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Strategic assessment of solid waste management services and systems in Nepal

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

For Itahari Sub-Metropolitan City

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Abbreviations

AAQ	Ambient air quality
AEPC	Alternative Energy Promotion Center
BOD	Biological oxygen demand
CAGR	Compound annual growth rate
CAO	Chief Administrative Officer
CRIS	CRISIL Risk and Infrastructure Solutions Limited
DBFOOT	Design, build, finance, own, operate, and transfer
DDR	Detailed design report
EHS	Environment health and safety
EPA	Environment Protection Act
ESA	Environment and social assessment
GIS	Geographical information system
GPOBA	Global Partnership for Output Based Aid
HDPE	High density polyethylene
HIG	High income group
IBN	Investment Board Nepal
IBRD	International Bank for Reconstruction and Development
IEC	Information education and communication
IEE	Initial environmental examination
ISMC	Itahari Sub-Metropolitan City
ISO	International Organization for Standards
KPI	Key performance indicator
KVA	Kilo-volt-ampere
LFG	Landfill gas
LIG	Low income group
MIG	Middle income group
MOFAGA	Ministry of Federal Affairs and General Administration
MOFE	Ministry of Forest and Environment
MRF	Material recovery facility
MSW	Municipal solid waste
NGO	Non-governmental organization
NIMBY	Not in my backyard
NPR	Nepalese rupee
NUGIP	Nepal Urban Governance and Infrastructure Project

OHS	Occupational health and safety
OSR	Own source revenue
PPE	Personal protective equipment
PPP	Public-private partnership
RDF	Refuse-derived fuel
RESP	Renewable Energy Subsidy Program
RPM	Respirable particulate matter
SCP	Secondary collection points
SIIP	Service and Infrastructure Improvement Plan
SLF	Sanitary landfill
SOP	Standard operating procedure
SPM	Suspended particulate matter
SREP	Scaling Up Renewable Energy Project
SWM	Solid waste management
TLO	Tole lane organization
TPD	Ton per day
TRC	Technical review committee
ULL	Urban local level
USD	United States dollar
VAT	Value-added tax
WEMPL	Waste and Enviro Management Private Limited

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Executive Summary

Background

By 2050, it is estimated that nearly half the world's population will reside in cities. Bulging population in cities coupled with their rising income levels has led to an increase in the amount of waste generated by these urban centers. Cities and towns across the globe today face acute challenges in managing their waste in terms of its efficient collection, transportation and scientific disposal. Moreover, they need to comply with the prevalent environment standards and negate any adverse impact on general public health and environment.

A developing country such as Nepal is no different in facing these challenges. In 2015, Nepal established a three-tier government while adopting the new constitution. Local levels have become an equally strong tier of the government as compared with provincial and federal government. Among its other functions, the local level is also responsible for managing municipal waste generated within its jurisdiction. Nepal generates ~7 lakh metric ton (MT) of waste per annum of which only half is collected. All the collected waste is disposed without any treatment. Of the 293 urban local levels (out of total 753 local levels), only few cities have developed a sanitary landfill to dispose the collected waste scientifically.

Systematic improvement of solid waste management service delivery through a pilot program was attempted with support under Global Partnership for Output-based Aid (GPOBA) in 2013, covering five cities of Nepal. Taking the approach of performance-linked grant support to these cities yielded successful achievement of targeted outcomes in service delivery and financial sustainability.

Building on the success of the GPOBA and to identify city-wide infrastructure investments for solid waste management (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 as well as the plain (locally known as '*terai*') regions of Nepal to conduct an assessment of their SWM services and systems.

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

Second stage of this assessment is to understand the federal-level environment in terms of policy support, fiscal transfer mechanism to cities, environment monitoring, and support available to local levels to implement projects on public-private partnership (PPP) basis in the SWM sector. This city level assessment covered Pokhara from the western development hilly region and Itahari, an emerging town from the eastern terai region situated on the junction of the east-west and the north-south highway.

Methodology of this city level assessment included a reconnaissance survey of the city's waste management system and primary surveys (waste quantification and characterization and socioeconomic survey) to understand the waste profile and socioeconomic profile of waste generators. Structured discussions with the staff of respective local levels and private operators engaged in waste management in the city were carried out to understand the institutional, policy and financial aspects of waste management in respective cities.

This city-level assessment and service and infrastructure improvement report covers the deep diagnostic study of Itahari's waste management service and system and recommends measures that are required for improving the SWM service delivery holistically.

City-level assessment—Itahari

Itahari Sub-Metropolitan City (ISMC) is situated in Sunsari district in the Koshi Zone in Province-1 of south-eastern Nepal. The geographical area under the administrative jurisdiction of the ISMC is 93.78 km^2 and houses 1.4 lakh people (Census 2011). The ISMC has 20 administrative wards of which four are urbanized and identified as core wards, eight are semi-urban and identified as outer, and the rest are rural and are identified as rural wards.

Stakeholders in SWM

As a local level, the ISMC is responsible for the provision and management of solid waste management along with other core functions such as health and social development, education, youth and sports, local infrastructure development, economic development, and disaster and environment management.

The sanitation branch, under the environment and disaster management division, is responsible for monitoring service within the ISMC. The environment and disaster management division has a total staff strength of 12 individuals of which there are four posts sanctioned for the sanitation branch, including an environment engineer. However, the sanitation branch is staffed with only one environment engineer.

Prior to 2018, the collection and transportation of waste in the ISMC was outsourced to a private operator, '*Enviro Care Concern Private Limited*' for five years. In 2016, with support from the Alternative Energy Promotion Center (AEPC), ISMC initiated a process to select a private operator to develop a waste-to-energy facility on PPP mode. A private operator, Waste and Enviro Management Private Limited (same promoter of the company managing collection and transportation earlier), was selected to develop a bio-methanation-based waste-to-energy facility on design build finance own operate and transfer (DBFOOT) basis. A 20-year contract for collection, transportation of waste and developing a waste-to-energy facility has been signed wherein the ISMC and AEPC are joint concessioning authorities. Currently, the project has received the design approval from the AEPC and the construction on the site has begun in February 2020. The contractor is currently engaged in collection and transportation of waste from the city and disposing it at a designated site in the Forest (Charkose Jhadi) as identified by ISMC.

Socioeconomic profile of waste generators and waste profile

Demographics: Of all the respondent households (HH), 93% were permanent residents with 32% residing in the city since the past 10 years, 44% since 11-30 years and another 22% since 31-50

years. As many as 22% of the respondents were female. Some 67% of the respondent households have five persons or below staying in the house, 28% were between six and 10 individuals residing in the same house, and the average household size was 5.5.

Employment and economic status: 41% of the respondents were working in the private sector; by 27% self-employed and 20% worked in the government sector. Of all households, 32% own at least a radio, 98% own television, 84% have a cable connection, 58% have a computer at home, 64% have internet (including mobile), 65% have a telephone, 98% have a mobile phone, 21% own a car, 67% have own a motor cycle, and 70% own a cycle. Average monthly household income is NPR (Nepalese rupee) 49,117 (maximum NPR 160,000, median NPR 40,000 and minimum NPR 10,000) while the per capita monthly income is NPR 9,000. At the same time, the average monthly expenditure of the surveyed household is NPR 29,609 (maximum NPR 80,000, median NPR 26,000, and minimum NPR 8,000) and the per capita expenditure is NPR 5,426 per month.

Current user charge and affordability: Of all the respondent households, 20% did not respond on the user charge they pay. However, 69% of the households pay NPR 100-199 per month, 7% pay NPR 200-299 and 4% pay NPR 300 and above. Of all the respondent households, 63% mentioned the current user charges are affordable.

Willingness to pay more for improved services: On seeking the views of respondents on their willingness to pay more for the improved waste management services, 96% responded affirmatively. On asking how much they are willing to pay more compared with current user charge, 11% are willing to pay up to 10% increased charges, 49% are willing to pay 11%-30%, 32% are willing to pay 31%-50% more, and 7% are ready to pay even more than 50% of the current level of user charges.

