/day)**			**MRF**	**C&D**	**Biomethanation**	**Composting**	**SLF (TPD)**
Location	**Nos**	**Total TPD**	**Location**	**Nos**	**Total TPD**	**At 20-acre Patharghata site**			**At Bhangor**	
Salt Lake - Duttabad (sector I)	1	5	Existing AD Vat (Sector I)	1	0.3					
Salt Lake - IB (sector III)	1	5	Existing AA Vat (Sector I)	1	0.3					
Salt Lake - AK block (left to Kathgola Island), sector II	1	5	Existing Baishaki Vat (Sector II)	1	0.3					
Rajarhat - Harichand polly	1	5	Existing EE Vat (Cannel Side) (Sector	1	0.3					

Decentralized System						Sharing of Centralized System by ULBs (20 years planning)				
5 TPD biomethanation Plant for bulk generators			In situ automatic organic waste composter (300 kg/day)			MRF	C&D	Biomethanation	Composting	SLF (TPD)
			III)							
			Existing Vat Opposite of UCO Bank (Sector)	1	0.3					
			Canal Side (Kestopur khal), near 206 bus stand (Sector II)	1	0.3					
			Existing BF-CF Vat (Sector I)	1	0.3					
			CA MARKET (Sector I)	1	0.3					
			AE MARKET (Sector I)	1	0.3					
			EC MARKET (Sector I)	1	0.3					
			IA MARKET (Sector III)	1	0.3					
			GD MARKET (Sector III)	1	0.3					
			CK MARKET (Sector II)	1	0.3					
			BAISAKHI (Sector II)	1	0.3					
			KURNAMOYEE (Sector II)	7	2.1					

Decentralized System						Sharing of Centralized System by ULBs (20 years planning)				
5 TPD biomethanation Plant for bulk generators			In situ automatic organic waste composter (300 kg/day)			MRF	C&D	Biomethanation	Composting	SLF (TPD)
			LABONI (Sector I)	3	0.9					
			PURBACHAL (Sector III)	7	2.1					
			SRABONI (Sector III)	1	0.3					
			BAISAKHI (Sector II)	3	0.9					
			FALGUNI (Sector III)	1	0.3					
			BICHITRA (Sector III)	1	0.3					
			SHAMOLI (Sector I)	1	0.3					
Total	4	20		38	11.4	323	236	100	429	224

10.3.3. Concept Plan & Solution Model for NKDA

NDITA has a mixed nature of waste generation comprising biodegradable, non-bio-degradable, e-waste etc. Primarily four different categories of waste generation sources have been observed, such as – a) Housing societies, b) Other residential individual plots, c) Institutions/ Offices, d) markets.

Wet waste from housing societies and office/ institutions will be treated in situ through organic waste converters. For dry waste 1100 lit compactor bins will be placed adjacent to the generator premises from where, refuse compactors will pick the dry waste and bring it to the centralized MRF facilities.

From other residential areas and markets, Low Capacity Vehicles (LCVs or dedicated auto tippers) will collect the wet waste and send it to decentralized Bio-methanation plant. Dry waste will be collected through separate designated auto tipper and will be sent to the centralized MRF.

C&D waste will be separately carried to the centralized C&D Plant. Below figure depicts the model:

