Strategic assessment of solid waste management services and systems in Nepal

City-level Assessment and Draft Service Improvement Plan for Solid Waste Management

For Pokhara Metropolitan City

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Abbreviations

AEPC	Alternative Energy Promotion Council
BMW	Bio-medical waste
BOD	Biological oxygen demand
BOOT	Build own operate and transfer
BOT	Build operate transfer
CAO	Chief Administrative Officer
CLA	City-level assessment
COD	Chemical oxygen demand
COVID	Corona Virus Disease 19
CPHEEO	Central Public Health and Environmental Engineering Organization
CRIS	CRISIL Risk and Infrastructure Solutions Limited
C&D	Construction and demolition
DCB	Demand, collection and balance statement
DPR	Detailed project report
DG	Diesel generator
DoE	Department of Environment
EA	Environmental assessment
EHS	Environment-health-safety
EIA	Environment impact assessment
EPA	Environment Protection Act
EPR	Environment Protection Rules
GoN	Government of Nepal
GPOBA	Global partnership on output-based aid
GPS	Global positioning system
HCF	Health care facility
HDPE	Hyper density polyethylene
HIG	High income group
IBN	Investment Board Nepal
IEC	Information education and communication
IEE	Initial environment examination
KPI	Key performance indicator
LGO	Local Government Operation Act
LIG	Low income group
PMC	Pokhara Metropolitan City
MIG	Medium income group
MoF	Ministry of Finance
MoFAGA	Ministry of Federal Affairs and General Administration
MoFE	Ministry of Forest and Environment
MoUD	Ministry of Urban Development
MRF	Material recovery facility

MSW	Municipal solid waste
MT	Metric tons
NGO	Non-governmental organization
NIMBY	Not in my backyard
NPC	Nepal Planning Commission
NPR	Nepali rupee
NNRFC	National Natural Resources and Fiscal Commission
NUGIP	Nepal Urban Governance and Infrastructure Project
OBA	Output-based aid
OHS	Occupational health and safety
O&M	Operation and maintenance
PLGSP	Province and Local Government Support Program
PPP	Public private partnership
RDF	Refuse-derived fuel
SIP	Service improvement plan
SIIP	Service and infrastructure improvement plan
SLF	Sanitary landfill facility
SOP	Standard operating procedure
SWM	Solid waste management
TPD	Tons per day
TLO	Tole lane organization
ULL	Urban local level
USD	US dollar
WB	World Bank

Contents

List of tables

List of figures

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Executive Summary

By 2050, it is estimated that nearly half the world's population will reside in cities. With a growing population and increasing income levels, the waste generated by these urban centers will increase. Cities and towns across the globe, especially in developing countries, face acute waste management challenges in terms of efficient collection, transportation and scientific disposal, while complying with the prevailing environment standards and negating any adverse impact on general public health and the environment. Developing countries like Nepal are no different.

Nepal, in 2015, established a three-tier government while adopting a new constitution. Local governments have complete autonomy in local operations and necessary decision making. Management of waste generated in its jurisdiction is the functional responsibility of the local governments. Nepal generates approximately 7 lakh ton of waste per annum, of which only half is collected and is disposed without any treatment. Of the 293 urban local level (out of a total 753 local level governments) only a few cities have developed sanitary landfills for the scientific disposal of collected waste.

A pilot program for systematic improvement of solid waste management sector was attempted under the Global Partnership for Output Based Aid (GPOBA) in 2013, covering five cities of Nepal. A performance-linked grant support approach with these cities led to the successful achievement of targeted outcomes in service delivery and financial sustainability of SWM sector.

Building on the success of GPOBA and to identify city-wide municipal infrastructure investments for SWM that can be covered under the proposed Nepal urban governance and infrastructure project (NUGIP), the World Bank identified two representative cities from the hilly and plain (locally known as '*terai*') regions of Nepal to conduct an assessment of solid waste management services and systems.

At the first stage, this city level assessment warranted a detailed assessment of waste management systems, including a primary waste quantification and characterization survey as well as a questionnaire based socioeconomic profiling survey of waste generators. Additionally, a complete service assessment through a deep dive into institutional and governance systems, technical assessment of service delivery and its models, financial assessment of local government managing the service, and environment and social management practices is being followed w.r.t. waste management as a local function.

Second stage of this assessment is understanding the federal-level environment in terms of policy support, fiscal transfer mechanism to cities, environment monitoring and support available to local governments to implement projects on a PPP basis in the solid waste management sector.

This city level assessment report provides a brief description of the solid waste management practices in Pokhara and provides recommendations on service delivery improvement.

Pokhara is the second largest metropolitan city in Nepal after Kathmandu. It is the largest metropolitan area in Gandaki Province *(Pradesh)* spread over 424 km^2 and housing approximately 400,000 people (as of Census 2011). The current estimated population (2019) of Pokhara is 515,000.

Pokhara Sub-Metropolitan City was merged with Lekhnath Municipality and some village development committees in fiscal 2016 to create Pokhara Metropolitan City (PMC). PMC has 33 administrative wards. These are classified as core, outer and rural wards. The core area (12 of 33 wards) has an estimated population of 179,551 (as of 2019). The current estimated population of the outer area and rural area is 170,221 and 53,223, respectively. These terminologies i.e. core, outer and rural, are only utilized to plan for services and do not have any legal connotation. Tourism activities in Pokhara are on the rise, as are commercial activities. This implies a further population increase in Pokhara and consequently more pressure on existing service infrastructure.

Institutional and policy framework for solid waste management

Ministry of Federal Affairs and General Administration (MoFAGA), Ministry of Urban Development, Ministry of Finance, Ministry of Forests and Environment are the key ministries relevant to solid waste management for technical, operational and financial management and monitoring related guidance to local governments. Investment Board Nepal provides guidance on investments and PPP structuring for infrastructure project including solid waste management (SWM).

Solid Waste Management Act, 2068 (2011 AD) and Solid Waste Management Rules, 2070 (2013 AD) are the two regulations that govern the SWM sector in Nepal. PMC, in line with the SWM Act and Rules has enacted 'Local SWM Rules', 2074 (2017 AD). The key provisions of the national SWM Act are:

- Local governments are responsible for the collection, transportation and disposal of waste in an environmentally sustainable manner
- An SWM Council must be formed in the city to frame local policies, set up SWM charges, etc.
- Waste reduction and segregation is the responsibility of the waste generators, and collection and transportation of the waste is the responsibility of the ULLs. The ULL needs to prepare and comply with a schedule for collection
- Waste needs to be processed and safely disposed in the sanitary landfill site
- PPPs are encouraged to develop SWM infrastructure

Under the Constitution of Nepal (2015), MoFAGA is the nodal Ministry guiding local government operations. MoFAGA has enacted the Local Government Operations Act, 2074 (LGO Act), which is currently being followed by all the urban local levels (ULL) for their day-to-day operations. MoFAGA is in process of preparation of a model law for the local bodies to implement the Local Government Operations Act 2074 effectively. MOFAGA is also planning to draft new policy for solid waste management.

From the environmental pollution control perspective, currently there are no technical standards developed in Nepal w.r.t solid waste management e.g. there are no regulations/norms/standards for monitoring the quality of the leachate that is being generated in waste treatment facilities. Also there are no norms available to the ULL to guide them identify suitable land for development of waste management facilities. Also, the 'Environment Protection Act' was revised in 2019 and the Ministry of Forests and Environment is currently in the process of formulating 'Environmental Protection Rules' under the provisions of the recently published Environmental Protection Act. However, this Act only covers the requirements of carrying out environmental assessment, initial environmental examination, environmental impact assessment, etc., prior to implementation of

SWM projects. This Act does not provide environmental quality standards to be complied with during the operations of waste management facilities. 'Intergovernmental Fiscal Arrangement Act' (2017) and Public Private Partnership and Investment Act (2019) are other relevant regulations impacting financing and project preparation w.r.t SWM at local level.

City-level assessment

PMC is responsible for providing solid waste management services in the city. To assess the practice and performance of solid waste management, our methodology included:

- **Reconnaissance survey** by visiting various residential, commercial areas, tourist locations, bulk waste generators from core, outer and rural areas
- **Primary survey** was carried out for 100 waste generators distributed across the core, outer and rural areas of Pokhara. Primary surveys were carried out for waste quantification and characterization and socioeconomic profiling of the waste generators. Primary survey covered 60 residential, 30 commercial and 10 institutional waste generators (upstream) and also considered samples reaching the dumpsite (downstream). The survey was designed to cover various economic profiles. The primary survey covered waste generators from various professions such as private services (20%), retail or wholesale trade (18%), government services (12%) and farming (15%). NPR 40,000 is the average monthly family income of 70% of the respondents, with 12% (four samples) earning NPR 80,000 to 100,000 monthly
- Various secondary data for the institutional and financial assessment of SWM services were collected and assessed. This assessment included qualitative and quantitative assessments
- Group discussions were carried out with various identified stakeholders such as PMC officials, TLO1s, private operators involved in city's SWM service, rag-pickers and big recyclers in the city to understand the roles and responsibilities of these stakeholders and their perception of issues in SWM service of PMC

Understanding the waste: Based on the primary survey results, the domestic waste generation in core, outer and rural areas is 282, 382 and 188 grams per capita per day, respectively. Combining domestic, commercial, institutional samples, the daily per capita waste generation in Pokhara is 354 grams. Basis the population of 515,000 (estimated for 2019), the city generates 182 metric tons (MT) of municipal waste daily. Domestic waste generators contribute 80% of the total waste generated. Commercial and institutional contributions are 16% and 4%, respectively.

The organic fraction of waste generated is high, varying from 64% in core to 87% in rural wards. The average organic content (upstream and downstream) of the waste is 57%, followed by plastic with 19%. Paper constitutes 11% of the waste generated and the rest is a mix of glass, rubber, metal, etc. Due to high organic fraction, the moisture content is high (74%) and the average calorific value is 2746 kcal/kg. The carbon nitrogen ratio is about 36 and total solids in the waste is 26%.

SWM service delivery: Service delivery has been assessed across the SWM value chain i.e. collection, transportation, processing and disposal. Solid waste collection is outsourced to seven private contractors who provide services in 25 wards (covering 84% i.e. about 88,000 households

[1] Before Nepal accepted a federal system of governance – local, provincial and federal – small-scale community groups were prevalent in the form of tole lane organizations (TLOs). These function as micro-level community groups comprising of 100-150 households

compared to number of households as per Census 2011). Six wards are served by PMC, covering about 14% i.e. 15000 households, and remaining two wards (3% of the households i.e., 3140 units) being rural in nature are not covered with the waste collection service.

Pokhara practices curbside waste collection wherein the vehicles stop in the main arterial roads, blow their horns and waste generators come to the vehicles to dispose their waste. Waste collection frequency varies from daily (in the core city and commercial areas) to fortnightly in rural areas. It was observed from stakeholder consultations that waste collection vehicles do not follow a fixed time scheduled.

Waste collection fleet comprises four vehicles of PMC and 22 vehicles of private contractors. 170 personnel from the operators and 17 personnel from PMC are engaged in waste collection and transportation activities. The SWM Act mandates waste generators to segregate the waste and dispose it in the waste collection vehicles. However, this has not been followed in PMC. Mixed waste is collected and transported to the dumpsite. Due to very low frequency of waste collection, households in the outer and rural areas tend to segregate the waste in wet and dry fractions and the wet waste is used in agricultural land or as fodder for cattle.

An efficient waste collection and transportation system requires complete adherence to the schedule, i.e., day and time of collection need to be fixed and followed daily. This impacts the predictability of the service. Such issues are not monitored, as the existing contracts of the private contractors do not have provisions to penalize contractors if schedules are not prepared and adhered to.

PMC has developed a sanitary landfill site constructed over 4 hectare land that has been operational since 2004. However, this is used as a dumpsite i.e., all the waste collected from the city is dumped here without any segregation and processing. A septage management plant was also installed within the dumpsite but is currently non-functional. An international airport has been proposed within two km radius of the current landfill site (operationally this site is being used as a dumpsite) for which the construction has already begun. Hence this landfill needs to be scientifically closed by December 2020. Currently the biggest challenge for PMC is closing existing landfill operations in an environmentally sensitive manner, identifying and constructing an alternative landfill site on immediate basis.

A private agency has been appointed by PMC to segregate the recyclable waste (paper, plastic, glass, etc.) from the waste that is reaching this landfill facility daily and in return the agency pays a royalty to PMC. The agency extracts recyclables daily and sells the same to large scrap dealers. There are approximately 70 big recyclers and 1000 small scale individual recyclers in Pokhara. A private initiative, M/s Three Star Pipe Udyog in Pokhara receives recyclable plastic from small scale recyclers and recycles it to manufacture plastic pipes. Daily plastic waste intake of this unit is 600-700 kg and produces 400 kg of pipes.

In all, the city produces about 182 MT waste daily, of which 47 MT wet waste and 21 MT dry waste is segregated and recovered at source. Recovery means the wet waste is used to produce compost or feed cattle. Dry waste is sold to individual or retail recyclers. The dry waste comprises of plastic, glass, and paper. Thus, disposable waste amounts to 114 MT. As per the primary survey, 85 MT waste is reaching the landfill daily. Hence, 29 MT waste is not collected. Because of the frequency of collection, the waste is usually stored within the premises. As organic waste is used by the waste generators for household composting, this stored waste will mainly by dry recyclables.

Other waste management: The biomedical waste (BMW) from the city is collected by a separate private contractor appointed by PMC. BMW is collected and transported in separate vehicles and disinfected in autoclaves at the biomedical waste management facility. The disinfected waste is further segregated and handled separately. There is no structured system of managing construction and demolition (C&D) waste generated in PMC. Entities generating C&D waste inform either the private operators or PMC if they have to dispose of construction waste. Such waste is lifted by the private operator (on separate payment basis) or PMC and is disposed in low-lying or unused lands. PMC is not mandated to manage industrial waste. However, the general waste produced at these industries is collected by PMC.

Institutional assessment: Chief Administrative Officer (CAO) heads various operations of PMC. There are 15 operational divisions in PMC including ward operations which function under the CAO. 'Environment and Disaster Management' division is responsible for solid waste management in the city. The division is further divided into:

(1) Sanitation branch- responsible for managing day to day SWM operations

(2) Environment branch- tree plantation and environmental conservation are the key responsibilities

(3) Landfill branch- looks after the construction of sanitary landfill site, operation and management of the same

(4) Vehicle branch- responsible for repair and maintenance of the PMC-owned waste collection vehicles

A total of 91 personnel under the Environment and Disaster department are engaged in SWM operations, of whom 20 are managerial staff, 17 are drivers and helpers, and 59 are sweepers.

Planning for SWM infrastructure in PMC, in most cases, is ad-hoc and not evidence-based. Also, asset management is not formalized. Thus, stock replenishment (vehicles and other equipment) is also ad-hoc. Contracts between PMC and private operators engaged for collection and transportation are weak and lacks in any performance standards. Additionally there are no set processes or system for contract management and enforcing penal provisions from the contracts onto contractors. These contracts are not managed well and that has impacted the service delivery. Some of the key issues in the contracts are:

- Obligations of PMC and the private party are not clearly defined. TLOs are third-party in some of the contracts and their roles are also not clearly defined
- Scope of work for the private contractor is to collect and transport waste in closed vehicles in an environmentally sustainable manner. Based on the scope, it is a service contract but the responsibility of procurement of vehicles and other equipment is on the private operator. These contracts are short-term contracts (average 2 years) and thus not conducive for capital investments.
- The private operators are responsible for collecting SWM charges of which 20% is retained by PMC and 80% is given back. There is an inherent risk of revenue leakage.
- Mention of any performance standards that are required to be achieved by the private contractor and appropriate performance measurement and monitoring mechanism is absent in these contracts. Therefore, penalizing private party for non-performance is absent.

To understand whether waste is being collected from the streets or from households, the PMC staff often relies on complaints received from the waste generators through phone calls. Whenever a complaint is received from any resident regarding waste not being collected, the PMC asks the operator to send vehicles over for waste collection. However, such checks are not done proactively by the PMC.

Pokhara was one of the five cities to receive performance-based grant support under GPOBA. Various output indicators were developed to measure the improvements to be achieved in SWM in Pokhara. These indicators were focused on short and long-term strategy preparation and developing institutional capacity for decision making. Indicators were also developed focusing on the efficiency of service delivery, including landfill operations, waste reduction, service delivery monitoring and the existing communications system. Service monitoring indicators such as effectiveness of service delivery i.e., coverage of waste collection, cleanliness of the city, beneficiary satisfaction were formulated too. Increase in revenue through SWM user fee over time was the parameter to capture financial progress.

However, measuring and reporting of these output indicators was not institutionalized within PMC and were more of one-time activities and not all the reporting was evidence-based. Therefore, data management w.r.t SWM operations and transparency is an issue. Also, due to ambiguous and poorly drafted terms of the contract with private contractors, no data related to SWM operations is shared between PMC and the operators regularly. Thus unavailability of SWM operations related makes service improvement planning difficult for PMC.

Complaint management system related to waste management is still not evolved in PMC and there is no two-way communication process established. It receives 4-5 complaints are daily that are registered in a complaint register. These complaints predominantly pertain to removal of dead animals and delay in arrival of waste collection vehicle. A complaints register is maintained at the office records information w.r.t date, name of the complainant/institution registering complaint, location of complaints (area, ward number), personnel/driver allocated for the job, status (completed/pending), and remarks (if any). There is no formal mechanism for receiving consumer feedback post redressal of the complaints. Redressal of complaints is not a time-bound activity, not monitored and the complaints data is not utilized in service improvement planning.

Financial assessment: Revenue sources of PMC include fiscal transfers from federal government (tied as well as untied grants), revenue sharing grants from provincial governments and revenue from its own sources i.e. local taxes and fees such as integrated property tax, SWM user fee, license fee etc. Revenue income of PMC has declined from NPR 38 crore in 2014 to NPR 35 crore in 2016 and during the same period, revenue expenditure (establishment, administrative, operation and maintenance expenditure) has increased from NPR 15 crore to NPR 23 crore.

Share of taxes to own source revenue has increased from 32% in 2014 to 42% in 2017. In 2017, the revenue income was increased to NPR 247 crore owing to receipt of 'equalization grant' from the federal government to meet the revenue deficit. Due to this, share of own source revenue to total revenue decreased from 75% (2014) to 22% in 2017. Also, the contribution of untied grant has increased from 18% in 2014 to 41% in 2017. This has implication of the PMC's independence to spend the grant revenue as per the priority and requirements.

Monthly SWM charges are levied to the waste generators in Pokhara and a sanitation card is maintained to record the receipt of SWM user charge from the respective waste generator. There are about 29,000 such sanitation cards issued to the waste generators vis-à-vis the total

households 105,000 (Census 2011). This implies wither the coverage of SWM user fee payers is low i.e.28% or there are waste generators who pay the SWM fee and are not provided the sanitation card implying leakage of revenue. Based on our primary socioeconomic survey, households from the low income group (LIG) are paying 0.2% of their monthly income on the SWM charges whereas for medium income group (MIG) and high income group (HIG) households pay 0.4% and 0.9% respectively.

Environmental and health safeguards: Currently there is no environmental monitoring practice in place w.r.t testing of water quality samples and other environmental compliances in and around the landfill facility. Health check-ups for the workers engaged at the dumpsite and biomedical waste management facility are done the by the respective private operators. Also, measures to address occupational health hazards were inadequate. Due to absence of regulatory and contractual obligations, environment and health safeguard measures are not monitored.

To summarize, PMC's waste management service is outsourced to private contractors, but there is no oversight of those private contractors to improve on the service delivery. Basis these identified issues and gaps, a service and infrastructure improvement plan (SIIP) is prepared for Pokhara. All the recommendations for infrastructure improvement have to be supported by strengthened institutional and financial system. The SIIP also explores private sector engagement in the SWM operations of Pokhara.

Service and infrastructure improvement plan

Service improvement concept: The SIIP provides guidelines to PMC on improving existing infrastructure and operations, leading to better, more reliable, and equitable SWM service delivery. The key aspects covered under SIIP include infrastructure improvements, and financial and institutional reform requirements. It further guides on environmental and social safeguards to be adhered to for improved service delivery. This also identifies the role of the private sector in improving service delivery. These improvements in infrastructure and service levels could form part of the proposed Nepal Urban Governance and Infrastructure Projects (NUGIP). The proposed NUGIP may also seek to institutionalize operations through a strong consistent capacity building program.

It is envisioned that the SIIP will **(a) bridge the infrastructure gaps** (technically viable solutions leveraging the existing infrastructure such as waste collection vehicles and landfill site); **(b) bring in efficiency in service delivery** (operational and financial efficiency by ensuring reliable and equitable service across the city); and **(c) improve consumer connect and effectiveness of service** (measured through consumers' satisfaction and strong compliance with environmental quality requirements and health standards).

For Pokhara, the system is designed to cater to 203 tons per day (TPD) waste in 2020, 271 TPD in 2021 and 351 TPD in 2040. Wards in core area of PMC are projected to contribute 43% of waste generated in the city, whereas 50% will be contributed by wards in outer and 7% by wards in rural areas. Basis this demand, a hybrid and a bin-free service delivery model has been proposed for Pokhara i.e. a combination of centralized as well as decentralized waste management. Conceptual pillars for the SIIP are:

- **Waste should be segregated at the source** and **collected and transported separately**. Dry waste from the core, outer and rural areas will reach the centralized material recovery facility (MRF). Household wet waste from the core areas and commercial wet waste from the outer

and rural areas will be brought to the centralized compost facility. Wet waste generated by the bulk generators in the outer and rural areas can be treated locally in small-scale decentralized biomethanation plants

- A centralized composting facility will be set up for the wet waste. It will have a capacity to process 120 TPD which will be enough to meet the demand for 10 years until 2030. It will have an option to enhance the capacity to meet the demand increase over another 10 years until 2040
- Dry waste from the city will come to the centralized MRF to segregate the recyclables such as glass, bottle, paper, plastic, cardboard, and thermocol. Segregation in rural and outer wards can be decentralized depending on availability of suitable land, but such segregated recyclables shall also reach the centralized MRF.
- A centralized sanitary landfill site will be established to receive the rejects from centralized composting facility and composting plant
- Necessary vehicles and other equipment are to be procured in order to ensure 100% collection rate and efficient transportation of waste to these facilities.

Since a bin-free SWM plan has been conceptualized, no secondary collection points are envisaged. Only large bins need to be installed for the bulk organic waste generators i.e. vegetable markets, fruit markets etc. For collection and transportation, 28 dual compartment closed tippers (3 MT capacity) will be required for the core area, 23 dual compartment closed tippers of 2 MT capacity for the outer areas and 9 dual compartment hydraulic tippers will be required for the rural wards. This requirement has not considered the existing stock of 22 vehicles owned by the private operators.

For processing and treatment, various thermal (like incineration, pyrolysis), biological (composting and biomethanation), and physical processing (RDF, palletization) methods have been considered and evaluated as an option for treatment of waste generated in Pokhara. Considering the waste characteristics of Pokhara, biomethanation and centralized composting have been proposed. For the bulk generators of the outer and rural areas, wet waste to be locally managed through biomethanation and ten (10) small scale biomethanation plants (by 2030) of 1 TPD capacity each are proposed to be installed in the outer and rural areas. Wet waste generated in the core area should be treated at the centralized composting (aerobic digestion) plant with a designed capacity of 120 TPD (by 2030). Wet waste generated by domestic and non-domestic units (except bulk generators) will also reach the centralized facility. The dry waste shall reach the centralized material recovery facility with designed capacity of 130 TPD.

The rejects of the biomethanation plants, compost plant and material recovery facility shall be disposed in the sanitary landfill site. The current dumpsite needs to be scientifically closed which shall include biomining, reclamation of land and inert removal. The proposed sanitary landfill site is to be constructed in four equal phases (five years each) over 20 years. The site is to be designed considering an average waste intake of 70 TPD.

Financing requirement: Capital outlay of the SIIP is $13 million considering the cost of all infrastructure including the waste collection vehicles. PMC's budget is highly dependent on fiscal transfers which is not formula-based and may vary from year to year. Also, PMC has other liabilities and priorities. Hence, it can explore capital funding options such as NUGIP or look for engaging private sector for development of the complete or part SWM system as a way to meet the capital investment requirement for improving the SWM sector performance in Pokhara.

Annual operations and maintenance cost of the entire service would be approximately $0.5 million (NPR 6 Crore[2]). If PMC decides to outsource the activities to private sector, approximately $0.6 million has be recovered through SWM charges to make the service self-sufficient and sustainable. Basis the present waste contribution of domestic and non-domestic users of 80% and 20%, respectively, to the total waste, NPR 6 crore is to be recovered from domestic and NPR 1.2 crore from the non-domestic units. Only by increasing the coverage sanitation cards can this O&M expenditure be recovered. At tariff levels of NPR 15, NPR 50 and NPR 150 for the LIG, MIG and HIG households, respectively, potentially NPR 8 Crore can be recovered. These charges are about 50% lower than the existing charges that the households are paying.

Thus, only by increasing coverage of levying charges and 70% collection efficiency can 80% of the total estimated O&M cost be recovered. The principles of tariff determination may follow pro-poor cost rationalization, i.e., subsidizing the charges for the LIG group further by loading more on the non-domestic units.

System of imposing charges currently is very complex. PMC levies charges based on different categories such as access to the building, built-up area and structural specification. These rates can vary across the city based on the location, i.e. core, outer and rural. Further, SWM charges are calculated separately for domestic and non-domestic waste generators. The SWM Act 2068 (2011 AD) prescribes charges based on the quantity of waste generated. This cannot be implemented because it is difficult to measure the waste generated by each household.

We recommend that the current system to continue, however the categories should be merged to simplify the overall system of billing and collection. The four user groups can be domestic, commercial, industrial, and institutional/public use, and the rates should vary based on the location (core, outer and rural).

At present, private operators have the responsibility of issuing sanitation cards and primary revenue management. This responsibility should be vested with PMC. It can undertake a one-time survey of the properties in the city. Based on the property identification number, sanitation cards can be issued. These cards should also have a unique identity code, representing the ward number, etc. Complete information of the waste generators needs to be captured while providing the sanitation card.

As SWM charges should be flat rate-based, the card shall mention the amount to be paid by the waste generators every month. The responsibility of collection of charges, considering the human resource availability with PMC, may be vested with a private operator. However, there should be performance-linked payment to the private operators to ensure the collection efficiency of charges improves over time and there is no leakage of revenue.

Institutional reform requirement: Currently, sanitation sub-branch looks after collection and transportation activities and the vehicle department looks after vehicle maintenance. The landfill sub-branch is responsible for management of the landfill site. Basis the infrastructure development and service delivery improvement, the departments can be reorganized as

I. **Collection and transportation:** This is essentially the merger of the existing sanitation and vehicles sub-branch. All works pertaining to collection and transportation of municipal solid waste, including street sweeping, shall be under the purview of this sub-branch

[2] 1USD=114 NPR

II. **Processing, treatment and disposal:** In alignment with the new proposals, the responsibility of the landfill department needs to be expanded to all the centralized processing, treatment and disposal facilities

III. **Environment:** The sub-branch shall be responsible for environmental quality monitoring and to ensure clean disposal of waste. This shall be in addition to the existing responsibility of tree plantation

IV. **Community engagement:** This branch will introduce engagement with communities for the improvement of service delivery. Carrying out IEC activities and complaint management will be the responsibility of this sub-branch

Contract management also can become a part of their responsibilities. Pokhara can have one service contract instead of seven for the collection and transportation of waste. However, PMC will need support to prepare a fair and performance-based service contract and appoint an operator through a competitive bidding process. Further, PMC will also need a handholding support for contract management such performance-based contract. Vehicles and other equipment shall be procured and owned by PMC and private contractor shall only be responsible for waste collection and transportation as per the approved schedule. Defaults due to delays in human resource mobilization or non-performance are to be the basis for penalizing the private contractor. However, non-performance due to delays in asset handovers can be attributed to PMC. Changes in scope should be mutually agreed and accordingly the financials are to be worked out.

For the operation and maintenance of the other proposed centralized facilities i.e., compost plant, material recovery facility, sanitary landfill site, there could be a separate private contractor. This contract shall be a performance-based management contract and should be of 5-8 years. Asset ownership will be with PMC and assets will be handed over to the private contractor for operation, maintenance and management.

Such an arrangement will help PMC to carry out operations efficiently and improve service delivery.

Further to these, the legal framework needs to be strengthened to enable the SWM operations to be carried out efficiently. Technical norms of site selection, environmental and social safeguards are other areas to be strengthened for improved service delivery.

The overall improvement of SWM service delivery will depend upon constant monitoring of operations and progress in infrastructure development and persistent efforts to build PMC's capacity for management. This could be done through various indicators covering the following aspects:

- **Service delivery** performance - encompasses performance of all operations of the SWM chain, i.e., segregation of the waste at the source, its collection and transportation, and treatment and disposal
- Efficient financial management - refers to improvement in cost recovery through improved collection of charges, resulting in sustainable SWM operations
- Institutional strengthening - Improvement in technical, monitoring and management capabilities of the PMC to upkeep service delivery

The Nepal Urban Governance and Infrastructure Project (NUGIP) can be harnessed to fund the capital works. Based on the identified indicators, an output-based grant can be structured. Further, the project can focus on the identified capacity building aspects such as building technical knowhow, contract management to ensure sustained results of these investments.

1 Background

Nepal is experiencing a shift from a unitary to a three-tier government structure. The transition has led to increased financial independence and decision-making responsibilities for urban local level (ULL) governments.

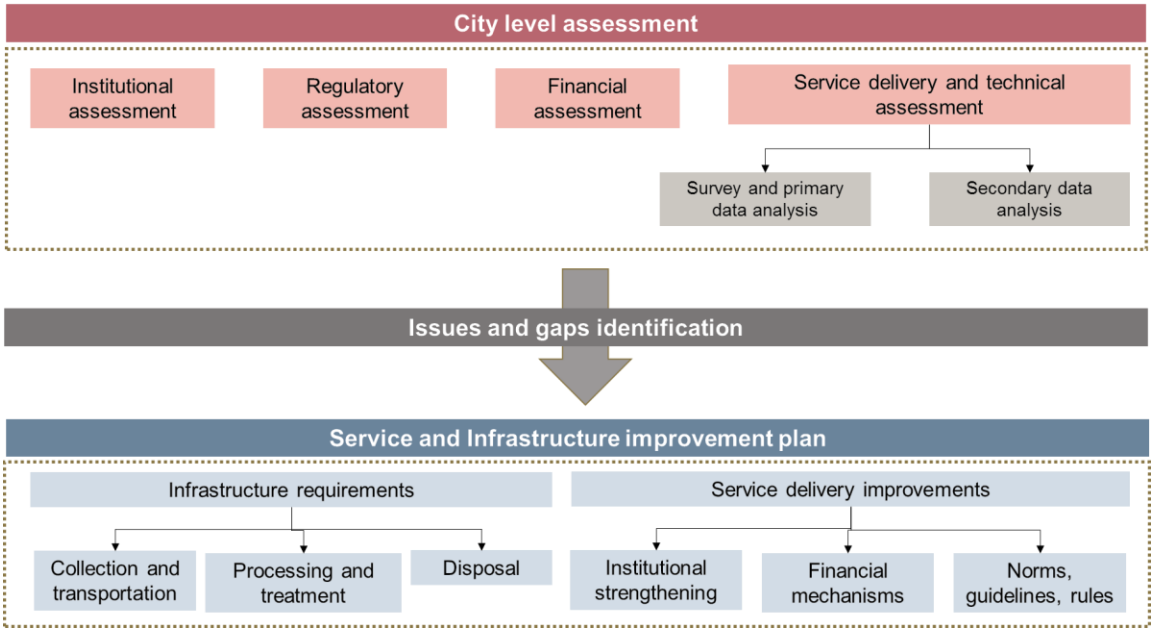
Solid waste management is primarily the responsibility of the ULLGs. Legally, the ULLGs can also formulate their own regulations in order to manage the waste efficiently. The World Bank (WB), via the Global Partnership on Output-Based Aid (GPOBA), supported five cities (Dhankuta, Ghorahi, Lalitpur, Pokhara, and Tansen) in 2013 in addressing the challenges of efficient waste management, financial bottlenecks and the willingness of residents to pay for waste management services. The subsidy offered under the project was designed to diminish as cities achieved pre-defined outputs (technical and financial) leading to thus improving their waste management performance.

Leveraging the success of the GPOBA, the WB aims to prepare a robust strategy for solid waste management (SWM) in Nepal. As part of this initiative, a detailed city level assessment of solid waste management service and systems in the project cities- Pokhara and Itahari is to be carried out in order to prepare a robust service and infrastructure improvement plan.

This report is prepared for Pokhara Metropolitan City (PMC). This requires a thorough understanding of the solid waste management activity chain, identification of any service gaps, and provision of an end-to-end service delivery improvement plan. Further, key performance indicators will have to be identified against which output-based assistance can be designed and funded under the Nepal Urban Governance and Infrastructure Project (NUGIP).

Then learnings from this exercise shall form the base of a national-level policy advisory to address the current SWM problems in cities of Nepal. This deliverable includes key technical, social and environmental challenges, that the service is facing and provides comprehensive recommendations for improvement. The recommendations are for institutional, governance, technology, service delivery, financing, cost recovery, and citizen engagement in solid waste management.

Figure 1: Coverage of the deliverables

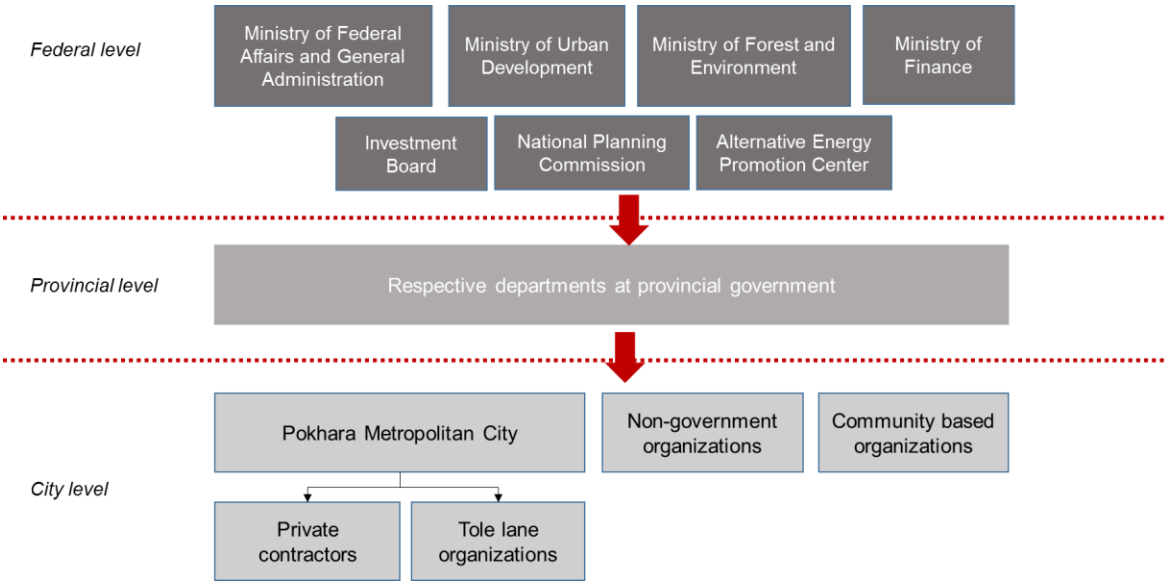


This city level assessment (CLA) report provides a detailed assessment of existing SWM practices in PMC and recommends a service and infrastructure improvement plan (SIIP) for it.

1.1 Federal-level institutional arrangement for SWM

Ministry of Federal Affairs and General Administration (MoFAGA), Ministry of Urban Development (MoUD), Ministry of Finance (MoF), and Ministry of Forests and Environment (MoFE) are the key ministries overseeing the technical, operational, financial and environmental aspects of SWM and guiding ULLs in their respective areas. In addition, the Investment Board Nepal, Public Private Partnership Center (established under the National Planning Commission) are some of the other federal-level organizations support local governments in developing projects on a PPP basis. Provided below is a schematic of institutions operating at various levels and their roles and responsibilities, with respect to SWM.