Waste profile: Major contributors to Itahari's waste generation are households, commercial establishments such as hotels, shops, restaurants, mall, and bulk waste generators such as vegetable, fruit and weekly markets. Profiling of municipal waste generated in Itahari as well as the profile of waste generators was done through primary waste quantification and characterization surveys and questionnaire-based socioeconomic surveys, respectively. The primary survey of 100 waste generators (three-day samples from domestic and two-day sample from others) to estimate the total waste generation and arrive at a per capita waste generation norm was undertaken through a waste quantification survey. The waste samples were analyzed to assess the physical and chemical character of waste generated. It is estimated Itahari generates ~58 metric ton of waste daily (TPD). Households contributed 48% of the waste generated, followed by bulk generators generating 19%, and commercial establishments 33%. Daily per capita waste generation assessed based on the waste quantification survey is 369 grams.

Service delivery assessment

Coverage of service: Waste collection and transportation is currently being carried out in 19 out of 20 administrative wards, covering close to 96% population of Itahari. Ward number 14 is excluded, being a rural ward with low population density. Waste generators in this ward prefer use waste to feed their cattle. Households, bulk generators such as vegetable and fruit markets and weekly markets, commercial establishments such as hotels, restaurants and shopping generators, and institutional organizations such as schools, colleges, hostels, etc., are major contributors to waste generation in the city. Of the 19 wards covered under the service, waste from four core wards (5,6,9,10) is collected on a daily basis, covering 21% population, since the

main market areas are in these four wards. For the rest of the wards covering 75% of Itahari's population, waste is collected on a weekly basis on a designated day of the week.

Storage: There has been no standard bin system that is been followed to store the waste at the primary level, i.e., at the source of waste generation. In the core wards where the collection is daily, waste generated on a daily basis is stored in plastic bags by household waste generators as well as commercial establishments. Such plastic bags are then kept on the sides of the road for collection by the waste collection operator. In wards where the collection is on scheduled weekdays, households store waste in big plastic bags and keep it in the court yard of the house till the waste collection vehicle arrives. Frequently, there are delays in collection of waste at a designated time and that has led to dumping of waste by the waste generators in nearby water bodies and open areas. It is revealed through the socioeconomic profiling of the waste generators that 48% of the respondents from the core area practice open dumping or burning of waste. Similarly, 40% of the respondents from the outer and 52% respondents from rural areas practice dumping of waste in the open as well as burning of waste. Though this may be a practice in case the waste collection service provider defaults on collection of waste or there is a delay and not a general practice by the waste generators.

Segregation of waste: Households having cattle and small-scale farming within their premises tend to segregate the organic waste from the other waste to either convert it into organic fertilizer along with excreta of animals or feed the organic waste to cattle. Waste management practice assessment in the socioeconomic profiling of the waste generators has revealed 30% of the domestic waste generators practice some kind of recycling of waste at source which is generally given to retail recycling material collectors (locally known as '*kabadiwalas'*). Some 41% of the respondents practice some or other form of composting of organic waste. Since the waste collection in outer and rural areas is on a weekly basis, the practice of recycling and composting of waste predominates compared with core areas where the waste collection frequency is on daily basis. In core wards, 16% respondents stated practicing recycling as well as composting of waste. As compared to this, in outer areas, 57% and 66% respondents practice recycling and composting, respectively.

To promote segregation of waste at source, in the contract that ISMC has entered into with the private operator there is a provision to provide two separate primary storage bins (dry and wet) for segregation of waste (one from private operator and one from the ISMC). However, this has not been initiated by either party.

Collection: A fleet of 10 waste collection vehicles is deployed by the private operator for collection and transportation of waste on a daily basis. These vehicles are owned by the private operator and each vehicle has been designated a specific area and route to be covered on a specific day of a week. As per the waste collection schedule, in certain areas which are main markets and commercial areas in core wards, waste collection frequency is on a daily basis; for the rest of the areas, the collection frequency is weekly. The private operator has 11 drivers and 51 helpers engaged in waste collection and transportation activity.

Waste is being collected from the source and at present there are no formal or informal designated secondary collection points in Itahari. Waste collection activity starts at 6:30 am and continues till 3 to 4 pm. Each collection vehicle is manned with one driver and 3-4 helpers to support waste collection activity. In the designated area of waste collection, the waste collection vehicle is stopped and helpers from the vehicle bring waste which is kept along the road by the

waste generators. Once the waste is received in the collection vehicle, helpers' first segregate and separately store recyclables in large plastic bags. Once such segregation and collection is completed at a particular collection point, they move to the next collection point. Time taken by the waste collection workers in extracting recyclables at each collection point from the collected waste, delays overall waste collection and waste is seen lying on roads.

The capacity of each collection vehicle is close to 3 metric ton (MT). Looking at the collective waste carrying capacity of each vehicle, the private operator can collect approximately 30 MT waste on a daily basis considering each vehicle makes only one trip to the disposal facility daily. We can assess total capacity available to collect the waste generated in the city is inadequate when compared to the daily waste generation. Capital investments are essential to increase the waste collection capacity by procuring waste collection vehicles that ensure segregated waste collection to complement the proposed waste-to-energy facility.

Transportation of waste**:** A tractor which is attached to a trolley having a length of 2.5 meter, breadth of 1.8 meter and an increased height of 2.31 meters (to hold more waste in the trolley) is used to collect and transport waste. Ten (10) such waste collection vehicles, owned by the private operator, are deployed to collect and transport waste to the designated disposal facility. These 10 vehicles make close to 10-12 trips to the disposal facility post collection of waste for disposal at the designated dumpsite identified by the ISMC. Since the height of three sides of the trolley is increased, there are no cases of spillage of waste while transporting to the dumpsite. Each vehicle carries approximately 2.6 to 3 ton of waste to the disposal facility and the total estimated waste reaching the disposal facility is 26 MT. Current waste transportation vehicles deployed by the private operator do not have the provision of collecting waste in a segregated manner. To establish the system of segregated waste collection and transportation, these vehicles either need to be modified or replaced with suitable waste collection vehicles.

Disposal of waste**:** ISMC does not have an engineered landfill facility. Until five years ago, all the waste collected from the city was disposed in low-lying areas on the road side, nearby forest, rivers or any other available places, indiscriminately. Owing to unavailability of such spots and opposition of the general public, the ISMC four years ago identified a disposal site in the nearby forest called '*Charkose jhadi'* which is 11 km from the city center. The current disposal site is on the bank of the Sevti River which is passing through the Forest. A 4 (four) kilometer stretch along the river has been used to dispose waste since the past four years. Based on estimation, it is assessed that close to 21,000 cubic meter of waste has been dumped in the past four years. The same disposal site, along with disposal of municipal waste is also being used for disposal of untreated fecal sludge. Various private fecal sludge collection operators in Itahari also dispose fecal sludge at the same disposal site. In addition to the municipal and fecal sludge, this site also receives medical waste that is not processed within the health care facilities.

Uncontrolled burning of waste at the disposal facility to extract copper wires creates smoke which spreads to nearby villages owing to which people face health issues. During the monsoon months, since the waste is disposed along the river flowing north-south, it carries waste to the downstream habitation areas, creating health hazard. Though the ISMC has been using this disposal facility since the past four years and the extent of objection they have received is from the community in the downstream village (*Bhawanipur*). The ISMC has been informing them it is in process of developing a waste-to-energy project which will ensure this facility will not be used any more. It is of utmost importance for the ISMC to develop the proposed waste-to-energy facility at the

earliest to discontinue the negative environmental and social impact of the current disposal facility.

Proposed waste-to-energy/biogas facility: ISMC, with support from the AEPC, has entered into a contract to develop a 30 ton per day (TPD) waste-to-energy plant using bio-methanation technology with Waste and Enviro Management Private Limited (WEMPL). Land admeasuring 2.37 hectares has been identified in Ward 10 for the purpose. The contract between the WEMPL and ISMC states the responsibility to facilitate the private operator with light, access road, three-phase electricity, and community coordination to install the waste-to-energy plant at the proposed site is with the ISMC. The WEMPL will carry out collection and transportation of waste from ISMC jurisdiction, develop the bio-methanation plant to process the organic municipal waste, develop a suitable material recovery facility for the recyclable waste, and generate energy from the combustible waste. The ISMC is required to develop a sanitary landfill facility for disposing process rejects and inert. Though the project has been initiated since 2016, construction activity has been initiated only in February 2020. In the absence of a waste segregation practice, the WEMPL currently collects mixed waste from the waste generators. The success of bio-methanation plant largely depends on the extent of the segregated waste received at the waste processing facility. For efficient functioning of the proposed facility, it is essential to establish waste segregation practices at the primary waste generation level and establish a separated waste collection system to ensure that suitable feedstock from the municipal waste is available to this facility.