Figure 39 SWM solution model for NKDA

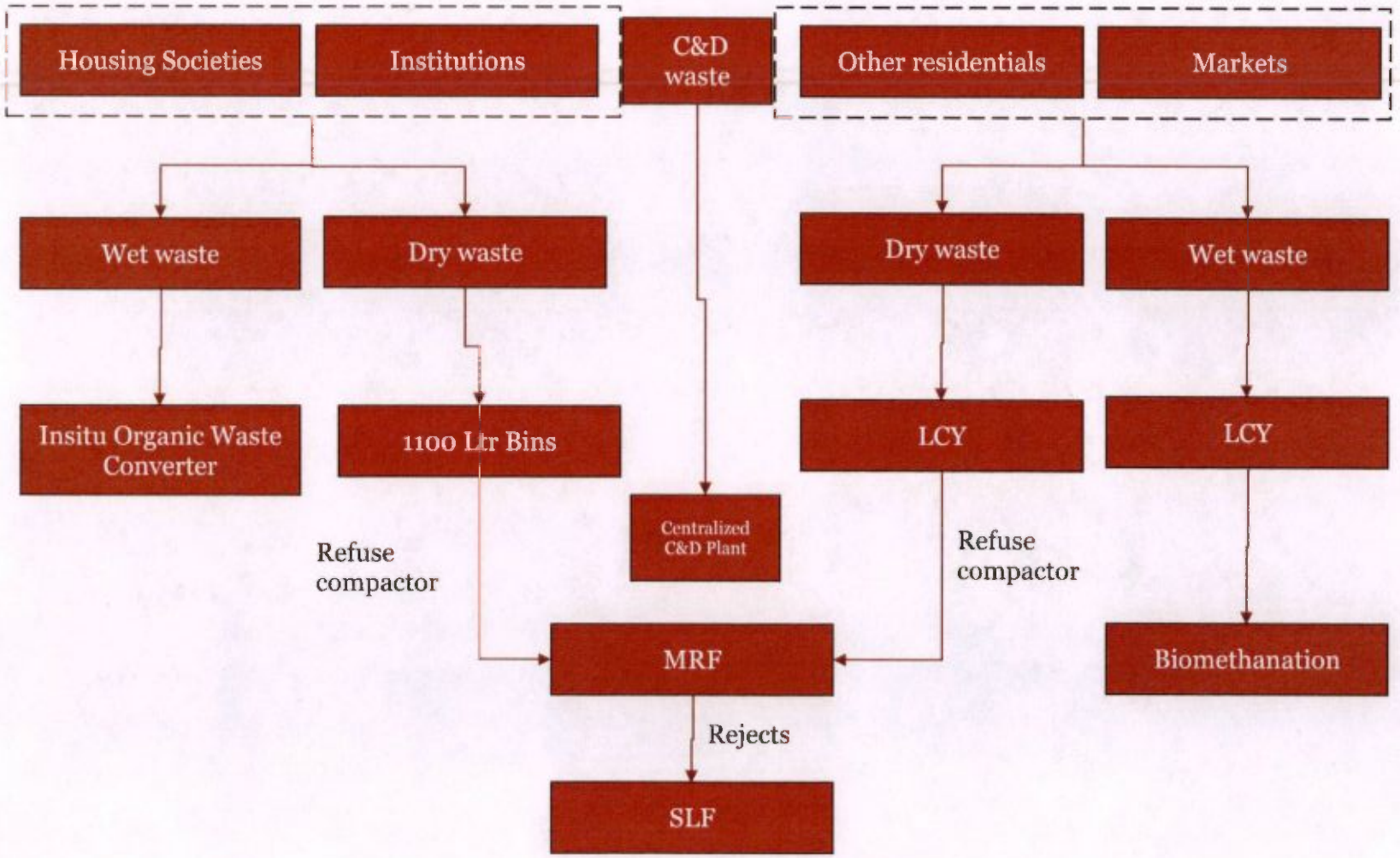


Figure 40 SWM solution model for NKDA - Mass balance

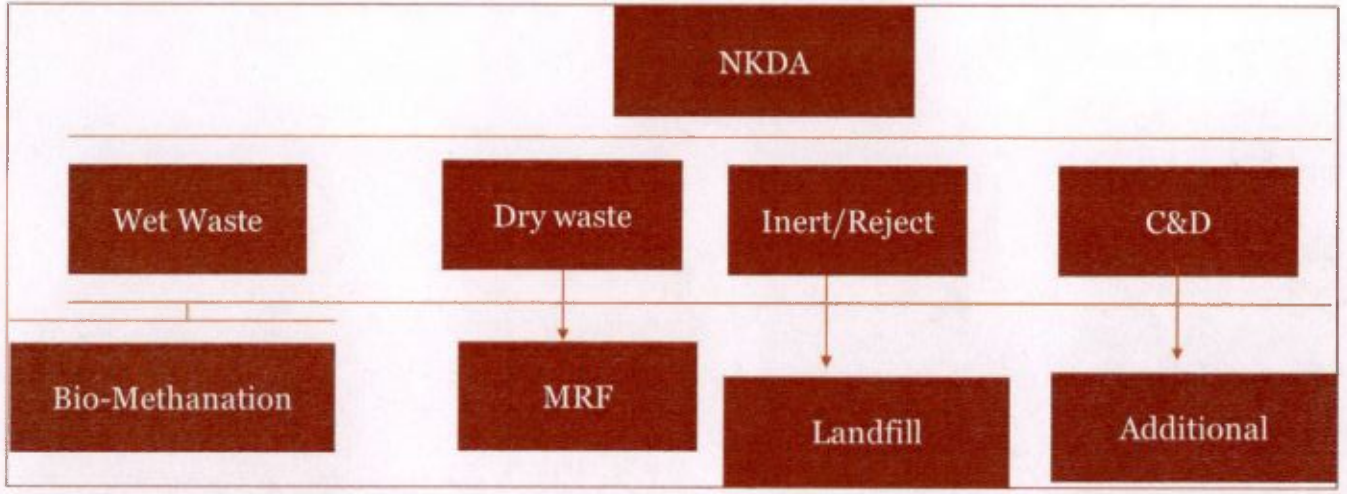


Table 40 Mass Balance for NKDA

Decentralized System						Sharing of Centralized System by ULBs (20 years planning)				
5 TPD biomethanation Plant for bulk generators			In situ automatic organic waste composter (300 kg/day)			MRF	C&D	Biomethanation	Composting	SLF (TPD)
Location	Nos	Total TPD	Location	Nos	Total TPD	At 20-acre Patharghata site			At Bhangor	
CG Market	1	5		0	0	19	14	28	0	15

10.3.4. Concept Plan & Solution Model for NDITA

NDITA is a commercial area with IT establishments. Most of the generated waste is from canteens, kitchens, food courts etc., with good portion of paper waste. It was understood that although it is an IT hub, but no –E-waste is generated as such, since it is recycled/ sold to the designated vendors by each of the IT establishments based on discussed with the concerned officials

Segregated waste from IT offices will be collected through compartmental Tata Ace CNG Garbage hopper tippers from each of the establishments. Then the wet waste could be sent to a decentralized biomethanation plant within the ULB area. Alternatively, in situ treatment of organic waste through composter at office premises level may be also proposed.