Figure 2: Schematic of institutional arrangement



1.2 Legal provisions impacting SWM operations

The Government of Nepal (GoN), in order to make the management of solid waste systematic and effective, formulated the Solid Waste Management Act, 2068 (2011 AD)—the SWM Act, which was further strengthened by Solid Waste Management Rules, 2070 (2013)—SWM Rules. The following section presents an assessment of the SWM Act and SWM Rules, roles and responsibilities of the stakeholders at the federal and local levels.

1.2.1 Review of Solid Waste Management Act, 2068 (2011 AD)

The SWM Act defines what construes solid waste generated in the city and provides a legal and regulatory framework for how local governments shall manage the waste generated in their jurisdiction; engage private as well as other entities to support SWM; prescribes an institutional mechanism at the federal level to provide continued policy and regulatory guidance to local governments to better manage the solid waste generated; and how local governments shall engage local communities affected by the development of solid waste disposal facilities.

An assessment of the Act, presented in Table 1 below, looks at provisions from two areas i.e. the institutional and service delivery-related parameters.

Table 1: Key provisions of Solid Waste Management Act, 2068 (2011)

Sl.No.	Parameter	Provision
A. Institutional parameters		
1	SWM Council	A 25 member solid waste management council (SWM Council) constituted at the federal level to formulate a policy for management of solid waste in Nepal. The council, chaired by a minister from the Ministry of Local Development, has representation from various ministries (Local Development, Physical Planning and Infrastructure Development, Industry, Health, Environment, Planning Commission), as well as the chief of Kathmandu Metropolitan City, representatives from the Chamber of Commerce, chiefs of municipalities from five development regions of Nepal, specialists and scientists working in the SWM sector, etc.
2	Responsibilities, power and duties of council	The SWM Council shall formulate policy on the management of solid waste to be approved by the GoN, determine the standards for the fixing of user charges to be levied by the local governments or any other function as prescribed. It is mandated that the council meet at least once a year.
3	Definition of solid waste	Solid waste means domestic waste, industrial waste, chemical waste, health institution-related waste or harmful waste which cannot be used presently; is thrown away or rotten or in the form of solid, liquid, gaseous, thick liquid, smoke, or dust damaging the environment; or materials and equipment used for electrical or information technology or any other materials of such nature; or unauthorized posters, and pamphlets posted at public places; or other substances prescribed as solid waste through publication of notice in the Nepal Gazette by the GoN from time to time.
4	SWM responsibility	Local governments are responsible for the collection, transportation, processing and disposal of solid waste generated in the city. Waste generated from health institutions, industries and chemical waste shall be managed by the bodies producing such solid waste. However, any industry or health institution can request the local body to manage the residue waste (post management of harmful waste) on a pre-fixed service fee basis.
5	Private sector /community engagement in SWM	• A private body can obtain a license from the local government for management of solid waste generated by submitting a SWM plan and details of resources (manpower and technology) to be deployed. However, the local government can issue such a license only after obtaining permission from the GoN with a pre-condition that the proposed technology be transferred by the developer to the ULL within a stipulated time period (as per the agreement). • Local government, post a due competitive process, can appoint a company or a community sector through a license for management of waste in its jurisdiction. This is to enhance community awareness, collect and transport solid waste, use-reuse recycle solid waste and dispose the waste and management after closure of the dumpsite.
6	Procurement for SWM through	Procurement of a private company or the community organization for management of solid waste generated in the city shall be through a competitive tendering process. The basis for selection of an entity shall be the amount agreed to be paid to the local government, the entity's

Sl.No.	Parameter	Provision
	competitive modes	capacity to generate energy or produce organic fertilizer, its capital, technology and human resource capacity, its financial and technical capability, the sustainability of the technology proposed, management charge proposed, and the royalty to be paid to the local government in case of solid waste reuse and recycling.
7	SWM through PPP	Local governments, within the provisions of prevailing laws, may partner with the private sector, a foreign entity or any community sector or non-governmental body for management of solid waste. Such engagement shall be restricted to awareness for waste reduction, collection of solid waste, post closure management of landfill, construction of garden or beautification.
10	Committee for landfill affected area	A local committee shall be formed to advise the local government on economic and social development and environment conservation in areas severely affected by landfill site management.
B. Service delivery parameters		
1	Waste reduction and recovery at source	Any waste generator shall, to the extent possible, reduce the generation of waste at source. Also, the waste generator shall reduce the amount of waste through disposal or reuse within its own premises (house compound, industrial premises, hospital premises, etc.)
2	Segregation of waste	Local governments shall advise waste generators to segregate waste into organic and inorganic waste.
3	Waste collection	Local governments may make necessary arrangements by providing waste collection containers (terming them waste collection centers/secondary collection points) in every '*tole*' or settlement for efficient waste collection.
4	Transportation of waste	***From point of generation to collection center***: Waste generators shall be liable for transportation of waste from the point of generation to the collection centers. The local government shall support them by providing the required technology, goods, equipment and containers, etc., for ease of transportation. ***From collection center to transfer station /SWM site:*** Local governments shall be liable for transfer of waste from the collection center or secondary collection point to either the transfer station or the solid waste management site. ***Transportation vehicle:*** The prescribed transportation vehicle shall be used for transportation of waste. It is important to take into account the weight, age and carrying capacity of the vehicle, and the roads to be traveled. The environmental impact of waste also needs to be considered.
5	Waste collection timings	Local governments shall define the time, place and manner in which the solid waste needs to be discharged.
6	Reduction, reuse and recycling of waste	Local governments shall take necessary steps to encourage reduction and re-use of solid waste and issue directives for the effective implementation of these steps. Also, local governments may coordinate with industries to encourage them to re-use the packaging material used for industrial products.

Sl.No.	Parameter	Provision
7	Transfer center /secondary collection point	Local governments may fix a location within the city for primary storage of waste, considering environment and public health.
8	Landfill site	• Under the prevailing laws, local governments shall prescribe a sanitary landfill site for permanent disposal of solid waste collected from the city. • Local governments may take land on lease if such suitable land is not available with the local government. Landfills can be developed on private land as well. • If such suitable land is unavailable with it, local governments can identify the land parcel on which the landfill can be developed and request MoFAGA (erstwhile MoFALD) to make such land available to the local government through land acquisition under prevailing laws.
9	User charges	• Local governments may fix a service charge, to be realized from the waste generators for management of solid waste generated in the city. • Service charge shall be based on quantity, weight and nature of solid waste and other matter as prescribed by the local government and can be recovered either by the local government staff or an external agency. • Any entity managing solid waste generated in the city can, through an understanding with the local government, collect service fees from the generators, with discounts for underprivileged sections of society.
10	Environmental and social	Local governments shall, post due consultation with the local community, prepare a master plan for financial, economic, social and physical development of the landfill-affected area and implement the same. The master plan shall cover areas such as the building of roads, electricity supply, provision of drinking water, sewage discharge, sanitation and environment conservation establishment and operation of schools and health facilities, implementation of programs for the uplift and development of the economically disadvantaged and socially under-privileged in the landfill-affected area.

1.2.2 Solid Waste Management Rules, 2070 (2013)

The SWM Act has been further strengthened by the enactment of SWM Rules in 2013 which provides the details of execution of the provisions of the relevant sections of the SWM Act. Assessment of the SWM Rules, presented in Table 2 below, looks at provisions from two areas i.e. the institutional as well as service delivery-related provisions.

Table 2: Key provisions of Solid Waste Management Rules, 2070 (2013)

Sl.No	Parameter	Provision
A	*Institutional parameters*	
1	Committee for monitoring of SWM services	The SWM Rules prescribe a committee at the federal level to monitor segregation, processing, discharge and final disposal of solid waste. Such committee shall be comprised of seven members, one each from Ministry of Local Development; Environment Science and Technology; Urban Development; Health and Population; SWM Technical Assistance Center, Federal Affairs. The committee may invite a sector specialist as it deems fit.
2	Private sector engagement in SWM	A company or organization can apply for a license from the local government to providing waste management services by providing information (in addition to what is required under the SWM Act) such as the desired working area for solid waste management, arrangement of land required for the services to be provided, the amount proposed to be paid to the local body and whether the activity of managing solid waste is to be carried out for commercial or not for profit reasons. Issued licenses may be revoked if conditions mentioned there are violated or any prevailing standard for solid waste management or any environmental law is violated or the license is not renewed.
3	Engaging non-governmental organizations (NGOs)	Local government may empower NGOs to segregate, reducing solid waste at source, reuse/recycle solid waste generated and mobilize the community for awareness generation to improve management of solid waste generated in the city.
4	Compliance with standards	Private sector bodies obtaining licenses from the local government for management of landfill or waste processing sites shall do the same in compliance with the standards prescribed by the local government.
5	Determination of service charge	Local governments shall determine the service fee to be collected from the waste generators, based on technology, procedure and process adopted by waste generator for management of waste at source, size /shape and type of solid waste generated, environmental impact, and estimated expense for management of waste generated. Local governments may also give a concession on the predetermined service charge of up to 50% to underprivileged groups, considering the economic condition of the waste generator. Such underprivileged groups shall be identified on a yearly basis by the local governments. Local government may award a full concession on payment of service charge to individual households involved in reduction of solid waste at source.
6	Committee for Sanitary Landfill Affected Area	Local government may form a 10-member committee to address the issues of the community where the sanitary landfill facility is being developed.
B	*Service delivery parameters*	
1	Waste segregation	Local government shall make arrangements for segregation of harmful or chemical waste through the respective waste generators and the

Sl.No	Parameter	Provision
		responsibility for management of such waste lies with the respective waste generators.
2	Management of harmful and chemical waste	Individuals or industries generating harmful and chemical waste must first obtain permission from the local government for generation, management, processing and disposal of such waste. Waste generators within the city shall ensure that harmful and chemical waste is not mixed with the municipal waste. Disposal arrangements along with the general waste shall be made only after processing of such harmful and chemical waste.
3	Management of waste from health institutions	Health institutions shall ensure segregation and management of waste on their own after obtaining prior permission from the local government. In case of the inability of the health institution to manage the waste generated, it may request the local government to manage the generated waste by paying an appropriate service fee. Only after the processing of harmful waste will the generated waste be mixed with the general waste for final disposal.
4	Transportation of waste	Local governments, while selecting vehicles for transportation of solid waste, shall ensure that no waste is visible and there is no spillage of waste during transportation, no leachate or odor is emitted, the waste can be easily loaded and unloaded. The vehicles are suitable for the capacity and condition of the road.
5	Sanitary landfill facility	***Operation of sanitary landfill facility*** Operations of the sanitary landfill facility shall be conducted in order to reduce the adverse impact on the environment that might be caused by factors like leachate, gas, odor emitted during the management of waste reaching the landfill facility. Operations shall also consider possible changes in geographical condition of the landfill site and the economic, social and physical effect the operations will have on the population around the sanitary landfill facility. ***Post-closure management*** Post-closure management of the landfill facility shall ensure reduction of negative impact on the environment of the area from the leachate, gas, obnoxious odor, etc., originating from the site. Local government shall also apply measures to utilize and manage the gas emanating from the landfill site post closure. Additionally, the local governments shall also consider the possibility of reusing the landfill site post closure.

The SWM Act and Rules govern the service delivery w.r.t solid waste management, environmental pollution control, meanwhile, is enforced through the Environment Protection Act, 2019 (EPA) and the Environment Protection Rules, 1997 (EPR[3]) enacted by the MoFE. The EPA and EPR

[3]As on May 2020 the stakeholders from the Ministry of Forests and Environment informed that EPR 1997 is being revised and the draft has been published for consultation and comments. Soon the revised EPR may be officially published repealing the EPR 1997.

necessitates to carry out an initial environmental examination (IEE) or environment impact assessment (EIA) based on annual quantity of waste disposed, population of the urban centers and size of the current waste management facility. However, the requisite environment standards to be complied for operations of waste management facilities are yet to be developed.

1.2.3 Key issues in the current regulatory provisions

As presented in the section above, the SWM Act and Rules are the governing regulations that govern the solid waste management sector in Nepal. It is understood from the federal level consultations that, at present, there is no institution that is monitoring the implementation of the provisions of the Act and the Rules. These regulations cover the provisions the management of value chain of solid waste management. However, there are areas of these regulatory provisions which needs to be strengthened. The following table presents such areas of the Act which need to be strengthened.

Table 3: Key issues in current legal and regulatory framework for SWM

Sl.No	Provision of the Act	Remarks on strengthening
1	Definition of waste	Current definition of the waste in the Act includes all kind waste generated in the city i.e. municipal waste, industrial waste and biomedical waste. Globally, considering the public health impact of the municipal waste, and other waste i.e., industrial and biomedical waste, there are separate policy regulations for each category of waste. It is therefore needed that the municipal waste is segregated from the definition and there are separate policies required for hazardous and non-hazardous industrial waste as well as biomedical waste management in local governments in Nepal.
2	Waste Streams	Current definition of waste also includes material from which dust is emitted and is harmful for the environment. However, the definition of solid waste that is generated in urban areas need to clearly define construction and demolition waste, plastic waste which needed to managed and processed separately.
3	Waste treatment	Provisions of the current Act clarify that the waste generators need to reduce the waste at generation, ensure segregation at source. Waste generators need to dispose the waste at specific waste collection points and final discharge of the waste that is collected will be carried out by the local level. However the Act need to mention that no waste can be disposed without treatment.
4	Site for waste management facility	The Act gives powers to the local government to identify land for transfer station and landfill post, considering the prevailing environment standard. However, it needs to clearly state that land identification norms or guidelines (through a support guideline) if in case any environment law does not prescribe any such provisions.
5	Regional Faculties	Current Act fixes the responsibility of waste management with the respective local government. However, often, local governments are incapable of envisaging regional waste management facilities or common waste management facilities to share the financial burden

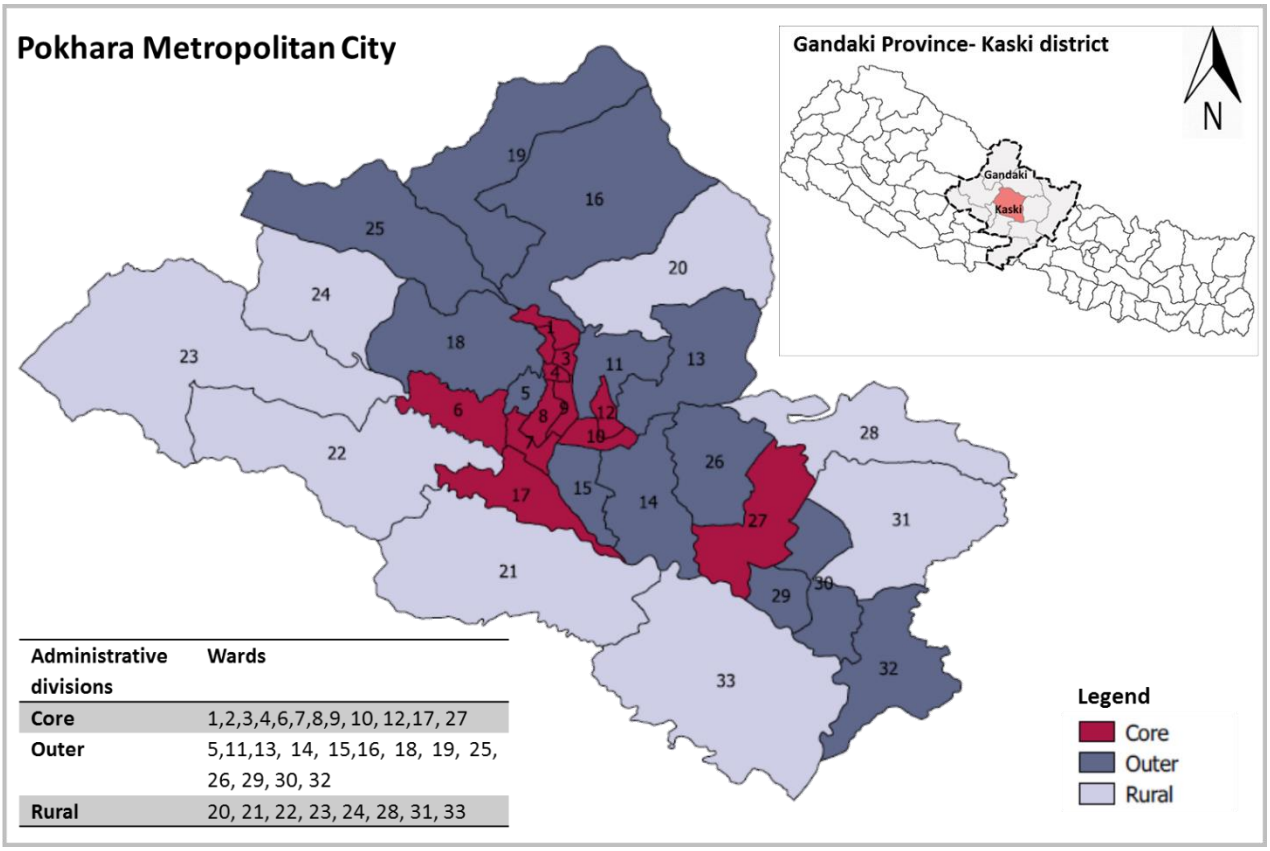
		such facilities. State governments, in such cases, play a role in identifying the cluster of local governments for whom a common waste treatment and processing facility can be developed and the collection and transportation of waste may be managed locally. However, the role of the state government is not envisaged in this Act.
6	Waste-related data	In order to ensure country-level data w.r.t waste management in Nepal, it is essential that the Act warrants each of the local governments to generate basic information w.r.t solid waste management i.e., estimated generation, collection of waste and the details of the means of disposal and waste composition analysis at a regular interval. Land details of the disposal site need to be generated annually and shared with the ministry to be collated which may then be used to create technical guidance and policy to support local governments in waste management.
7	User charge /Service fee	The Act prescribes that the service charge shall be charged on the basis of quantity, weight and nature of solid waste and other matters, as prescribed by the local level. However, there is substantial variation in the quantity and nature of waste generated by each waste generator. Additionally, it is practically difficult to measure the quantity of waste generated daily and accordingly charge the waste generator. Globally, solid waste management charge is either collected as a fraction of property tax or as a fixed monthly fee. In order to bring parity to how local governments charge the waste generators, the Act need to clearly state the methodology to charge the waste generators.
8	Engagement of informal sector	There is no provision to engage the informal sector whose livelihood is dependent on the city's waste management system i.e., the rag-pickers, recyclers, etc. The informal sector is an integral part of the overall waste management system and provisions w.r.t inclusion of informal sector need to made a part of social policy in the Act.
9	Monitoring	In the current institutional framework, at the federal level there is no entity monitoring the provision of the Act. Provision of the council which is present in the Act is not functional as of now. The Act needs to consider the fact that the monitoring of the provision of the Act is an integral part of ensuring compliance with the provisions.
10	Policy and technical support from federal government	The SWM Act mandated creation of SWM Council responsible for preparing a national policy for improving waste management and providing requisite institutional framework for interagency coordination. Further the Act mandated setting up of a Technical Cooperation Center to provide all the requisite technical support to local level governments such as technology selection, private sector participation and so on. The Council and the Centre were abolished post adoption of new constitution in 2015. There is a requirement to develop enabling sector improvement policy framework and establish a unit at federal level for providing requisite technical support to the local level governments for improving the SWM sector performance.

1.3 City profile

Pokhara, the second largest metropolitan city of Nepal, is centrally located and is the entry point for the Annapurna trek circuit of the Himalayan range. The city grew around the Phewa Lake and is one of Nepal's major tourist destinations. It is the largest metropolitan area of Gandaki Province *(Pradesh)* spread over 464 km^2 and houses 414,141 people (Census 2011). The city's estimated population as of 2019 is about 500,000 people[4].

Pokhara Sub-Metropolitan City was merged with Lekhnath Municipality and a few surrounding villages in 2016 to create PMC. PMC has 33 administrative wards, classified as core, outer and rural. The core area (12 of 33 wards) includes the old city of Pokhara and the core of Lekhnath. The estimated population of the core area is 179,551. The estimated population of the outer area and rural area is 170,221 and 53,223, respectively. The classification into core, outer and rural areas is only for the convenience of planning for services and do not have any legal connotation. The following diagram provides the distribution of wards and various zones in PMC.

Figure 3: PMC wards and administrative divisions to plan for services



Administrative divisions	Wards
Core	1,2,3,4,6,7,8,9, 10, 12,17, 27
Outer	5,11,13, 14, 15,16, 18, 19, 25, 26, 29, 30, 32
Rural	20, 21, 22, 23, 24, 28, 31, 33

[4] Estimated based on last two decade population data

In 2073 (2016), Pokhara Sub-Metropolitan City was merged with Lekhnath Municipality and some village development committees, which increased the population of Pokhara by 85,000. Pokhara is a hub for paragliding and is well-known among mountaineers. Paragliding in Pokhara has become hugely popular, with tourist inflow increasing from 8,999 in 2015 to 21,017 in 2018, a growth of 133%. The rise in population, because of the merger and influx of tourists, has increased the demand for infrastructure and for efficient service delivery.

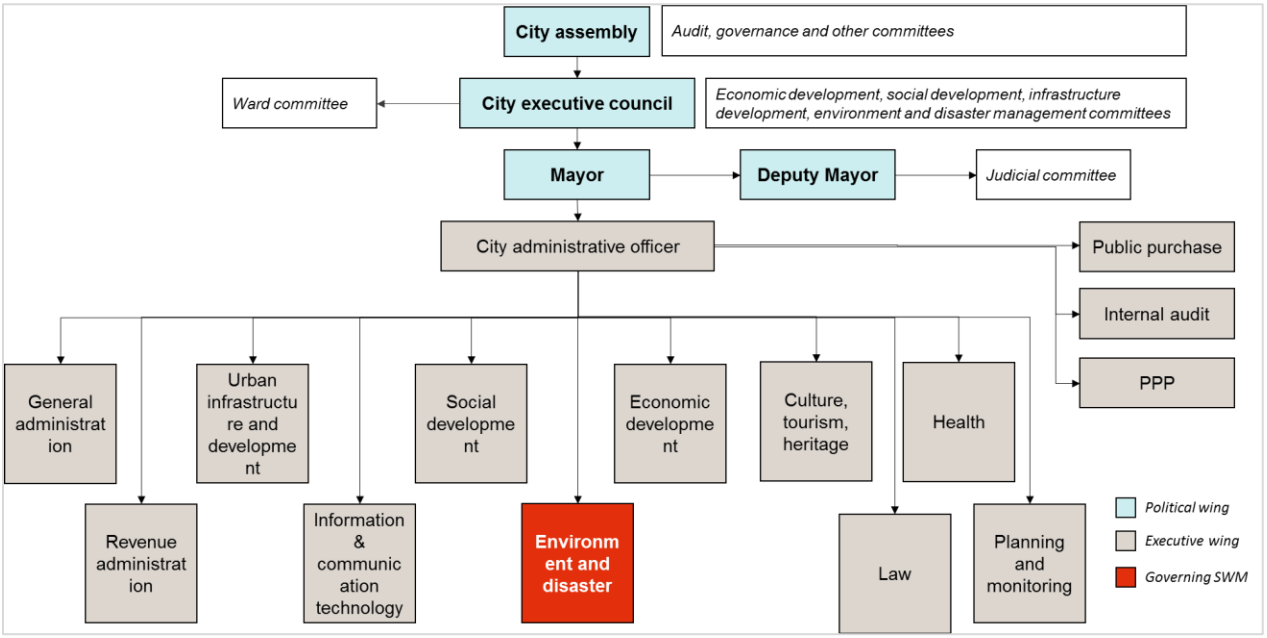
1.4 Administration and governance of Pokhara

1.4.1 City administration

The two key divisions of the ULL are city assembly and executive body. The city/municipal assembly constitutes mayor, deputy mayor, ward chairpersons, four elected representatives from the wards, and elected representatives from the minorities. The decisions related to finance, legislation and governance are vested with the city assembly. The executive body is responsible for the development of socioeconomic infrastructure. The chief administrative officer (CAO) heads the functional divisions/units of the ULL, and carries out the executive and obligatory responsibilities.

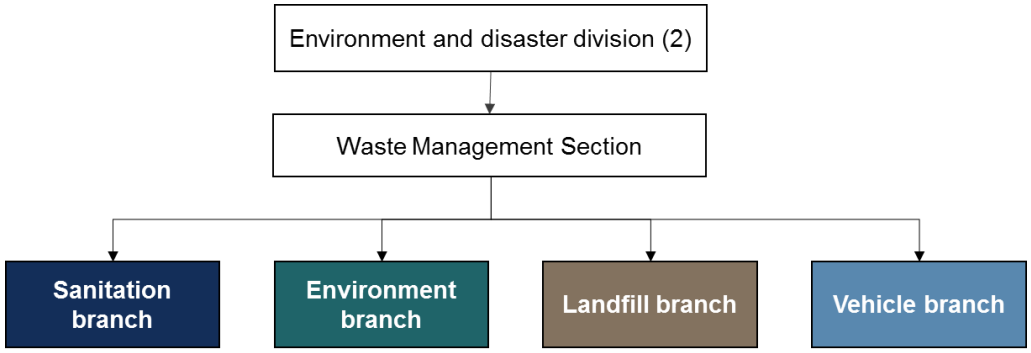
PMC has around 15 functional divisions, including the ward operations. These divisions are further divided into function-specific branches and each branch is headed by a section officer. The following is a diagrammatic representation of the city's administrative organization structure.

Figure 4: Organogram of PMC



1.4.2 City's institutional arrangement for solid waste management

Environment and disaster management is one of the fifteen main divisions of PMC, with the waste management branch under it. The waste management branch has four sub-branches.



The waste management section has 90 personnel to undertake management and on-ground operations. The responsibilities and strengths of the sub-branch are described below:

- **Sanitation branch** is the key branch looking after solid waste operations and management. It is manned by one management staff, one office helper, four drivers, one guard and 59 sweepers. About 32 of 59 sweepers are female. The sweepers are responsible for sweeping about 8 km of roads, including market areas, every day
- **Environment branch:** The responsibility of this branch includes tree plantation and conservation, conducting training and awareness programs. This sub-branch has three personnel—two management staff and one office helper
- **Landfill branch:** The branch has 18 personnel—one for management, five drivers, eight helpers and four guards. All are associated with landfill operations
- **Vehicle branch:** The branch is manned by three personnel—two management staff and one office helper. They operate and manage the vehicles utilized for SWM operations

After the merger of Lekhnath and other rural areas, the institutional structure is under evaluation and revision. SWM operations are managed by PMC and seven private operators appointed by PMC for collection and transportation of waste. Further, PMC has engaged separate private operators for biomedical waste handling, landfill and septage management.

PMC has four vehicles which they operate to collect and transport waste from six wards of the city. The ULL has four drivers in the sanitation sub-branch and five drivers in the landfill division to run these vehicles. They are supported by eight helpers. PMC has 59 sweepers to sweep the main commercial streets, market areas, temples and other public spaces.

Sweeping does not come under the scope of the private contractors. The private contractors appoint drivers and helpers for collection and transportation of waste. Also, they have a team of management staff and personnel to collect sanitation charges.

Key observations:

As many as 75 out of 90 staff in the department are engaged in sweeping and waste collection (drivers and helpers). There is only one management staff for the management operations, which is clearly inadequate.

The sanitation branch is responsible for providing waste collection and transportation but has only one management staff. The head of the sanitation branch has to supervise seven contractors collecting waste in the city and the municipal operations as well. The branch does not have adequate staff strength to plan and execute large-scale projects. Also, they do not have sufficient technical strength to plan for a comprehensive SWM plan.

The environment department is currently more concerned with the urban environment, i.e. plantation, conservation and awareness creation. Environmental compliance with respect to SWM is not handled by any of the branches.

From our interactions with officials, we learnt that the staff do not have required skillsets to plan, execute and monitor large-scale infrastructure projects and integrated SWM.

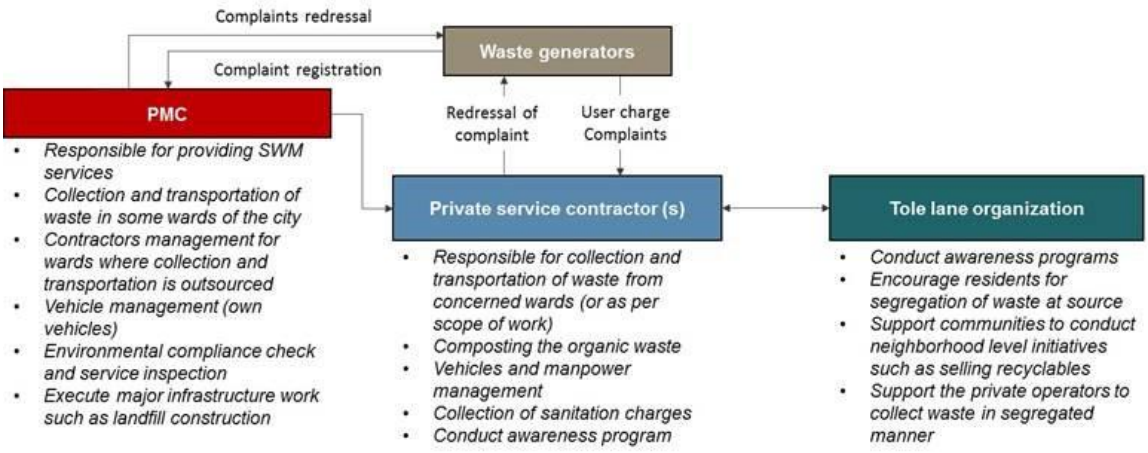
1.4.3 Roles and responsibilities of key stakeholders in Pokhara

PMC is responsible for SWM in the city. PMC has appointed seven private contractors to collect and transport waste from 25 out of 33 wards. The rest of the wards are served by PMC staff. PMC has appointed two contractors to manage the landfill site and biomedical waste.

Other than these contractors, at neighborhood level, there are tole lane organizations (TLOs), which work towards awareness creation, and conduct local-level programs to discuss various issues. The TLOs have representation from the elected personnel of the ward.

Also, Pokhara has various women's group and youth clubs that promote segregation of waste, support collection of waste from the households, manage local bins (in tourist areas), and clean lakes or public spaces.

Figure 5: Roles of various stakeholders in SWM in Pokhara



The ULL and contractors are involved in the waste collection, transportation and disposal. Here, the ULL is providing services and managing the contractors to ensure service delivery. The engagement of both these parties is formal.

1.5 Legal provisions in the city for SWM

1.5.1 SWM rules

PMC has enacted local Solid Waste Management Rules, 2074 (2017) and published in the local gazette in 2075 (2018). The coverage of the rules is as per the SWM Act. Unlike the Act, no major changes have been made in the PMC SWM rules.

Local rules are crucial to implement the national level regulations. From this perspective, this rule needs more elaboration. The key issues in the rules are:

- The rules do not provide any proforma or minimum eligibility criteria to appoint private operators as per the federal law
- They do not mention the requirements and components of developing SWM plan for the city
- There is no elaboration on processing and treatment of waste, environmental standards which are to be complied with
- They do not provide details of cost recovery principles of the ULL
- They stipulate penalty for any violation but do not provide any mechanism for monitoring the acts
- Appointing private contractors for service delivery is allowed, but there are no guidelines on payment modalities

1.5.2 Occupational health and safety manual for PMC, 2075 (2017)

PMC has created a manual for occupational health and safety (OHS) under GPOBA. A comprehensive study was carried out to create a baseline of OHS focusing on SWM activities. Based on the gaps identified, the guidelines and an implementation plan were prepared. As per the assessment, PMC did not have measuring equipment, safety indicators and checklist, and standard operating procedures (SOPs).

The highlights of the guidelines are as follows:

- They identified various category of workers, such as compost workers, collection workers and landfill workers
- They identified pollutant sources, exposure, and probable health impacts and symptoms, and linked them with the various groups of workers
- They contained norms for action to be taken and performance indicators for each identified exposure

- They included requirements and performance measurement indicators for infrastructure development, improvement in regulatory framework, institutional strengthening, system and documentation improvement

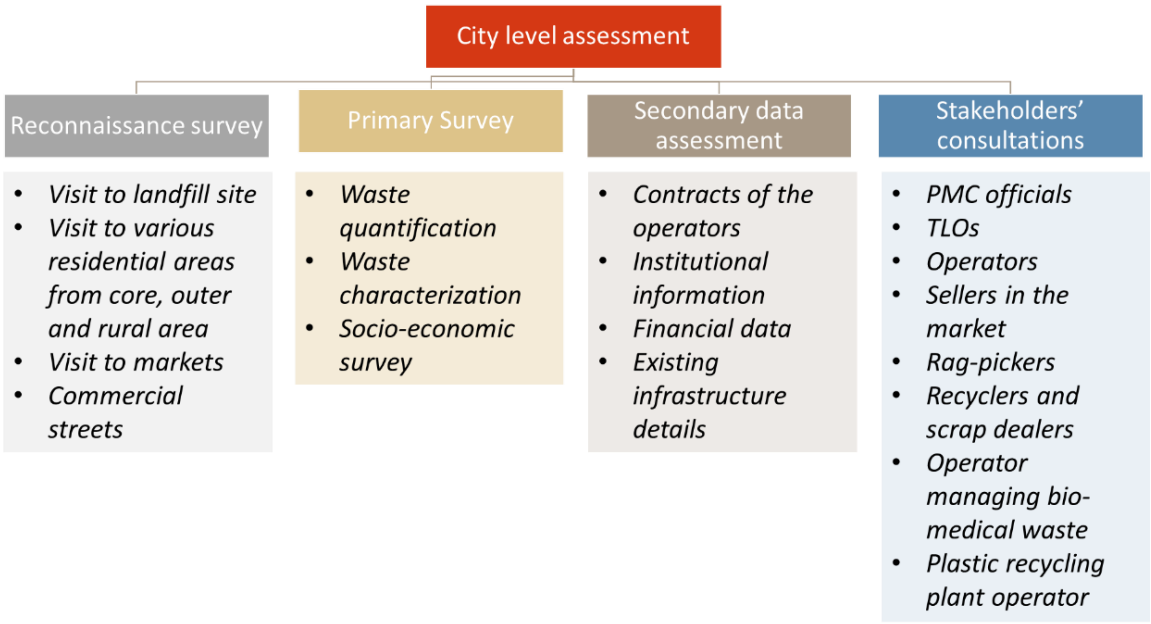
The manual is yet to be adopted by PMC in their daily operations due to the department's limited capacity. And no initiative has been taken till date to strengthen the capacity.

1.6 Methodology of city level assessment

This output assesses city-level SWM and provides recommendations for improvement. The assessment of solid waste has been carried out across the SWM activity chain based on:

a) Reconnaissance survey
b) Primary survey
c) Secondary information assessment
d) Stakeholder consultations

Figure 6: Methodology adopted for city-level assessment



1.6.1 Reconnaissance survey

Reconnaissance visits to various residential and commercial areas to study waste management practices such as storing and disposal mechanism, and cleanliness of the streets and public areas were carried out. Also visits to the existing dumpsite and material recovery and processing facilities to obtain deeper understanding of the actual processes were carried out. Additionally, visits to the markets to understand the waste generation and disposal pattern of bulk generators and tourist areas such as Phewa Lake and Begnas Tal in order to find out about the issues of littering, if any were carried out.

1.6.2 Primary survey

The primary survey covered 100 waste generators (Annexure A.1) for waste quantification and characterization and assessment of socioeconomic profile, behavioral analysis of waste generators in Pokhara. Of them, 60 were households/domestic generators, 20 commercial and 10 institutional waste generators. The samples were picked up from across PMC and of various income levels. Three samples were collected from domestic waste generators and two from institutional as well as commercial to normalize the variation in the quantity and physical composition of waste generated.

Table 4: Profile of surveyed domestic waste generators

	High income	Medium income	Low income /slum
Core area	15	12	3
Outer area	4	6	5
Rural area	3	6	6
Total	**22**	**24**	**14**

Source: CRIS assessment.

The same 100 waste generators were considered for socioeconomic profiling, and waste quantification and characterization survey.

(i) The **socioeconomic survey** was aimed at understanding the demographic and economic profile of the respondents; their waste management practices; their awareness about the SWM services in the city; affordability of SWM charges; and their willingness to pay for the service provided.