Informal sector: There are 12-13 ragpickers (male and female) engaged in extracting recyclable material from the waste disposed at the current disposal site. These ragpickers have been picking the recyclable waste from the disposal site since the past two years and normally collect plastics, water bottles and metals five days a week, store it at a designated place, and sell it to recyclers in Itahari market once a week. These ragpickers work from 8:00 am to 3:00 pm without using any personal protective gear while operating at the disposal site. Small incidents of their skin being cut with broken glass, syringe or metal waste while extracting recyclables is quite common. Frequency of such incidents is once or twice per month and there is no immediate treatment available to them at the site. Also, since this disposal facility is 11 km away Itahari, they avoid going for any medical treatment post such incidents to save on transportation and medical costs. Their monthly income from this activity is NPR 10,000-12,000. Families of the male ragpickers are solely dependent on the income generated from this activity.

***Waste recycling*:** Recycling of waste is mainly undertaken by the unorganized recyclers (*kabadiwallas*- recyclable waste aggregators). There are close to 15-20 small-scale recyclers in Itahari. The largest recycler on a monthly basis on average collects and sells 1,300 MT of recyclables to the designated industries.

Construction and demolition waste: Itahari does not have any infrastructure to manage construction and demolition (C&D) waste on its own. C&D waste does not fall under the purview of the private operator in the long-term PPP contract Itahari has signed. Private contractors engaged in construction or demolition of any real estate, manage and dispose the waste in low-lying areas, jungles, etc. Often, when the quantity of such waste become huge, they seek the ISMC's help to dispose such waste. The ISMC requests the WEMPL to collect and dispose such C&D waste on a fixed payment basis.

***Bio-medical waste*:** The biomedical waste generated predominantly from the hospitals include syringes, needles, plaster, bandages, slightly pathological waste, used gloves, wrapping plastics,

etc. Needles, glasses and organic waste is given to the outside vendor and disposed of from the hospital. The rest of the waste is treated inside the hospital through an incinerator installed within the premises. The hospital staff in Itahari has not been given any waste-handling training. Hazardous waste generated from the hospitals is kept inside the hospital until the vehicle comes to collect the waste on a daily basis. NPR 15,000-20,000 is paid monthly to the waste collecting agency.

Industrial waste: As per the recent survey undertaken by the ISMC, there are 148 small- and large-scale industries in the city. Industrial waste (mostly liquid) is disposed of in nearby drains along the North-South highway. The ISMC has implemented the Environment Protection Act (EPA) rule for industries in Itahari to manage the hazardous waste within their own premises. Accordingly, different industries, such as tanneries, soap units, textile manufacturers, etc., have established their own hazardous waste treatment system inside their property. However, as a practice, most of industries neutralize the waste first and then dispose it in the river.

Waste flow: On the basis of primary waste surveys, it is estimated 58 MT of waste is generated daily in Itahari. Of the total waste generated at the source, dry waste having an economic value is recovered across the solid waste management value chain. The first level of recovery takes place at the source where waste generators segregate dry materials such as plastic, paper, glass, and metal which is sold to retail recycling agents who collect recyclable material door to door. The second level of waste recovery is during waste collection and transportation wherein the workers engaged in the collection of waste further recover recyclables during collection and transportation and sell it to recyclers at the end of each work day. The third level of material recovery happens at the dump site where 12-13 ragpickers recover recyclables from the waste dumped in the disposal site.

The socioeconomic profiling survey reveals of the total respondents from the wards in the core area, 16% segregate their waste into wet and dry. Similarly, 57% of the waste generators segregate their waste in outer areas. Also, 16% of respondents from core wards, 66% from outer wards and 29% from the rural wards practice some way of composting the wet waste which is generated at source. If this information is seen at an aggregate level, it assessed 30% of respondents practice some kind of waste segregation and 41% practice home composting. Additionally, 48% of the respondents from the core city area, 40% from the outer area and 52% from the rural area practice open dumping or burning of waste. It is estimated of the total waste generated in Itahari, 30% waste is recovered at the source itself of which 12% is wet waste and 18% is recyclable. An additional 3% waste is either dumped in open areas or burned and additional 1% recyclable waste is extracted by the workers engaged in waste collection and transportation. It is estimated that since the waste collection in 15 out of 19 wards is on a weekly basis, 22% of the waste generated on a daily basis is stored within the premises of the waste generators and does not reach the disposal facility. Some 44% of the waste reaches the disposal facility daily.

Financial assessment of the ISMC

ISMC maintains accounts using the cash-based single entry accounting system with the income and expenditure heads maintained on cash basis. Own source revenue for Itahari comprises tax as well as non-tax revenue. The tax revenue is from integrated property tax as well tax on house rent, health service, education, transport vehicle registration, future service improvement, and advertisement and entertainment tax. The non-tax revenue is from the fees and charges levied by the ISMC. Another source of revenue for the ISMC is assigned grants and transfers from the

federal as well as provincial governments, i.e., fiscal transfers of grants (fiscal equalization grants, conditional grants, complementary and special grants) from the federal government and revenue share from the provincial government (stamp duty). Of all the grants the ISMC receives from the federal government, except the fiscal equalization grant, all other are tied grants.

Revenue receipt: During the assessment period, i.e., fiscals 2017, 2018 and 2019, the revenue receipt has come down from NPR 856 lakh to NPR 774 lakh owing to decrease in grants from the federal government. During the same period, receipt through own source tax as well as non-tax revenue (OSR) has increased 98% and 76%, respectively, increasing the share of own source revenue (OSR) to total revenue from 11% to 21% during the period. However, during the assessment period, the assigned revenue (fiscal transfer from federal government and revenue sharing from provincial government) for the ISMC remained at 80-90% of the total revenue of the ISMC, making the body dependent on fiscal transfers from the federal as well as provincial governments. The user charge for the SWM service is levied, collected and retained by the WEMPL as a revenue and is thus not reflected in the municipal accounting.

Revenue expense: ISMC's revenue expense has increased tenfold during the same assessment period from NPR 67 lakh to NPR 695 lakh owing to an increase in the establishment expenditure in the latest fiscal year (fiscal 2019). This is because the ISMC has increased its staff strength and program expenditure in health and education sector to impart skill development and awareness training. Though establishment expenditure has increased in absolute terms from NPR 37 lakh to NPR 275 lakh, the share of establishment expenditure has come down from 57% to 40%. Since waste management in the ISMC is outsourced, apart from payment of cleaning charges for de-silting of drains and picking up dead body of animals, there is no expenditure on SWM which is incurred by the ISMC.

Capital income: Capital income comprises mainly tied grants received from the federal government for implementation of capital infrastructure projects. It has increased 300% from NPR 157 lakh to NPR 475 lakh during the assessment period.

Capital expenditure: Capital expenditure is mainly through the tied grants received from the federal government to implement infrastructure projects such as construction of roads, bridges, etc. Expenditure for capital asset creation has increased three-fold during the assessment period, from NPR 158 lakh to NPR 475 lakh. However, there is no capital expenditure incurred by the ISMC for the SWM service since it has been completely outsourced.

User charge: ISMC has been levying a monthly user charge for SWM to waste generators of different categories. At present, there are 126 categories of user charges for different types of waste generators, each type of waste generator is further divided into small, medium and large categories. There is no set process for determining the user charge for various categories. The function of levying and collection of user charge is managed completely by 14 user charge collectors (all women) employed by the WEMPL on commission (on the amount of user charge collected per month) basis. A sanitation card, which keeps a record of payments and payable (for a period of two years), is issued to each waste generator by these collector to maintain the record of payments from the respective waste generator. There is no comprehensive data of all the waste generators in the city to assess the category-wise number of waste generators and potential revenue demand from SWM user charge. It is assessed a minimum user charge collected from the residential waste generators is NPR 100 per floor. There are eight fixed per month SWM user charge rates (NPR 100, 150, 200, 250, 300, 500, 1,000, 2,000, and 5,000) which are applied to

these 126 categories of different waste generators. Of these categories, 34 are further divided into small and medium and 40 are classified into small, medium and large category, making 231 categories of waste generators. Of these categories, 52% fall under the monthly rate category of NPR 100 to 200, 37% between NPR-200 to 500 and the rest 11%, which are bulk waste generators, pay NPR 1,000-5,000.

There is no comprehensive data available on the number of sanitation cards (category-wise) issued to waste generators to assess the potential revenue demand and its collection efficiency. Discussion with the staff of the private operator has revealed that close to 9,000 sanitation cards have been issued and monthly revenue through SWM user charge is NPR 18 lakh to NPR 21 lakh. Comparing 35864 households in Itahari (as per census 2011), only 9,000 waste generators are covered under the collection of SWM user charge, thus covering ~25% waste generators. Also, since the user fee levying and collection is completely managed by the private operator, there is no or very little control from the ISMC administration on revenue generated by the private operator. It is essential that a comprehensive assessment of waste generators in Itahari is carried out through a primary survey to assess the potential revenue demand from SWM user charges.

Institutional and governance system assessment

Planning of services: Since SWM as a service has been outsourced, planning of services and infrastructure in Itahari is limited to undertaking awareness programs, cleaning public spaces such as religious places, market areas, and awareness program related to hospital waste management. Ward-level organizations such as tole lane organizations (TLO), non-governmental organizations (NGO), and Red Cross, along with the stakeholders from the general public, conduct a consultation meeting to identify ward-level needs for better waste management. These needs are then sent to the head office for amalgamation in the city-level budget.

Procurement and contract management: SWM function has been outsourced to a private operator through a 20-year PPP contract. ISMC internally does not have the capacity to manage such procurement and, thus, sought support from the AEPC in 2016 to first conduct the feasibility of a developing a centralized waste-to-energy facility and design bidding documents to select a private developer for the purpose. The ISMC staff does not have the knowhow or the capability to design complex contract structures for procurement through the PPP mode. The staff has also not received any training on procurement or PPP designing and contract management. Thus, the city is largely dependent on external agencies such as the AEPC. Also, currently, the city does not possess any capacity to undertake contract management and monitor the provision of the existing PPP contract.

Monitoring KPIs, performance of service: At present, collection and transportation of solid waste is carried out by a private operator engaging 10 waste collection vehicles. No system of performance measurement is in place to check the operational and functional efficiency of the operator. Also, payment to the private operator is not linked to any performance parameter. Hence, the private operator is not accountable. Additionally, there is only one environment engineer who is responsible for monitoring the solid waste service provided by WEMPL. Practically, it is not possible monitor the complete service of WEMPL. Thus, service monitoring of WEMPL is done through complaints received from citizens and field observations by the ISMC staff of unattended waste lying on the streets.

Health and safety norms: Across the value chain of waste management in Itahari, workers come in direct contact with waste generated in the city, i.e., during primary collection (picking of waste and dumping of waste in the waste collection vehicle), sorting of recyclables once the waste is dumped in the vehicle, sweeping of streets, collection of waste in bins, and disposal of the waste in the dump site. There are incidents of injury reported by the workers owing to broken glass, or needles and other harmful waste. There are no health and safety norms that are available to be followed by the employees of the private operator.

Grievance redressal system: Though there is a formal process of registering the grievance, the process is quite cumbersome. To register the grievance, the section chief has to assess the admissibility of the grievance. Once the admissibility is established, the complainant has to register the grievance to generate a complaint number only after which the redressal process is initiated. Owing to the complex mode of complaint registration and resolution, the number of complaints received during a month are only two to three. To improve the service delivery performance, the ISMC needs to establish a robust complaint registration and resolution mechanism. It should have maximum modes to register complaints and a tracking system for time-bound resolution which is linked to payment to WEMPL for effective and timely performance.

Environment and social monitoring frameworks: There are no environment monitoring frameworks in place in the ISMC. The ISMC established a committee of 11 for SWM monitoring and management in September 2019. The rules of business of this committee have not been framed.

Service and infrastructure improvement plan

Service and infrastructure improvement plan (SIIP) focuses on supporting Itahari in developing institutional and service governance systems, deploying infrastructure to improve service delivery, establishing financial management systems for achieving sustainability, enhancing the role of the private sector to improve service delivery and environment and social safeguards that needs to be adhered to by while improving the service delivery.

Key principles of the service improvement plan are;

- Integration of existing infrastructure made into the proposed system
- Synchronization of any existing scheme or planning into the proposed system
- Optimization of land utilization (minimum disposal)
- Reduction of manual handling
- Compliance with rules, environmental and social safeguards
- Technological flexibility and options
- Defined performance parameters
- Robust monitoring and tracking system

Infrastructure improvement plan: A centralized waste management facility has been proposed keeping in mind the existing proposed waste-to-energy facility. It is estimated the city will generated 74 TPD waste in 2020, 103 TPD in 2030 and 141 TPD in 2040 and the proposed system is designed catering to the waste to be generated till 2030.

- ***Segregated waste collection:*** The proposed waste management system warrants that all the bulk and non-bulk waste generators need to segregate the waste in organic as well as non-organic fractions
- ***Segregated collection and transportation:*** The existing fleet of 10 waste collection vehicles is to be utilized to collect organic waste from the bulk generators such as markets. For non-bulk waste generators, a new fleet of 24 vehicles is envisaged for daily door-to-door segregated waste collection
- ***Separate processing of organic and inorganic waste***: Segregated organic waste is to be received and processed at the centralized, bio-methanation-based waste-to-energy facility with a capacity of 50 TPD. The inorganic dry waste is to be further reduced in a centralized material recovery facility of 50 TPD
- ***Sanitary landfill:*** Only the process rejects and the inert material received at the centralized waste processing facility would be disposed into the sanitary landfill facility
- ***Reclaim existing disposal facility:*** Land at *Charkose Jhari* that is currently being used to dispose waste is to be reclaimed through bio-mining of waste. Any further negative impact on its surrounding environment is to be negated

Financing of SIIP**:** On the basis of the infrastructure improvement plan, we can assess upgrading the infrastructure for the SWM service improvement in Itahari would entail a capital investment of USD 2.15 million (NPR 237 million[1]). The corresponding operations and maintenance expenditure per annum will be USD 0.12 million (NPR 14 million per annum).

Source of financing for capital investments: The ISMC, being completely dependent on fiscal transfers of tied grants for capital investment, will have to look for external funding support to secure the capital investments, including the financing available under the NUGIP program.

Operations and maintenance expense recovery: The operations and maintenance expenditure is close to NPR 1.3 crore, i.e., close to NPR 11 lakh per month. Currently, the households in the core, outer as well as rural wards are paying 0.42-0.46% of their monthly expense towards SWM user charges. While assessing the affordability of current user charges and willingness to pay more for improved SWM services, 63% domestic respondents say the current user charges are affordable. As many as 96% respondents are willing to pay more the improved service. However, 60% of the respondents from the lower income group state the current user charges are not affordable and close to 25% from the same category are not willing to pay more.

User charge rationalization: The low income group (monthly income less than NPR 20,000) currently spends close to 0.58% of the monthly expense as SWM charge. While the middle income group (monthly income from NPR 20,000-40,000) spends 0.43% of their monthly expense as SWM user fee, the high income group (monthly income above NPR 40,000) spends 0.33% of their monthly expense as SWM user fee. Applying the pro-poor approach, it is proposed that the rationalized user charge for the low and middle income groups will be in the range of 0.10% of their monthly expense and the same for higher income group will be in the range of 0.20%. On this basis, the revised user charge for the low income group is NPR 20 per month, for middle income group it is NPR 30 per month, and for the high income group it is NPR 80 per month. Considering the revised tariff structure, improved coverage of SWM user fee and 60% collection

[1] 1 USD = 110 NPR

efficiency of user charges, the operations and maintenance costs for the proposed system can be recovered.

User charge billing and collection modality: The ISMC will have to initiate a comprehensive survey of waste generators and create a primary data-base of all waste generators to generate the potential revenue demand of user charges that can be collected. Additionally, in the absence of the institutional capability to collect these user charges from the waste generators monthly, the collection responsibility will be vested with the WEMPL. However, a performance parameter with regard to user charge collection will be negotiated and inserted as part of the existing contract.