(ii) As part of the **waste characterization and quantification survey**, domestic assessment was carried out over three days—two weekdays and one on weekend. For commercial and institutional units, waste was collected twice over a week. Quantification and characterization surveys were carried out at the source (upstream) and at the dumpsite (downstream) to understand the loss/leakage of waste from the source to disposal.

About 78% of the respondents belong to Pokhara, and 62% of them has been residing there for over 20 years. Other respondents and their families are from other locations of Nepal. Around 48% of the respondents were females. As much as 68% of the domestic waste generators has a household size of 1-5, the mode being four.

The survey covered various professions such as private services (20%), retail or wholesale trade (18%), government services (12%) and farming (15%). Around 16% of the households have all the facilities such as TV, mobile phone, computers, vehicle, refrigerator etc. More than 50% of the households have amenities such as television, refrigerator etc. but do not necessarily own two- or four-wheelers. The monthly average family income of 70% of the respondents was NPR 40,000 and that of 12% (four samples) was NPR 80,000-100,000.

1.6.3 Stakeholder consultations

CRIS team discussed SWM practices of Pokhara with PMC officials over two visits to the city. The objectives of the discussions were:

- To understand the activities undertaken as SWM, focusing on the processes and management perspectives
- To document past and present initiatives of large infrastructure implementation and proposed projects or plans, if any

The CRIS team also had conducted meetings with representatives of TLOs to understand their involvement in the waste management processes and awareness creation. Also, issues of current SWM in their respective toles were discussed. We interviewed rag pickers at the dumpsite and on street, and also large recyclers to have an in-depth understanding of dry waste recycling practices in Pokhara. The team held a detailed discussion with private operators providing waste collection and transportation services in the city. The objective of the discussions was to understand actual scope of work, issues of contract execution and private sector interest in SWM operations. A snapshot of discussions with TLOs and operators is provided in Annexure A.3.

1.6.4 Secondary data analysis

From PMC and private operators, the CRIS team collected necessary information pertaining to municipal finance, institutional structure, existing infrastructure details etc. in order to assess the service holistically.

The city-level assessment was done using this methodology. Compliance with the regulatory setup, financial analysis and technical assessment of the SWM service have been described in the following chapter.

2 City-level Assessment

This chapter is a diagnostic assessment of institutional, regulatory, financial and technical aspects of SWM in Pokhara. The technical assessment encompasses service delivery model and infrastructure availability in Pokhara across the SWM activity chain. Assessment of institutions and governance aims to identify the adequacy of staff and efficiency of governance in SWM. This chapter also includes financial assessment of PMC focusing on SWM. Based on the assessment, gaps and issues in service delivery have been identified.

2.1 Technical assessment of infrastructure and service delivery

This section focuses on municipal solid waste (MSW). The waste generation and the generators' profile is identified based on the primary survey results. The technical assessment across the activity chain has been described based on secondary data assessment, primary survey results and on-field observations.

2.1.1 Municipal solid waste profile

2.1.1.1 Assessment of waste generators

The main waste generators of Pokhara are the domestic, commercial establishments and bulk generators, such as markets. For overall understanding of the waste generators, we have undertaken a reconnaissance survey in various identified areas. The following are our observations:

Table 5: Excerpt from field observation

Domestic waste generators	Pokhara core city and Lekhnath core area (ward 27) have dense mixed use development with dominating commercial usage along the major arterial roads. The outer areas (as explained in Section **1.3**) **are** predominantly residential. In ward 6, waste was being dumped on the street. A discussion with domestic waste generators revealed the waste collection routes and schedules are not always complied with. So, they tend to throw their waste outside their premises.
Commercial and bulk generators	Bulk generators are the markets from where substantial quantity of organic waste is generated. Some of the prominent market areas of Pokhara include Mahendrapur Market (ward 9), New Road Market (ward 8), Prithvi Chowk (ward 9), Lakeside Main Market (ward 6), Amar Singh Chowk (ward 10), and Bagar Market (ward 1). In Lekhnath, two major areas generating waste are Tal Chowk in ward 27 and Begnas Tal in ward 31. The frequency of collection is once a day (even in bigger markets). The reliability of service (compliance with the time and frequency) is not very high, which creates problems. Not all the market areas have street sweeping, which results in littering.
Lakes and tourist areas	Begnas Tal and Phewa Lake are major tourist areas. Waste from the Phewa Lake market area is collected every day. However, collection vehicles come to Begnas Tal area

	weekly or sometimes fortnightly. As per schedule, the frequency of waste collection is weekly, but this is not complied with strictly.

2.1.1.2 Waste quantification

Based on the primary survey results, the city generates about 182 MT of solid waste per day. Based on the population estimate of 5,15,000, as of 2019 per capita waste generation in the city is 354 gm per day, 60% more than 220 gm in 2012[5]. About 85 MT solid waste reaches the dumping site daily.

Table 6: Summary of waste quantification for Pokhara

Sl No	Item	Quantity (MT/day)
A	**Primary waste quantification results**	
1	Quantity of waste generated by households	145.55
2	Quantity of waste generated by bulk generators	4.50
3	Quantity of waste generated by commercial establishments	25.53
4	Quantity of waste generated by institutions /offices	7.12
B	**Total waste generated (TPD)**	**182.50**
C	**Estimated current population of PMC**	**5,14, 890**
D	**Estimated generation (gram/capita/day)**	**354**
E	**Average waste quantity received at the dump site (TPD)**	**85**

Source: CRIS assessment based on primary survey results and projections for 2019

Per capita waste generation varies across the city. The household waste generation in core, outer and rural areas is 282, 382 and 188 grams per capita per day, respectively. Combining various use categories such as domestic, commercial and institutional, the city-level daily per-capita generation is 354 grams.

2.1.1.3 Waste characterization

Physical and chemical characterization of waste was done at the point of generation and downstream at the dumping site as well. At the source, share of organic content is the highest at ~65%, followed by plastic (~19%), paper (~6%) and glass (~4%).

[5] Source: Report of solid waste management baseline survey in Pokhara Sub-metropolitan City, Solid Waste Management Technical Support Center (SWMTSC), Ministry of Local Development, July 2012.

Table 7: Summary of waste characterization

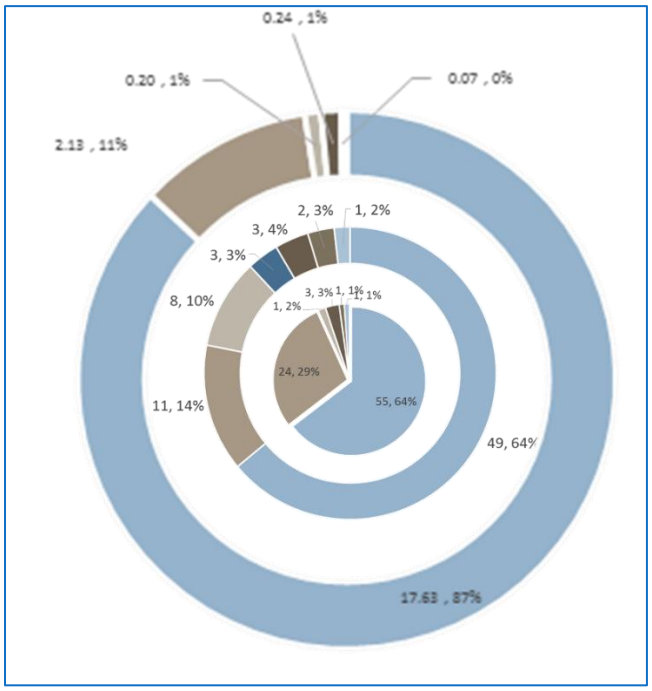
SN	Parameter	Unit	Point of waste generation	Downstream sample
A Physical composition				
1	Organic	**%**	65%	48%
2	Plastic	**%**	19%	19%
3	Paper	**%**	6%	16%
4	Glass	**%**	4%	8%
5	Rubber	**%**	0%	0%
6	Textile	**%**	2%	4%
7	Metal	**%**	2%	4%
8	Others	**%**	1%	0%
B Chemical composition				
1	Moisture content	%	81.73	67.12
2	Bulk density	kg/m^3	149.8	155.62
3	Organic content	%	65.42	48.09
4	Calorific value	Kcal/kg	2532	2961
5	Carbon/nitrogen ratio		43.71	28.87
6	Total solid	%	18.27	32.88
7	Volatile Solids (VS)		62.6	52.91

The variation in organic content in the waste is high. Of the waste generated in core and outer areas, about 65% is organic waste and in the rural area, it is 87%.

Plastics form 29%, 14% and 10% of the waste generated in core, outer and rural areas, respectively. This clearly shows typical differences in characteristics of waste from rural and urban areas.

Paper content is the highest in the waste from outer at 10%, compared with 1-2% in the core and rural areas.

Figure 7: Waste characteristics (core, outer, rural)- quantity (TPD) and percentage share



Source: CRIS assessment

2.1.2 Coverage of service—waste collection

PMC has appointed seven service providers for the collection of waste from 25 out of 33 wards. PMC itself serves the balance. In wards 22 and 28, there is no regular service and waste is collected based on complaints received. PMC provides services in six wards covering 14,689 households and private contractors cover 88,000 households.

The frequency of collection varies from daily to once a month. As much as 3% of the households (3,140 out of 105,828) are not covered at all. The daily collection covers 10 out of 12 wards of the core area (42,835 households out of 105,828).

In the core area, waste is collected on a daily basis. However, consultations with residents there revealed that the service is not reliable. There have been days when waste collection vehicles do not come as per the schedule.

In the outer areas, the frequency is weekly. However, discussions with residents indicated the same problem – collection vehicles not following the schedule. Waste from these areas is collected once in 10 days or fortnightly.

Frequency of collection from rural areas as low as once a month. Hence, households here usually do not store the organic/biodegradable waste.

An efficient waste collection and transportation system requires strict adherence to the schedule. Predictability of the service is crucial in SWM. However, Pokhara's contracts with private service providers do not have provisions to penalize contractors if not adhered to the schedule of collection.

2.1.2.1 Segregation at source

Primary waste generators are responsible for segregation of waste at the source of its generation as stipulated in the SWM Act. However this provision of law is not implemented in Pokhara. There has been advisories from the ULL to the waste generators to segregate waste, but this is not practiced. There have been various community or neighborhood-level IEC activities undertaken by the TLOs to promote segregation at source. From the reconnaissance survey, it was understood that in the rural wards—which have weekly, once in 10 days or fortnightly waste collection frequency—the generators tend to segregate their wastes. They usually store the recyclables to throw in the garbage collection vehicles, whereas the wet waste is used as fodder for the cattle or to produce manure for the kitchen garden/agricultural fields.

Figure 8: TLO community-level sell of recyclables

A TLO "Himali Tole" in ward no. 10 recently organized a community level sell of recyclables. 1000 bins of 20 litre capacity were distributed in the ward to segregate and store plastic waste.

All the households of the tole were asked to store the dry recyclables separately for 15 days and the private service provider was asked to come at a common location on a scheduled date to collect all the recyclables. This was first of its kind initiative in the city. The rates to sell these plastic products are fixed by the TLO and the entire revenue from this sell goes to the TLO to meet their operational need.

Also, 76 composting bins (~50 litres capacity each) have been distributed in the ward and Himali Tole has received 4 of them. Those who have received such bins segregate wet waste from which compost is being made.


Residents queueing to dispose the recyclable waste


Mix of recyclable waste while disposing


Composting bin

2.1.2.2 Bin system and storage of waste

There is no formal bin system in Pokhara. Waste is stored generally in plastic bags by the households and then directly disposed of in waste collection vehicles or kept on the roadside to be collected by the waste collection staff. Of the respondents to the socioeconomic survey, 73% used plastic bags and 12% used jute bags and bins each to store the waste.

In the market areas, waste is stored during the day and kept by the road in gunny bags. These are lifted by waste collection vehicles in the morning. In the tourist locations, which are not located in the core area, waste management is an issue. Full bins and litters were seen around Begnas Tal (ward 31). The local youth club installed these bins. It also collects waste from these bins, store in a different location and dispose of through collection vehicles.

Figure 9: Waste storage and bin system in Pokhara

Bins along Begnas Tal | Storing waste at mixed used establishment | Stored in gunny bags, kept by the road, lifted in the morning

2.1.3 Transportation of waste

As mentioned in earlier sections waste collection and transportation is outsourced to seven private contractors. Private vehicles deployed by all seven contractors for waste collection have a cumulative capacity of 132 ton, provided the entire fleet is in operation and completely filled with waste (refer Annexure A.4). Based on the logbook records maintained at the landfill, we estimate these vehicles make ~50 trips per day, carrying ~85 ton to the landfill. Thus, vehicle utilization is about 60% provided the vehicles are full on reaching the landfill site.

PMC has prepared waste collection routes for the private service providers. In the market areas, waste is lifted between 7 am and 10 am every day. Basis the primary socioeconomic survey, 51 of 60 respondents said they have waste collection service. Of 60 respondents, 59 said they throw the waste in open fields otherwise. Three of 60 said they burn the waste.

Table 8: Contractor-wise human resource available for waste collection and transportation activities

Name of the company	Management staff	Operational staff	Others (including collector of sanitation charges)	Total
Pokhara Waste Management Pvt Ltd	NA*	Driver-6 Helper-7	32	45
Batawaraniya Sundar Nepal Pvt Ltd	9	Driver- 7 Helper- 18	NA	34
Nepal Public Health and Environment for Development	NA	Driver-3 Helper- 6	12	21
Waste Management Recycling Pvt Ltd	1	Driver-3 Helper-4	4	12
Pragati Sansar Nepal	NA	Driver-1 Helper-2	4	7
Just in Time	NA	Driver-2 Helper-4	12	20
Pokhara Greenmart	7	Driver- 5 Helper- 10	10	32

Source: PMC and private operators, November 2019.
* Data not available.

Figure 10: Daily waste collection in most of the core area wards

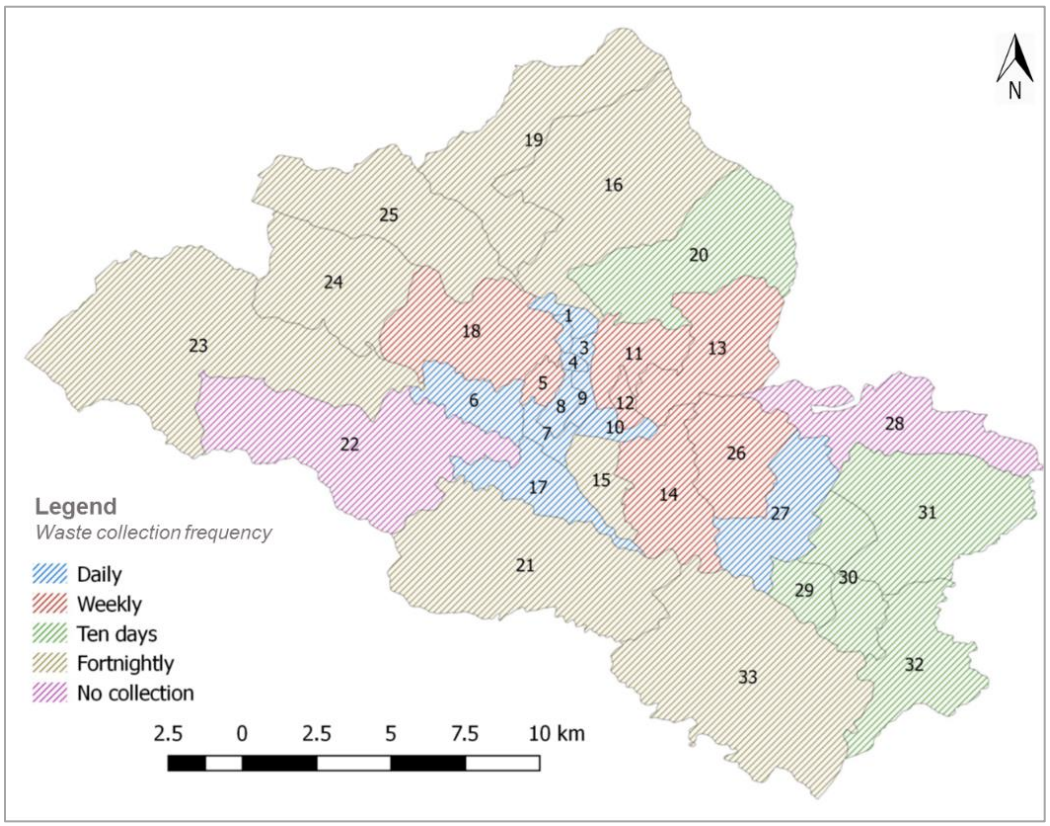


Table 9: Wardwise waste generation

Ward	Location	Service provider	Estimated population (2019)	Waste generation (TPD)
3	Core	Batawaraniya Sundar Nepal Pvt Ltd	12656	4.48
4	Core	Batawaraniya Sundar Nepal Pvt Ltd	12197	4.32
8	Core	Batawaraniya Sundar Nepal Pvt Ltd	34884	12.35
9	Core	Batawaraniya Sundar Nepal Pvt Ltd	19701	6.97
26	Outer	Just in time construction pvt.ltd.	17221	6.10
27	Core	Just in time construction pvt.ltd.	12817	4.54
29	Outer	Just in time construction pvt.ltd.	11985	4.24
30	Outer	Just in time construction pvt.ltd.	14476	5.12
31	Rural	Just in time construction pvt.ltd.	9868	3.49
32	Outer	Just in time construction pvt.ltd.	14280	5.06
33	Rural	Just in time construction pvt.ltd.	13116	4.64
1	Core	Nepal Public Heath Environment for Development Pvt Ltd	20750	7.35
2	Core	Nepal Public Heath Environment for Development Pvt Ltd	11676	4.13
5	Outer	Nepal Public Heath Environment for Development Pvt Ltd	19800	7.01
22	Rural	Not covered	6594	2.33
28	Rural	Not covered	6322	2.24
14	Outer	PMC	17689	6.26
18	Outer	PMC	11174	3.96
20	Rural	PMC	3588	1.27
21	Rural	PMC	8110	2.87
23	Rural	PMC	4387	1.55
24	Rural	PMC	5257	1.86
25	Outer	PMC	10940	3.87
6	Core	Pokhara Greenmart Pvt Ltd	19701	6.97
11	Outer	Pokhara Greenmart Pvt Ltd	19684	6.97
12	Core	Pokhara Greenmart Pvt Ltd	15533	5.50
13	Outer	Pokhara Greenmart Pvt Ltd	22842	8.09
7	Core	Pokhara Pohormaila Byawasthapan Pvt Ltd	17221	6.10
17	Core	Pokhara Pohormaila Byawasthapan Pvt Ltd	35783	12.67
16	Outer	Pragati Sansar Nepal	27123	9.60
19	Outer	Pragati Sansar Nepal	9478	3.36
10	Core	Waste Management Recycling Pvt Ltd	24705	8.75
15	Outer	Waste Management Recycling Pvt Ltd	22775	8.06

Source: CRIS assessment.

Issues of infrastructure and collection-transportation of waste:

1. It is mandatory for the waste generators to segregate waste at source. However, this has not been implemented yet. As the waste collection frequency is not adequate, storing waste is a challenge. Thus, households in outer and rural areas segregate waste. Hence, segregation is more need-based than a mandated practice.
2. Waste is not collected in segregated manner. The contracts with the operators do not mandate them to collect and transport the waste in segregated manner. For the ULL, the adequacy of vehicles and waste collection personnel.

2.1.4 Waste processing and treatment

PMC does not have material recovery facilities (MRFs), transfer stations or treatment plant within the city. Part of biodegradable/organic waste is segregated by the residents and composted. Recyclable waste is sold to *kabadiwalas* (informal recyclers). The second level of sorting takes place at the landfill site where PMC has appointed a private contractor. Recyclable/salable wastes are segregated and sold to large recyclers. The following two sections describe these processes further.

2.1.4.1 Dry waste recycling

PMC has appointed a private contractor to separate the dry waste from the general waste reaching the landfill site. This contractor has appointed 80-90 rag pickers (60 of them females) to work at the landfill site and extract recyclables from the incoming waste once it is unloaded at the landfill. The segregated waste includes plastic, water bottles, aluminum, copper, tin, spray cans, teddy paper, books, etc. Each worker separates three-four gunny bags of such dry waste and store them in the landfill site itself. Once a week, the segregated waste is sold to the scrap dealer who runs his business in the same premises.

Once a week, the rag pickers sell the recyclable items to the recycling vendor. The two largest recycling vendors in Pokhara are Vikas and Santosh. At the disposal site, the rag pickers sell their recycled materials to Vikas. He has around five employees whom he pays around NPR 15,000 per month. The rag pickers earn NPR 20,000 monthly on average. Buying and selling prices of different items are given below:

Table 10: Rates of recyclable items

Items	Buying price (NPR/kg)	Selling price (NPR/kg)
Plastics	11	13
Beer bottles	1	1.5
Books/paper	8	12
Iron	13	15
Other metals	70	90

Source: Primary survey by CRIS

Figure 11: Narratives from the landfill

Narratives from the landfill……

80-90 rag-pickers are working at the landfill site. From each family on an average 2-3 people are associated with rag picking activities at the disposal site. Most of the workers stay around Prithvi Chowk which is about 9 km away from the site. Most of these families belong to Lamjung district of Gandaki Province.

Their day starts at 6 am and ends at 6 pm, thus, they clock 12 hours in the waste dump everyday. A respondent, during our discussion with the rag-pickers, said that they come to the landfill site everyday, including heavy monsoons. In monsoon, it is difficult to work, however, they cannot skip coming to work.

The health history was discussed with the rag pickers. It was understood that during last 12 years of one respondent, they need to see doctor around 4-5 times in a year. Cut through syringe, broken glass bottle etc. are very common and happens almost on daily basis.

There is no provision of clean drinking water for the workers at the landfill site, which is a serious problem from social and health safeguard point of view. A worker, who is working for more than 10 years in this landfill site, since the initiation of the operations, mentioned that long back gumboots were distributed to the labourers, however currently they have to buy any such protective equipment while working in the disposal site at their own expense.

It was stated during the discussion that one person had fallen from the hillock within this disposal site and was severely injured. Also, four months ago (in July 2019) there was an incident of big smoke and fire, but none was injured.

Discussion with the rag-pickers at landfill site

Segregated recyclables

This recycler sells plastic recyclables to Himalayan Plastic Life Pvt Ltd and beer bottles to a beer factory in Narayangar. This recycler/scrap dealer is from India and he said he worries about losing his livelihood if material recovery centers are set up in the city.

The total waste generation is 182 TPD. Of this, ~35 TPD, or 19%, is plastic and ~20 TPD, 11%, is paper. If this is separated at the source itself, the potential revenue that can be generated from plastic waste is more than NPR 350,000 and from papers is NPR 160,000.

Figure 12: Narratives from the landfill

Excerpt of discussion with scrap dealer, Ranipowa, Pokhara

The owner of the business is Mr. Rajiv Jaiswal and the shed is managed by Mt. Mohai Shah who has been involved in this business since last 20 years. They have given bicycles to around 10 informal individual *kabadiwalas* (recyclers). Everyday morning they come and take cycles to the city. These individual recyclers bring plastic, paper and metal waste from the city and sell here. Everyday they buy such recyclable worth 10,000- 20000 NPR from these individual recyclers.

These waste are further segregated by 2 persons into plastic and glass bottles. Beer bottles, plastic, metal etc. Usually there is no non-sellable component. Plastics are sold in Kathmandu, metal scrap in Virabha and Birgunj region. Usually the profit margin is around 15%. while selling the goods. The main operational cost that they incur include mainly rent (9000 NPR/ month), establishment expenditure, and regular operation and maintenance of the premises.

Monsoons are the lean period as collecting waste from households is difficult in rains. The interviewee mentioned that there are 70 such scrap dealers in entire Pokhara who usually buy from around 1000 small scale recyclers or individual dry waste collectors.


The stakeholders


Site for storing waste


Segregated recyclables

2.1.4.2 Organic waste management


Composting bin distributed in Ward 10

In the core and outer areas, where the frequency of waste collection is more than once a week, residential waste generators tend to segregate their biodegradable waste. In rural areas, organic waste is used as fodder for cattle or used as manure in the kitchen garden or agricultural fields. As per the primary survey results, agricultural waste, mainly generated in outer and rural areas, is used as organic manure (62% of the respondents said this) and to feed cattle (38% of the respondents).

Some TLOs have provided composting bins to households to store and reduce their organic waste. For example, in ward 10, 76 composting bins of approximately 50-liter capacity each were distributed.

Also, small-scale biogas units have been distributed by a private supplier with support from the Alternative Energy Production Council (AEPC) and PMC. Of the units distributed, 42 are for small-scale waste generators in rural areas and 40 are for small-scale waste generators in urban areas (households). The biogas units were distributed based on recommendations from ward chairman. The cost of each unit is NPR 60,000, of which AEPC pays NPR 10,000, PMC NPR 40,000 and the beneficiary NPR 10,000. These domestic bio-digesters can generate 1.0-1.5 cylinders of gas in a four-member family over a month.

Gandaki Urja Pvt Ltd, a waste-to-energy project, is under construction in ward 32 of PMC. The capital cost of the project is NPR 25 crore, of which AEPC contributes NPR 5.4 crore under its large

biogas plants initiative. The plant, which will collect required waste from identified poultry farms, will be commissioned in 2020.

2.1.5 Disposal of waste

All the waste collected is transported to the sanitary landfill site located in Bacchebuduwa in ward 14 of Pokhara. Although it was designed to be a sanitary landfill site, all unsegregated waste collected from the city reaches the site. The site is accessible from the highway (9 km away). The total area is about 10 ha, of which the landfill area is 4 ha. Rest of the area within the premise is used for reed-bed treatment, biomedical waste handling, etc. All the waste reaches the landfill which is 12 meters deep. After collecting waste from generators, no process is undertaken to segregate, reduce, recover, and treat it. Thus, not only inert waste comes to the landfill. All the waste from the city reaches the site. Dry recyclable waste is then segregated and sold to large recyclers.

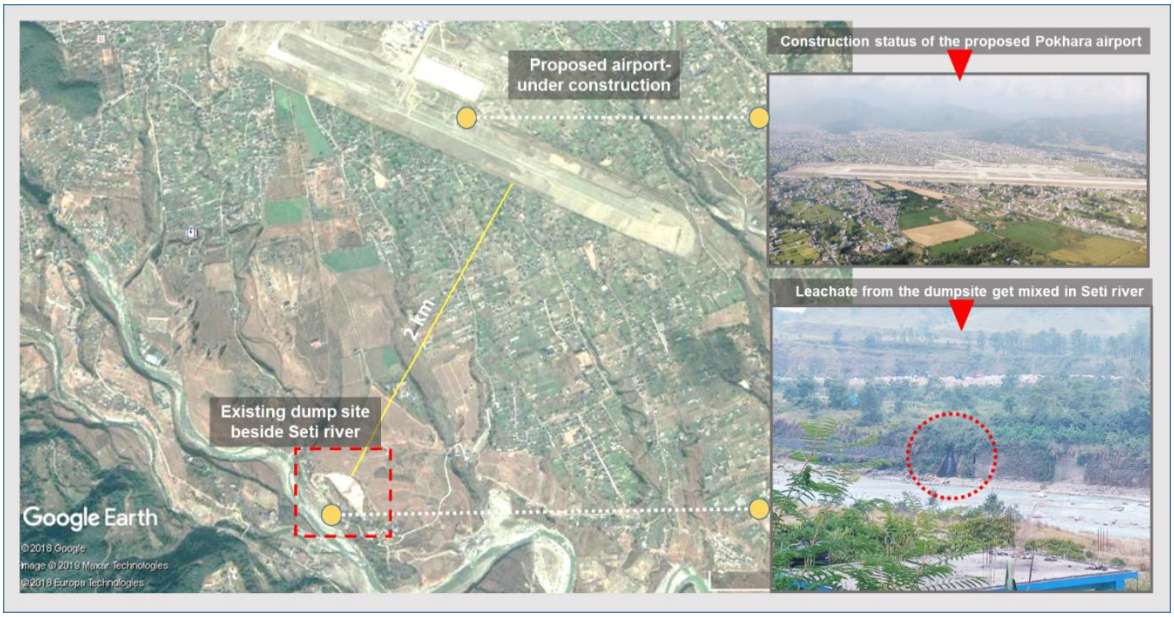
The leachate from the disposal site is treated using the reed-bed treatment technology. Treated leachate is disposed in the Seti River, which is around 50 m from the site. However, before the disposal, it is not tested in a laboratory. This plant is 15 years old (commissioned in 2004). Currently, it is not functioning well. The filter depth is 1 m and comprises sand, pebble, bolder, etc. The dumpsite is being used since 2004 and the total leachate generation is estimated at 377,318 m^3 (refer 0 for details).

Figure 13: A few snaps of the dumpsite

Further, the dumpsite is located within 2 km radius of the proposed international airport site and, thus, needs to be scientifically closed by December 2020. Hence, the biggest challenge of the ULL is to construct an alternative landfill site on an immediate basis and close the current one.

At present, ULLs in Nepal need not follow any land identification norms for creating such an infrastructure as no such land identification exist. PMC officials said government land is given priority while selecting a plot for such an infrastructure. Also, landfill or any such operations (which may generate bad odor) can only be set up far away from waterbodies and residential areas. However, there are no guidelines to select an environmentally and socially suitable land for a landfill or other infrastructure.

Figure 14: Existing landfill site, proposed airport, and Seti River in the vicinity



2.1.6 Summary of waste flow

Based on the primary survey, we estimate Pokhara generates 182 MT waste daily. Dry waste having economic value is recovered at various levels—at the source or during collection and transportation.

Of the primary survey respondents, 57% in core, 80% in outer and 67% in rural areas segregate the waste they generate into dry and wet. Thus, out of total domestic generation of 151 TPD, 105 TPD waste potentially gets segregated at the source. The primary survey and stakeholder consultations revealed that all those who segregate sell dry waste with economic value, such as bottles (glass/plastic), paper etc., to waste recyclers.

Waste that is not segregated and recovered at the source is the mixed waste to be collected. In some of the core wards, waste is collected daily and in outer and rural areas, it is done weekly or fortnightly. Rural households use the organic waste to either feed the cattle or convert it into compost. Commercial establishments, especially hotels and restaurants, segregate bottles and cardboards and sell them to recyclers. Institutional establishments use a small fraction of wet waste in gardens and part of dry waste such as paper is sold to the recyclers. Following are the recovery assumptions made based on collection frequency and existing practices:

The following points can be derived from these assumptions:

- 47 TPD wet waste and 21 TPD dry waste is segregated and recovered at source. Recovery means wet waste is used to produce compost or used to feed cattle and dry waste (plastic, glass, and paper) is sold to individual or retail recyclers
- The balance 119 TPD mixed waste is disposable

Table 11: Recovery percentages of segregated waste

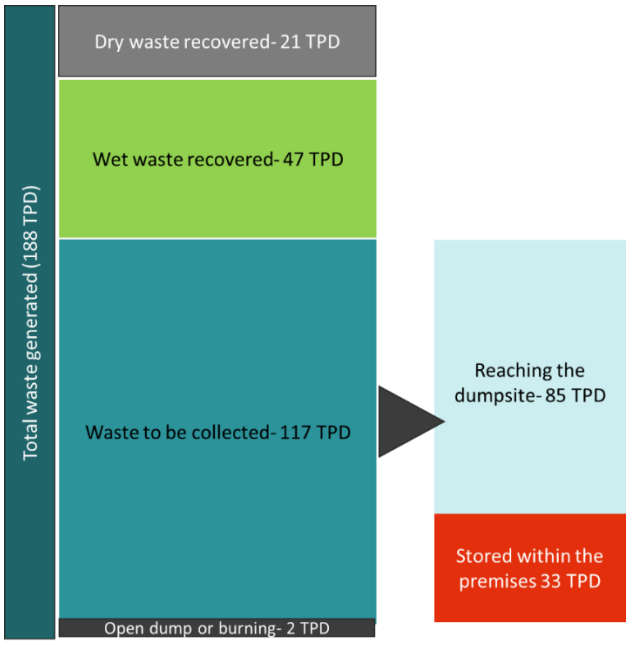
Sl. No.		Core area		Outer area		Rural area	
	Waste generators	Wet waste	Dry waste	Wet waste	Dry waste	Wet waste	Dry waste
1	Households	50%	60%	70%	40%	100%	25%
2	Bulk generators	-	-	-	-	-	-
3	Commercial establishments	-	30%	-	20%	-	20%
4	Institutions and offices	-	50%	50%	50%	50%	50%

Source: CRIS assessment

- About 2% of the primary survey respondents said they dump waste in any open field or burn, in case they do not give it to the waste collection vehicles. So, 2.4 TPD waste is not given to collection vehicles
- Primary survey results show on an average 85 TPD waste reaches the dump site. This means 32 TPD waste is not collected. Because of the frequency of collection, waste is usually stored within the premises. As organic waste is by the waste generators, this stored waste will mainly by dry recyclables.

This waste flow is shown in the diagram below.

Figure 15: Waste flow and diversions



2.2 Assessment of other waste management

Other than municipal solid waste, we have also assessed management of construction and demolition (C&D) waste, industrial waste, and biomedical waste in Pokhara. The following sections briefly describe these.

2.2.1 Plastic waste management

Pokhara, being a tourist destination, has high concentration of markets, hotels and restaurants especially around Phewa Lake, Begnas Tal. Based on the primary survey results, the city generates about 19% plastic waste. Plastic waste forms about 29% of the total waste in the core areas of the city which can be attributed to the commercial activities. From the discussions with citizens and the waste recyclers in Pokhara on the composition of the plastic waste, it was understood that the packets of instant noodles and readymade food products are predominant.

There have been sporadic initiatives in the city to manage the plastic waste. The city banned plastic waste in 2017, however, enforcement of the ban remained a challenge. Three Star Pipe Udyog, a private initiative, manufactures pipes from plastic waste. The plant has been operational for the past two years. The company buys 600-700 kg plastic waste per day, including plastic buckets, cans, water bottles, pipes, polythene packets, etc., from *kabadiwalas*. It converts these into 16 mm or 20 mm diameter electrical insulating wiring pipes. The production capacity is 400 kg/day and the pipes are sold on weight basis.

Figure 16: An initiative to recycle and reuse the plastic waste

One production cycle produces 90 m pipe (one roll) which weighs ~13 kg, and a complete cycle takes about 45 minutes. The average cost of operation is around NPR 3.75 lakh per month and capital investment made was ~NPR 2 crore. The plant's area is around 5 ropani (~2,500 sq m). The

company has a work force of 16 (including five operators and three managers) in the plant, all males. Eight female workers are involved mostly in cleaning, segregation of waste, drying, etc.

The plant runs eight hours a day and six days a week. It requires two hours to start up, and runs for six hours daily. The selling price of the finished product is NPR 120 per kg.

2.2.2 C&D waste management

Pokhara does not have an organised system of collecting C&D waste from construction sites. Upon requests from developers, PMC (itself or a service contractor) collects the waste at a rate of NPR 3,000 to 4,000 per truck. There is no designated site to dispose the C&D waste. Usually, the collected waste is dumped at any nearby low-lying area.

2.2.3 Industrial waste management

Ward 9 has an industrial area which has units manufacturing biscuits and noodles, milk processing plants, etc. General waste from these industries is collected by ULL-appointed agencies. However, industrial waste, which is primarily liquid, is disposed into the nearby drains. There is no monitoring as of now to check the quality of the discharge.

2.2.4 Biomedical waste management

Two hospitals, namely Pokhara Swastha Bigyan Protisthan (erstwhile Western Regional Hospital) and Gandaki Hospital, manage and process their waste within their premises. The private operator collects waste from other healthcare institutions in a separate vehicle, brings it to the treatment facility and then disposes it. The management of biomedical waste is explained below.

2.2.4.1 Management by the hospitals

Pokhara Swastha Bigyan Protisthan has a capacity of 500 beds and can handle 1,200-1,500 outpatients. There are 142 doctors, and 170 nursing and other staff. The hospital segregates the waste, but the weight of the waste is not measured.

Waste there is categorized as: 1) Infectious; 2) non-infectious; 3) municipal/general waste; and 4) liquid waste. The collected waste is segregated. Waste with blood strain, bandage, syringe, needle, bile glass, saline water bottle, used gloves, dialysis pipes, etc. are collected in a red trolley, and plastic, paper, bottles, food waste, etc. are collected in green/blue trolley. Waste collected in the green trolley is further segregated and sold.