Institutional and governance improvements

The sanitation branch, which monitors the SWM service, is staffed with only one environment engineer. It is proposed to have a dedicated solid waste management unit within the environment and disaster management division. The role and responsibility of each individual would be fixed as under;

- *Solid waste/Environment engineer:* Complete responsibility of service delivery monitoring and planning and development for future development needs
- *Environment engineer (Processing & Disposal)*: Development and management of sanitary landfill and monitoring waste to energy and MRF facilities
- Sanitation supervisor: Supervision of waste collection and transportation activity
- Accounts officer: Management and monitoring of revenue through SWM user fee.

Capacity building of staff: Building the capacity of the ISMC staff is essential for sustainable service delivery. Training and capacity-building areas are identified depending on the role and responsibility assigned to the employees. Identified areas of capacity building for the senior staff in the planning and management role are global best practices in institutional and governance systems, public procurement and PPP, financing SWM investments, data management, and service-level benchmarks. For the engineering staff, areas such as management of solid waste systems, collection and transportation planning, technologies for processing municipal waste, designing sanitary landfill facility, and associated environment management systems have been identified. The capacity-building training program will have a mix of classroom teaching, workshop seminar and exposure visits.

Private sector engagement: For SWM system components which are outside the purview of the WEMPL, it is envisaged that infrastructure investments will be made by the ISMC. A contract will be issued to manage the infrastructure while defining key performance standards and corresponding penalties. Since the collection, transportation and treatment is to be managed by WEPL, ISMC will be required to develop a sanitary landfill facility on its own and a long-term management contract can be structured to manage the landfill facility as per the standards devised by the ISMC.

Environment monitoring

Further to these, the environment monitoring framework has been proposed for strengthened SWM operations and technical norms. It can be adhered to for selecting the land parcel to be used to develop a solid waste processing or disposal facility. Based on various environment and social parameters, suggestive norms have been designed for the SWM facility site selection.

Additionally, it is recommended that during the project development phase, various environment management plans need to be followed during the operation, closure and post closure phase. These are to be prepared and institutionalized within the environment monitoring framework of the ISMC.

Citizen engagement

Early engagement of citizens, the key stakeholder for any efficient waste management system, is essential for the success of any proposed system. It is proposed that the ISMC needs to first identify the key stakeholders that need to be engaged, then design activities through which these stakeholders can be engaged, and arrive at the mode and frequency of engagement for each stakeholder group. Key stakeholders, i.e., tole lane organizations, elected officials, citizen groups, and ward committee members, have been identified. Also, indicative activities of engagement, i.e., preparation and designing promotional materials and meeting with all stakeholder, have been identified. Also the engagement modes such as focus group discussions and use of mass communication medium have been identified as effective tools of engaging key stakeholders.

Performance monitoring of SIIP

Overall improvement of SWM service delivery will depend systematic improvement in the internal institutional structure responsible for service monitoring, improving the financial management systems, constant monitoring for improving the service delivery operations, and persistent efforts to build the ISMC's capacity for the service management. This can be achieved only through a structured, output-based approach. Improvement indicators for measuring outcomes of such a structured approach have been identified and classified into:

- ***Service delivery improvement*** - 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
- ***Improvement in financial management*** - refers to improvement in cost recovery through improved collection of charges, resulting in sustainable SWM operations
- ***Institutional improvement*** **-** Improvement in technical, monitoring and management capabilities of the ISMC to monitor the service delivery

Financial assistance available under the Nepal Urban Governance and Infrastructure Project (NUGIP) can be harnessed to fund the investments required for infrastructure improvement. Based on the identified indicators, an output-based grant can be structured to achieve associated service and financial management improvement through strengthened institutions.

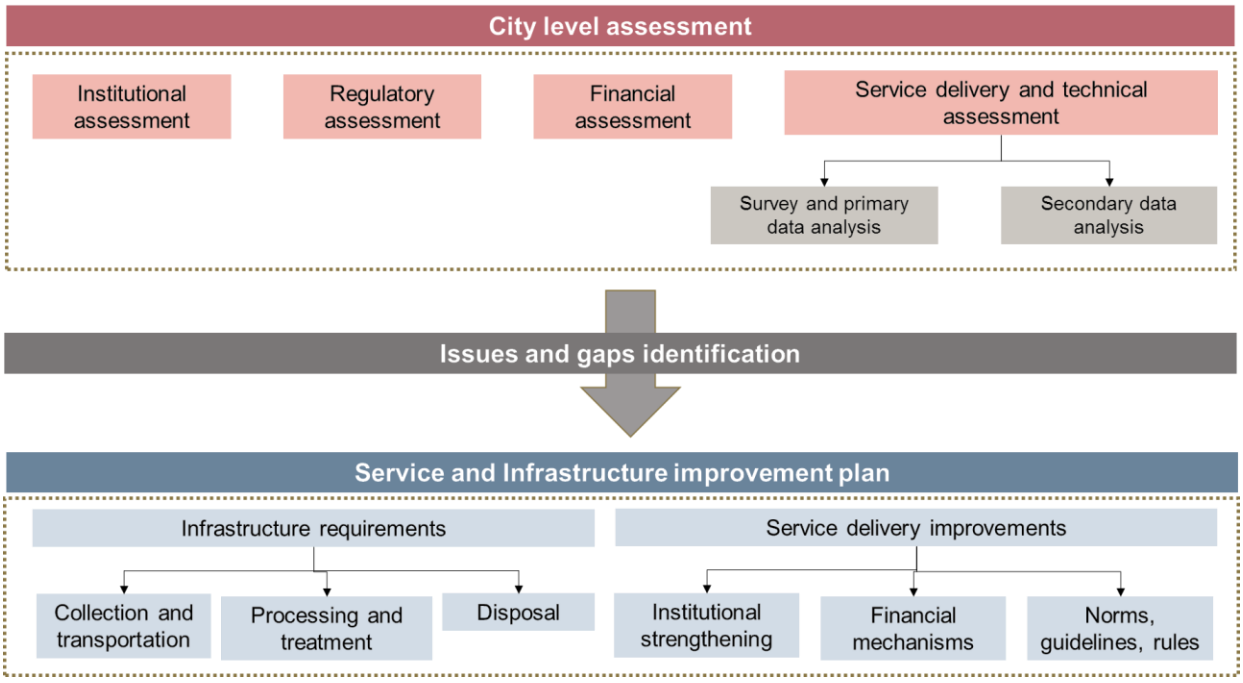
1 Background

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

SWM is primarily the responsibility of the ULLs. Legally, the ULLs can also formulate their own regulations to manage waste efficiently. The World Bank (WB), via the 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 SWM in Nepal. As part of this initiative, a detailed city level assessment of solid waste management services and systems in the project cities, i.e., Pokhara and Itahari, is to be carried out to prepare a robust service and infrastructure improvement plan.

Figure 1: About the city-level assessment and service and infrastructure improvement plan



This requires a thorough understanding of the SWM 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 NUGIP.

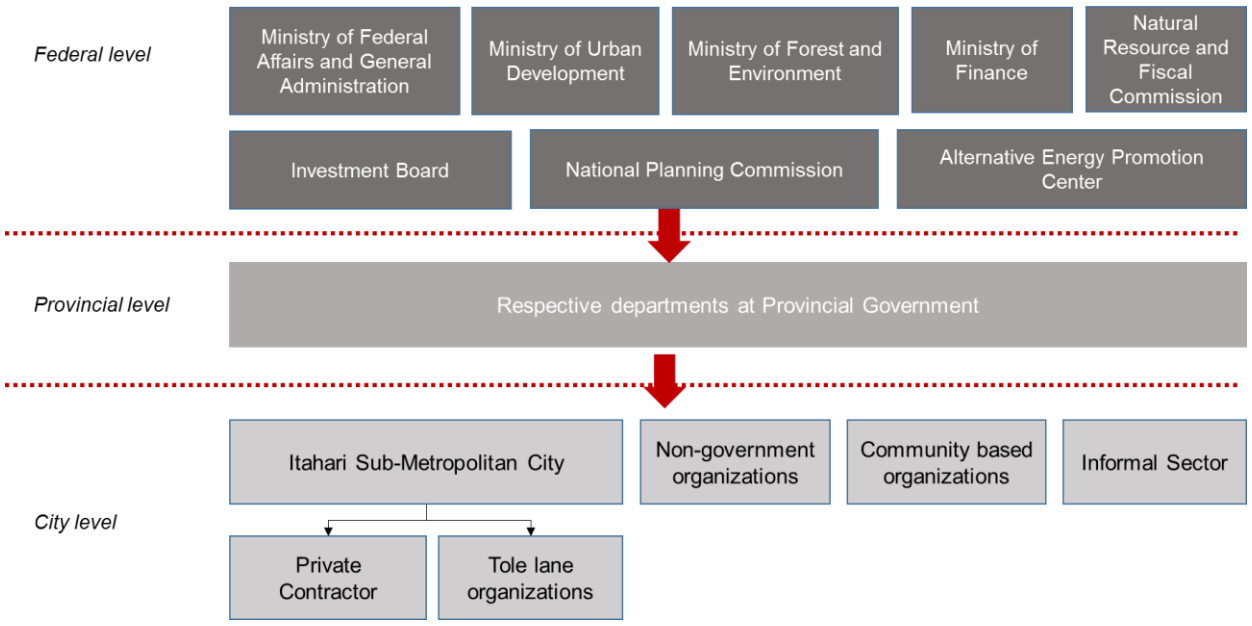
Learnings from this exercise will form the base of a national-level policy advisory to address current SWM problems in cities of Nepal. This deliverable includes key technical, social and environmental challenges that the service is facing and provides comprehensive recommendations for improvement. The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

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

1.1 Federal-level institutional arrangement for SWM

The 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 with regard to technical, operational, financial and environmental management of SWM services, while offering service monitoring-related guidance to local governments. Along with these, the Investment Board Nepal (IBN) and PPP center (established under National Planning Commission) are some of the other federal level organizations supporting local governments in developing projects on a PPP basis. Focusing on SWM, provided below a schematic of institutions present at various levels, and their roles and responsibilities.

Figure 2: Schematic of institutional arrangement



1.2 Legal provisions impacting SWM operations

Owing to rapid urbanization and the economic upgradation of its residents, there has been a marked increase in the quantity of solid waste generated in Nepal's cities. It was expedient for the Government of Nepal (GoN) to ensure cities managed their waste effectively and systematically by reducing waste at source, re-using waste to the greatest extent possible, and disposing residual waste in an environmentally effective manner to negate the negative impact on the environment and general public health.

It was in this regard that the GoN formulated the Solid Waste Management Act, 2068 (2011)—SWM Act, which has been further strengthened by the Solid Waste Management Rules, 2070 (2013)—SWM Rules.

The following section presents an assessment of the SWM Act and SWM Rules and defines the roles and responsibilities of stakeholders at the federal and local levels.

1.2.1 Solid Waste Management Act, 2068 (2011)

The SWM Act defines what construes solid waste generated in the city and provides the legal and regulatory framework for local governments to: a) manage the waste generated in their jurisdiction; b) engage private as well as other entities in SWM; c) institute a mechanism at the federal level to provide continued policy and regulatory guidance to local governments to better manage the solid waste generated and; d) guide local government on how to engage the local communities affected by the development of solid waste disposal facilities. An assessment of the Act, presented in Table 1 below, looks at provisions with respect to two parameters i.e., institutional and service delivery.

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

Sr no	Parameter	Provision
Institutional parameters		
1	SWM council	A 25-member SWM Council has been constituted at the federal level to formulate a SWM policy in Nepal. The council is chaired by a minister from the Ministry of Local Development and has representatives 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, chief of municipalities from five development regions of Nepal, representatives from Chamber of Commerce, specialists and scientists working in the SWM sector.
2	Responsibilities, power and duties of council	The SWM council shall formulate the SWM policy to be approved by the GoN, fix standards to determine user charges to be levied by local governments or undertake any other function as prescribed. It is mandated that the council meet at least once a year.

Sr no	Parameter	Provision
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 is in solid, liquid, gaseous, thick liquid, smoke, or dust form damaging the environment or materials and equipment used for electrical or information technology or any other materials of such nature or unauthorized posters, pamphlets posted in public places or other substances prescribed as solid waste through the publication of a notice in the Nepal Gazette by the GoN from time to time.
4	Responsibility for management of solid waste	Local governments are responsible for 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 body 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 sector body can obtain a license from the local government for the management of generated solid waste by submitting an SWM plan, as well as 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, based on the pre-condition that the proposed technology will be transferred to local government within a stipulated time period (as per the agreement). Local government, post a due competitive process, can appoint a company or a community organization through a license to manage waste in its jurisdiction to enhance community awareness, collect and transport solid waste, use, reuse, recycle or process solid waste, dispose of solid waste and management of the disposal site after closure.
6	SWM procurement through competitive modes	Procurement of a private company or 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, its 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, the management of the entity, and the royalty to be paid to the local government in case of solid waste reuse recycling.
7	SWM through PPP	The local governments, within the provisions of prevailing laws, could 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 raising awareness for waste reduction, collection of solid waste, post- closure management of landfill, construction of gardens or beautification.
10	Committee for landfill-affected area	A local-level 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.

Sr no	Parameter	Provision
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 generators shall minimize the waste generated by disposing or reusing the same within their own premises (house compounds, industrial/ hospital premises etc.).
2	Waste segregation	Local governments shall advise the waste generators to segregate waste into organic and inorganic waste.
3	Waste collection	Local governments could make necessary arrangements for the same by providing waste collection containers (terming them waste collection centers/ secondary collection points) in every '*tole*' or settlement for efficient waste collection.
3	Waste transportation	*From point of generation to collection center*: A waste generator shall be liable for transportation of waste from the point of generation to the collection center. The local government shall support the same by providing the required technology, goods, equipment and containers, etc. *From collection center to transfer station/SWM site:* Local government shall be liable for transfer of waste from the collection center or secondary collection point to either the transfer station or the SWM site. *Transportation vehicle:* A prescribed transportation vehicle shall be used for transportation of waste, considering the weight, age and load capacity of the vehicle, as well as the condition of roads to be traversed and the environment impact of the waste transportation.
4	Waste collection timings	Local governments shall define the time, place and manner in which the solid waste needs to be discharged.
5	Reduction, reuse and recycling of waste	Local governments shall take necessary steps to encourage reduction, reuse of solid waste and issue directives for its effective implementation. Also, local government can coordinate with industries to encourage them to reuse the packaging material used for industrial products.
6	Transfer center/secondary collection point	Local governments can fix a location within the city for primary storage of waste, taking the environment and public health into consideration.
7	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 can lease land the if such land is not available with the local government. Landfills can be developed on private land as well. Local governments shall, if suitable land is unavailable with it, identify the land parcel on which the landfill can be developed and request the Ministry of Federal Affairs and General Administration (erstwhile *Ministry of Local Development*) to make such land available to the local government through land acquisition under prevailing laws.

Sr no	Parameter	Provision
8	User charges	Local governments can fix a service charge and realize the same 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 through an understanding with the local government can collect a service fee from waste generators, with a discount for underprivileged sections of society.
9	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 it. The master plan shall cover areas such as building roads, offering electricity supply, drinking water, sewage discharge, and sanitation and environment conservation, establishing and operating schools and health facilities, and running programs for the uplift and development of the economically disadvantaged and socially underprivileged in the landfill-affected area.

1.2.2 SWM Rules, 2070 (2013)

The Solid Waste Management Act was strengthened by the enactment of SWM Rules in 2013 which provides details regarding the execution of provisions of relevant sections of the SWM Act. Assessment of the SWM Rules, presented in Table 2 below, looks at provisions from two areas, i.e., institutional and service delivery-related.

Table 2: Key provisions of SWM Rules, 2070 (2013)

Sr no	Parameter	Provision
A	***Institutional Parameters***	
1	Committee to monitor SWM services	The SWM Rules prescribe there shall be a federal-level committee to monitor segregation, processing, discharge and final disposal of solid waste. Such a committee shall be comprised of seven members, one each from the Ministry of Local Development, Environment—Science and Technology, Urban Development, Health and Population, SWM Technical Assistance Center, Federal Affairs and Local Development. The committee may also invite a sector specialist as it deems fit.
2	Private sector engagement in SWM	A company or organization can apply for license to the local government to provide waste management services by providing information (in addition to what is required under the SWM Act) such as desired working area for SWM, arrangement of land required for the services to be provided, 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. Such issued licenses can be revoked if the conditions mentioned therein are violated or any prevailing standard for solid waste management or any environmental law is violated or the license is not renewed.