The biomedical waste is disinfected in autoclaves and then handed over to the waste collector of the ward. This on-premise treatment is carried out by the operator appointed by PMC (the same operator who is appointed by PMC to manage biomedical waste at the landfill site). The hospital pays NPR 2 lakh per month to PMC for providing the service. There are four autoclaves - two in the biomedical waste treatment room (cumulative capacity is 320 liters per day), one in the post-mortem room, and another in the operation theatre. The treatment room autoclaves run for two hours in the morning cycle and 1.5 hours in the evening cycle. After autoclaving, the waste is segregated, before handling over to the private collection operator. The saleable items (mostly MSW recyclables) are sent outside the hospital premises once in 15 days and the non-saleable

items are disposed of to the dumpsite once in seven days. The general waste is picked up daily from the premises.

The hospital authority is of opinion that all biomedical waste should be sterilized at the disposal facility and the transportation should be done in closed vehicles.

Figure 17: Snippets of biomedical waste management in Pokhara

Autoclave at the treatment location | Segregation of paper waste at WRH | General/ MSW collection at WRH | Autoclave at the Western Regional Hospital (WRH)

2.2.4.2 Biomedical waste treatment plant operated by the private operator

Waste Services Pvt Ltd, appointed by PMC to collect, treat, and dispose of biomedical waste, has been operating for the past two years. The facility has autoclaving machines located at the dumpsite.

Except for Western Regional Hospital and Gandaki Hospital, all other healthcare units (around 80) utilize this biomedical waste treatment facility. The agency collects the waste from the hospitals/health facilities, treats it through autoclaving, and segregates it into biomedical waste, recyclables, and disposables. Gloves, pipes, syringes, etc., are put into the autoclaving system. Saline water bottles, mineral water bottles and plastics are recycled. As per the plant operator's statement, the autoclave runs three-four cycles per day and ~600 kg of waste is treated daily.

According to our interaction with the private operator, the company uses six waste collection vehicles. They have five vehicles (Tata 407) to collect MSW/general waste from the hospital and one Mahindra vehicle (1 MT) for biomedical waste. The biomedical waste-collecting vehicle makes two-three trips daily. Most hospitals give segregated waste to the waste collectors. These serve 22 large healthcare centers, 10 small healthcare centers, and some clinics.

This establishment has seven workers and three drivers. The workers undergo a medical check-up (occupational health check-up) every three months. The capital investment for this plant was done by the private operator. They charge NPR 20 per kg for MSW and NPR 35-40 per kg for biomedical waste collection from the healthcare units. The operator pays NPR 10 lakh per year to the ULL.

2.2.5 Key issues in SWM service delivery

Highlights from the technical assessment of the city's service delivery/SWM are detailed below:

Table 12: Activity-wise gaps identified in SWM of Pokhara

Sl. No.	Activities	Existing practices in Pokhara	Identified gaps and issues
1	Waste segregation at source	• Domestic level segregation is in place, where people have cattle to be fed or agricultural fields or kitchen gardens • People usually segregate waste, demonstrating compliance if any initiative is undertaken by TLOs or other social organizations	• No organized mandate for waste segregation at source; segregation is more of a choice and requirement of the waste generators
2	Collection	• Collection is done by seven private operators and some wards are served by the PMC • This is a point-to-point collection system where vehicles halt on the main road and waste generators come to the vehicle to discard waste; it is not a door-to-door collection system • Waste is mainly collected from the roadside in commercial or market areas • Waste is lifted from the vegetable markets and other bulk generators in separate vehicles • Waste is collected daily from the markets of the core area. Waste is collected from most places on a weekly basis and can go up to once a month in remote areas	• The coverage of waste collection is not 100%. Even in places that are covered, collection frequency is an issue • Waste is not collected on a daily basis and the frequency of waste collection is very low. Residents have shown concern over the collection frequency and irregular timing/scheduling of the waste collection vehicles • Under-capacity equipment and vehicles
3	Processing and treatment	• Collected waste is eventually disposed of to the Bachhebuduwa disposal site (which was constructed as a scientific landfill site) without treatment • Reed-bed leachate treatment facility has been installed there, but is currently not operational	• Absence of processing and treatment facilities as of now
4	Waste disposal	• No scientific disposal site; disposal happens at the disposal site very close to the Seti River • The depth of the dump is around 12 m	• Unscientific dumping poses an environmental and social hazard to the river and soil • Stability of the accumulated waste dump is a concern
5	Awareness level and enforcement	• TLO-level awareness, campaigning and demonstrative implementation of source segregation and recycling • People are comparatively more aware of waste management practices and their impact on the environment	• Weak enforcement of rules or penalty mechanism • Lack of communication and awareness generation activities
6	Other waste management	• Biomedical waste is collected separately and treated in situ as well as in a centralized system	• Health hazard to the informal recycling sector to some extent, when part of the medical waste mixes with the general waste stream

There is no treatment facility available, waste dumping is uncontrolled and unscientific. As this is fresh waste, chances of contamination of soil, surface and groundwater are very high. Also, it impacts ambient air quality. Moreover, as this garbage heap is unstable, it may slide, thereby resulting in a further environmental hazard. The leachate treatment plant is not operational and this untreated leachate is contaminating the adjacent Seti River.

The contractor and the PMC are not using any personal protective equipment. Also, the rag-pickers who spend hours at the landfill facility, are directly exposed to fresh waste and are prone to health hazards. The rag-pickers spend more than 10 hours a day at this disposal site for their livelihood. Untreated waste results in emission of methane and rag-pickers have reported that inhalation of this gas has led to several health issues. As the disposal site receives untreated, unorganized mixed waste stream, unrecycled dry waste—such as broken glass and domestic hazardous waste—pose a risk of injury. Moreover, rag-pickers keep their food and water near the waste disposal site, which is a potential health hazard. Their food and water could be subject to oral contamination.

2.3 Assessment of finances for SWM services

The assessment covers analysis of the PMC's revenue income and expenditure. This is to understand the budgetary availability of the ULL to spend on capital works and cover the operational expenses for SWM.

2.3.1 Municipal budget analysis

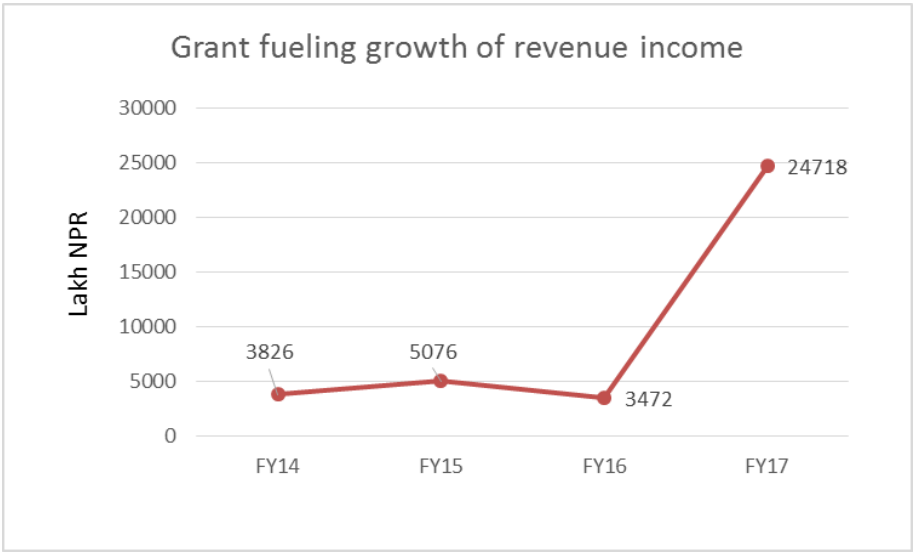
The PMC's revenue income consists of tax revenue such as property tax, rental tax, business tax, entertainment tax, etc. It levies various charges such as vehicle license fee, sanitation charges, tourism fee, and penalties on defaults.

Revenue increased 33% between fiscals 2014 and 2015, but dropped 32% between fiscals 2015 and 2016. This decrease was due to fall in collection of vehicle parking charge, house number charge, road repair charge, recommendation fee, etc. This includes auctions, sale etc. Also, accounts had to be adjusted due to merger of Pokhara sub-metropolitan city with Lekhnath Municipality and other surrounding villages. The subsequent year recorded 600% jump in revenue fuelled by a 'local equalization grant'. This is a matching grant provided to the ULLs to meet the revenue deficit.

As per the Intergovernmental Fiscal Arrangements Act, 2074 (2017 AD), revenue sharing on account of value added tax and excise is credited to the local government's accounts every month. Local equalization grant is a formula-based untied grant given to the ULLs on a quarterly basis. Conditional and complimentary grants are two tied grants given to the ULLs that are disbursed every trimester. The first instalment is credited unconditionally and the remaining disbursement requires reporting of physical progress and fund utilization. Physical progress is authorized by the line departments.

Further, the share of a tied grant versus untied grants has been reducing. This means the PMC has more flexibility to utilize the grants as per the requirements. However, this increase can be attributed to the increase of local equalization grant. The act mentions recovery of O&M cost through charges and fee collection. Thus, it is imperative to improve the own-source revenue.

Figure 18: Revenue income of the PMC (fiscals 2014-2017)



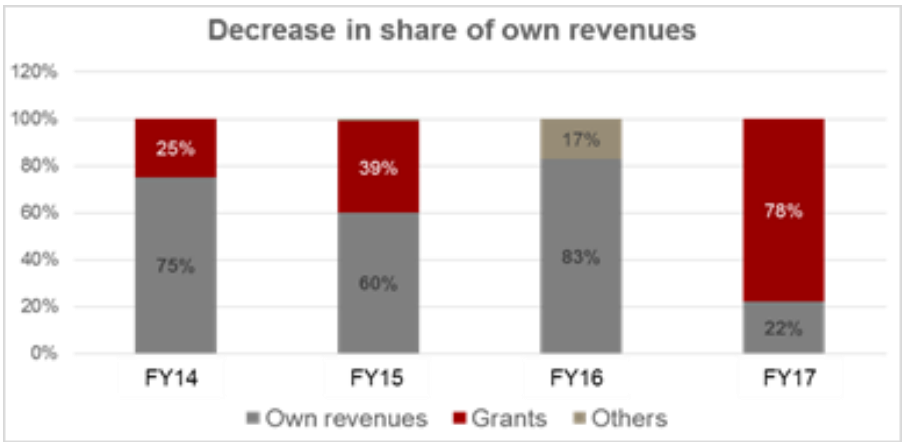
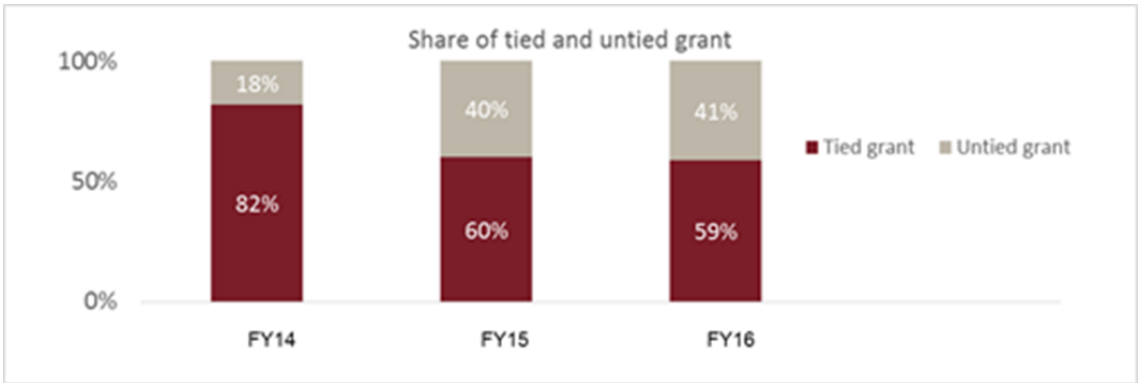
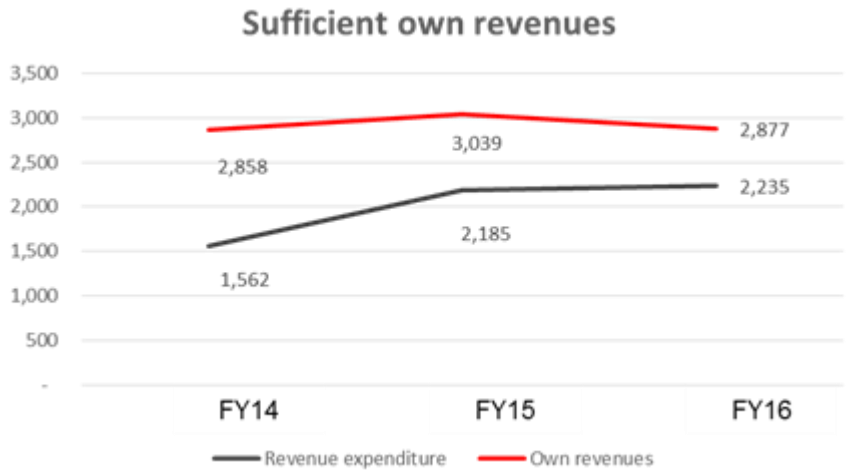


Figure 19: Share of tied and untied grant



The share of tax revenue to own-source revenue increased from 32% in fiscal 2014 to 42% in fiscal 2017. Property tax is the main source of tax revenue (19%, on average, to the total revenue) and growth has been stable over four years (fiscals 2014-2017).

Figure 20: Share of tax revenue to own-source revenue



Expenditure also increased from NPR 15 crore in fiscal 2014 to NPR 23 crore in fiscal 2016. Establishment expenditure is the dominant contributor (70% of total expenditure[6]) followed by administrative expenditure (18%). Comparison of own-source revenue with expenditure reveals a revenue surplus.

2.3.2 Financial management of SWM services

SWM expenditure decreased from NPR 325 lakh in fiscal 2015 to NPR 302 lakh in fiscal 2017. Currently, most of the PMC's SWM operations are outsourced to the private sector, which include collection and transportation of waste to the dumpsite and management of the dumpsite. Hence, the PMC's operational expenditure on SWM services is limited. As much as 70% of the expenditure incurred is establishment expenditure. This expenditure can be attributed mainly to road sweeping and salaries linked to it.

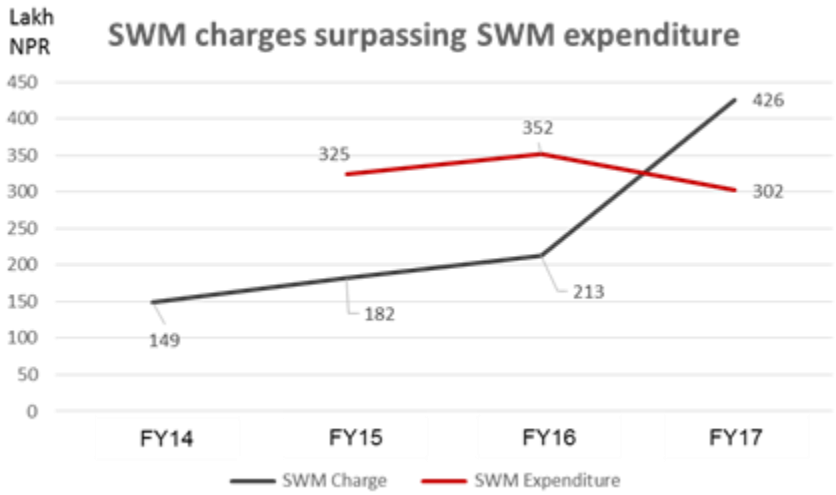
Table 13: SWM expenditure decreased from FY 2015 to FY 2017

Figures (NPR lakh)	FY13-14	FY14-15	FY15-16	FY16-17
Establishment expenditure	210	239	203	275
% of establishment expenditure to total SWM expenditure	65%	68%	67%	75%

[6]Revenue expenditure is inclusive of establishment expenditure, admin expenditure and part of O&M expenditure.

Revenue increased from NPR 149 lakh in fiscal 2014 to NPR 426 lakh in fiscal 2017. This surpassed the expenditure of NPR 302 lakh in fiscal 2017. Cut in expenditure is due to reduction in the PMC's SWM operations. All the operations of collection and transportation of waste have been outsourced except for collection in six wards. Also, there is no operational waste processing and treatment facility. This further reduces the O&M cost.

Figure 21: SWM charges and expenditures



Responsibility of waste collection and transportation is outsourced to seven contractors and they are responsible to collect SWM charges. The collected amount is deposited in the PMC's account. The PMC retains 20% of the collected amount and gives 80% back to the contractor. Also, the contractor engaged at the dumpsite to segregate waste and the contractor managing the biomedical waste pay NPR 2 lakh and NPR 1 lakh per month to the PMC, respectively. These are the sources of revenue for the department.

2.3.3 Cost recovery of SWM services

Sanitation cards are distributed to waste generators for the payment of SWM charges. Currently, 29,995 sanitation cards have been distributed in Pokhara. The PMC has issued only 26 sanitation cards in the six wards being served. Pokhara currently has more than 110,000 households in the city. Hence, coverage of the sanitation card is less than 30%. These cards are issued to the establishments. Demand slips are provided by the PMC to the operators. Operators are responsible for collecting the SWM charges from the waste generators. Although out of 117 TPD disposable waste, on average 85 TPD is collected (which is approximately 71%), revenue collection is less than 30%. With 30% coverage, the total SWM charges collected add up to NPR 426 lakh. At the current rate, with full coverage, it can potentially generate NPR 1,420 lakh.

SWM charges are decided based on the built-up area, type of construction, access to the establishment, etc. Further classification is made based on the location of the property. For determining domestic user rates, four areas across the city have been identified and then based on the aforementioned criteria, charges are fixed. SWM charges of the commercial units depend on the type of business (such as jewellery shop, hotel, restaurant, etc.) and location of the

establishment (main/small market).The SWM Act allows for levying charges based on the quantity of generation. SWM charges cannot be calculated based on the waste generated as there is no mechanism to ascertain the quantity of waste. These charges are not revised regularly, there is no fixed method to do that.

Currently, O&M expenditure is recovered as the PMC's service is limited and private contractors share 20% SWM charges. It is important to note that the PMC does not have a comprehensive database for the number of sanitation cards issued by the operators. Although the contracts mention that the receipts would be provided by the PMC, database of the actual amount of SWM charges is not available with the corporation. Thus, there is no modality to understand revenue leakage.

2.3.4 Summary of issues in financial management

Financially, the PMC has revenue surplus, but it is grant-dependent. The share of own-source revenue has been decreasing over the past four years, which needs to be relooked at. Own-source revenue needs to be increased to meet the operational expenses and to reduce the dependency on the grant component.

Higher share of tied grant does not provide flexibility to the ULL to spend as per requirements or priority. Due to the sudden increase in local equalization grant, the share of tied grant has reduced; however, this is a one-time event. The local equalization grant may vary from year-to-year based on a formula. Service delivery cannot be planned based on grant availability.

All SWM revenue and expenditure need to be budgeted for item-wise. In the absence of proper accrual-based accounting, the clear picture of financial management cannot be derived.

For SWM services cost recovery is a concern. Not all the establishment units are charged for SWM services as less than 30% of the establishments is currently paying SWM charges. This results in lesser cost recovery. Further revenue leakage might be happening due to absence of oversight on the contractors The existing contract documents do not ensure that the entire collected amount from SWM charges are deposited in the PMC's account. The contracts do not hold the contractors accountable for not billing and collecting SWM charges from the waste generators. Also the payments to the contractors are not linked to the billing and collection performance. This warrants for improved coverage of levying SWM charges, rationalization of tariffs, and assurance of no leakage in the collection process by improving the procurement.

2.4 Institutional assessment

The key parameters of assessment—planning, implementation, operation and maintenance, monitoring and management—are assessed through the following:

2.4.1 Planning for services and infrastructure

This is usually carried out at the ward offices based on on-ground requirements. The sanitation and landfill units plan for the city-level infrastructure. Requests from the wards are aggregated at the head office and further assessed for budget approval (detailed in 2.4.4).

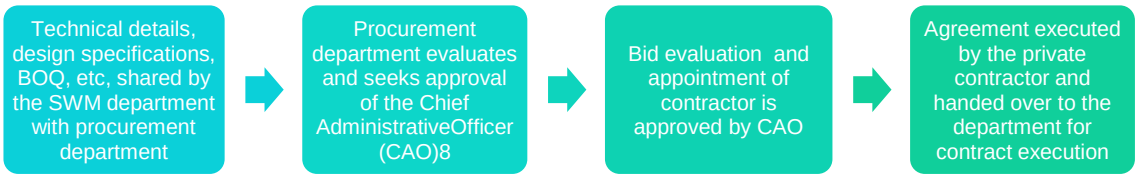
The key observations are:

- Planning for infrastructure in most of the cases ad-hoc, not evidence-based
- Asset management is not formalized; thus, stock replenishment is also ad hoc

2.4.2 Procurement and contract management

Procurement is undertaken by the centralized procurement unit in the PMC. The modalities of appointment and contract management are based on the size and type of contract. Small-scale procurement—such as purchase of gloves, masks, etc.—is managed directly by the store department. However, the procurement of vehicles, engaging private operators for service delivery (for instance, collection and transportation of general waste) and infrastructure construction are managed by the public purchase department. The Procurement Act, 2064, is being followed for all procurements. However, after procurement, the responsibility of contract management lies with the nodal department, which is responsible for the service.

Figure 22: Procurement and contract management



In the waste management department, 10 contractors operate and manage activities such as collection and transportation of waste, landfill management, septage management, handling biomedical waste, and recycling dry waste.

Table 14: Private contractors managing SWM activities in PMC

Activity	Name of private operators	Wards served
Waste collection and transportation	Pokhara Waste Management Pvt Ltd	7 and 17
	Batawaraniya Sundar Nepal Pvt Ltd	3, 4, 8, and 9
	Nepal Public Health and Environment for Development	1, 2 and 5
	Waste Management Recycling Pvt Ltd	10 and 15
	Pragati Sansar Nepal	16 and 19
	Just in Time	26-33
Collection—transportation and septage management (sludge collection from septic tanks)	Pokhara Green Mart Pvt Ltd	6, 11, 12, and 13
Reed-bed treatment management	Hariyali Nepal Pvt Ltd	At the dumpsite
Waste segregation and recycling at the dumpsite	Arc D Architectural Engineering Services Pvt Ltd	City wide
Biomedical waste management	Waste Service Pvt Ltd	At the dumpsite and selected hospitals

The existing contracts have been reviewed and assessed based on the parties involved, the scope of work, contract monitoring and implementation, and risk distribution. All the existing contracts are essentially service contracts.

The key features and our observations (refer to Annexure A.5 for contract-wise details) on the contracts are:

Table 15: Key features and observations

Parameter	Assessment
Parties involved	• The contracts are drawn between: (a) the PMC and the contractor, (b) the PMC, contractor, and TLO • The roles and responsibilities are not clearly defined • Which TLO will be party to the contract or whether all TLOs will be involved in the wards concerned, is not mentioned in the contracts
Scope of work	• Collection and transportation of waste, but routes, schedules, etc., are not mentioned • Procurement of vehicles, O&M come under the purview of operators • Composting is included in the scope if the operator fails to make waste generators aware of segregation
Contract period	• Usually for 2-3 years, which is not adequate to recover the O&M cost and capital expenditure • No process followed for contract renewal. All contracts due for expiry are renewed for an indefinite period until a further decision is taken
Performance monitoring	• Contract only mentions that the contractor has to perform satisfactorily • It does not provide performance measurement indicators and monitoring mechanisms
Collection of charges and revenue sharing	• Collection of SWM charges is the responsibility of the contractors. The contracts do not mention the frequency of collection of charges. Also, the PMC does not have any record of issuance of sanitation cards by the contractors • 20% to be retained by the PMC and 80% to be given back to the contractors • Where TLOs are involved, contractors receive 75% and TLOs receive 5% • Out of the collected arrears, 50% is retained by the PMC, 45% is given to the contractor and 5% to the TLO
Penalty	• The contract mentions that if the performance of the operator is unsatisfactory, the PMC will penalize the operator • It does not provide the basis for establishing the performance of the operator
Termination	• If the performance of the operator is unsatisfactory, the PMC will issue a notice. If there is no improvement, the PMC may terminate the contract • The performance measurement criteria is not mentioned in the contracts

Key observations

- Roles and responsibilities of the parties involved are not clearly defined in the contracts
- Contractual obligations are seldom enforced and audited. Contracts drafted for waste collection operators are quite open-ended, ambiguous, and monitoring mechanisms and measurable performance standards are missing
- Short-term contracts discourage contractors from investing in infrastructure, such as vehicles, due to the apprehension of no-cost recovery. Moreover, based on our interaction with operators, we infer that uncertain termination/cancellation clause is a risk to their business proposition
- Capital expenditure (procurement of vehicles and other assets) and O&M expenditure are borne by the contractors and is expected to be recovered through collection of sanitation charges. This does not guarantee operators' cost recovery, thus resulting in less private sector interest
- Frequency of sanitation charges is not mentioned in the contracts. In accordance with the PMC's general guidelines, these charges are to be collected on a monthly basis by operators and deposited with the PMC. Adherence to this is poor among contractors
- The key issues in revenue management are:
  - There is no check from the PMC to curb revenue leakage
  - Contractors are paid the entire 80% amount irrespective of the services provided
  - Unclear revenue distribution amongst TLOs, as a single ward may have a number of TLOs operating
  - TLOs' share of arrears collected is at the discretion of the PMC. Owing to non-payment by generators, contractors may stop collecting waste from them. Also, with additional amount paid by generators, operators may provide extra services such as frequent waste collection
- The department does not have the technical and management capabilities to manage design-build-operate-transfer contracts. The staff are aware of the new procurement and PPP Act. However, they have not received any support or training to shape and execute such contracts

2.4.3 Monitoring KPIs, performance of service

Currently, collection and transportation of solid waste in Pokhara is undertaken by operators (there are three more operators for other SWM operations) and the PMC. No auditing or performance measurement is in place to check the operators' operational and functional efficiency. Moreover, payment to operators is not linked to their performance. Therefore, operators have no compulsion to adhere to the contract requirements.

To understand whether waste is being collected from the streets or from households, the ULL often relies on complaints data. Whenever a complaint is received from any resident regarding waste not being collected, the PMC asks the operator to send vehicles for waste collection. However, these checks are not done proactively by the PMC.

Under GPOBA, various key performance indicators were developed as follows:

- **SWM strategy and action plan:** Focusing on short- and long-term plans and institutional capacity for decision making
- **Performance monitoring KPIs:** Focusing on the efficiency of service delivery, including landfill operations, waste reduction, service delivery monitoring and the existing communications system
- **Service monitoring KPIs:** Focusing on the effectiveness of service delivery, i.e. coverage of waste collection, cleanliness of the city and beneficiary satisfaction
- **Financial KPIs:** The key parameter was increase in revenue

The GPOBA introduced various indicators for institutional, financial, service delivery, etc. Our assessment highlights are:

1. Institutional reforms: They include preparation of SWM plans and improvements in institutional capacity. However, these were qualitative indicators and operationalization of the procured resources was excluded.
2. Service delivery: It does not provide objective targets to be achieved over time, such as year-wise targets for segregation of waste, procurement of equipment and development of infrastructure as per plans, progress on landfill construction, and processing facilities.
3. Financial management: It focuses on revenue increase, but does not capture improvement in cost recovery of services, collection efficiency of charges, etc.

From our discussions with the PMC staff, we understood that measuring and reporting these performance indicators was not institutionalized. These were more like one-time activities. Also, not all the reporting was evidence-based. Therefore, data management and transparency of the operations are the key issues here. Also, due to ambiguous and poorly drafted contract terms, no data is being shared between the PMC and operators. This intensifies the problem further.

2.4.4 Budgeting process

Budget preparation is initiated by the wards, reviewed by the department at the head office, sent to the disaster and environment committee, and finally approved by the General Assembly.

It is observed that budgeting is done mostly in an ad-hoc manner at the wards, regardless of the existing performance of SWM services. The wards' role in SWM is not clearly defined. The planning of common infrastructure is not very transparent. As most of the responsibility of SWM is on the private operators, the PMC has made no substantial investment in SWM.

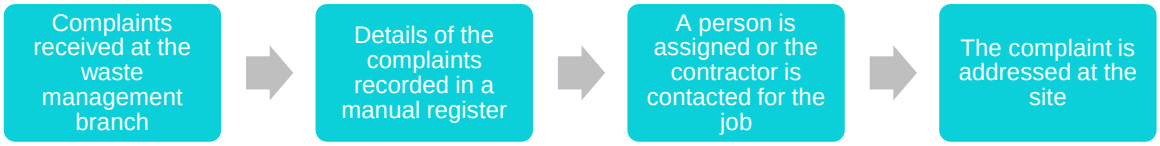
Prior to preparation of the budget requirements at the ward level, the ward chairman conducts a public meeting (with a public notice seven days in advance) for discussion of issues and priorities, based on which budget requirements are finalized. There is no SWM-specific citizen consultation. It is usually covered as a part of ward-level budget consultation.

Figure 23: Current budgeting process for SWM

2.4.5 Grievance redressal

The process of grievance redressal is not formalized in the PMC. The complaints reach the PMC via various modes such as tele-calls and written communication. The process is presented below:

Figure 24: Process of grievance redressal



Based on primary discussion at the ULL and the complaint register, 4-5 complaints are registered daily. The complaints predominantly pertain to removal of dead animals and delay in arrival of the waste collection vehicle. The complaints register maintained at the office records information pertaining to the date, name of the person/institution registering complaint, location of complaints (area, ward number), personnel/driver allocated for the job, status (completed/pending), and remarks (if any). There is no formal mechanism for receiving consumer feedback post redressal of the complaint.

Observations

1. No monitoring of the type of complaints, recording area/location with frequent complaints
2. Absence of two-way communication; no feedback is sought post complaint redressal
3. No time-bound redressal of complaints
4. Not all complaints are recorded in the register
5. Complaint registration and redressal are not linked with the performance of the operators

2.5 Environmental, social, and health safeguard

2.5.1 Environmental compliance

Environmental compliance of the existing SWM services and their facilities can be assessed with respect to (i) existence of the monitoring framework, and (ii) compliance of these operations with the quality standards.

- **Assessment of the monitoring framework**

The Ministry of Population and Environment published sampling and analysis methods for checking the environmental quality in Nepal Gazette in 2060 (2004 AD). This provides guidance on designing sampling programs, sampling techniques, preservation and handling of samples, wastewater sampling following the provisions of ISO standard 5667. There are no specific environmental standards for SWM. The leachate that is mixed with the adjacent waterbodies may be tested by comparing with the generic standards for tolerance limits for industrial effluents to be discharged into inland surface water (the standards were published in Nepal Gazette in 2058 by the then Ministry of Population and Environment).

The Department of Environment (DoE), under the Ministry of Forest and Environment (MoFE), sometimes collects water samples from the provinces to check compliance with environmental quality standards. However, there is no fixed schedule for collecting samples and publishing these results for the waste management facilities. Currently, it is limited to environmental monitoring of industrial discharges only.

An environmental monitoring framework is required for the storage facilities (where waste is primarily stored) or material recovery centers and the landfill/disposal site. While transporting the waste, the leachate needs to be handled properly. As per the requirements of the Environmental Protection Rules, 2054 (1997 AD) and the amendment of 2055 (1998 AD), thresholds were prescribed for initial environmental examination (IEE) and environmental impact assessment (EIA). The threshold parameters are landfills (catering to 100-10,000 ton waste per year) and transfer stations with more than 3 ha land, facilities for recycling with more than 2 ha land, and composting facility of 1-5 ha of land, etc. Pokhara's existing dumpsite (which is actually a designed landfill) qualifies in these criteria and requires an EIA to be done for the site. However, the existing site has not done an EIA.

- **Compliance with environmental standards**

Compliance with the environmental standards cannot be established as there is no process for checking water quality of Seti River and other small streams/water bodies. A monitoring framework has been designed by the MoFE and its counterpart department at the provinces to check the quality of discharge from such sites.

The PMC has appointed Arc D Architectural Engineering Services Pvt Ltd to segregate waste and manage the dumpsite. Hariyali Nepal Ltd has been appointed to manage the reed-bed facility to treat the septage sludge. However, there is no monitoring mechanism for the PMC to oversee the performance of these operators and check their adherence to the environmental quality standards. Also, the treatment facility is not operational.

In the summer of 2018, a fire incident at the dumpsite lasted for 15 days though no casualty was reported. This was discussed during the interviews of workers at the dumpsite. There is no system for documentation and tracking of such incidences, and taking proactive measures to control such incidences. Sometimes, complaints regarding odor and flies are reported from the villages adjoining the dumpsite. Documentation of complaints regarding frequency of occurrence, area-specific issues, etc. are not assessed regularly by the PMC.

2.5.2 Health and safety assessment

The PMC has not outlined any health and safety guidelines for the sweepers and workers handling city waste. The existing contracts do not provide guidelines or requirements for the health and safety of workers handling waste. The waste collection and transportation contracts only mention using covered vehicles for transferring waste to the dumpsite to control en route environmental issues. The biomedical waste handling contract also mentions leachate control from the waste collected from health centers to avoid contamination. However, there is no obligation for operators to maintain occupational health and safety.

Figure 25: Biomedical waste handling

Biomedical waste from healthcare facilities is managed Waste Service Private Limited appointed by the ULG. The establishment to treat bio-medical waste has 7 workers and 3 drivers. The workers run autoclave and then post disinfecting, segregate the waste.

These workers have received uniform for the working hours. They get medical check-up (occupational health check up) done once in every quarter. No major health issues have been reported as yet.

The landfill workers mentioned that long boots were distributed couple of years ago, but since then the workers themselves buy these. There is no medical cover or health check-up facilities provided to these waste segregators at the dump site. It was mentioned during the discussion with these segregators that they take tetanus in case they get any cuts from glass or metal. These expenses are borne by themselves.

Key environmental issues:

- There are no norms for the selection of sites to locate SWM infrastructure, such as landfill site and material recovery facility
- In the absence of a regulatory framework, all the waste from Pokhara is dumped beside Seti River without treatment. Leachate from the waste contaminates the water
- No environmental standards are laid out for water quality testing for the leachates mixing in waterbodies. Also, the schedule for environmental quality check is absent for the SWM facilities
- Fire in the waste dump increases air pollution
- Solid waste workers are directly exposed to the waste and are not provided with required gears and safety measures

There is no mechanism to monitor whether the waste management contractors are complying with the minimum health and safety requirements. Under the GPOBA project, the city had prepared an occupational health and safety manual, but the guidelines have not been implemented as yet.

2.5.3 Social inclusion

2.5.3.1 Community engagement

Communities are actively involved in various SWM activities in Pokhara. TLOs have been formed (with 60-80 households on average) at the neighborhood level that undertake various local-level initiatives in SWM. Additionally, various women groups and youth clubs actively participate in the waste management of their locale.

Figure 26: Benas Tal Yuva Club

Begnas Tal Yuva Club (located in Ward 31) cleans the tourist area weekly and store the waste at one location from where the collection vehicle lifts it. Under their initiative 'Begnas Tal Brihat Sarsafai' they have procured 70 dustbins and have installed in the area as well as around the lake. The waste composition is dominated by noodle packets and bottles. To them, the issues of SWM are low awareness level of citizen. Reduction in waste needs to be handled at the household. They sweep the roads weekly and clean the lake occasionally. To them, waste needs to be collected every three days.

Road approaching Begnas Tal; dustbins are inslatted by the Yuva club

Informal seller cleans the littered waste

Stakeholders' consultation

Women's clubs are also active in the city. These clubs and TLOs are involved in the collection of waste and generating awareness among people. Such groups organize cleanliness drives along with the PMC for cleaning the area around the water body, i.e. streams, lakes. Sometimes, banks in the city also organize sanitation campaigns for cleaning certain areas.

A women's group from Ward 7 (Machhapuchhare) collects the recyclable waste from the households and sells it on the first Sunday of every month to a local recycler. Earnings from sale of recyclables are used for the welfare of the children of the group members.

2.5.3.2 Inclusion of the informal sector

There are 450-500 rag-pickers (including women, street children and elders) in the PMC area. They collect the recyclables (that have an economic value) from public areas and sell them to the local *kabadiwalas*.

Informal boundaries for collection of recyclables are outlined between the different groups of rag-pickers.

The rag-pickers generally collect waste during the day as the local police does not allow collection of recyclables at night due to security reasons.

2.5.3.3 IEC initiatives and community awareness generation

The PMC, through the ward offices, organizes various awareness generation programs on solid waste management for the residential households. The PMC has issued a public notice on the do's and don'ts, which includes:

- Putting a stop to burning plastic waste
- Stopping the sale of products in plastic bags
- Encouraging production of compost from biodegradable waste

The PMC has initiated on-road surveillance to stop littering and has identified 28 people throwing garbage in public places and punished them. The PMC has initiated grievance/complaints data management for further monitoring. However, this is yet to be done in an organized manner.

TLOs and women's groups actively participate in awareness generation programs and representatives at the PMC's head office support these activities.

Most of the awareness programs are initiated by either ward offices or TLOs and they focus on waste segregation at the source. However, the PMC is also promoting biogas generation from biodegradable waste. According to PMC officials, ~1,000 people have participated in or attended these programs.

Table 16: Awareness program organized in 2075-76 (2019 AD)

Sl. No.	Organized by	Theme	Participants/attendees
1	TLOs and women's groups of the ward	Overall waste management practices	Ward 30
2	Machhapuchhre TLO	Waste segregation in classified bins	Ward 12
3	Machhapuchhre Women's Club	Waste segregation in classified bins and market potential for selling recyclables	68 women
4	Women's group	Waste segregation	Ward 11
5	PMC		Ward 21
6	PMC	Segregation of waste and sharing revenue from the sale of recyclables among the TLOs	3 TLOs of ward 29
7	PMC	Reduction and segregation of waste at source	108 women in ward 2
8	Sinhanath Mohariya Tole	Waste segregation	Ward 1
9	PMC	Biogas production from household biodegradable waste	56 attendees representing various toles and women's groups of ward 9
10	PMC		50 attendees representing various toles and women's groups of ward 6
11	PMC		120 people from the ward representing toles and women's groups of ward 10
12	Forest Research Centre	Conducted training program on waste management	All 33 wards

Source: PMC, 2019

Community engagement (TLOs, women's group, youth clubs) is limited. TLOs undertake various awareness generation initiatives, but they are sporadic.

IEC initiatives are very important to implement the SWM regulations; however, these initiatives are limited till date.

Informal sectors, especially the individual recyclers, can be formalized and made a part of the SWM processes.

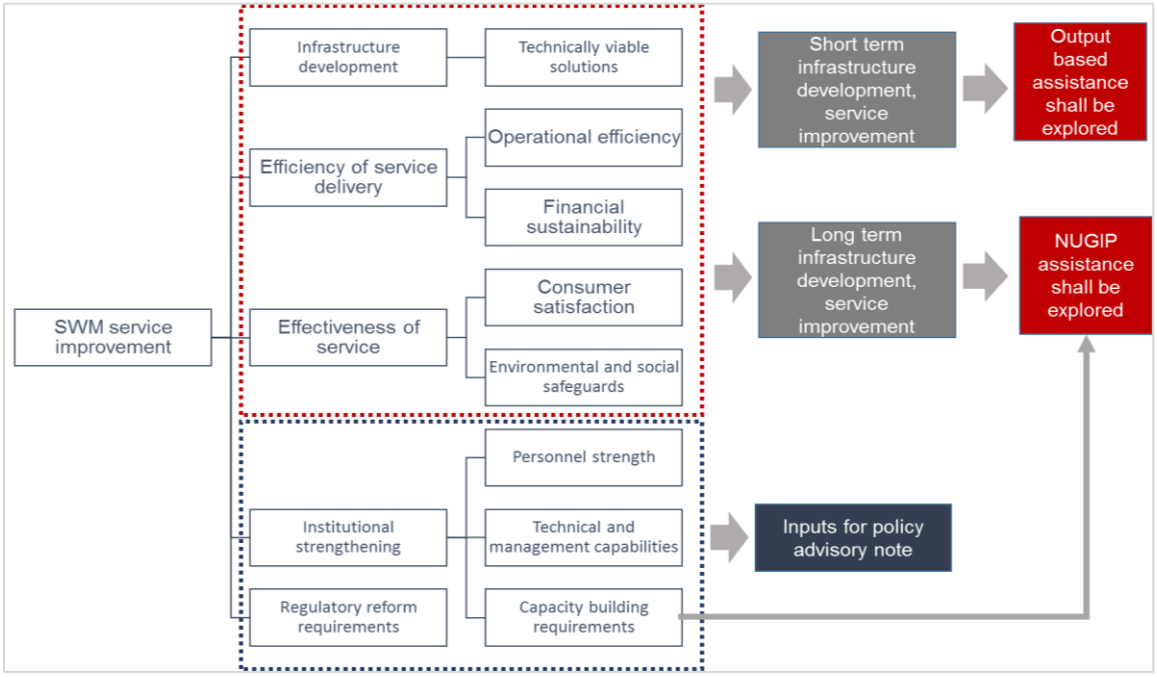
3 Service and Infrastructure Improvement Plan

A service and infrastructure improvement plan (SIIP) has been prepared based on the identified operational and management constraints, and gaps. This provides guidelines to the PMC on improving existing infrastructure and operations, leading to better, reliable, and equitable SWM service delivery. The key aspects covered under SIIP include technical improvements, and financial and institutional reform requirements. The recommendations also consider environmental and social safeguards and identify the role of the private sector in improving service delivery.

3.1 Conceptualizing the SIP framework

The SIIP broadly covers two components- additional infrastructure requirements and the various reforms in institutional and financial management processes. This also identifies the requirements of financial support from federal government or other external sources toto strengthen the service delivery. The proposed SIIP is to be implemented over the next 7-10 years. Improvements in infrastructure and service levels could be a part of the Nepal Urban Governance and Infrastructure Projects (NUGIP). The proposed NGUIP may also seek to institutionalize operations through a strong consistent capacity building program.

Figure 27: SIP development framework



The key objectives of SIIP are to:

a) **Bridge the infrastructure gaps:** This includes technically viable solutions leveraging the existing infrastructure such as waste collection vehicles and landfill site

b) **Bring in efficiency in service delivery:** Operational and financial efficiency by ensuring reliable and equitable service across the city

c) **Improve consumer connect and effectiveness of services:** Measured through consumers' satisfaction and strong compliance with environmental quality requirements and health standards

3.2 Recommendations for service delivery improvement

3.2.1 Demand assessment: Waste projections and requirement analysis

In order to improve service delivery, all the processes across the value chain needs to be strengthened. The waste projection of Pokhara has been calculated based on population growth in its core, outer and rural areas. To cater to this generated waste, the city needs to boost its infrastructure and its operational and management practices in a phased manner.

Table 17: Estimation of waste generation for designing SIP

Sl. No.	Year	Estimated waste generation (TPD)			Total(TPD)	Area-wise share of waste (%)		
		Core	Outer	Rural		Core	Outer	Rural
1	2020	87.29	101.15	14.86	203.30	42.94%	49.75%	7.31%
2	2030	20.66	134.23	15.94	270.83			
3	2040	160.80	173.71	16.81	351.32			

Source: CRIS assessment

Various sources of waste generation have also been considered to develop a waste profile. Primary survey results are the basis of the assessment.

Table 18: Waste profiling based on land use

Sl. No.	Generation source	Waste generation (TPD)			
		2019	2020	2030	2040
1	Total waste	182	203	270.83	351.32
2	Households	145.55	163	217.76	282.48
3	Bulk generators	12.50	12.53	16.69	21.65
4	Commercial establishments	17.53	19.87	26.47	34.33
5	Institutions, offices and health facilities	7.12	7.44	9.91	12.86

Source: CRIS assessment

3.2.2 Proposed service delivery model

Typically, service delivery models are of two types—centralized and decentralized. A decision on which model could be adopted for Pokhara, is to consider factors such as density and spread of development; land and capital availability; and management capability of the organizations involved. The key features of the two models are discussed below.

a) **Centralized system**— Under this model, all the waste from the city comes to one point for treatment and processing and is then sent for disposal. It requires large infrastructure as it covers the entire city. Hence, land area (preferably single plot) and capital requirements are high. Economies of scale can be achieved in this model as the quantity of waste handled is large. However, people may show resistance towards such projects because of the NIMBY issues especially in case of Pokhara where the development is dense. Site selection for such centralized projects becomes challenging.

b) **Decentralized system—**This is a distributive system wherein waste is handled in the vicinity of the source of generation. These can be built on small plots available in various neighborhoods based on simple and low cost technology. Also, these are small facilities and not very cost intensive.

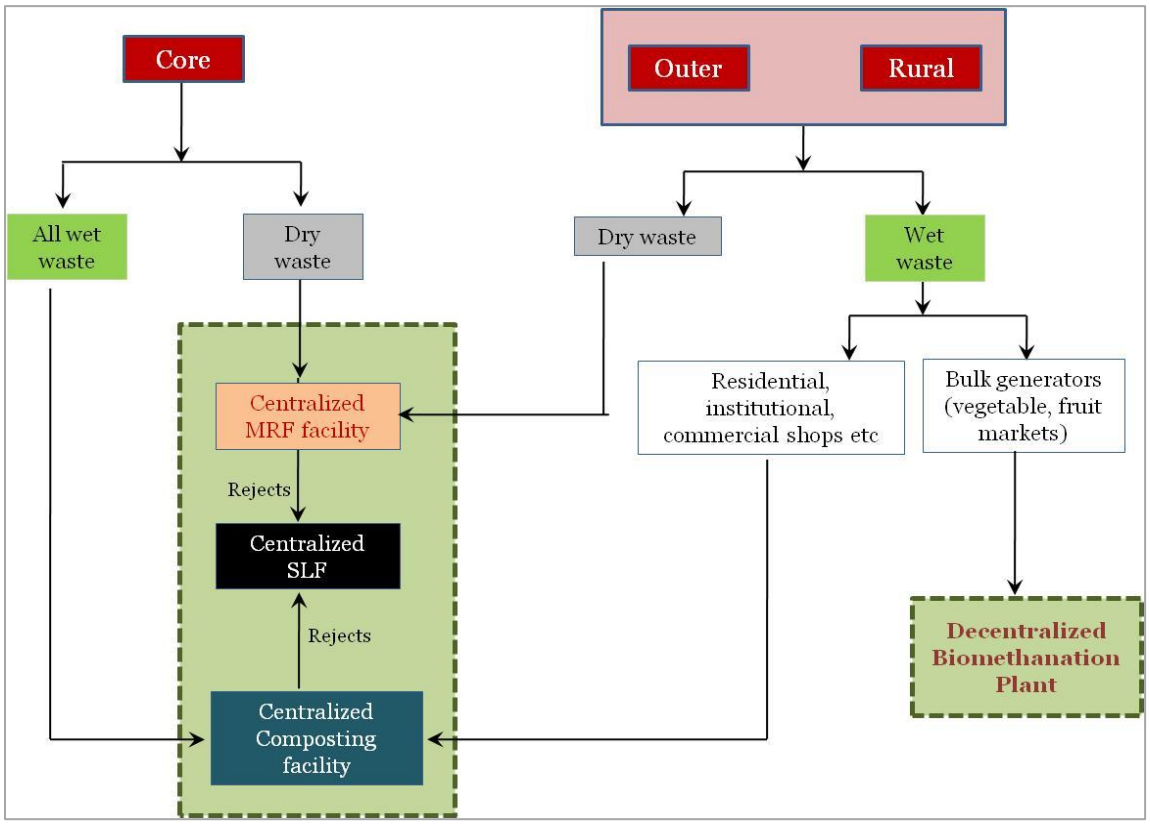
Both the options for Pokhara have been assessed based on the following parameters:

Table 19: Proposed service delivery model parameters

Waste quantity and character	About 43% of the waste is estimated to be generated from the core area and 50% from the outer area. Only 7% is from the rural area. Rural wards are sparsely populated and the terrain is mountainous. Also, the spread of the outer wards is wide. Collection vehicles will have to travel a long distance.
Land availability	The core area of the city is densely developed and there is no land available. Building large infrastructure is not possible. Small patches can be made available instead of large plots. Considering the land constraint in the city, this seems more viable. This will also reduce local resistance to projects.
Market assessment	In Pokhara, domestic waste generators or households cooperate with the PMC and TLOs in segregating waste. They also practice composting and generate biogas using small units of bio-digesters. Pokhara has a ready market for compost and biogas.
Financial capability	The PMC is in revenue surplus. As discussed in the previous chapter, revenue is highly grant-dependent, but the share of tied grant has been reducing over time.

Considering the estimated waste generation, the PMC's constraints, and the requirements of an efficient system, **a hybrid system for Pokhara—a blend of centralized and decentralized SWM has been proposed**

Figure 28: Concept for improving SWM in Pokhara Metropolitan City



Source: CRIS.

A decentralized system is apt for rural and outer areas as the availability of land is not a major concern. As a certain share of waste could be handled at the localized facilities, waste coming to centralized facility will be less. The key design elements of the plan are as follows:

- **Waste should be segregated at the source and collected separately**. Dry waste from the core, outer and rural areas will reach the centralized material recovery facility (MRF). Household wet waste from the core areas and commercial wet waste from the outer and rural areas will be brought to the centralized compost facility. Wet waste generated by bulk generators in the outer and rural areas can be treated locally in small, decentralized biomethanation plants
- A **centralized composting facility** will be set up for the wet waste. It will have a capacity to process 120 TPD which will be enough to meet the demand for 10 years until 2030. It will have an option to enhance the capacity to meet demand increase over another 10 years until 2040
- Dry waste from the city will come to the **centralized MRF** for segregating the recyclables such as glass, bottle, paper, plastic, cardboard and thermocol. Segregation can be decentralized on outer and rural wards of the city, but such recyclables shall also reach the centralized MRF
- A **centralized sanitary landfill site** will be established to receive the rejects from a centralized composting facility and composting plant
- Necessary **vehicles and other equipment** are to be procured in order to ensure 100% collection rate and efficient transportation of waste to these facilities

3.2.3 Proposed infrastructure requirements and process improvements

For effective implementation of the hybrid service delivery model, the following two requirements are to be met:

a) Improvement in SWM operations, i.e. process improvements. This will require adequate staff and the authorities will have to put in place enabling policies.

b) Plugging the gaps in infrastructure.

In Pokhara, service delivery can be improved by:

- Making segregation of waste at the source, into wet and dry, compulsory. This will help achieve maximum recovery of waste
- Establishing an efficient door-to-door waste collection system with maximum participation from waste generators. The service provider should ensure 100% collection and transportation of waste generated
- Providing necessary attention to reduce manual handling of waste. For this, the entire waste collection and transportation system should be automated to the maximum extent possible
- Designing the system to facilitate daily movement of vehicles to the compost plant and MRF. The trips should be undertaken only for 6-8 hours a day so as to increase the life of the vehicles and reduce the O&M cost of the infrastructure
- Making the system compliant with the SWM regulations or best practice norms that restrict landfilling to only inert and rejects from waste processing, which are not suitable for either recycling or processing
- Setting up an effective monitoring system in order to ensure sustainability of the service delivery system

The following sections elaborate the operations for the entire SWM service.

3.2.3.1 Proposal for storage and segregation at source

A-free system for Pokhara is recommended. This means that there will be no primary and secondary bins in the city to accumulate waste from the neighborhoods. Instead, door-to-door collection of waste is proposed. Waste generators need to segregate waste themselves.

For bulk generators, such as vegetable and meat markets, bins could be installed. Considering their locations and the current and projected waste generation, we propose hyper density polyethylene (HDPE) containers to be placed in these markets. The requirement of bins will be as follows:

Table 20: Waste collection bins requirement

	Bins	Core	Outer	Rural
1	**Capacity (l)**	1100	1100	1100
2	**Number of bins**	**32**	**37**	**5**

Waste needs to be collected on a daily basis from the core and outer areas, and at least once in three days from the rural areas as wet waste cannot be stored longer.

3.2.3.2 Collection and transportation: Proposals

The PMC currently owns four vehicles and private operators about 20 vehicles that are used for collection of waste. However, at present waste is not collected after segregation. The requirement of vehicles is presented in Table 21. Other technical details is provided in 0. We have explored two scenarios while designing the collection and transportation system:

Scenario 1

Use the current compactors and tippers to collect waste from the core and outer areas. The PMC may consider procuring additional vehicles to meet the requirement. Here, the assumption is that the current contracts will continue. However, if the existing vehicles are to be used, they will need to be modified by putting in place a partition in order to collect dry and wet waste separately. They could be used in the core and outer areas, where the requirement will be 51 vehicles. The current availability (the PMC and contractors together) is 22, which means 29 more will have to be procured. For use in the narrow lanes of the rural areas, hydraulic tippers of 2 MT capacity could be procured. They will also need separate compartments for dry and wet waste. Nine such tippers are to be procured. The following table sums up the total vehicle requirement for collection and transportation of waste:

Table 21: Recommendations on vehicles requirements

Head	Core		Outer		Rural	
	Wet waste	Dry waste	Wet waste	Dry waste	Wet waste	Dry waste
Proposed vehicles	Closed tippers				Hydraulic tippers	
Type of vehicles	Dual compartment vehicles					
Capacity (MT) of vehicles currently in use	3	3	2	2		
Capacity (m^3) of new vehicles					3.3	3.3
No. of vehicles required for waste collection	18	10	14	9	8	1
Total requirement of closed dual compartment tipper vehicles	28		23			
Closed dual compartment tipper vehicles currently in use	9		13			
Closed dual compartment tipper vehicles to be procured	19		10			
Total requirement of hydraulic tipper vehicles					9	
Hydraulic tipper vehicles currently in use					0	
Hydraulic tipper vehicles to be procured					9	
Total no. of vehicles to be procured		19		10		9

Scenario 2

If we assume all the capital assets belong to PMC, then it needs to procure 51 closed dual compartment tippers for collection of waste from the core and outer areas. For the rural areas, it will have to procure nine compartmentalized hydraulic tippers. In this case, the PMC will own the assets. It would provide the services or it could sign service contract(s) with private contractor(s).

3.2.3.3 Processing and treatment of waste

Pokhara does not have any system to process or treat waste. The collected waste is dumped at the Bacchhebuduwa site. Waste treatment refers to various techniques that can be used to reduce the volume and toxicity of waste, making it easier to dispose of. We explored various technologies that are available and suitable for Nepal. The exercise was carried out in three stages: *a)* Identification of technology, *b)* suitability analysis for Pokhara, and *c)* recommendations with a rationale.

a) Identification of technology

Three types of technologies can be used to treat waste—thermal, biological, and physical. The following table provides a snapshot of the technologies that have been considered for Pokhara. Further details are provided in 0.

Table 22: Waste treatment technologies considered for Pokhara

Sl. No.	Processing technology	Processes
1A	Thermal processing technologies	Incineration (mass burn)
1B		Pyrolysis
1C		Plasma arc gasification
2A	Biological processing technologies	Aerobic digestion (composting)
2B		Anaerobic digestion (biomethanation)
3A	Physical processing technologies	Refuse-derived fuel (RDF)
3B		Densification /palletization

Source: CRIS assessment

b) Suitability analysis

Treatment methods are selected based on the composition, quantity and form of waste. The factors that are considered while deciding the technology to be used to process waste in a city are:

- *Reliability:* Whether the technology has a successful track record of treating similar kind of waste elsewhere and whether it has the capacity to treat the entire waste the city generates
- *Suitability:* Whether the technology is suitable for the physical composition and chemical characteristics of the waste generated by the city
- *Viability*: Whether the ULL is capable of making the required capital investment and bearing the O&M cost of the technology
- *Environment and social impact:* Whether the environmental and social impact of the technology is minimal, and whether the technology conforms with the regulatory requirements and is the most appropriate

Table 23: Suitability analysis for technology selection in PMC

Sl. No.	Technology	Suitability	Waste characteristics	Comments
1	Biomethanation	Kitchen/restaurant waste	Organic content > 40% Moisture content > 50%	Requires source segregation of waste, proven and widely-applied technology
2	RDF	Mixed municipal solid waste	Calorific value > 1200 kcal/kg Moisture content < 45%	Simple technology, flexibility to utilize auxiliary fuel
3	Incineration	Mainly suitable for hazardous waste	Calorific value > 1450 kcal/kg Very low moisture content	Has not been successful in treating municipal solid waste
4	Pyrolysis	Woody biomass	Moisture content < 25% Calorific value > 2000 kcal/kg	Require skilled personnel, sufficient operational experience is required before full scale operation of the plant, and waste needs to be segregated and dried before treatment
5	Plasma technology	Mainly suitable for hazardous waste	Calorific value 3500–4700 kcal/kg	Handled at very high temperature, require skilled personnel to control the processes, should run a pilot plant before starting full-scale operation, and proper segregation must before treatment
6	Composting	Economic, simple	Organic waste, landscaping and garden waste	Successfully running in developing countries; capacity varies from 30 TPD to more than 650 TPD

Source: CRIS assessment

c) Recommendations for processing and treatment in Pokhara

Based on the above considerations, we recommend biomethanation technology to treat the segregated wet waste in Pokhara. For dry waste or recyclables, we propose a centralized material recovery center. The proposed designs are:

Table 24: Projected waste generation in Pokhara

Sl. No.	Description	Year		
		2020	2030	2040
1	Waste (TPD)	203.300	270.830	351.320
2	Average wet fraction (%)	53.74%	53.74%	53.74%
3	Dry fraction (%)	46.26%	46.26%	46.26%
4	Wet waste (TPD)	109.26	145.55	188.81
5	Dry waste (TPD)	94.04	125.28	162.51

Source: CRIS assessment

Based on these projections, our recommendations for the processing and treatment of waste in Pokhara over the next 20 years are as follows in Table 25:

Table 25: Recommendations for processing and treatment of waste in Pokhara

Wet waste processing:

a. Biomethanation
b. Composting

For bulk generators of the outer and rural areas, wet waste can be locally managed through biomethanation. Approximately 10 biomethanation plants of 1 TPD capacity each are proposed to be installed in the outer and rural areas.

If the waste can be handled locally, its transportation will become more efficient. Thus, we propose anaerobic digestion, i.e. biomethanation (refer to Annexure B.4 for details), to treat wet waste collected from bulk generators of the outer and rural areas.

Wet waste generated in the core area needs to be treated at the centralized composting plant (aerobic treatment technology). Wet waste generated by domestic and non-domestic units (except bulk generators) will also be taken to the centralized facility.

While carrying out the feasibility of biomethanation plant, co-treatment of sludge and organic waste could also be considered. It is well established that the energy recovery from co-treatment is much higher than that of processing only organic waste.

Sl. No.	Items	Year		
		2020	2030	2040
1	Waste (TPD)	203	271	351
2	Average wet fraction (%)	53.74%	53.74%	53.74%
3	Dry fraction (%)	46.26%	46.26%	46.26%
4	Wet waste (TPD)	109	146	189
5	Dry waste (TPD)	94	125	163

Based on this waste inventory, the design requirements for the composting and biomethanation plants are as follows:

Sl. No.	Items	Year		
		2020	2030	2040
1	Wet waste diversion at domestic level (%)	15%	15%	15%
2	Wet waste diversion at domestic level (TPD)	17	22	29
3	Wet waste available for treatment (TPD)	93.00	124.00	160.00
4	Decentralized waste to energy plant for outer and rural (TPD)	7.15	9.53	12.36
5	Centralized compost plant (TPD)	85.85	114.47	147.64
6	No of 1 TPD biomethanation plant	8	10	13
7	Designed capacity of the compost plant	90.00	120.00	150.00

Dry waste processing:

Centralized material recovery facility

Dry waste from the core, outer and rural areas will be taken to the material recovery facility. Material segregation and sorting will be followed by waste processing. The capacity proposed is given below:

Sl. No.	Items	Year		
		2020	2030	2040
1	Estimated dry waste quantity (TPD)	94.04	125.28	162.51
2	Designed size of the plant (TPD)	**100**	**130**	**170**

The facility will have the following components: *i)* Receiving or tipping area, *ii)* sorting/processing area, *iii)* storage area for recyclables, *iv)* residuals storage area, *v)* equipment area, *vi)* space for an office, and *vii)* loading area for residuals and processed recyclables.

3.2.3.4 Disposal of waste

Rejects from the MRF and centralized composting plant will be transported to the sanitary landfill. The present dumpsite receives waste without segregation. Moreover, the site is located in a 2-km radius of the proposed airport at Pokhara. Also, as per the EIA report, it has to be closed by December 2020.

Considering these factors, we propose closure of the site scientifically and construction of a new sanitary landfill facility (SLF), which will only receive inert that are rejects from other centralized facilities. For disposal, we recommend:

- **Scientific closure of existing dumpsite**
- The waste lying at existing site of Bacchhebuduwa is suggested to be rehabilitated and bio-mined for closure. Biomining is a technology that separated the entire unscientifically dumped waste into combustible and non-combustible soil residues. The entire process is done through stabilization and then screening through a series of screens or trommel. During this process any sort of biodegradable waste (including animal bodies) gets stabilized and any sort of medical waste gets separated out. Biomining is completely mechanized process and there is no manual handling (or direct contact of waste with human body) of waste. Also, through bio-mining reclamation of land is possible whereas in the simple closure, the land (post-closure) could be utilized only for greenery. After bio-mining, the land will be reclaimed and the inert from the site will be sent to the proposed SLF. Combustible materials are to be used for the production of RDF, which has the potential to generate revenue. The process to scientifically close the site is provided in Annexure B.6. Considering that the dumping operations need to be discontinued on an immediate basis in Pokhara for the upcoming airport operations, it is recommended that PMC adopts this approach.
- **Construction of SLF**

  The SLF is to be designed for average waste intake of 70 TPD until 2040. Construction will be carried out over 20 years, divided into four phases of five years each. Currently, there are no standards set for the construction of landfill site. The government has mandated only preparation of EIA

3.2.3.5 Land requirement and preliminary assessment for the facilities

The centralized facility will include sanitary landfill, composting facility and MRF. Following is the area requirement for the proposed centralized facility:

Table 26: Area requirement of the centralized facility

Sl. no.	Description	2020	2030	2040
1	Capacity of the MRF plant (TPD)	100.00	130.00	170.00
2	Area required for MRF plant (acre)	0.91	1.18	1.55
3	Capacity of compost plan (TPD)	90.00	120.00	150.00
4	Area required for compost plant (acre)	2.6676	3.5568	4.446
5	Area required for SLF (acre)	16.68	16.68	16.68
6	Total area required (acre)	20.26	21.42	22.68
7	Circulation, road, infrastructure, greenbelt etc. (@30%), acre	6.08	6.43	6.80
8	Grand total of area required (acre)	26.34	27.85	29.48
9	Grand total of area required (hectare)	10.66	11.27	11.93

Source: CRIS assessment

Land has been identified at Timurpato in Ward 33 of Pokhara. We have carried out a primary assessment of the site located near Dandagaon village.

Figure 29: Primary screening of land parcel available for the centralized facility

- Location of the site: 28°07'54.5"N, 84°01'53.2"E
- Suroudhi Khola (river) on the south at 1.5 km distance
- To the north is Surtane Village at a distance of 3 km, with ~100 households
- Samudaik Gairi Banjyang forest is located on the eastern side of the site
- Another village, Singada Bas, is located 2.5 km away from the site, towards the west

Source: CRIS assessment

There are no habitations, water bodies and any other sensitive areas in a 500 m radius of the identified site. It is accessible from Dara Sultane Village (one of the major locations in this rural ward) via a motorable road. The land, although located on a hilly terrain, is almost flat. It is currently an un-notified forest. The dominant vegetation are local varieties, such as*Sal, Dhairo, Katus and Chilaun*e.

However, before shortlisting the plot, technical and economic feasibility, and detailed project reports need to be prepared.

3.3 Strengthening financial capability

This section provides a snapshot of capital and O&M expenditure that would be required to improve the SWM service delivery. The O&M expenditure is a recurring cost, and will be sustainable only if it is met through user charges collected for the SWM services. This section also details the principles of cost recovery and charging modalities for PMC to recover the O&M cost.

3.3.1 Capital and O&M requirements

The capital cost of the project is estimated at $12.5 million. For collection and transportation, it is assumed that ~22 vehicles currently in use can be modified and deployed.

Table 27: Summary of capital cost of the proposed infrastructure and other components

Sl. no.	Proposed component	Amount (NPR)	Amount* ($ million)
1	Collection and transportation cost (additional vehicle procurement)	11,43,98,050	1.00
2	Decentralized biomethanation plant	2,75,18,421	0.24
3	Material recovery facility	16,43,00,500	1.44
4	Sanitary landfill	31,14,48,750	2.73
5	Centralized compost plant	43,33,20,000	3.80
6	Rehabilitation of existing disposal site	37,68,00,000	3.31
Total cost		**1,42,77,85,721**	**12.52**

Source: CRIS assessment
* Conversion rate assumed is $1 = NPR 114

At present, collection and transportation of waste is done by seven private operators. Based on the service delivery model, it is to be decided whether all the assets (vehicles, in this case) are to be owned by the PMC. If the PMC procures all the 51 vehicles required for collection and transportation of waste, then the capital cost of the vehicles will be NPR 1,50,58,83,193 and the total capital cost will be $13.2 million. But PMC's budget is highly dependent on the equalization grant, which, in practice, is supply-driven. Also, PMC has other liabilities and priorities. Hence, it can explore various grants as a way to meet the capital investment requirement.

The O&M cost of the entire service will be ~NPR 6 crore, which is equivalent to $0.5 million per annum. This considers establishment expenditure, O&M of the assets, and also administrative expenditure that is to be incurred for the service delivery.

Table 28: Summary of O&M expenditure

Sl. no.	Item	Quantity	Unit	Amount (NPR)/year	Amount ($ million) year
1	Sanitary landfill	69.00	TPD	93,56,547	0.08
2	Compost plant	120.00	TPD	2,09,62,618	0.18
3	Biomethanation plant	9.53	TPD	5,54,739.20	0.00
4	Material recovery facility (5% of capital cost)		Lumpsum	83,47,547	0.07
5	Collection & transportation[7] (10% of capital cost)		LS	1,92,49,552	0.17
Total yearly O&M cost				5,84,71,005	0.51

Source: CRIS assessment

3.3.2 Recommendations on user charges

Primary survey results reveal that 28% of the domestic samples do not pay SWM charges. Secondary data shows that there is a huge gap in the issuance of sanitation cards, at 30,000, vis-à-vis households in the city, which are 1,05,000 in number.

Table 29: Sanitation charges paid by the respondents

SWM charges paid	No. of samples	Frequency (%)
None	17	28%
NPR 10-19	0	0%
NPR 20-49	4	7%
NPR 50-99	12	20%
NPR 100-199	14	23%
NPR 200-299	7	12%
NPR 300 and above	6	10%

Source: CRIS assessment based on primary survey

Based on the proposal, the total O&M cost is $0.5 million per annum. If the service is outsourced to a private operator, let us assume 18% profit will also have to be recovered. With an assumed 5% contingency for the service, the total O&M cost that is to be recovered through SWM charges is $0.65 million, or NPR 7 crore.

[7] Considering all vehicles are operated and maintained by a single party

Assumptions for the calculation of user charges:

- Income group quintiles based on national economic survey 2017 and percentage distribution of households in each economic quintile
- Current expenditure on SWM charges derived from the socioeconomic survey and linking the monthly incomes of the respondents to the economic quintile
- Derive the expenditure to be recovered from the domestic units
- Distribute the cost to be recovered based on the economic quintiles

Currently, domestic and non-domestic units generate 80% and 20%, respectively, of the total waste. If we assume that cost recovery will follow the same ratio, then NPR 6 crore is to be recovered from domestic units and NPR 1.2 crore from non-domestic units.

As per the current expenditure pattern, LIG, MIG and HIG households spend 0.2%, 0.4% and 0.9% of their monthly expenditure, respectively, on SWM charges. Assuming 100% coverage in levying of SWM charges and 100% collection of the charges, SWM tariff of the domestic units will be as follows:

Table 30: Proposed slabs for SWM charges for domestic waste generators

Economic classes of user groups	% of total household, approx. household count	Average charges per household per month (NPR)	Percentage of income spent on SWM charges	Potential SWM charges (lakh NPR)	Percentage to be recovered
LIG	32%, 34,000	15	0.1%	62	7%
MIG	42%, 44,000	50	0.20-0.25%	265	32%
HIG	26%, 27,000	150	0.35%	508	61%
Total cost recovery potential (lakh NPR)				835	

Source: CRIS assessment

Basis this assessment, even at 50% rate of the current tariff charges, just by improving the coverage for levying of SWM charges to 100% and 70% collection efficiency thereof, 80% of the operations and maintenance cost can be recovered. However, improvement in coverage of SWM charges is a gradual process and will take time. Thus, while considering improving the coverage and collection efficiency, PMC needs to first focus on improving the coverage and gradually decrease the SWM charges. Hence, intermediate targets need to be set for such improving coverage increase and reducing the SWM tariff charges and so on to recover 100% of the O&M costs. In addition, while determining the principles for fixing the SWM tariff, PMC needs to follow pro-poor cost rationalization, i.e., subsidizing the charges for the LIG group further by increasing the charges on non-domestic units.

Charging modalities

The system of imposing charges is complex. PMC levies charges based on different categories, such as access to the building, built-up area and structural specification. These rates can vary across the city, based on the location, i.e., core, outer and rural. Further, SWM charges are calculated separately for domestic and non-domestic waste generators.

The SWM Act 2068 (2011 AD) prescribes charges based on quantity of waste generated. This cannot be implemented because it is difficult to measure the waste generated by each household.

It is recommended that the same system continues, but the categories need to be merged to simplify the overall system of billing and collection. The four user groups can be domestic, commercial, industrial and institutional/public use, and the rates should vary based on the location (core, outer and rural).

Institutionalization of waste generation and collection of SWM charges

An efficient billing and collection system for SWM will require:

i. Comprehensive and updated database of waste generators to ensure coverage

ii. Assessing the receivables in a timely manner

iii. Initiating drives to maximize collection of charges, and incentive mechanisms for the waste generators to pay on time

iv. Tracking debtors and maximize arrear collection

At present, private operators have the responsibility of issuing sanitation cards. This responsibility can be vested with the PMC. It can undertake a one-time survey of the properties in the city. Based on the property identification number, sanitation cards can be issued. These cards need to have a unique identity code, representing the ward number, etc. Complete information of the waste generators needs to be captured while providing the sanitation card.

As SWM charges will be flat rate-based, the cards need to mention the amount to be paid by the waste generators every month. The responsibility of collection of charges, considering the human resource availability with the PMC, can be vested with a private operator. However, the collection of payment is to be performance-linked to ensure that collection efficiency of the charges improves over time, and there is no leakage of the revenue.

Revenue management through use of technology

There are various technological solutions available which can also be adopted once the basic system of charging 100% waste generators is implemented. Volumetric sensors at the bottom of the bin or on the lid, smart radio-frequency identification (RFID) tags etc. are some of the commonly used technology in this field. Identification of the waste generators is the first step. Post identification, the waste generators are tagged with tech-enabled bins or chamber system. Upon receipt of waste, the quantity of the waste is directly transmitted to the billing system. These technologies enable implementation of pay-as-you-throw. Polluter's pay principles can also be implemented easily through such systems. However, in the given context of Pokhara, the primary objective is to improve the coverage of levying rationalized SWM charges and ensure

maximum collection. Post implementation of this, the city may gradually move to further sophisticated technologies of automated billing.

3.4 Public-private partnership (PPP) potential

Providing services with respect to SWM through private sector participation is widely adopted by local governments globally. This section details the scope for involving the private sector to provide services (either entirely or for part of the SWM value chain) and various forms of private engagement in SWM operations, and provides a guiding framework for the ULL for selecting a contracting model.

3.4.1 Scope for private sector engagement

Depending on the scale and complexity of operations in the city, there can be various forms of PPP contracting. The scope of work, risk allocation, and revenue management should be decided, based on the shortlisted model.