Sr no	Parameter	Provision
3	Engaging Non-governmental organizations (NGOs)	A local government can empower an NGO to segregate, reduce solid waste at source, reuse/recycle solid waste generated and mobilize community for awareness generation to improve the management of solid waste generated in the city.
4	Compliance with prescribed standard	A private body obtaining a license from the local government to manage a landfill or waste processing site shall do so in compliance with the standard prescribed by 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 can also give a concession on the predetermined service charge of up to fifty percent (50%) to underprivileged groups, considering the economic condition of the waste generator. Such underprivileged groups shall be identified on a yearly basis by local governments. Local governments can also 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	The local government can 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	The local government shall make arrangements for segregation of harmful or chemical waste through the respective waste generators and the 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 the 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 the harmful waste can the generated waste be mixed with the general waste for final disposal.

Sr no	Parameter	Provision
4	Transportation of waste	Local governments while selecting vehicles for transportation of solid waste shall ensure that no waste is visible, there is no spillage during transportation, no leachate or odor escapes, the waste can be easily loaded and unloaded and the vehicles are conducive to the road capacity and condition.
5	Sanitary landfill facility	***Operation of the sanitary landfill facility*** Operations of the sanitary landfill facility shall be conducted in a manner that reduces the adverse impact on the environment 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 the negative impact on the environment of the area by the leachate, gas, obnoxious odor, etc., emitted 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 re-using 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[2]) enacted by the MoFE. The EPA and EPR 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 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 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 need to be strengthened. The following table presents such areas of the Act which need to be strengthened.

[2] 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 will be officially published repealing the EPR 1997.

Table 3: Key issues in current regulatory provisions

Sr 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 bio-medical waste. Globally, considering the public health impacts of the municipal waste and other waste, i.e., industrial and bio-medical waste, there are separate policy regulations for each category of waste. It is therefore needed that municipal waste is segregated from the definition and there are separate policies required for hazardous and non-hazardous industrial waste as well as bio-medical waste management in local governments of Nepal.
2	Waste streams	The 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 needs to clearly define construction and demolition waste and plastic waste which needed to managed and processed separately.
3	Waste treatment	Provisions of the current Act clarify that waste generators need to reduce the waste at generation and ensure segregation at source. The waste is to be collected from specific waste collection points and needs to be disposed in a manner, time and location of the final discharge of the collected waste. However, the Act needs to mention that no waste can be disposed without treatment.
4	Site for waste management facility	The Act gives powers to the local government for identification of land for the transfer station and landfill post considering the prevailing environment standard. However, it needs to state clearly the norms or guidelines (through a support guideline) if an environment law does not prescribe any such provisions.
5	Regional faculties	The current Act fixes the responsibility of waste management with the respective local government. However, often, local governments themselves are not capable of envisaging regional waste management facilities or common waste management facilities to share the financial burden such facilities. State governments, in such a case, 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 with regard to waste management in Nepal, it is essential the Act warrants each local government to generate basic information on solid waste management, i.e., estimated generation and collection of waste. The details of the means of waste 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 in creating technical guidance and policy for supporting local governments in managing their waste.

Sr no	Provision of the Act	Remarks on strengthening
7	User charge/Service fee	The Act prescribes that the service charge shall be made on the basis of quantity, weight and nature of solid waste and other matters as prescribed by the local body. However, there is substantial variation in the quantity and the 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 on how local governments charge the waste generators, the Act needs to clearly state the methodology to charge the waste generators.
8	Engagement of informal sector	There is no provision of engaging the informal sector whose livelihood is dependent on the city's waste management system, i.e., the ragpickers, recyclers, etc. This informal sector is an integral part of the overall waste management system and provisions with regard to inclusion of the informal sector need to be made a part of social policy in the Act.
9	Monitoring	In the current institutional framework at the federal level, there is no entity which is monitoring the provisions 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 provisions of the Act is needed to ensure 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.

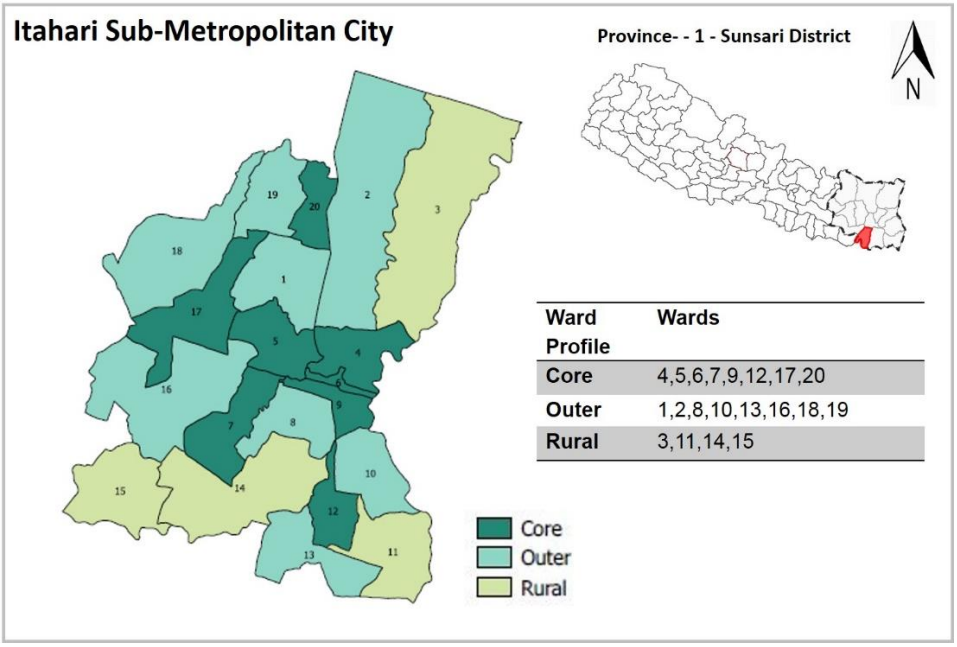
1.3 Institutional and regulatory framework for SWM in Itahari

1.3.1 City profile

Itahari, a sub-metropolitan city, falls in Sunsari district in Province No 1 (whose district capital is at Biratnagar, about 23 km from Itahari). It is the largest city in Sunsari district in the Koshi Zone of south-eastern Nepal. Itahari is located at the main transport node of eastern Nepal i.e. at the center of the east-west Mahendra Highway and north-south Koshi Highway, and is, therefore, is a city of promise. The North-South (H08) and East-West highway (H01) cross at the center of Itahari. The administrative jurisdiction of Itahari Sub-Metropolitan City (ISMC) is 93.78 sq. km. The city is surrounded by the Morang district in the east, Ramdhuni Municipality in the west, Dharan sub-metropolitan city in the north and Duhavi Municipality in the south. The city is divided into 20 wards, housing a total population of 140,517 (Census 2011). The nearest airport from the city is Biratnagar, which is well connected to Kathmandu with daily flights. Though the city is divided

into 20 wards administratively, certain wards are highly populated compared with other wards that are predominantly rural and sparsely populated. The following figure presents the location of the Sunsari district in Nepal and the distribution of wards in the city.