Table 31: Private sector engagement in waste management

Sl. no.	Scope of engagement of private sector	Applicability
1	Collection and transportation	• Inadequate manpower and equipment for collection and transportation • Inadequate technical and managerial expertise for sustainable waste management solution • Lack of funds for initial capital investment requirement for equipment, vehicles, etc
2	Setting up waste processing	• Landfill site more than 30 km away from the city requiring decentralized waste processing
3	Waste processing and landfill facilities	• Inadequate technical and managerial expertise for sustainable waste processing and disposal facilities • Inadequate funds for initial capital investment required for setting up processing and disposal facilities • Lack of market linkages for recyclables and by-products (compost, RDF, power, etc)
4	Integrated SWM	• Lack of adequate manpower and equipment for collection and transportation • Lack of technical and managerial expertise for sustainable waste management solution • Lack of funds for initial capital investment requirement for processing facility • Lack of market linkages for recyclables and by-products (compost, RDF, power, etc) • Availability of land for setting up processing facility and sanitary landfill

3.4.2 Models of private sector engagement

Contracts need to be based on the scope of work. Parameters vary among various forms of contracts. This section provides various models of contracting and risk allocation for successful execution of the contracts.

3.4.2.1 Contracting options

The key parameters of a PPP contract include asset ownership, O&M responsibility, capital investment responsibility, and contract terms. These parameters need to be carefully designed for different contracts.

Table 32: Model of contracting and responsibility allocation

	Models		
Responsibility	**Service contract** *(Collect, transport, sorting, disposal of MSW)*	**Management contract** *(Collect, transport, sorting, disposal of MSW)*	**BOOT/concession** *(Integrated MSWM/waste processing and treatment)*
Asset ownership	Ownership with ULL other than investment by private service provider in transportation fleet	Ownership with ULL other than investment by private service provider in transportation fleet and related equipment	Ownership with private developer during the contract period other than the land, and to be transferred back to ULL at the end of the contract
Operation and maintenance	Private service provider	Private service provider	Private developer
Capital investment	Only in transportation fleet by private service provider	Only in transportation fleet and related equipment by private service provider	By private developer, excluding land
Commercial risk	ULL or state agency	Partly with private service provider and with ULL	Completely with private developer
Contract duration	1-2 years	3-8 years	10 years or above

3.4.2.2 Risk identification and allocation

Based on the identified model, risks are to be assessed. Risk allocation needs to be balanced between the project proponent and the private party. The ULL's objective is to achieve economy of operations and effectiveness of service delivery. The private party's key objective is to achieve efficiency in order to maximize profitability.

Table 33: Risk identification and allocation matrix

Type of risk	Event of occurrence	Implication	Risk allocation		
			Service contract	Management contract	BOT/ concession
Design risk	• Design fault while preparing DPR • Inconsistent assumptions taken while preparing tender documents • Faulty design consideration of PPP operator	This would adversely affect desired outcome and cost structure of the project, and financial outcome expected from PPP intervention	ULL and/or state agency	Private developer	Private developer
Construction risk	• Due to inefficient working practice by private service provider • Delay in asset transfer from ULL and/or state agency	This would result in cost escalation and time overrun, thus affecting timely service delivery and quality. It would also adversely affect project financials	To be borne by both parties as per provision of the contract	To be borne by private developer other than asset transfer delay	
Operation risk	• Change in the project scope during the operation period by the project sponsor • Mobilization delays in manpower/equipment • Due to labor unrest, imprudent management practices • Financial mismanagement and significant increase in the input cost	Project objective not achieved, increased operating cost and/or reduced revenue realization from the project	To be borne by private developer other than change in scope of the project by the ULL and/or state agency		
Revenue risk	• Change in tariff rates • Inadequate MSW generation • Inadequate demand for the processed waste and/or by-product	The financial objective of the project not achieved	ULL and/or state agency	Partly by ULL and private player as per the provision of the contract	

Type of risk	Event of occurrence	Implication	Risk allocation		
			Service contract	Management contract	BOT/ concession
Financial risk	• This will arise due to improper capital structure resulting in high debt component and fluctuation in the interest rate	Unable to service its financial obligations	ULL and/or state agency	Private developer	Private developer
Environmental risk	• Non-compliance to the applicable laws, or pre-existing environmental liability	Additional cost incurred to rectify an adverse environmental impact on the project	ULL and/or state agency	Private developer other than the pre-existing environmental liability to be taken care of by ULL and/or state agency	
Force majeure risk	• This may arise due to an act of God, public unrest, change in tax and law, breach of terms or contract cancellation	Additional cost to be rectified, resulting in increased cost or operation, time overrun, non-achievement of service levels	To be borne by parties as per provisions of the contract		
Insurance risk	• Uninsured loss or damage to project facilities due to an act of God or public unrest	Financial loss	To be borne by the private developer as per the provisions of the contract		

3.4.3 Potential for private sector engagement in Pokhara

In Pokhara, seven private contractors manage collection and transportation of waste in 25 (out of 33) wards of the city. These are service contracts, but vehicle procurement is the responsibility of the private parties. These contracts are short term, which is not conducive for the private parties to invest in assets.

Also, the service contracts do not have defined performance indicators. Thus, PMC cannot monitor the performance of these service providers. Payments are not linked to service performance as well, and, hence, the contractors are not held responsible for providing inefficient services.

PMC has also appointed one private operator to segregate recyclable waste at the dumpsite. Thus, PMC has eight contracts to supervise, for which it does not have adequate technical and management capabilities.

Hence, we propose that construction of the facilities, and procurement of the assets and equipment will be PMC's responsibility. Processing, treatment and disposal facilities are to be constructed on engineering, procurement, construction basis. In line with the proposed system,

we recommend that PMC has two contracts for operationalization of the facilities and service delivery. The scope of work can include:

I. Collection and transportation
II. Processing, treatment and disposal

Collection and transportation contract will be performance-based; whereas processing, treatment and disposal contract will be a long term performance-based management contract. The following table explores the mode of execution of these two contracts:

Table 34: Tentative structuring of the PPP for SWM operations

Items	Description
Collection and transportation of waste	
Model of contracting	- Service contract
Contract period	- Usually two years, but for Pokhara the contract can be for 3-5 years, considering PMC's management capability and experience in bid process management
Asset ownership	- Assets (vehicle and other equipment) will be procured and owned by PMC
Responsibility matrix	- PMC to provide vehicles and other equipment necessary for collection and transportation of waste - PMC will be responsible for contract monitoring and management - O&M of vehicles and other equipment (fuel, repair, personnel, but not asset replacement) will be the private contractor's responsibility - A collection route plan and schedule to be prepared by the private operator and approved by PMC - The private operator's key responsibilities will be door-to-door waste collection and transportation of waste in a segregated manner - The private operator has to establish a robust grievance redressal system, which is to be housed in the PMC office and regularly monitored by the PMC - Private operator will collect SWM charges on behalf of the PMC
Risk allocation	- Private party may be penalized for mobilization delays, especially manpower - Private party needs to maintain operational and financial efficiency, and perform as envisaged in the contract - Delay in asset transfers, in this case, will be on the PMC - If the project scope changes, then both the parties need to mutually agree; and in case of additional work, the PMC needs to bear the excess cost
Commercials	- Private operator will be paid at regular intervals as agreed in the contract - PMC may penalize or reward the private operator based on the performance, as per contract provisions
Processing, treatment and disposal of waste	
Model of contracting	- Management contract
Contract period	- Will be for 5-8 years, based on the scope
Asset ownership	- PMC will own all the facilities - Private operator might have to deploy necessary equipment for efficient functioning

Items	Description
Responsibility matrix	- PMC will construct the facilities and hand over to the private operator only for O&M - PMC will be responsible for contract monitoring and management - The O&M facility will be the private contractor's responsibility. The facilities are to be handed over to PMC after the contract period - Processing and treatment of waste will be the private operator's responsibility - The rejects from the processing facilities are to be transported to the sanitary landfill site by the private operator - Environmental quality is to be maintained and all environmental standards are to be complied with - Sale of the processed waste and/or by-products shall be the private operator's responsibility
Risk allocation	- Inadequate waste generation for optimum operation of the facilities can be PMC's responsibility - The private operator may be penalized for mobilization delays, especially manpower - Major replacement shall follow contract provisions - Delay in asset transfers will be on PMC - If the project scope changes, then both parties need to mutually agree, and in case of additional work, PMC needs to bear the excess cost
Commercials	- The private operator is to be paid at regular intervals, as agreed in the contract - PMC may penalize the private operator based on performance, as per the contract provisions

3.5 Improvements in institutional and governance system

For effective implementation of the service delivery plan, governance will play an important role. We have dealt with two aspects: (i) institutional strengthening, i.e., personnel and technical strength; and (ii) process improvement, i.e., interactions, approvals, project formulation, execution, and contracting.

3.5.1 Institutional strengthening

Currently, the waste management department, under the environment and disaster division, manages solid waste of the city. Sanitation, vehicles, landfill, and environment are the four sub-branches responsible for specific operations in SWM.

In alignment with the requirements of the proposed improvement plans, institutions need to be strengthened. Proposed structure of institutions is elaborated in Figure 31. The attempt is to minimize changes, and modify the roles and responsibility within the approved organogram.

The waste management department has two administrative staff. We propose to strengthen this department with technically-skilled personnel. It will be nodal for all the operational sub-branches. The waste management department will have four sub-branches:

i. **Collection and transportation:** This is essentially the merger of the existing sanitation and vehicle sub-branch. All works pertaining to collection and transportation of municipal solid waste, including street sweeping, will be under the purview of this sub-branch

ii. **Processing, treatment and disposal:** In alignment with the new proposal, the responsibility of the landfill department needs to be expanded to all centralized processing, treatment and disposal facilities

iii. **Environment:** The sub-branch will be responsible for environmental quality monitoring and to ensure clean disposal of waste. This will be in addition to the existing responsibility of tree plantation

iv. **Community engagement:** This branch will engage with communities for improvement of service delivery. Carrying out IEC activities and complaint management will be the responsibility of this sub-branch

Also, under the revenue management division, there needs to be one personnel to coordinate with the waste management branch for the issuance of sanitation cards, monitoring and management of SWM charges, contractor's payments, etc.

Also, currently, procurements are centrally managed in the PMC. The procurement process is to be initiated from the waste management department. All the technical requirements and procurement criteria are to be set by the department. Bid process will be managed by the public purchase division, and, post procurement, the responsibility of contract execution will be with the waste management department.

Figure 30: Proposed institutional structure

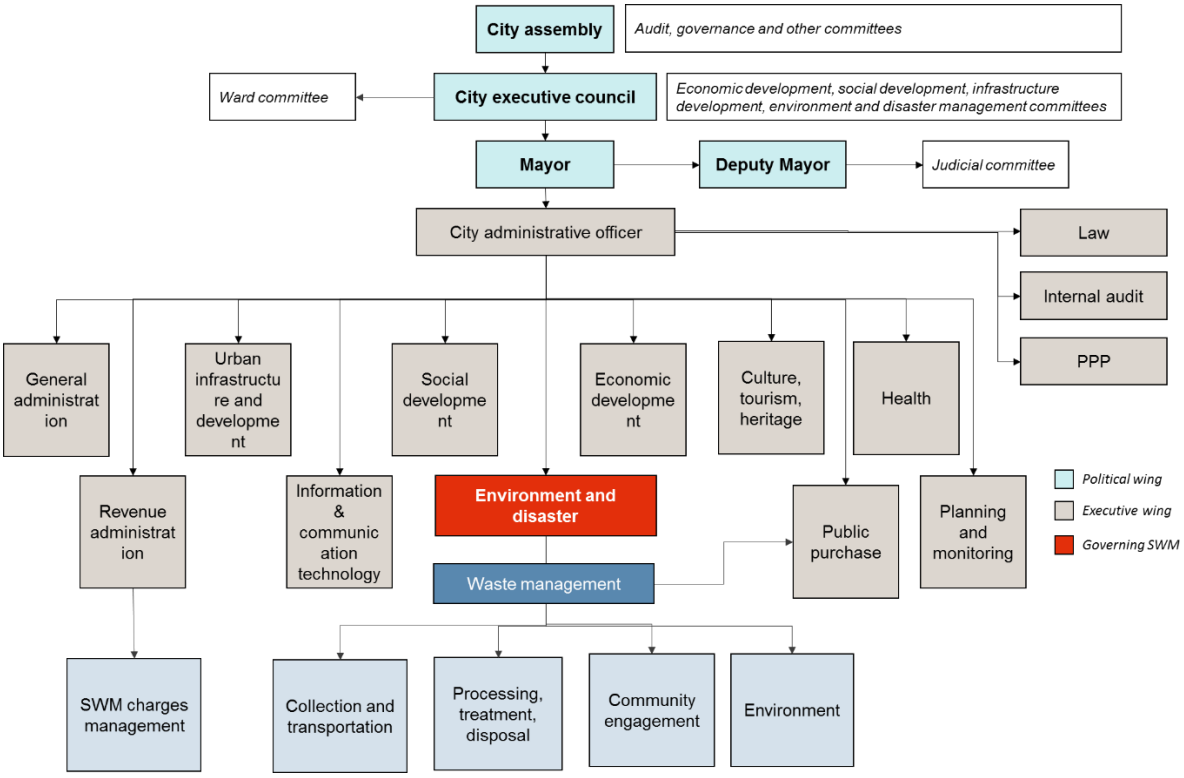
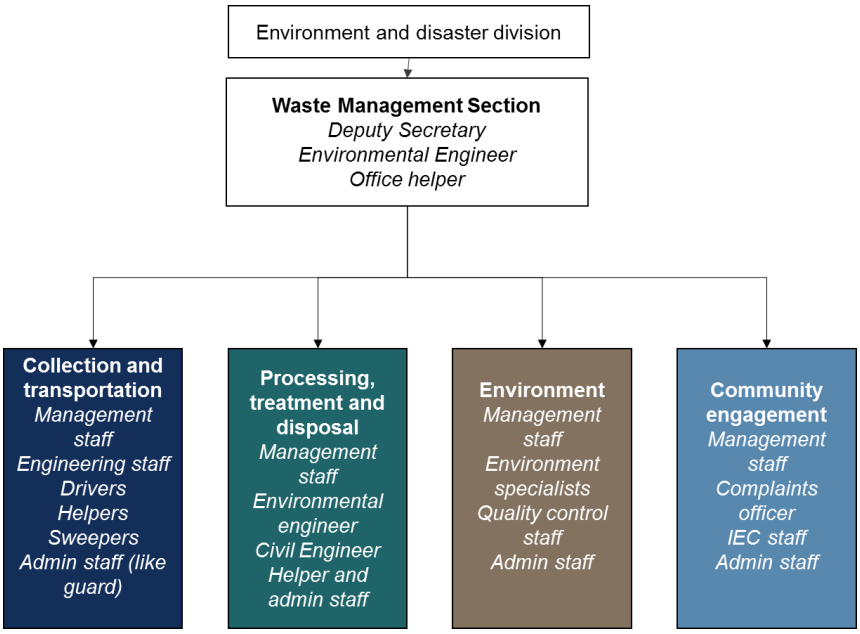


Figure 31: Proposed structure of waste management department



Currently, the waste management department is manned by two personnel - Deputy Secretary and Office Helper. We propose to introduce the position of Environmental Engineer, who will be the nodal decision-maker for all the sub-branches. He/she will be responsible for overall monitoring and management of SWM operations, compliance with technical norms, OHS guidelines, and environmental quality.

The roles and responsibilities of the branches and the proposed personnel are:

Table 35: Roles and responsibilities

Personnel and role	Responsibilities	Remarks
Collection and transportation	• Roles of sanitation and vehicle departments to be identified • Street sweeping, waste collection and transportation will be key functions of ULLs • Execution, monitoring and management of contract(s) in relation to collection and transportation of waste including compliance with OHS norms	
Sanitation Section Officer	• Will oversee all operations of collection and transportation of waste • Vehicle/fleet management • Management of sweeping activities	This is an existing position, but the role needs to be more focused on collection and transportation

Engineering staff	• Assist the section officer • Will be instrumental in designing and operationalizing SWM collection route planning, waste collection schedules, etc. • Monitoring and management of collection and transportation of waste, sweeping activities	Technical skills required for this position. Currently, the position is called 'Assistant'. Based on the skillsets, a new role could be assigned. Electrical and mechanical engineers will be preferable for fleet management
Driver	• For driving the waste collection vehicles as per the schedule prepared by the PMC	Designation and role are unchanged. The number of positions is to be decided based on number of vehicles, number of trips, and shifts
Helper	• Loading and unloading of waste in the collection vehicles	
Sweeper	• Cleaning streets, temples and various public places of Pokhara as decided by the PMC	Role is unchanged. Currently, 59 sweepers sweep ~10 km every day, i.e., 200 m per sweeper per day. This could be increased to 500 m to 1 km per sweeper per day, based on density of development
Admin staff	• Support in all administrative works for the sub-branch	Unchanged
Processing, treatment and disposal	• Project structuring and preparation of processing, treatment and disposal facilities such as sanitary landfill, biomethanation plants, and material recovery facility • Project execution supervision and ensuring compliance with technical and environmental standards and OHS norms • Managing and monitoring O&M of the facilities, and related contract management	
Management staff	• Project execution management and oversee operations of the centralized facilities of processing, treatment and disposal of waste • Ensure compliance with all applicable technical and environmental norms, OHS guidelines	The existing position 'Landfill In-Charge' is to be retained with additional responsibilities
Environmental Engineer	• Project conceptualization, project structuring are the key responsibilities • Will be responsible for overseeing the SWM O&M of contracts	Proposed positions to be staffed with personnel with required skillsets
Civil Engineer	• Project execution monitoring and ensure compliance with all technical norms • Responsible for the upkeep of operations of the facilities	
Admin staff	• Support all administrative works for sub-branch	Unchanged

Environment	• This branch is responsible for maintaining the environmental quality in the city by planting trees and conserving greens • In addition, this branch will be responsible for carrying out environmental quality checks and ensure compliance of the SWM operations with the environmental standards	
Management staff	• Environment conservation works such as tree plantation and conservation, conducting training and awareness programs	The existing designation is environment officer. This position is unchanged
Environment specialist	• Management and monitoring of environmental quality and ensuring compliance with the environmental quality standards for all the SWM activities • Coordinate with other government and non-government agencies for environmental compliance purposes	Proposed position
Quality control staff	• Carrying out sample checks at the landfill site and other locations of SWM facilities • Coordinate with labs and third party to check the compliance of disposal with required environmental standards	Proposed position
Admin staff	• Support in all administrative works for the sub-branch	Unchanged. However, the number of staff might be increased to manage the additional responsibility
Community engagement	• This is a proposed branch to improve people's connect with the ULL • This branch will be responsible for IEC activities for awareness generation among people • Managing, tracking complaints, and ensuring complaint redressal in a time-bound manner	
Management staff	• Oversee all community engagement activities, coordinate with TLOs • Necessary decision-making for improvement of people's connect	Proposed position
Complaints officer	• Maintain centralized database of all complaints received • Tracking the complaints and ensure redressal in a time-bound manner	Proposed position
IEC staff	• Coordinate with the ward committees and TLOs • Organize IEC activities across the city • Continuous engagement with the citizen	Proposed position
Admin staff	• Support in all administrative works for the sub-branch	Proposed position

3.5.2 Involve TLOs, citizens, and informal sector in SWM activity

Other than these institutional requirements, the TLOs need to be actively involved in the waste management process. Some of the TLOs are conducting awareness generation programs for segregation of waste at the household level, as already documented and discussed in the report. However, these efforts are sporadic. The involvement of the TLOs need to be formalized. The role of proposed 'community engagement' branch also includes coordinating with the TLOs across the city.

In Morocco, under a Development Policy Loan, the World Bank had proposed that the private contractors need to provide jobs to the existing rag-pickers. Under the assistance 154 rag-pickers were included in city's waste management system (2013) and the system was made ready for inclusion of another 20,000 rag-pickers[8]. There have been multiple such instances where the Bank is providing assistance (2019-2024) in Morocco to rebuild the citizen trust, more effective protection of poor and vulnerable, inclusive and accountable service delivery. Morocco has introduced citizen scorecard as one of the parameters for renewal of the contracts of the private operators. Similarly, such contract provisions of citizen score cards could be introduced in Pokhara along with the recommendations provided in section **Error! Reference source not found.**.

In response to the national movement of waste pickers, the Brazil government was the first to formalize the job of collection of recyclables (2002) and called the occupation "catador de material reciclável" (recyclable material picker). For this recognition, a nation-wide database was developed recording the waste-pickers involved in the activity. Such formalization benefitted recording of nation-wide recycling activities, employment information, earnings and socio-economic characteristics of the waste pickers.

On a similar line, it is proposed that the 'Community Engagement Branch' needs to be made responsible to enroll the individual rag-pickers in Pokhara. This listing/ registration could include individual recyclers to small scale aggregators and large-scale recyclers. The occupational health and safety norms are to be developed and implemented by providing them with identity cards and safety gears to reduce the ill-effects of the waste on their health.

3.5.3 Outcome-based budgeting

Budgeting is an important parameter to ensure that project implementation can progress as planned. This should start with project planning. In order to have a structured approach for service delivery improvement, the PMC first needs to prepare a comprehensive waste management plan, considering a 10-year horizon (to be updated once this period is over). The plan needs to cover all components of service planning, covering provisions for ensuring segregation of waste at the source, collection and transportation of waste, processing and disposal of waste, recycling plan of the waste, community engagement plan, and modes and means of undertaking IEC activities for improving the service. The plan preparation process needs to ensure a thorough consultative process, engaging all relevant stakeholders at the local level.

The outcome of the waste management plan preparation needs to clearly define the sector priorities, i.e., in terms of short-, medium- and long-term. Each of the identified priorities, as an

[8] Source: https://www.worldbank.org/en/results/2013/05/22/morocco-improving-municipal-solid-waste-management-through-development-policy-operations as accessed in June 2020

outcome from the waste management plan preparation process, will then guide the budget preparation process for improving the SWM sector once the comprehensive waste management plan is approved and internalized for implementation by the Council of the PMC.

3.5.4 Complaint management system

A complaint management system is required for assessing the performance of the ULL as well as provide an opportunity to improve the service delivery. The ULL, through an analysis of complaints or grievances it receives, is able to identify lacunae and bridge gaps in service delivery. The time taken for resolution of grievances and the action taken are also monitored and recorded through this system. A complaint redressal system is effectively supported through the introduction of a citizen charter. The citizen's charter is a written voluntary declaration by a ULL with the basic objective to empower citizens to receive public service in a given timeframe.

The citizen's charter includes:

- Information on municipal services and expected outcomes
- Municipal service delivery standards
- Response time for rendering services or redressing grievances
- Information dissemination process on the complaint redressal process
- Contact details of officers responsible for provision of the various municipal services

A digital complaint management system is proposed for this. Key elements of the complaint management system are:

- Digital database of complaints registered at the ULL and a dedicated unit to address/acknowledge the receipt of the complaint
- It should provide various mediums to register a complaint
- Robust complaint management system needs to be developed to record all the basic information about the complaint, complainant, resolution process, resolution time, closure of complaint and feedback from the complainant
- The system needs to have provisions to generate various complaints related reports and analytics, such as type and frequency of complaints, location of complaints, repetition of complaints, improvement in resolution time, etc.

3.6 Environment, health, and safety considerations

The Government of Nepal does not have norms for siting landfill sites for the disposal of waste, post processing. This is highly important for the environment, and from a health and safety perspective. This section provides various measures to be taken to ensure SWM operations are carried out in an environmentally sustainable and safe manner.

As per the **Environmental Protection Act 2019** and the **Environmental Protection Rules 1997**,[9] the Government of Nepal, the project proponent, is to carry out environmental assessment (EA), initial environmental examination (IEE) or environmental impact assessment (EIA). As per the rule, the following threshold has been provided to carry out IEE for activities relating to waste generated from houses and residential areas:

- Filling of land with waste from 1,000-5,000 tons of waste/year
- Activities relating to transfer stations and resource recovery area spread over 5-10 hectares
- Selecting, picking, disposing, and recycling waste through chemical, mechanical or biological techniques in an area of 5-10 hectares
- Activities relating to compost plants in an area ranging 5-10 hectares

The following thresholds are mentioned for EIA to be carried out. This is applicable to waste management services provided to over 10,000 population, and to activities relating to waste emitted from houses and residential areas:

- Filling of land with waste more than 5,000 tons of waste/year
- Activities relating to transfer stations and resource recovery area spread over more than 10 hectares
- Selecting, picking, disposing, and recycling waste through chemical, mechanical or biological techniques in an area larger than 10 hectares
- Activities relating to compost plants in an area larger than 10 hectares
- Burying of waste generated from an urban area with a population of more than 10,000

Environment, health and safety need to be ensured through the following:

- Technically sound, environmental- and socially-sensitive site selection for waste disposal (refer to Section 3.6.1)
- Preparing plans and implement to reduce the impact on the environment at various stages of operations (Section 3.6.2 and 3.6.3)
- Consider potential occupational health hazards and undertake safety measures (Section3.6.4)

3.6.1 Site selection norms

There are various standards globally for siting processing treatment and disposal facilities. The basic parameters that the PMC needs to consider while finalizing land for the centralized facility, including the sanitary landfill site, are:

[9] The Environmental Protection Rules (1997) is valid until this is updated under the Environmental Protection Act, 2019.

Table 36: Key criteria for site selection

Sl. no.	Aspects	Criteria	Key consideration
1	Environmental	Inland waterbodies - lake/pond	200 m from lake/pond
2		Inland waterbodies - river/streams	100m from river/stream
3.		Flood plain	No land fill within 100-year flood plain
4.		Highway	200 m from highway
5.		Wetlands	No landfill within wetland
6.		Groundwater table	Groundwater table > 2m
7.		Forest area (reserved, protected, etc.)	The site selection needs to comply with the requirements of Forest Act; loss of forest cover is key parameter
8.		Critical habitat area, ecologically sensitive area	No landfill within critical habitat area. It is defined as area in which one or more endangered species live in
9.	Social	Land ownership	Government land can be prioritized
10.		Settlement	500 m away from notified habitation area. Along with human settlement, distance from community facilities such as school, playground, etc. are to be considered
11.		Public parks or open facilities	300 m away from public parks
12.		Airports	No landfill within 20 km radius
13.		Water supply schemes /wells	Minimum distance of 500 m
14.		Access	There should not be access cutting in selected land parcel. If selected, alternative route or access is to be provided
15.		Public acceptance	Site is to be finalized based on stakeholder consultation, i.e., with people residing in neighboring areas

Source: Adapted from SWM manual of Central Public Health and Environmental Engineering Organization, India

3.6.2 Environmental management plans and safeguards

Post selection of the site for constructing processing and treatment facilities, it is important to operate the landfill site in an environmentally sustainable manner. Hence, plans are to be prepared and implemented at various stages of the operation.

Table 37: Planning for operation, closure, and post closure of SWM facilities

Sl. no.	Monitoring and management requirements	Way forward	Details
Operation phase			
1.	Leachate generated from waste is contaminated and contains suspended and dissolved materials. This needs to be managed onsite before discharge	Leachate management plan	Annexure D.1
3.	Precipitated water in the centralized facility needs to be channelized and discharged safely	Storm water management plan	Annexure D.2
4.	In landfill sites, organic waste is broken down by enzymes produced by bacteria. Considerable heat is generated by these reactions, with methane, carbon dioxide, nitrogen, oxygen, hydrogen sulfide, carbon dioxide and other gases as byproducts. Methane and carbon dioxide are principal gases produced from landfill operations. The pressure of the gas is usually very high and has the potential to damage vegetative cover	Landfill gas management	Some of the measures that can be taken to manage the gas are: • Controlled passive venting • Uncontrolled release • Controlled collection and treatment
Closure phase			
5.	During the closure phase, the main air emission anticipated is dust. This requires measures to be taken to keep dust emission within control	Air quality monitoring and control measures	Annexure D.3
6.	The existing dumpsite at Bacchebuduwa has been operational since 2004. Odor will be a major issue during closure of the dumpsite	Odor control and management	Annexure D.4
7.	During closure, noise issue arises from equipment and vehicles	Noise management	**Error! Reference source not found.**
8.	Dust and odor issues due to continued decomposition, etc. are key issues during closure	Landscaping /buffer zone plan	• Plantation for beautification of the area • Plantation to absorb air pollutant • Replantation if trees are cut
Post closure phase			
9.		Groundwater monitoring plan	The groundwater monitoring system (monitoring wells) will be installed at all landfill disposal facilities
10.		Surface water monitoring plan	0

Sl. no.	Monitoring and management requirements	Way forward	Details
11.	After closure of the dumpsite, probability of groundwater contamination could remain. During the monsoon, surface water, if mixed with residue waste, may lead to further contamination downstream. Issues of gas coming out from the closed landfill remains at times. These require sampling-based (refer to Annexure D.6) continuous monitoring and management	Quality of leachate after treatment	Annexure D.8
12.		Ambient air quality monitoring	0
13.	Post closure, use of diesel generator (DG) sets and plying vehicles are responsible for noise	Noise management	**Error! Reference source not found.**

3.6.3 Buffer zone management

Guidelines for management of buffer zone area of landfill

Nepal has been experiencing unprecedented rate of urbanization over the last decade. At present, though Nepal is among the 10 least urbanized countries, it is one of the fastest urbanizing countries. Rapid urbanization of cities in Nepal has also led to increase in solid waste being generated in the country. MSW management is entirely mandated to local governments and is the core priority for the newly formed ULLs. It is estimated that cities in Nepal generate ~7,00,000 tons of waste per year, but less than half of this is collected, and almost all the collected waste is dumped in a haphazard manner.

The unprecedented growth of cities in Nepal has posed several challenges for municipal authorities. Identification of suitable sites for construction of waste management infrastructure in cities is one of the toughest challenges municipal authorities are facing. Lack of proper/updated land use plan with urban authorities is a stumbling block in implementing solid waste management projects. Hence, disposal of waste in open dumpsites without any treatment is typically practiced, though it impacts the surrounding environment and habitat.

Waste management sites encompass waste processing/disposal facilities, which become sources of air, water, land and noise pollution, besides emitting foul smell. Therefore, provision of buffer zone around these facilities is essential to protect people living in the surroundings from exposure/impact of such pollution, and also to ensure continued safe operations of the waste management facility by maintaining its “island character”. The buffer zone also acts as a barrier, absorber and, to some extent, as a remedial measure against the emissions, i.e., emissions from pollutants emitted during handling of waste, storage, transportation and movement of traffic.

Currently, though, no scientific basis is available for making provisions for buffer zones around waste processing/disposal facilities that are being developed in urban areas of Nepal.

Provisions for buffer zones around landfills as well as waste processing facilities in various countries is assessed and is tabulated in the table below.

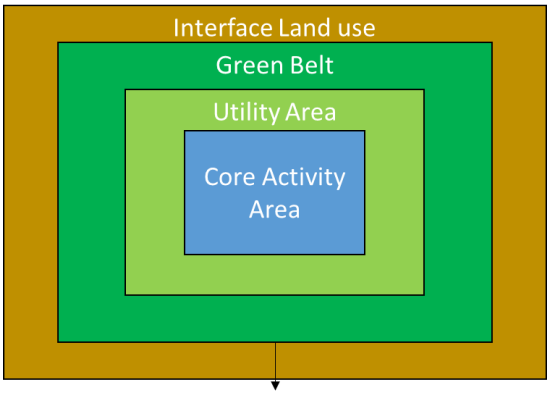
Table 38: Guidelines for management of buffer zone area of landfill

Country /Association	Criteria for maintaining buffer zone around waste management facility
Landfill Facilities	
International Solid Waste Association	500 m should be provided depending on the size of landfill, height, wind direction
South Australia	500m buffer distance shall be maintained between areas dedicated for waste disposal and the nearest surface water
Ontario, Canada	Buffer area shall be at least 100 m wide at every point, if that does not apply to a buffer area, if the buffer area is at least 30 meters wide at every point and a written report confirms that; (a.) the buffer area provides adequate space for vehicle entry, exit, turning, access to all areas of the site and parking; (b.) the buffer area provides adequate space on the surface of the site for all anticipated structures, equipment and activities; and (c.) the buffer area is sufficient to ensure that potential effects of the landfilling operation do not have any unacceptable impact outside the site.
Malaysia	500m
South Africa	Buffer zone min 200m to 500m
Bangladesh	250m from the habitat
Hong Kong	250 m away from the edge of the waste (landfill boundary)
Waste processing facilities	
Canada	Minimum buffer strip between composting facility boundary and adjacent property. For in-vessel, composting distance between active area and nearest residential or institutional building is min 500m, nearest commercial or industrial building, 250 m, and nearest property boundary is min 100m
Canada-Nova Scotia	In case of in-vessel composting facilities, where it can be demonstrated that particular equipment will not release odor generated from the composting process into the surrounding environment, the distance between the equipment and the nearest property boundary shall be a minimum of 30m
Malaysia	Production of compost from organic waste - 500m
Devon City Council (UK)	Buffer distance 500m
China	300m buffer zone between incineration plants and local residents

Various countries have adopted buffer zones, with a distance criteria from a minimum of 100 meters to a maximum of 500 meters for landfill as well as waste processing facilities. However, based on geographical constrains and land availability, distance of the buffer zone can be derived in case of cities in Nepal (separate norms for hilly and terai areas), but in no case the buffer zone distance should be less than 250 meters.

Provisions of buffer zone

Buffer zone around the core waste management area consists of utility area and green belts. Further, depending on feasibility of planning, the interface land use between the boundary of the waste management facility and sensitive receptors, i.e., human habitations, can also be developed as an additional measure. Indicative layout of the buffer zone (utility area and green belts), including core waste management area and optional interface land use, is shown in the figure.



While identification of land as well as designing the SWM facilities, it is required to clearly define the core activity area, the utility area around the core activity area, and finally the green belt around the core and utility areas to form a boundary of the solid waste management facility. For clarity, these different areas are:

- ***Core activity*** (processing /landfill) area typically requires space for receiving waste, storing waste, segregation of waste and treatment units within the facility. Similarly, for landfilling, it is the area that is receiving the waste/inert
- ***Utility area*** within the facility is designated area for the facility operations other that the core activities, such as weigh bridge, parking, vehicle cleaning, laboratory, emergency services, etc
- ***Green belt*** is an area that is kept in reserve within the allotted land for setting up the facility around the core SWM processing area, for the purpose of plantation and landscaping, to reduce the adverse effects from pollutants, such as air and noise, and soil erosion control, etc. It also works as a natural shield to protect people around the facility from these pollutants. The entire area covering the utility area and the green belt around the core solid waste processing as well as landfill areas should be construed as the buffer zone around the core waste processing facility
- ***Interface land use***: The buffer zone could be further augmented with interface land use area, where above beneficial and feasible as an additional optional measure, after approval of the concerned authorities. The interface land use should not generate significant emissions, nor warrant protection from these. The activities that can be allowed in the interface land use, included but not limited to, are vehicle showrooms, service stations, warehouses, display homes, emergency services facilities, funeral, veterinary clinic, parks, etc

Separation distances for solid waste processing and disposal facilities

Ideally, a distance of 500 meters from the boundary of the solid waste processing and disposal facility (sanitary landfill) should be maintained. However, on a case-to-case basis, a minimum of 200 meters from the solid waste processing and disposal facility (sanitary landfill) can be considered.

The provisions are suggested keeping in view the high population density in urban areas, scarcity of land to set up such facilities, and protest from local inhabitants in the area of the processing/disposal facility, and is in-line with those being adopted internationally. Besides, the following three conditions need to be ensured:

(a.) The buffer area provides adequate space for vehicle entry, exit, turning, access to all areas of the site, and parking

(b.) The buffer area provides adequate space on the surface of the site for all anticipated structures, equipment and activities

(c.) The buffer area, along with technological interventions, is sufficient to ensure that potential effects of the processing/landfilling operation do not have any unacceptable impact outside the site

3.6.4 Safety measures for environmental and occupational health hazards

The PMC will identify the environmental and occupational health hazards, and the associated risks on an ongoing basis to formulate objectives, set targets, and mitigate risks. Key measures and management required to mitigate health hazards are:

- Develop an environment-health-safety (EHS) system to monitor implementation of works, regulatory compliance, adherence to standards, etc. Key components are calibration of the EHS equipment, taking action to mitigate impact, and incorporate corrective and preventive actions
- Lay down procedures to identify training needs and provide training to employees to ensure effective implementation of the EHS system
- Prepare emergency preparedness and response plans by identifying potential accidents and emergency situations, and prepare measures to prevent, control and mitigate the environmental impact and occupational risks

Other than the EHS system, some of the general measures to mitigate such hazards and risks are:

- Restrict vehicle speeds to 15 km/hour at the site to minimize potential for dust generated in the surroundings
- Employ appropriate measures to minimize windblown litter and dust during transportation, by either covering trucks or transporting the waste in enclosed containers
- Provide holding areas for heavy goods vehicles waiting to deliver their load at the work sites so as to avoid queuing on connecting roads
- Fixed noise sources should be more than 50 m away from the site fence
- Site workers working near high noise equipment to use personal protective devices like ear muff/plugs to minimize exposure to high noise levels

- Maintain clearance between electric lines and work spaces /nearest service lines, and ensure enough space for maintenance
- Take adequate precautions to prevent accidents from machines. Also, all machines should conform to relevant Indian standards
- All workers employed to mix materials such as cement, concrete, etc. need to wear protective footwear and goggles, welders need protective eye-shields, earplugs to be provided to the workers exposed to loud noise. Also masks, safety belts, helmets etc. are to be provided to the workers working on-site.

Further, regulations concerning fire safety to be followed include:

- Installation of fire extinguishers
- Provision of water sprinklers for unpaved roads
- Proper labeling of exits and location of fire protective systems
- Train personnel to use fire control systems
- Display phone numbers of the city/local fire services, nearest hospital, ambulance facility, etc.
- Ensure easy access to a first aid unit, including providing adequate supply of sterilized dressing materials and appliances
- Ensure availability of suitable transport at all times to take injured or sick person(s) to the nearest hospital

3.6.5 Waste management during emergency situations, pandemics

The SWM infrastructure design and implementation requires consideration of hazards and disasters. Nepal is located in the Himalayan belt and thus, geo-tectonically prone to earthquakes. Nepal has been exposed to incidences of flooding, landslides in recent past due to its geography.

During such natural hazards or disasters, the stress on existing infrastructure increases (e.g. water in landfill). Also, it becomes critical to maintain service delivery, and the access and operations of waste management facilities. Due to these extreme weather events, the services break, leachate mixes with fresh water, issues of odour and dust are prevalent. Hence, Pokhara, owing to its location, needs to prepare a detailed disaster resilient emergency response plan for SWM.

The designs of infrastructure need to follow the required technical standards considering such scenario. The plan needs to consider building adaptive capacity by screening the probable disasters and identifying the risk mitigation measures. The plan needs to identify long term technical solutions and design new climate-resilient infrastructure.

During earthquake, debris management becomes very important. As Nepal has seen major earthquakes in recent times, it is imperative to include debris management in the emergency response plan.

In addition, the world currently is witnessing unprecedented times facing the pandemic situation due to novel coronavirus, COVID-19. During such crisis, first target should be to ensure that waste collection services are continuously delivered all around Pokhara, without any disruption and without any discrimination based on income, religion, race or nationality.

To achieve that, waste collection workers should be protected, as they are one of the most vulnerable part of the population since they are already exposed to several health risks, including infections. Following are the few measures that local level needs to ensure for safety of the frontline waste workers:

- ***Health and safety information and guidance:*** First priority is to make sure that collection workers will increase their protection from infections. The protection of both waste management workers and the general public means that it is essential that the highest levels of health and safety are observed, including providing adequate and hygienic washing facilities for personnel, updated risk assessments, deployment and use of appropriate personal protective equipment, and clear procedures in the event of a suspected or confirmed cases of COVID-19 in the waste management workforce.
- ***Bio-medical waste management***: Management of waste generated from the health care facilities (HCF) becomes of immense importance during COVID-19. There are norms developed by the countries according to the local legislations for screening, treatment, management and immunization etc. of waste from treatment of COVID-19 patients. The HCF should be responsible for necessary pre-treatment and segregation of certain categories of waste. Further there should be a separate collection of waste generated from treatment of COVID patients and needs to be segregated and stored in color coded bags. The HCF need to follow the storage and treatment protocols set by the national government of Nepal.
- ***Careful and continuous use of the relevant health and safety equipment*:** An important measure here is to make sure that the workers are removing masks and gloves without getting in contact with them, usually this means with the help of someone else. Protective equipment for eyes is also very useful for avoiding coronavirus infections. Additionally, direct contact with waste bins or bags should be avoided in any case.
- ***Encourage the waste management workers to change their clothes daily:*** Though waste management in Ithahari is managed by Private Operator, PMC may consider issuing the guidelines for waste management workers. PMC may consider directing waste management work force to clean work clothes to minimize the possibility of dispersing the virus in the air. Also the workers needs to make sure you do not shake clothes—and wash them at a temperature of at least 60°C with common detergents, add disinfectants if possible. Additionally, workers should be provided with disposable gloves to be put on before put on their regular work gloves.
- ***Availability of disinfectant:*** PMC need to direct the waste management operator on their own make available disinfectant available to each of the waste management vehicle and ensure that each of the waste worker is maintaining cleanliness and personal hygiene. Also, entire staff including drivers, collectors need to avoid any contact with residents and other employees.
- ***Make a contingency plan*:** Another priority for any waste collection system in Pokhara is to develop contingency plan to make sure that waste collection should be uninterrupted in any case, and no extra health risks are added. Contingency plans should involve alternative solutions for personnel, vehicles, infectious waste, accumulation of waste, washing, and disinfection and street cleaning services.

3.7 Capacity-building requirements

Human resources development is essential for internal capacity building of PMC. Training, motivation, incentives for outstanding service and disincentives for those who fail to perform are crucial for human resources development. Concentrated efforts need to be made by the PMC to inculcate among its officers and staff a sense of pride in the work they do and to motivate them to perform better and give their optimum output, to improve the level of services of Pokhara. Training and capacity building areas are identified based on the role and responsibility of the employee.

The personnel involved in IEC and community engagement have to play larger roles by including TLOs, women's group, and local youth clubs in training and awareness programs. As these groups represent the people, building capacities would percolate to the household level as well. These groups are formed of households from the same neighborhood, and thus, awareness can quickly be spread across the city by involving these groups.

The following table presents the roles and responsibilities for various activities carried out by PMC staff.

Table 39: Role-wise capacity building areas identified for PMC staff

Sr. no.	Role of staff	Capacity building areas	Mode of training
1	Planning and management	***Policy and institutional global best practices*** • Global best practices in regulatory, policy and legal aspects of SWM service provision and monitoring • Global best practices in SWM • Institutional strengthening, internal capacity building and human resources development ***Procurement in SWM*** • Public procurement, transparency and fair bidding practices—model procurement documents • Performance-based contracting for SWM • PPP models in SWM • Bidding documents, bidding process management and contract negotiations ***Financing SWM projects*** • Financing models for SWM projects • User charges modalities and tariff setting for financing SWM practices • Principles of setting tariffs for user fee to recover the costs towards managing urban waste ***Data management and management information systems for SWM*** • Data-based decision making for urban service delivery	Classroom, workshops, expert lectures and exposure visits

Sr. no.	Role of staff	Capacity building areas	Mode of training
		• Framework for data management in SWM. • MIS systems—data capturing, processing and analysis for decision making ***Service-level benchmarks*** • Basics of service-level benchmarking • Service-level benchmarks for SWM	
2	Engineering and sanitary supervision	***Planning and management*** • Managing integrated SWM systems • Zero-waste principles and practices • Designing of SWM systems ***Collection and transportation planning*** • Basics of waste collection operations • Household hazardous waste collection operations • Managing MSW collection systems • Transfer station, concepts and its management • Preventive maintenance of waste management vehicles ***Waste processing and treatment systems*** • Waste treatment and processing technologies—advantages and disadvantages • Selection modalities for waste processing and treatment technology • Waste recycling systems and concepts • Designing waste processing and treatment facilities ***Waste disposal systems*** • Operation of landfill facilities • Landfill gas systems (capture, handling and maintenance) • Leachate management and treatment • Environment management systems for landfill • Best practices—closure of legacy waste disposal sites ***Other waste management*** • Construction and demolition waste management • Biomedical waste management • Industrial waste management (hazardous and non-hazardous) • E-waste management—concept and best practices ***Health and safety requirements*** • Health and safety requirements and its monitoring for sanitation workers • Occupational health and safety management plan preparation and its monitoring	Certificate courses, classroom training, workshops, expert lectures and exposure visits

Sr. no.	Role of staff	Capacity building areas	Mode of training
		Environment and social norms • Global practices in environment norms across SWM value chain • Air, water and surface pollution due to unmanaged solid waste • Disaster resilience and vulnerability assessment of current and proposed SWM systems	
3	Worker engaged in sanitation and SWM.	• Importance of sanitation in urban areas • Present scenario of SWM system in Pokhara, deficiency in the system, etc. • Impact of inefficient SWM services on health and environment • Impact of inefficient SWM services on the health of sanitation workers • Inefficiency of tools and equipment used and loss of manpower productivity • Need for modernization of SWM practices • Options available for improving the services • Advantages of using improved tools and equipment for primary collection of waste and street sweeping	Class room as well as on field
4	Community engagement and IEC	***Awareness and engagement*** • Engaging with citizens—best practices and modes such as waste segregation, on-premise wet waste composting • Best practices of developing information, education and communication material for generating awareness for SWM • Developing feedback systems for awareness programs • SWM - impacts on health and environment ***Social aspects*** • Engaging with the informal sector in waste management—social aspects and livelihood dependency • Institutionalizing informal sector in waste management—best practices	Classroom and workshops
5	Financial management	• ***Modalities for tariff setting for SWM user charges*** • ***Administration of municipal revenue and revenue audit*** • ***Ring-fencing of municipal budgets***	Classroom and workshops

3.8 Performance monitoring framework for SIP

The PMC requires a systematic approach to improve SWM service delivery. Implementation of the service and infrastructure plan needs to be targeted through short-, medium- and long-term plans. Implementation needs to be equitable and sustainable through institutional strengthening and improvement in financial capabilities. Thus, progress in operational efficiency and effectiveness of service delivery are keys for the PMC to achieve complete implementation of the SIP.

Over five years, monitoring by the PMC to achieve complete implementation of SIP are:

- **Service delivery performance** - encompasses performance of all operations of the SWM chain, i.e., segregation of the waste at the source, its collection and transportation, and treatment and disposal
- **Efficient financial management** - refers to improvement in cost recovery through improved collection of charges, resulting in sustainable SWM operations
- **Institutional strengthening** - improvement in technical, monitoring and management capabilities of the PMC to upkeep service delivery

These monitoring parameters can be measured through various qualitative and quantitative indicators. Goals are to be rationalized, and accordingly, targets are to be set for every year. The objective of the monitoring system is to understand the status of service delivery and, scope for improvement, and clearly identify the tasks to be carried out.

The following tables provide a tentative list of qualitative and quantitative indicators for each parameter identified.

Table 40: Service delivery performance

Key parameters	Performance indicators [*description*]		
	Year 1	**Year 2-3**	**Year 4-5**
Segregation at source	**Procurement and distribution of separate bins for waste generators** *[whether standard procurement process followed - Y/N;* *No. of bins procured and distributed ward-wise vis-a-vis requirements]*	**Extent of segregation at the household level** *[One-time sample survey to be conducted by ward committee to assess quantity of waste being segregated by households]*	**Extent of segregation at the household level** *[One-time sample survey to be conducted by ward committee to assess quantity of waste being segregated by households]*

Key parameters	Performance indicators [*description*]		
	Year 1	**Year 2-3**	**Year 4-5**
	Conduct awareness programs *[Schedule of capacity building activities prepared - Y/N;* *Trainings conducted as per schedule - Y/N;* *Awareness generating communication has been made - Y/N]*	**Conduct awareness programs** *[Schedule of capacity building activities prepared - Y/N;* *Trainings conducted as per schedule - Y/N;* *Ward-wise number of attendees to be substantiated with signatures of attendees and photographic documentation]*	**Conduct awareness programs** *[Schedule of capacity building activities prepared - Y/N;* *Trainings conducted as per schedule - Y/N;* *Ward-wise number of attendees to be substantiated with signatures of attendees and photographic documentation]*
Collection and transportation of waste	**Preparation and approval of route plan and collection schedule** *[Preparation of route plan, waste collection schedule - Y/N]*	**Coverage of door-to-door collection** *[Monitoring of waste collection vehicles - Y/N]*	**Coverage of door-to-door collection** *[Monitoring of waste collection vehicles - Y/N]*
	Procurement of vehicles *[Adoption of standard procurement process for GPS-installed tracking-enabled vehicles - Y/N]*	**Compliance with collection schedule** *[Timeliness of service measured through number of defaults ward-wise]*	**Compliance with collection schedule** *[Monitoring of waste collection vehicles - Y/N;* *Timeliness of service measured through number of defaults ward-wise]*
	Tendering for appointment of private contractor for collection and transportation *[Preparation of terms of reference, contract document, etc. for competitive bidding - Y/N* *Conduct transparent bid process management -Y/N;* *Appointment of private operator - Y/N]*	**Waste collection efficiency** *[Total waste collected to total waste generated (%)]*	**Waste collection efficiency** *[Total waste collected to total waste generated (%)]*

Key parameters	Performance indicators [*description*]		
	Year 1	**Year 2-3**	**Year 4-5**
Processing, treatment and disposal	**Land identification** *[Land identified for SWM facilities complying with all technical, environmental and social requirements - Y/N]*	**Commissioning of facilities** *[Progress of construction of MRF, compost plant, sanitary landfill as per schedule - Y/N]*	**Extent of recovery at the MRF** *[Quantity of various category of waste segregated from total waste collected at the MRF (%)]*
	Possession of land for commencing construction *[Land preparation for the construction of the MRF, compost plant, sanitary landfill - Y/N]*	**Extent of recovery at the MRF** *[Quantity of various category of waste segregated from total waste collected at the MRF (%)]*	**Compost conversion ratio** *[Quantity of compost produced from the total waste brought to the plant (%). This can be measured daily or cycle-wise, and derived for a month]*
		Compost conversion ratio *[Quantity of compost produced from total waste brought to the plant (%). This can be measured daily or cycle-wise, and derived for a month]*	**Extent of material recovery** *[Quantity of waste recovered out of total collected waste (%)]*
		Extent of material recovery *[Quantity of waste recovered out of total collected waste (%)]*	**Percentage of waste reaching landfill** *[Quantity of waste reaching landfill site of total waste generated (%)]*
		Percentage of waste reaching landfill *[Quantity of waste reaching landfill site of total waste generated (%)]*	

Table 41: Financial management for SWM services

Key parameters	Performance indicators [*description*]		
	Year 1	**Year 2-3**	**Year 4-5**
Coverage of sanitation card	**Preparation of waste generators database** *[A comprehensive database to be prepared for all the properties of the city- Y/N]*	**Coverage of sanitation card** *[Number of sanitation cards to the total number of waste generators (%);* *Total number of new sanitation cards provided to the total number of new properties came up in the city (%)]*	**Coverage of sanitation card** *[Number of sanitation cards to the total number of waste generators (%);* *Total number of new sanitation cards provided to the total number of new properties came up in the city (%)]*
	Status of issuance of sanitation card *[Cross verification of the existing sanitation card against the waste generator database (%)]*		
Collection efficiency of SWM charges	**Estimation of demand** *[Estimation of demand based on the issuance of sanitation cards]*	**Estimation of demand** *[Estimation of demand based on the issuance of sanitation cards]*	**Estimation of demand** *[Estimation of demand based on the issuance of sanitation cards]*
	Collection efficiency of charges *[Total SWM charges collected to the total demand estimated (%)]*	**Collection efficiency of charges** *[Total SWM charges collected to the total demand estimated (%)]*	**Collection efficiency of charges** *[Total SWM charges collected to the total demand estimated (%)]*
		Preparation of demand-collection-balance (DCB) statement *[Preparation of DCB statement to assess the arrears for each financial year- Y/N]*	**Preparation of DCB statement** *[Preparation of DCB statement to assess the arrears for each financial year- Y/N]*

Key parameters	Performance indicators [*description*]		
	Year 1	**Year 2-3**	**Year 4-5**
Cost recovery	**Record keeping of SWM revenue and expenditure** *[Establish system to define all revenue and expenditure item and income expenditure statement prepared on a timely manner- Y/N]*	**Updated records of SWM revenue and expenditure** *[Timely entry of the income expenditure data for all the line items, as applicable- Y/N]*	**Updated records of SWM revenue and expenditure** *[Timely entry of the income expenditure data for all the line items, as applicable- Y/N]*
		Cost recovery of service *[Total operating revenue to the total operating expenditure (%)]*	**Cost recovery of service** *[Total operating revenue to the total operating expenditure (%)]*

Table 42: Institutional strengthening and performance improvement

Key parameters	Performance indicators [*description*]		
	Year 1	**Year 2-3**	**Year 4-5**
Database management	**Formulation of data reporting structure and database management** *[Collate information for all SWM operations and establish processes for data entry, update, approval and monitoring- Y/N]*	**Reporting of total waste collected (ward wise)** *[Measured through normative assumptions, tracking of waste collection vehicles]*	**Reporting of total waste collected (ward wise)** *[Measured through normative assumptions, tracking of waste collection vehicles]*
	Monthly reporting of total waste collected (ward wise) *[Measured through normative assumptions, tracking of waste collection vehicles]*	**Reporting of total waste reaching MRF** *[Measured at the weighbridge installed at the facility; data to be maintained daily and reported monthly]*	**Reporting of total waste reaching MRF** *[Measured at the weighbridge installed at the facility; data to be maintained daily and reported monthly]*
		Reporting of total waste reaching compost facility *[Measured at the weighbridge installed at the facility; data to be maintained daily and reported monthly]*	**Reporting of total waste reaching compost facility** *[Measured at the weighbridge installed at the facility; data to be maintained daily and reported monthly]*

Key parameters	Performance indicators [*description*]		
	Year 1	**Year 2-3**	**Year 4-5**
		Reporting of total waste reaching biomethanation plants *[Measured at the weighbridge installed at the facility; data to be maintained daily and reported monthly]*	**Reporting of total waste reaching biomethanation plants** *[Measured at the weighbridge installed at the facility; data to be maintained daily and reported monthly]*
		Reporting of total waste reaching sanitary landfill site *[Measured at the weighbridge installed at the facility; data to be maintained daily and reported monthly]*	**Reporting of total waste reaching sanitary landfill site** *[Measured at the weighbridge installed at the facility; data to be maintained daily and reported monthly]*
Complaints management system	**Establishing complaint management system** *[Establish processes of time-bound complaint redressal and setup necessary institutional processes- Y/N]*	**Complaints received per 1,000 households** *[Tracking of the complaints registered in the complaints management system, to be measured ward wise]*	**Complaints received per 1,000 households** *[Tracking of the complaints registered in the complaints management system to be measured ward wise]*
		Efficiency of redressal of complaints *[No. of complaints redressed within the stipulated time vis-à-vis the total number of complaints received; customer feedback is also to be assessed]*	**Efficiency of redressal of complaints** *[No. of complaints redressed within the stipulated time vis-à-vis the total number of complaints received; customer feedback is also to be assessed]*
Audits and compliance	**Preparation of sampling schedule for environmental quality monitoring** *[Preparation of sampling schedule, methodology of sampling, testing and monitoring processes- Y/N]*	**Ambient air quality monitoring** *[Testing done as per schedule- Y/N;* *No. of samples qualified to the total number of samples tested (%)]*	**Ambient air quality monitoring** *[Testing done as per schedule- Y/N;* *No. of samples qualified to the total number of samples tested (%)]*

Key parameters	Performance indicators [*description*]		
	Year 1	**Year 2-3**	**Year 4-5**
		Water quality monitoring *[Testing done as per schedule- Y/N;* *No. of samples qualified to the total number of samples tested (%)]*	**Water quality monitoring** *[Testing done as per schedule- Y/N;* *No. of samples qualified to the total number of samples tested (%)]*
		Monitoring of leachate discharge *[Testing done as per schedule- Y/N;* *No. of samples qualified to the total number of samples tested (%)]*	**Monitoring of leachate discharge** *[Testing done as per schedule- Y/N;* *No. of samples qualified to the total number of samples tested (%)]*

3.9 Conclusion

To ensure the implementation of the SIP, the city needs to clearly define the functions to be performed, identify functionaries responsible for performing those functions and sources of finances to ensure effective execution.

Functions

Key functions to be performed by the PMC are:

- Prepare a comprehensive waste management plan
- Identify and prepare projects ensuring segregation of waste at source, transportation, processing and disposal of residual waste in environmentally safe manner and negating any public health impact
- Prepare draft bylaws for SWM in adherence with the federal-level policies
- Implement priority projects as identified in the waste management plan, meeting the environmental and technical standards

Functionaries

To perform the abovementioned functions, the PMC needs to be adequately staffed with all the technical requisites as discussed in the report. TLOs and other community groups are required to be actively involved in the plan preparation process and awareness generation on segregation of waste, composting, etc.

Private operators are to be engaged as required with technical guidance from the federal government and using fair, transparent and competitive bidding process.

Fund

To operationalize these processes and implement the identified projects, special grants can be sought from the federal government. NUGIP provisions can be explored to meet the capital

expenditure. The PMC can also access the capacity building support that is required to operationalize the implementation of the functions as described above. In order to bring private sector financing and efficiently, private sector participation can be explored.

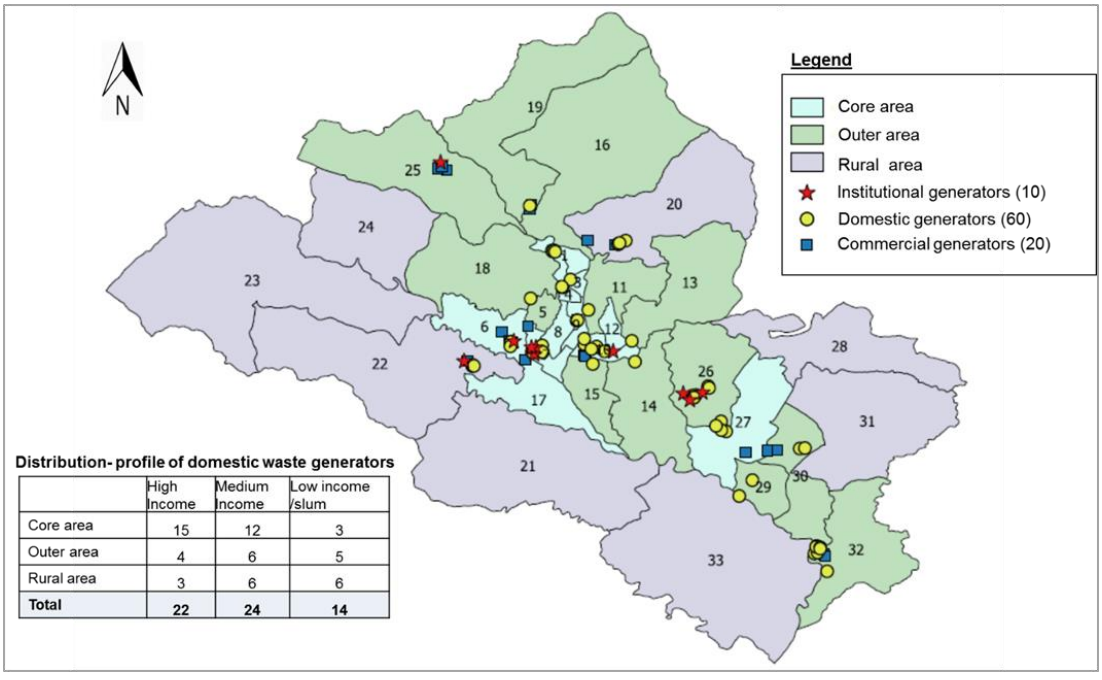
Annexure A : Primary survey and field observations

This annex presents information pertaining to the primary survey conducted for determination of socioeconomic profile, waste quantification and characterization. This also provides summary of the discussions conducted by the CRIS team with representatives from TLOs of the city.

Annexure A.1 : Sample distribution

Category	Description	No. of samples
Residential units	Core	**30**
	Outer area	15
	Rural area	15
Commercial units	Retail	7
	Restaurants/hotels	23
Institutional units	Banks/credit inst.	2
	Educational and child care	7
	Other	1
Total number of units		**100**

Annexure A.2 : Survey sample distribution



Source: CRIS assessment

Annexure A.3 : Excerpts from the discussions with TLOs

TLO representation	Key points of discussion
Ward 11	The elected member from Ward 11 stated that Pokhara needs a robust SWM system. This is a tourist destination and people throw plastic garbage bags on the streets. Such visuals are a deterrent to tourism in the city. According to the representative, plastic should be completely banned in Pokhara by the administration. The concerned tole has taken an initiative to sweep roads on a weekly basis (Saturday/Sunday), which has benefitted 80-100 households of the tole. In various toles of Ward 11, TLOs have collected money from residents on a voluntary basis to procure composting bins (capacity: 14.5 L each). The compost produced is utilized by the residents at the domestic level. The representative also suggested that TLOs should be given more responsibilities and power to carry out various works to manage solid waste.
Ward 10	In this ward, the solid waste cleaning campaign "*Sarfafai Abhijan*" has been initiated. Other initiatives include street sweeping, distribution of household-level compost bins, sale of plastic bottles, etc. The TLO representative mentioned that awareness generation among people and training of officials are the need of the hour. He also suggested that the PMC should use small vehicles to collect daily waste from narrow lanes.
Ward 8	A representative from the Sirjana Tole Vikas Sangstha commented that the city should implement the three-bin system. With most of the people working, many a times there is nobody at home at the time of garbage collection. To address this issue, litter bins should be placed at prime locations to collect waste from street sweeping and community bins for domestic waste generators to dump their waste. As per the representative, the corporation does not have enough vehicles, and waste is collected regularly. Also, awareness is a major issue in this area.
Ward 9	A representative from TLO of Mahendrapul area mentioned that waste collection vehicles collect garbage on a daily basis. Also, SWM charges should be levied and collected every month. A group "*Didi-Baheni*" comprising mothers, operates in this area, which spreads awareness among people on waste segregation. They request people to dispose waste in bins kept inside their houses, instead of throwing on roads.
Ward 14	The representatives were from Kadam Marg Tole. They commented that the ward requires both daily collection of waste and collection containers. They believe that Pokhara has the potential to grow further as a tourist destination, but that would require focusing on cleanliness of the city. Citizen awareness, enabling policy framework and penalization are the keys to achieve this.
Ward 13	A representative from this ward commented that there should be fund allocation for SWM and it should be tied in nature. The government should impose penalty for non-payment of SWM charges, and waste should not be picked from their houses.

Annexure A.4 : Vehicles used for transporting waste (of private operators)

Service providers	Vehicle type	No. of vehicles	Capacity (tonne)	No. of trips per day	Waste transporting capacity (TPD)
Pokhara Waste Management Pvt Ltd	Tata 407	4	2	3	24
Batawaraniya Sundar Nepal Pvt Ltd	Tata 407	3	2	3	30
	Tata 709	2	2		
Nepal Public Health and Environment for Development	Tata 407	2	2	3	18
	Tata 909	1	2		
Waste Management Recycling Pvt Ltd	Tata 407	1	3	2	12
	Swaraj Mazda compactor	1	3		
Pragati Sansar Nepal	Tata 407	1	2	3	6
Just in Time	Tata 407	2	3	2	12
Pokhara Green Mart Pvt Ltd	Tata 407	4	2	3	30
	Eicher Pro 2049	1	2		
Total available capacity (TPD)					132

Source: Discussion with representatives from private operators and PMC staff

Annexure A.5 : Waste collection contract evaluation

Private contractor	Wards served	Scope of work	Remarks
Pokhara Waste Management Pvt Ltd	7 & 17	This contract was renewed in 2071 (2014 AD) and is in effect till 2074 (2017 AD). It mentions that until any further decision is made, the contract will be renewed and continued. The contract provisions are: • Waste needs to be collected daily without affecting the environment and health of the people • Performance needs to be very good, which can set example for other wards and service providers • Biodegradable and non-biodegradable waste is to be segregated and only inert should go to landfill • 1 compactor and 1 tipper will be provided by the PMC to the contractor, but procurement of necessary equipment and	• The roles and responsibilities of the parties are not clearly identified • There is no clarity about who will incur the cost of operation and maintenance of municipal vehicles • There is no indicator to measure and monitor the performance of the contractor • There is no clarity on the segregation of waste. Primarily, it is the responsibility of

Private contractor	Wards served	Scope of work	Remarks
		human resource is the responsibility of the contractor • The contractor should promote waste segregation at source within six months from the date this contract comes into effect • Pokhara core city area was announced as 'black plastic zone', i.e., the waste should not be stored in black plastics. The contractor should inform the waste generators to segregate waste and not to use black plastic to store waste • The contractor will set up a composting plant. If segregation at source is not operationalized within six months, the contractor will segregate waste, and operate the composting plant • Essential equipment and manpower are to be procured and maintained by the contractor • Waste generators cannot be charged more than the rates fixed by the PMC • 80% of the total collected sanitation charges will be paid to the contractor and the PMC will keep the rest 20% • Waste collection needs to be done by 8 am or after 6 pm • Open transportation of waste is not allowed; the vehicles should be covered • The contractor needs to circulate contact numbers in wards serviced by them, for citizens to register complaints pertaining to SWM • The PMC will monitor the work of the contractor; any additional work or reduced work from the scope will be discussed at the PMC waste management and is to be mutually agreed between the PMC and the contractor • If there is any ambiguity in any of the clause, the dispute resolution will follow the SWM Act, 2068 (2011 AD), Procurement Act and PPP Act	the waste generator, but if waste generators do not segregate, then the contractor shall segregate waste and may have to set up compost plant, which are contradictory. Also such terms increase the risk of unforeseen expenditure by the private contractor

Batabaraniya Sundar Nepal Pvt Ltd	3, 4, 8, 9	• The contract was signed between the PMC and the contractor in 2070 (2013 AD) for the collection of general waste daily • They contractor has to levy SWM charges to the citizen as fixed by PMC; however, If waste generators request for additional services, the contractor may provide that with additional payment • The contractor needs to segregate organic waste and recyclables from general waste and transport the rest to the landfill • The PMC will provide 1 tipper and 1 compactor to the contractor; the contractor needs to procure additional vehicles if required • Waste segregation is the responsibility of waste generators. The contractor needs to develop a system to collect segregated waste from the source • Waste generators need to be informed by the operator that it would not collect waste in black plastic bags, as per the 'Black Plastic Free, 2067' initiative • The contractor needs to construct a composting plant to process organic waste • All equipment are to be procured, operated and maintained by the contractor • 80% of the total collected sanitation charges, will be paid to the contractor within three days of the date of presentment of the bills • Waste needs to be collected by 8 am from the core area • Waste collection vehicles should be covered during operation and transportation • The contractor needs to manage the leachate generated during the collection and transportation of general waste • An office will be provided to the contractor by the PMC for grievance redressal, and contact details of the private party need to be circulated • The contract is valid for three years, which includes one year of test period and two years of operation. If the contractor's performance is not satisfactory, the contract will be terminated. Additional sanction needs to be obtained for any extra service that the contractor may have to provide	• The roles and responsibilities of the parties are not clearly identified • There is no clarity about who will incur the cost of operation and maintenance of municipal vehicles • There is no indicator to measure and monitor the performance of the contractor • There is no clarity on the segregation of waste. Primarily, it is the responsibility of the waste generator, but if waste generators do not segregate, then the contractor shall segregate waste and may have to set up compost plant, which are contradictory. Such terms also increase the risk of unforeseen expenditure by the private contractor • Test period and operations period are not defined properly. There is no mention of clause that is applicable to any of these periods

Private contractor	Wards served	Scope of work	Remarks
Nepal Public Health and Environment for Development	1, 2, 5	This is a tripartite agreement among the contractor, the PMC, the TLO and the ward coordination committee, signed in 2073 and valid till 2076. The contract provides roles and responsibilities of all the parties involved. The key provisions are: PMC • All the provisions of the SWM Act, 2068, are binding on the party. Sections 3, 4, 17 of the Act are the responsibility of the PMC. The PMC is the principal agency responsible for the SWM in the city Contractor • Reduce-recycle-recover (3R) system is to be implemented by the contractor • The contractor will conduct public awareness programs on waste segregation and other activities • The entire responsibility of collection and transportation of waste in the mentioned wards vests with the contractor • Post closure of the current landfill site, the contractor will be responsible for operation and maintenance of the site, including construction of gardens, and beautification • During the test period, the PMC will provide 1 vehicle for collection and transportation of waste. Post this period, the contractor needs to procure own vehicles, and operate and maintain them • The contractor needs to segregate organic waste and recyclables from general waste and transport the rest to the landfill • 20 bill books will be given to the contractor to charge waste generators. When these are exhausted, the PMC will issue 20 more • Revenue distribution will be: 20% to the PMC, 75% to the contractor and 5% to the TLO • 50% of the collected arrears will remain with PMC, 45% will be given to the private contractor and 5% to the TLO. However, the contract also mentions that at PMC's discretion the share of TLOs can be increased	• This is a tripartite agreement, but the responsibilities are not clearly defined • There is no clear definition of TLOs - whether this includes all the TLOs of the wards or representative TLOs • Management of the landfill site post-closure is in the scope of the contractor, whereas there in no certainty or basis available for such work • 5% of the collected revenue is to be given to the TLO. A ward may have a number of TLOs. The contract does not mention the name of the TLO, whether to be given to one TLO or all TLOs • There is no clarity on the arrangement and responsibility distribution between the contractor and the TLO in the contract

Private contractor	Wards served	Scope of work	Remarks
		• Sanitation department is the nodal body for dispute resolution TLO • The TLO will act as a coordinator between the private contractor and the PMC • It will support the private party in SWM operations including segregation at source and maintaining cleanliness • It will also help the private party in collecting sanitation charges from waste generators • The TLO will support the private contractor in launching the 3R program • Generating social awareness for effective SWM will be the responsibility of the TLO • The TLO will also monitor the performance of private parties and if required, inform the PMC about the service levels of contractors • The TLO may provide recommendations to the PMC for the improvement of SWM services • The income of the TLO can only be spent on SWM activities	
Waste Management Recycling Pvt Ltd	10, 15	This is a tripartite agreement among the contractor, the PMC, the TLO and the ward coordination committee, valid till 2076 PMC • All the provisions of the SWM Act, 2068, are binding on the party. Sections 3, 4, 17 of the Act are the responsibility of the PMC. The PMC is the principal agency responsible for the SWM in the city Contractor • 3R system is to be implemented by the contractor • The contractor will conduct public awareness programs on waste segregation and other activities • The entire responsibility of collection and transportation of waste in the mentioned wards, vests with the contractor	• This is a tripartite agreement, but the responsibilities are not clearly defined • There is no clear definition of TLOs - whether this includes all the TLOs of the wards or representative TLOs • Management of the landfill site post-closure is in the scope of the contractor, whereas there in no certainty or basis available for such work • 5% of the collected revenue is to be given to the TLO. A ward may have a

Private contractor	Wards served	Scope of work	Remarks
		• Post closure of the current landfill site, the contractor will be responsible for operation and maintenance of the site, including construction of gardens, and beautification • The collection has to be completed by 8 am, as per schedule • The waste collection schedule is to be prepared by the private contractor • The contractor needs to segregate organic waste and recyclables from general waste and transport the rest to the landfill • Procurement, operation and maintenance of all essential equipment and manpower are the responsibilities of the contractor • The PMC will provide 1 vehicle for waste collection and transportation for a certain period. Post that, the contractor needs to return the vehicle and procure its own • In Nepal, the government prepares micro-plan for the collection and transportation of waste, and the contractor has to adopt it • 20 bill books will be given to the contractor to bill waste generators. When these are exhausted, PMC will issue 20 more • Revenue distribution will be: 20% to the PMC, 75% to the contractor and 5% to the TLO • 50% of the collected arrears will remain with the PMC, 45% will be given to the private contractor and 5% to the TLO. However, the contract also mentions that at PMC's discretion, the share of TLOs can be increased • Sanitation department is the nodal body for dispute resolution TLO • The TLO will act as a coordinator between the private contractor and the PMC • It will support the private party in SWM operations, including segregation at source and maintaining cleanliness • It will also help the private party in collecting sanitation charges from waste generators	number of TLOs. The contract does not mention the name of the TLO, whether to be given to one TLO or all TLOs • There is no clarity on the arrangement and responsibility distribution between the contractor and the TLO in the contract

Private contractor	Wards served	Scope of work	Remarks
		• The TLO will support the private contractor in launching the 3R program • Generating social awareness for effective SWM will be the responsibility of the TLO • The TLO will also monitor the performance of the private parties and if required, inform the PMC about its service levels • The TLO may provide recommendations to the PMC for the improvement of SWM services • The income of the TLO can only be spent on SWM activities	
Pragati Sansar Nepal	16, 19	• The contract is valid until 2075 (2018 AD); however, until any other decision is made, the contract is deemed to be renewed to continue operations • The contractor will collect general waste at weekly • The contractor may provide services on request if waste generators pay additional charges • The contractor will not discriminate waste collection from various economic groups of the society • The contractor needs to segregate biodegradable and non-biodegradable waste from general waste and transport the remaining to the landfill. The contractor should encourage segregation at source • Biodegradable material is to be composted at the source. If this is not practiced, the contractor will set up a composting plant to process the segregated biodegradable waste • All equipment are to be procured, operated and maintained by the contractor • 80% of the total collected sanitation charges will be paid to the contractor, within seven days from the date of presentment of bills • Waste collection from main areas of the given wards is to be completed by 8 am • No open collection is permissible. The waste collection vehicles are to be covered	• The roles and responsibilities of the parties have not been clearly identified • There is no clarity on who will incur the cost of operation and maintenance of municipal vehicles • There is no indicator to measure and monitor the performance of the contractor • There is no clarity on the segregation of waste. Primarily, it is the responsibility of the waste generator, but if waste generators do not segregate, then the contractor shall segregate waste and may have to set up compost plant, which are contradictory. Such terms increase the risk of unforeseen expenditure by the private contractor • Test period and operations period

Private contractor	Wards served	Scope of work	Remarks
		• For complaint redressal, the contractor needs to provide contact details for circulation among residents • For non-performance, up to three warnings will be given to the contractor. If the performance does not improve, the PMC may terminate the contract • Any unclear clause will be mutually discussed and finalized between the PMC and the contractor • The SWM Act, 2068, PPP Act and Procurement Act will supersede all provisions in case of dispute resolution	are not defined properly
Just in Time	26-33 (except 28)	• Waste is to be collected weekly. However, the contractor may provide services more frequently on request of the waste generators if paid additional charges • The contractor needs to segregate biodegradable and non-biodegradable waste from general waste and transport the remaining to the landfill • The contractor is responsible for launching awareness programs on organic waste composting. In the absence of waste segregation at source, the contractor will segregate organic waste, and set up and operate composting plants • The contract is valid till 2075. However, operations will continue until further notice is issued by the corporation • 80% of the total collected sanitation charge will be paid to the contractor, within seven days from the date of presentment of bills • Collection of waste in the core area is to be completed by 8 am • Closed containers are to be used for collection and transportation of waste • For complaint redressal, the contractor needs to provide contact details for circulation among residents • No other party can operate in these wards without sanction from the PMC • For non-performance, up to three warnings will be given to the contractor. If the performance does not improve, the PMC may terminate the contract	• The roles and responsibilities of the parties have not been clearly identified • There is no clear mention on who will incur the cost of operation and maintenance of municipal vehicles • There is no indicator to measure and monitor the performance of the contractor • There is no clarity on the segregation of waste. Primarily, it is the responsibility of the waste generator, but if waste generators do not segregate, then the contractor shall segregate waste and may have to set up compost plant, which are contradictory. Such terms increase the risk of unforeseen expenditure by the private contractor

Private contractor	Wards served	Scope of work	Remarks
		• Any unclear clause will be mutually discussed and finalized between the PMC and the contractor • The SWM Act, 2068, PPP Act and Procurement Act will supersede all provisions in case of dispute resolution	• Test period and operations period are not defined properly
Pokhara Green Mart Pvt Ltd	6, 11, 12,13	• The contract was signed in 2073 • Vehicle for collection will be given for one month by the PMC, after which, the contractor has to return the vehicle and deploy its own vehicles • A composting plant is to be set up by the private contractor to process the biodegradable waste • Weekly collection of general waste is the mandate under the contract • However, the contractor may provide more frequent services on request of the waste generators if paid additional charges • The mentions that the contractor's performance should be exemplary and set examples for other operators. • The contractor has to segregate recyclables, compost the organic waste and transport the rest to the landfill • Collection of user charge is the responsibility of the contractor • 80% of the total collected sanitation charge will be paid to the contractor, within seven days from the date of presentment of bills • If the performance is not satisfactory, three warnings will be given to the contractor and then, penalty imposed • Any unclear clause will be mutually discussed and finalized between the PMC and the contractor • The SWM Act, 2068, PPP Act and Procurement Act will supersede all provisions in case of dispute resolution	• The roles and responsibilities of the parties have not been clearly identified • There is no clear mention on who will incur the cost of operation and maintenance of municipal vehicles • There is no indicator to measure and monitor the performance of the contractor • There is no clarity on the segregation of waste. Primarily, it is the responsibility of the waste generator, but if waste generators do not segregate, then the contractor shall segregate waste and may have to set up compost plant, which are contradictory. Such terms increase the risk of unforeseen expenditure by the private contractor

Annexure A.6 : Estimation of leachate generation

Sr. no.	Head	Unit	Value
1	Surface footprint of the disposal site	ha	4
2	Surface footprint of the disposal site	m^2	40,000
3	Annual precipitation	m/year	3.468
4	Annual accumulation of precipitation in the area	m^3/year	138,720
5	Landfill operational since	Year	2004
6	Design year (base)	Year	2020
7	No. of years of accumulation	Years	16
8	Old waste	Year range	2004-2009
9	Intermediate waste	Year range	2010-2015
10	Recent waste	Year range	2016-2020
11	No. of years in old waste period	Years	6
12	No. of years in intermediate waste period	Years	6
13	No. of years in recent waste period	Years	4
14	Evaporated and escaped through surface runoff (factor) for old period	Factor	0.98
15	Evaporated and escaped through surface runoff (factor) for intermediate period	Factor	0.80
16	Evaporated and escaped through surface runoff (factor) for recent period	Factor	0.65
17	Subsurface percolation and effective accumulation of leachate during old period	m^3	16,646
18	Subsurface percolation and effective accumulation of leachate during intermediate period	m^3	166,464
19	Subsurface percolation and effective accumulation of leachate during recent period	m^3	194,208

Annexure B : Service delivery improvement - Details of proposed infrastructure

Annexure B.1 : Container details for bulk generators

	Head	Core	Outer	Rural
1	Type of bulk waste collection containers	HDPE containers at vegetable and fruit markets		
2	Capacity (L)	1100	1100	1100
3	**No. of 1,100 L bulk waste generator containers**	**32**	**37**	**5**

Annexure B.2 : Infrastructure requirements for collection and transportation

Sr. no.	Head	Core		Outer		Rural	
		Wet waste	Dry waste	Wet waste	Dry waste	Wet waste	Dry waste
1	Basic considerations	Designed for the entire city; roads are narrow in the rural areas or not suitable for large vehicles					
2	Vehicle proposed	Closed dual compartment existing tipper vehicles				Hydraulic tipper vehicle (new)	
3	Type	Dual compartment					
4	Capacity of existing vehicles (tonne)	3	3	2	2		
5	Capacity (m^3), new					3.3	3.3
6	Bulk density of waste, from primary survey	0.152	0.152	0.152	0.152	0.152	0.152
7	Average vehicle speed (kmph)	15	15	20	20	25	25
8	One-way average distance to travel (km)	28	28	25	25	25	25
9	To & fro distance travel time (min)	224	224	150	150	120	120
10	Average collection & tipping time (min)	20	20	35	35	45	45
11	Total time for one cycle (min)	244	244	185	185	165	165
12	Operational hours (hr)	8	8	8	8	8	8
13	No. of feasible trip by each tipper (no.)	1	1	2	2	2	2
14	No. of vehicles	18	10	14	9	8	1
15	Closed dual compartment existing tipper vehicles required	28		23			

Sr. no.	Head	Core		Outer		Rural	
		Wet waste	Dry waste	Wet waste	Dry waste	Wet waste	Dry waste
16	Closed dual compartment existing tipper vehicles existing	9		13			
17	Closed dual compartment existing tipper vehicles new to procure	19		10			
18	Hydraulic tipper vehicle required					9	
19	Hydraulic tipper vehicle existing					0	
20	Hydraulic tipper vehicle new to procure					9	

Annexure B.3 : Identification of technologies for waste processing and treatment

Processes	Description
Incineration (mass burning)	It is a combustion process that uses an excess of oxygen and/or air to burn the solid waste at high temperature (>700°C). It is the most common thermal technology used for waste processing with minimal pre-processing of waste at the facility. Though this method involves high cost of investment, it is very effective in significant volume reduction (<10% ash production).
Pyrolysis	Pyrolysis uses heat to break down combustible polymeric materials in the absence of oxygen, producing a mixture of combustible gases (primarily methane, complex hydrocarbons, hydrogen, and carbon monoxide), liquids and solid residues. The products of pyrolysis process are: (i) a gas mixture; (ii) a liquid (bio-oil/tar); and (iii) a solid residue (carbon black). Relatively low temperatures (400-900°C, usually about 650°C) are employed compared with gasification. Similar to gasification, this technology is also as effective for the mixed municipal solid waste.
Plasma arc gasification	It is a process that converts organic or fossil-based carbonaceous materials into carbon monoxide, hydrogen and carbon dioxide. This is achieved by reacting on the material at high temperatures (>700°C), without combustion, with a controlled amount of oxygen and/or steam. The resulting gas mixture is called syngas or producer gas and is itself a fuel. The technology is still in a nascent stage as far as operational experience with MSW is concerned. In a high-temperature pyrolysis process, the organic portion of waste solids (carbon-based materials) is converted to a gas while inorganic materials and minerals produce a rock-like glassy byproduct, called vitrified slag. The high temperature in this process is created by an electric arc in a torch, whereby a gas is converted into plasma. The process containing a reactor with a plasma torch processing organics of waste solids is thus called plasma arc gasification. The reactor for such a process typically operates at 4,000-7,000°C. The plasma pyrolysis method can be used efficiently for municipal solid waste and plastic waste, too. However, this technology is extremely expensive and requires very high degree of sophistication and process control, and therefore, rarely used for mixed MSW.

Aerobic digestion (composting)	It is a process of decomposition of organic matter, or organic waste (leaves, food waste, paper, etc.) in presence of microorganisms. It requires proper measured inputs of water, air, and carbon- and nitrogen-rich materials. The decomposition process is aided by shredding the plant matter, adding water and ensuring proper aeration by regularly turning the mixture. In comparison to thermal treatment methods, this method is less expensive but requires more land. Further, due to operational nuisance related to composting, high volume of reject is generated (~30% of incoming waste) and lack of market for sale of compost, this method is not preferred for mixed MSW in India.
Anaerobic digestion (biomethanation)	Anaerobic digestion is a natural biological process that stabilizes organic waste in the absence of air and transforms it into biofertilizer and biogas. This is a reliable technology for the treatment of wet, organic waste.
Refuse-derived fuel (RDF)	MSW is subjected to various physical processes that reduce the quantity of total feedstock and increase its heating value. It may be densified or palletized into homogeneous fuel pellets and transported and combusted as a supplementary fuel in utility boilers.
Densification/ Palletization	Densification of biomass for biofuel increases the calorific value, which is significant for the efficiency of any biofuel operation.

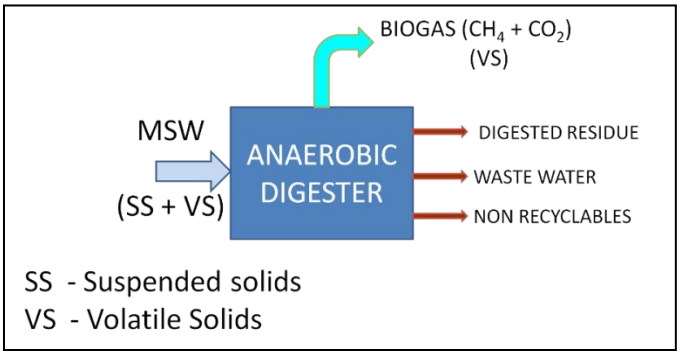
Annexure B.4 Details of biomethanation

Anaerobic digestion is the biological breakdown of organic materials in the absence of oxygen. The process is carried out by anaerobic microorganisms that convert organic material into three end products:

- Biogas, which is a gas primarily comprising methane (CH_4) and carbon dioxide (CO_2), with trace amounts of other gases;
- Digested residue, which is a partially stabilized organic material that can be used as a soil conditioner/compost after proper curing and drying; and
- Nutrient-rich liquid fraction, which in some cases can be used as liquid fertilizer if there is an agricultural user nearby or disposed of as wastewater.

The rejects (inert content of MSW) separated during the pre-digestion process, are sent to the landfill for final disposal.

Figure B.1: Flow diagram for anaerobic digestion process



The digestion of organic waste takes place in two stages. In the first stage, generally referred to as hydrolysis and acidification, organic material is broken down by a group of microns called acid formers. One of the end products of this stage is fatty acids that serve as a food source for different set of microbes. In the second stage, generally referred to as methanogenesis, a group of microbes called methane formers convert the acid produced in Stage 1 into simple products, which primarily consist of methane and carbon dioxide.

Proposed biomethanation process for Pokhara

Thermophilic anaerobic digestion is an advanced technology for processing of the organic part of waste. The process, as described below, is suitable for high solid content, given the reactor design and effective mixing that takes place:

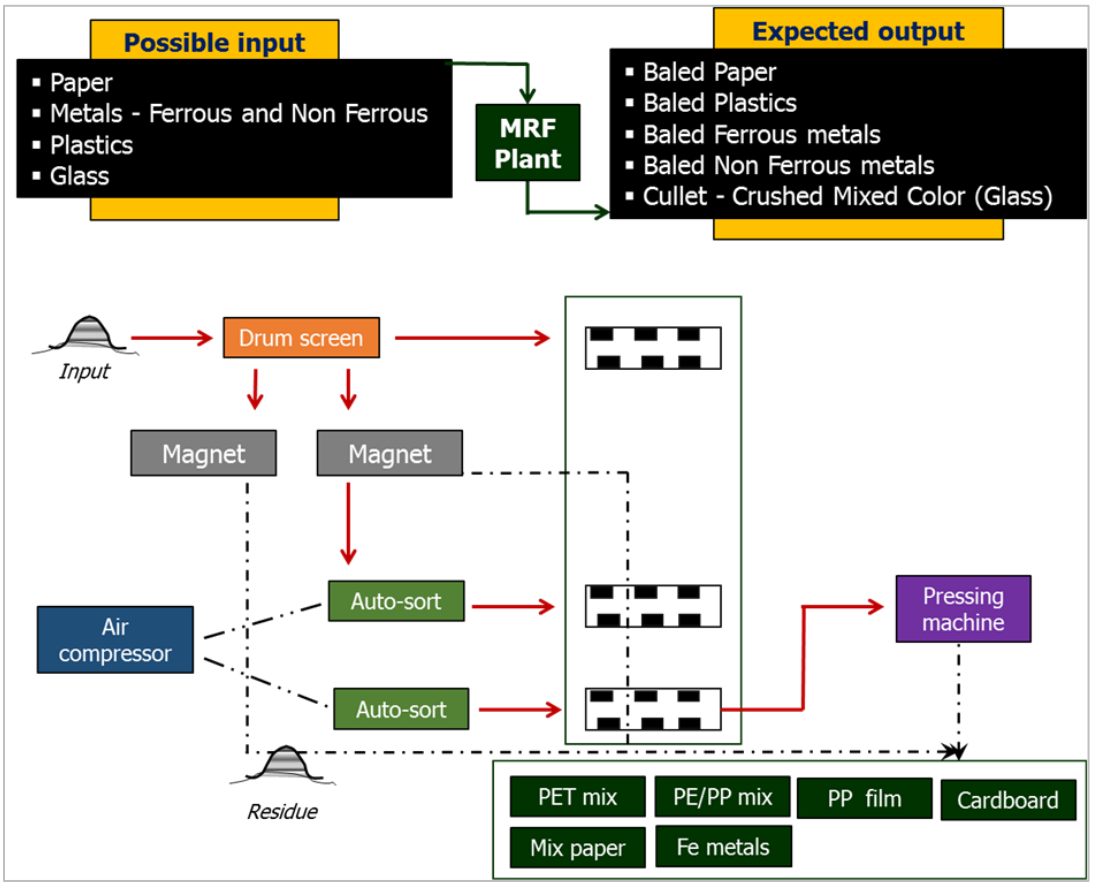
- **Pre-treatment**- The organic waste is fed into the pulverizer/homogenizer, where the material gets homogenized, sieved/shredded and size reduced to < 10 mm. After a retention time of few hours in the pulverizer/homogenizer, the waste is fed into the anaerobic digestion unit.
- **Digestion-** The anaerobic digestion unit is provided with recirculation. During the anaerobic digestion process, the material passes through the anaerobic digestion unit. The digested residue is extracted from the unit from the bottom. The biogas generated is collected at the top.
- **Biogas production**- The biogas generated through biomethanation process is used for power generation.
- **Power generation from biogas-** The gas stored in the gas holders is fed to biogas engines to generate electricity. Necessary utilities, basic safety requirements, and instrumentation are considered for proper operation, monitoring, and control of the plant performance. The captive power, generated through the process, is utilized from the gross generated power.
- **Slurry dewatering**- The residue left after the anaerobic digestion process is dewatered and dried. The dried solid can further be sold as organic compost.

The technology required for the facility is provided in the table below.

Table B.1: Technology required for the proposed biomethanation facility

Sr. no.	Item	Salient features
1.	Technology	Thermophilic anaerobic digestion
2.	Solid consistency	Operates at higher solid consistency up to 40%
3.	Water requirement	No water required
4.	Retention time	~14 days
5.	Loading rate	Requires small volumes of digesters because of higher loading rates
6.	Gas	Faster recovery of biogas
7.		More production of biogas (100–120 m^3/tonne/day)
8.	Compost	Produces better quality organic compost free of pathogens
9.		Complete dry compost
10.	Design	Pre-engineered, pre-fabricated containerized/movable, plug and play
11.	Flexibility	Flexible for variable operating conditions like weather, solid content (TS), organic content
12.	Construction	Less civil works (only site foundation and shed), lower execution time

Annexure B.5 : Proposed process flow for the MRF



Source: Multiple

Annexure B.6 : Processes of scientific closure of the existing dumpsite

Biomining and land reclamation is a process whereby waste that was landfilled is excavated and processed. Processing typically involves a series of mechanical steps designed to recover one or all of the following: recyclable materials, a combustible fraction, soil, and landfill space. In this option, material is recovered from the dumpsite, which is technically termed as biomining, followed by compaction, shifting of waste, and reclamation of the available land. The process has the following advantages:

- Dumpsite reclamation results in recovery of land for further use, e.g., construction of saleable buildings by ULL or any other purpose
- Revenue is generated from the sale of recovered combustible material
- Reclaimed soil can also be used as filling material after excavation, during any construction work taken place in the reclaimed land. Thus, the cost of filling soil can be reduced
- Combustible waste from the landfill, if any, can be used for the production of RDF and sold to cement or power plants for co-processing or co-incineration
- Dumpsite reclamation reduces costs of dumpsite closure and post-closure care and monitoring

The quantity of existing waste in this dumpsite has been calculated based on the reconnaissance survey at the disposal site, which is as follows:

Table B.2: Quantity of existing waste from dumpsite

Sr. no.	Details	Unit	Value
1	Area of the disposal site (filling)	ha	4
2	Area of the disposal site (filling)	m^2	40,000
3	Depth of fill	m	12
4	Volume of waste	m^3	480,000

Annexure B.7 : Conceptualizing the SLF and preliminary design requirements

The standards to be followed while shortlisting land for construction of SLF are as follows:

Sr. no.	Criteria	Standard adopted
1	Lake/pond	200 m away from the lake/pond
2	River/streams	100 m away from the river/stream
3.	Flood plain	No landfill within a 100 year flood plain
4	Highway	200 m away in case of highway
5	Public parks	300 m away from public parks
6	Wet lands	No landfill within wet lands
7	Habitation	500 m away from notified habitation area
8	Ground water table	Ground water table at >2 m from the ground level
9	Critical habitat area, reserve forest, protected area, ecologically sensitive area	No landfill within critical habitat area (defined as the area in which one or more endangered species live)
10	Airports	No landfill within 20 km of an airport
11	Water supply schemes/wells	Minimum 500 m away

Concept development and designing a landfill site requires to take into account the following design considerations.

- **Assessment of landfill volume and area required:** The land assessment is done based on the inert estimated to be reaching the SLF. We have estimated around 70 TPD on average will reach the centralized SLF.
- **Landfill life:** The design period of the SLF is 20 years (2020-2040). This is to be designed and implemented in phases of five years each. This will include silt, sand, and rejects from other facilities and processes designed for Pokhara.

- **Evaluation of concept development plan**: This refers to the footprint of the SLF and design requirements.

Table B.3: Evaluation of concept development plan

Landfill component	Requirement
Bottom/composite liner	• A 90-cm-thick compacted clay or amended soil (amended with bentonite) of permeability not greater than 1×10^{-7} cm/s • A HDPE geomembrane liner of thickness 1.5 mm • A drainage layer of 300-mm-thick granular material of permeability not greater than 1×10^{-2} cm/sec
Final cover	• Vegetative layer of 450-mm thickness with good vegetation supporting soil • Barrier layer of 600-mm-thick clay/amended soil with permeability 1×10^{-7} cm/s • Gas venting layer of 450-mm-thick granular material with permeability 1×10^{-2} cm/s
Maximum allowable leachate head within landfill	30 cm
Base slope	2%
Cover slope	Not steeper than 1:4

- **Design of leachate collection and liner system**

  Leachate control by a liner system within a landfill involves prevention of percolation of leachate from waste in the landfill to the subsoil by using a suitable protective system (liner system). The liner system is a combination of drainage layer and barrier layers. The system comprises a combination of barrier materials such as natural clay, amended soils, and flexible geomembrane. A drainage layer and a leachate collection system are placed over the composite liner system.

  The effectiveness of barrier layer depends on the hydraulic conductivity of the clay/amended soil liner and the density of the geomembrane. The clay/amended soil liner is effective only if it is compacted properly, and the geomembrane liner is effective only if it has the density or mass per unit area (minimum thickness specified) sufficient to withstand punctures. A landfill site composite liner of the following specifications has been recommended:

  - A 90-cm-thick compacted clay or amended soil (amended with bentonite) of permeability not greater than 1×10^{-7} cm/s
  - A HDPE geomembrane liner of thickness 1.5 mm
  - A drainage layer of 300-mm-thick granular material of permeability not greater than10^{-2} cm/s

Thus, main components of the composite liner are clay/amended soil layer and geomembrane liner, and performance of the landfill largely depends on this liner system. So, it is incumbent to design the liner system accurately and perfectly.

- **Assessment of landfill gas generation and collection system**

  Landfill gas is generated as a product of waste biodegradation. In landfill sites, organic waste is broken down by enzymes produced by bacteria in a manner similar to food digestion. Considerable heat is generated by these reactions with the release of methane, carbon dioxide, nitrogen, oxygen, hydrogen sulfite, carbon dioxide, and other gases as byproducts. Methane and carbon dioxide are the principle gases produced with near equal share. When methane is present in the air in concentrations of 5-15%, it is explosive. Landfills generate gases with a pressure sufficient enough to damage the final cover and affect the vegetative cover. Also, because only limited amount of oxygen is present in a landfill, when methane concentration reach such critical levels, there is a small risk of explosion. To avoid this, following gas management strategies should be adopted:

  - Controlled passive venting
  - Uncontrolled release
  - Controlled collection and treatment

  The landfill in Pokhara is designed to be a sanitary landfill, and it will receive inerts only, which will generate very less gas. Therefore, a passive gas venting system is proposed for the landfill.

- **Design of final cover system**

  A final landfill cover is usually composed of several layers, each with a specific function. The surface cover system must enhance surface drainage, minimize infiltration, support vegetation, and control the release of landfill gases. The landfill cover to be adopted will depend on the gas management system. The final cover system must comprise a vegetative layer supported by a barrier layer and gas vent layer. The final cover must thus have the following components:

  - Vegetative layer of 450-mm thickness with good vegetation supporting soil
  - Barrier layer of 600-mm-thick clay/amended soil with permeability 1×10^{-7}cm/s
  - Gas venting layer of 450-mm-thick granular material with permeability 1×10^{-2} cm/s

Table B.4: Calculation of design requirements for the proposed SLF

Sr. no.	Site calculation by area method	Quantity	Unit
1	Average waste receipt	68.79	TPD
2	No. of years	20	years
3	Total waste receipt in 20 years	502,148	Tonne
4	Achievable waste density in landfill	0.85	tonne/m^3
5	Waste characteristics		
6	*% inert rejects to landfill*	100	%
7	Waste to landfill (W) during the period	502,149	tonne
8	Volume of waste	590,763	m^3
9	Height of landfill (H)	12	m
10	Depth of landfill (D)	2.5	m
11	Slope above ground level (as 1:n1)	4	
12	Slope below ground level (as 1:n2)	2.5	
13	Area at the ground level (A)	67,548	sq m
		6.75	ha
		132.96	ropani
20	Width	270	m
21	Length	250	m

Annexure C : Financing proposed infrastructure

Annexure C.1 : Capital cost of the project

Sr. no.	Item	Quantity	Unit	Rate ($)	Amount ($)	Amount (NPR)
A	**Collection and transportation system**					
1	Closed tipper vehicle for waste collection in rural areas	9	Nos.	11,190	100,713	
2	1,100 L bins for bulk waste storage at markets	74	Nos.	490	36,229	
3	New transportation vehicle for core and outer areas	29	Nos.	30,424	882,291	
Sub-total (A)						
B	**Treatment, processing and disposal facility**					
1	**Decentralized biomethanation Plant**					
i.	Capital cost for biomethanation plant	9.53	TPD	22,381	213,197	
ii.	Infrastructure and utility with contingency etc. (@15%)	1	LS (lump sum)		31,980	
Total of component B.1					245,176	
2	**MRF**					
i.	Capital cost for MRF plant	130.00	TPD	9,792	1,272,905	
ii.	Infrastructure and utility with contingency etc. (@15%)	1	LS		190,936	
Total of component B.2					1,463,841	
3	**Centralized compost plant**					
i.	Capital cost for compost plant	120.00	TPD	27,976	3,357,113	
ii.	Infrastructure and utility with contingency etc. (@15%)	1	LS		503,567	
Total of component B.3					3,860,680	
4	**Centralized sanitary landfill site**					
i.	Construction of sanitary landfill	69	TPD	34,970	24,12,925	
ii.	Admin building, parking, infrastructure, utility, etc. (@ 15%)	1	LS	-	3,61,939	
Total of component B.4					27,74,864	
Sub-total (B)						
C	**Rehabilitation of Bacchhebuduwa landfill site**					
1	Biomining and disposal of inert from the legacy waste	480,000	m^3	7	3,357,113	
Total of component C						
Total capital cost (A + B + C)						

Annexure D : Guidelines on social and environmental compliance

Annexure D.1 : Leachate management

The fundamental approach for controlling leachate is to first confine leachate to the limits of the landfill, and then collect and dispose it safely. Main components of the leachate collection system are drainage layer and conveyance system. Leachate conveyance system comprises a network of HDPE pipes through which the leachate flows in to a sump.

Provisions may be made for on-site leachate treatment using solar evaporation ponds. Evaporation ponds rely on solar energy to evaporate water from the leachate, leaving behind precipitated salts.

Leachate pipes can be susceptible to particulate and biological clogging similar to the drainage layer material. Proper maintenance and design of pipe systems can mitigate these effects and ensure proper functioning of the system. Leachate trench ensures better collection efficiency. Leachate pipe backflushing or breakthrough water after leachate head builds up are some of the options to be explored under operations.

Annexure D.2 : Storm water management plan

Surface water management is required to ensure that rainwater run-off does not drain into the landfill area from surrounding areas and there is no water logging/ponding on landfill covers.

To develop a model for the drainage network, the entire site would be laid with a numbers of nodal networks. Each segment (node-to-node distance) should have its own catchment and should be connected to the second-order stream. The slope of the segment is to be designed based on the natural slope of the land, wherever possible.

The scheme is to be designed to cater to the storm water that would accumulate during the precipitation in the entire waste management facility. For this purpose, peripheral drains along the road and internal drains adjoining different individual facilities will be constructed. The drains will be with respect to the finished ground level wherever possible and/or provided with sufficient longitudinal slopes for gravity flow of water. The water will be conveyed to the lowest gradient area of the site and discharged.

Annexure D.3 : Air environment management norms during closure phase

The most cost effective dust suppressant is water. Water can be applied using water trucks, handheld sprays and automatic sprinkler systems. The following procedural changes in the construction activities are suggested to reduce dust emission:

Idling time reduction - Equipment are generally left idling while operators are on a break or waiting for the completion of another task. Emissions from idling equipment tend to be high, as catalytic converters cool down, thus reducing the efficiency of hydrocarbon and carbon monoxide oxidation. Existing idling control technologies, which automatically shut the engine off after a preset time can reduce emissions, without intervention from the operators.

Improved maintenance - Recognizing that significant emission reductions can be achieved through regular equipment maintenance, contractors will be asked to provide maintenance records to their fleet as part of the contract bid and at regular intervals throughout the duration of the contract.

Reduction of on-site construction time - Rapid on-site construction would reduce the duration of the project as well as reduce the emissions. Off-site fabrication of structural components can also enhance the quality of work, as the production takes place in controlled settings and external factors such as weather and traffic do not interfere.
Other measures to control dust emissions include reducing the vehicular speed limit on landfills and working on a smaller area at one point of time.

Annexure D.4 : Odor control and management plan

Significant odor will be generated from the Bacchebuduwa disposal site during the closure phase of the project. Following mitigation measures have been suggested to control odor:

- Excavation for slope reformation will be done on a smaller area once, and leveling and covering of the open patch done as early as possible to avoid odor emanating from the waste
- High odor producing activities (e.g., drying and segregation) will be limited to specific times of the day, temperature or wind conditions
- Excavation of odor producing waste may be suspended at times when the winds is blowing towards residential areas, in warm weather and /or during the time of the day when there is a higher public presence in the vicinity of the landfill
- Odor neutralizing solutions will be used

Annexure D.5 : Noise management plan

Closure phase: To mitigate the impact of noise from vehicle and equipment during the closure phase, the following measures are recommended for implementation:

- *Noise shields* - Construction equipment producing the maximum noise level should be fitted with noise shields
- *Time of operation* - Noisy construction equipment should not be permitted during night hours
- *Job rotation and hearing protection* - Workers employed in high noise areas will be rotated. Earplugs/muffs, or other hearing protective wear will be provided to those working close to the noise generating machinery

Post-closure phase **-** Sources of noise pollution post closure of the landfill include mainly the diesel generator (DG) set and vehicles. To mitigate the impacts of noise in this phase, the following measures are recommended:

- Acoustic DG set with enclosure
- Routine maintenance of the DG set to keep noise level within the prescribed limits
- Use of personal protective devices such as ear muffs and plugs to be strictly enforced for the workers engaged in high noise areas
- Low noise equipment must be procured, wherever feasible

- Development of peripheral green belt, which is expected to reduce noise impacts from project activities
- Ensure necessary spacing between individual vibration producing equipment, to control noise pollution due to vibrations
- Properly maintain vibration generating sources and their platforms to mitigate vibrations

Annexure D.6 : Sampling specification for environmental monitoring

Sr. no.	Description	Sampling specifications
1	Quality of leachate after treatment	One grab sampling at outlet of the treatment plant every month
2	Surface water quality	One grab sample at upstream side and one grab sample at downstream side for waterbody near the landfill site monthly
3	Groundwater quality	One sample at up-gradient side and three samples at down-gradient side of the closed landfill site every month
4	Quantity and quality of gas generated	24 hours' continuous stack monitoring at selected vent every month
5	Ambient air quality	48 hours' continuous ambient air quality monitoring at one location in upwind and three locations in downwind directions every month

Source: CPHEEO manual, India

Annexure D.7 : Surface water monitoring plan

Surface water monitoring system should be installed at the landfill site to test if there is any contamination resulting from the surface runoff from the landfill. Provision should be made at landfill sites for collection of surface runoff at the sump and then their final drainage. In no case should the runoff water come in contact with the landfill waste and get contaminated. This will lead to further contamination of the surface water source in its downstream.

The storm water drain will be operative only in rainy seasons; hence, it is very important to keep the drains clean to accommodate the rainwater and avoid flooding. All effort should be made to avoid any kind of failure in the drainage system due to choking of the drains by earth, plastic bags, dry leaves, and other foreign matters. The system should be properly maintained and inspected throughout the year. Storm water parameters need to be monitored on a regular basis.

Table D.1: Parameters to be monitored on regular basis for surface water quality

Sr. no.	Parameters	Desirable limit (mg/L, except pH)
1	Arsenic	0.05
2	Cadmium	0.01
3	Chromium	0.05
4	Copper	0.05
5	Cyanide	0.05
6	Lead	0.05
7	Mercury	0.001
8	Nickel	-
9	Nitrate as NO_3	45
10	pH	6.5-8.5
11	Iron	0.3
12	Total hardness (as $CaCO_3$)	300
13	Chlorides	250
14	Dissolved solids	500
15	Phenolic compounds (as C_6H_5OH)	0.001
16	Zinc	5
17	Sulfate (as SO_4)	200

Source: CPHEEO Manual, India

Annexure D.8 : Quality of leachate after treatment

The leachate quality after treatment must be monitored for the following parameters:

Sr. no.	Parameter	Parameter
1	Suspended solids, mg/L max	Cadmium (as Cd), mg/L max
2	Dissolved solids (inorganic) mg/L	Total chromium as Cr, mg/L
3	pH	Copper as Cu, mg/L
4	Ammonical nitrogen (as N), mg/L	Zinc A as Zn, mg/L
5	Total nitrogen as N, mg/L	Nickel as Ni, mg/L
6	BOD in mg/L (3 days @27°C)	Cyanide as CN, mg/L
7	Chemical oxygen demand, mg/L	Chloride as Cl, mg/L
8	Arsenic (as As), mg/L max	Fluoride as F, mg/L
9	Mercury (as Hg), mg/L max	Phenolic compounds (C_6H_5OH), mg/L
10	Lead (as Pb), mg/L max	

Annexure D.9 : Ambient air quality monitoring plan

Monitoring of ambient air quality is required in the vicinity of closed disposal site. Ambient air must be monitored regularly.

Pollutants	Time-weighted average	Concentration in ambient air		
		Industrial areas	Residential, rural and other areas	Sensitive areas
Sulphur dioxide (SO_2)	Annual average	80 µg/m^3	60 µg/m^3	15 µg/m^3
	24 hours	120 µg/m^3	80 µg/m^3	30 µg/m^3
Oxides of nitrogen (NO_2)	Annual average	80 µg/m^3	60 µg/m^3	15 µg/m^3
	24 hours	120 µg/m^3	80 µg/m^3	30 µg/m^3
Suspended particulate matter	Annual average	360 µg/m^3	140 µg/m^3	70 µg/m^3
	24 hours	500 µg/m^3	200 µg/m^3	100 µg/m^3
Respirable particulate matter (size less than 10 microns)	Annual average	120 µg/m^3	60 µg/m^3	50 µg/m^3
	24 hours	150 µg/m^3	100 µg/m^3	75 µg/m^3
Lead (Pb)	Annual average	1.0 µg/m^3	0.75 µg/m^3	0.50 µg/m^3
	24 hours	1.5 µg/m^3	1.00 µg/m^3	0.75 µg/m^3
Ammonia (NH_3)	Annual average	0.1 mg/m^3	0.1 mg/m^3	0.1 mg/m^3
	24 hours	0.4 mg/m^3	0.4 mg/m^3	0.4 mg/m^3
Carbon monoxide (CO)	8 hours	5.0 mg/m^3	2.0 mg/m^3	1.0 mg/m^3
	1 hour	10.0 mg/m^3	4.0 mg/m^3	2.0 mg/m^3

Source: CPHEEO Manual, India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