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

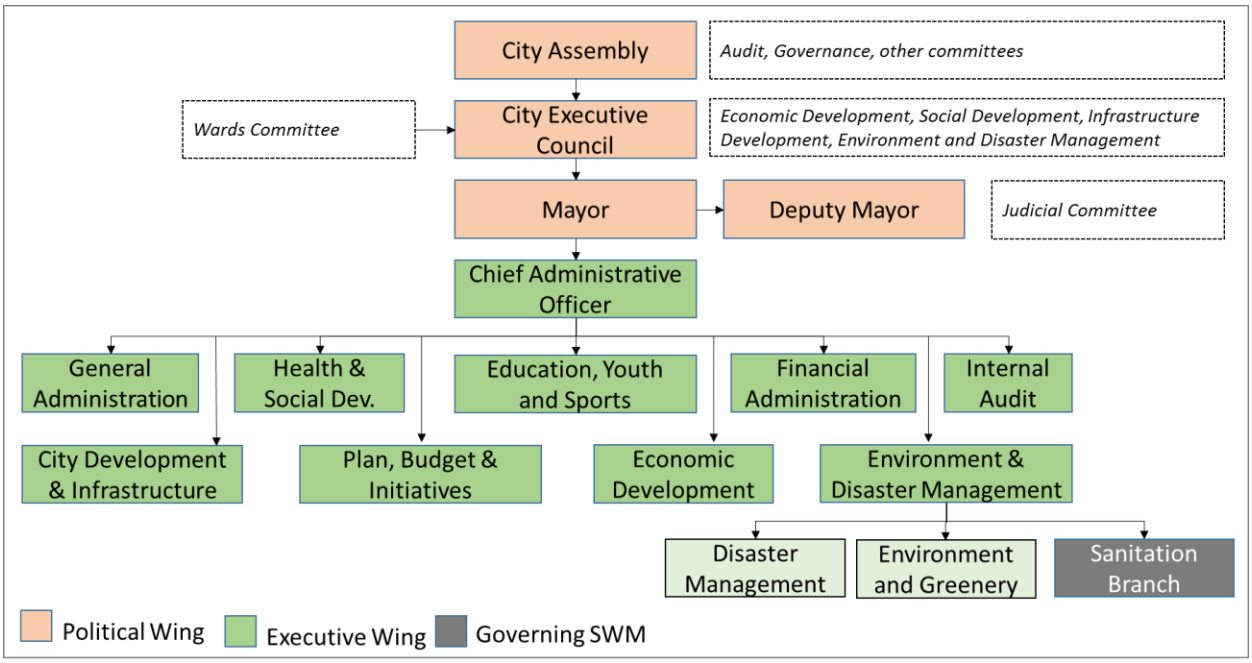


1.3.2 City administration

The urban local level in the city is divided into two distinct pillars, i.e., 1) the political wing, namely the city assembly and city executive council, headed by a mayor and deputy mayor, and 2) the administrative wing headed by a chief administrative officer (CAO). The city assembly is the apex decision-making body in the city, followed by the city executive council. For community and stakeholder participation, in each function of the city's development, various committees are formed in the ISMC having representation from the political wing, administrative wing, the industry concerned and citizens. These committees are chaired by the mayor or deputy mayor and work under either the city assembly or city executive council. A three-member judicial committee works directly under the deputy mayor as s/he is assigned judicial powers.

The ISMC has nine functional main branches responsible for a delegated functional responsibility. Each of these main branches is then further divided into subject-specific sub-branches. The following diagram presents the organizational structure of ISMC.

Figure 4: Organizational structure of the ISMC

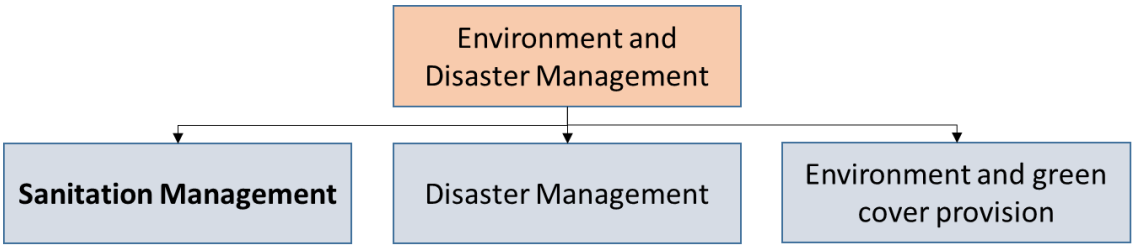


1.3.3 City's institutional arrangement for SWM

The environment and disaster management main branch has a total staff strength of 12 (refer Table 4), with further disaster management, sanitation management and environment and green cover provision sub-branches.

The following are the key responsibilities of these sub-branches:

Figure 5: Sub-branches of environment and disaster management division



- ***Sanitation management:*** SWM in the city is monitored by the sanitation branch, which is currently staffed with only one environment engineer. This branch is also responsible for construction of public toilets and other sanitation facilities, construction of storm water drains, water quality management, and public taps, etc.

- ***Disaster management***: This section looks at management of disasters such as fires, floods, earthquakes, snake bites and any accidents occurring within the jurisdiction of the city
- ***Environment and green cover provision***: This section is responsible for development of green cover, prevention and control of industrial pollution, etc.

Table 4: Staffing of environment and disaster management branch

Sr no	Branch	Positions sanctioned	Number of positions
1	Environment and disaster management main branch	Officer (General administration—GA)	1
2	Disaster management—Sub-branch	Officer (GA)	2
		Executive assistant (GA)	1
3	Sanitation management—Sub-branch	Officer (GA)	2
		Environment engineer	1
		Executive assistant (GA)	1
4	Environment and green cover—Sub-branch	Officer—2	2
		Environment inspector	1
		Executive assistant (GA)	1
	Total		12

Source: ISMC

Though the environment and disaster management division has a sanctioned staff strength of 12 people and the sanitation branch responsible for looking after SWM has a staff strength of four, currently the sanitation branch has only one environment engineer.

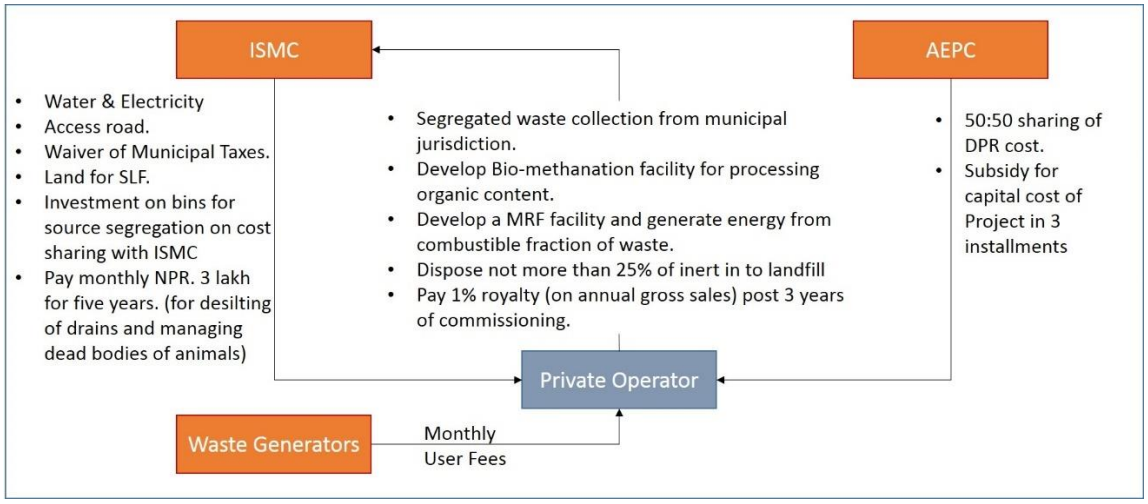
SWM in Itahari

SWM in Itahari is currently limited to collection, transportation and disposal of waste at the designated site identified by ISMC. On April 27, 2018, ISMC signed a long-term (20-year) contract on public-private partnership basis with (WEMPL/private operator) for waste management operations in the city. This private operator is responsible for the collection and transportation of waste from the ISMC area. Additionally, the private operator is responsible for processing the biodegradable waste using anaerobic digestion, adopting a suitable material-recovery facility for segregation of biodegradable and recyclable waste, generating energy from combustible waste and ensuring that not more than 25% of waste received at the processing facility is disposed in the landfill. The ISMC will arrange necessary land for disposal of inert. This project is supported by the Alternative Energy Promotion Center (AEPC) under the *Renewable Energy Subsidy Policy 2075 (RESP 2075)* and AEPC is a joint concessioning authority along with ISMC. Very recently, the private operator has received authorization for the construction of a waste-processing facility. Till

the time the waste processing facility is developed, the private operator will collect and transport waste from the city. The waste is disposed in a nearby forest (Charkose Jhadi) without any pre-treatment.

RESP 2075 provides subsidies to biogas-based projects implemented at the domestic as well as commercial and municipal levels. The GoN has received proceeds from the International Bank for Re-construction and Development (IBRD) towards the scaling-up of a renewable energy program, while AEPC is the nodal agency for implementing projects under this program. The ISMC expressed its desire for the development of a waste-to-energy facility in Itahari on a PPP basis for management of waste generated in Itahari and approached the AEPC. In 2017, AEPC initiated a feasibility study for development of a waste-to-energy facility using anaerobic digestion technology to process the organic waste generated in the city. Post the feasibility study, through a competitive bidding process, the WEMPL was selected to develop this waste-to-energy facility on a PPP basis.

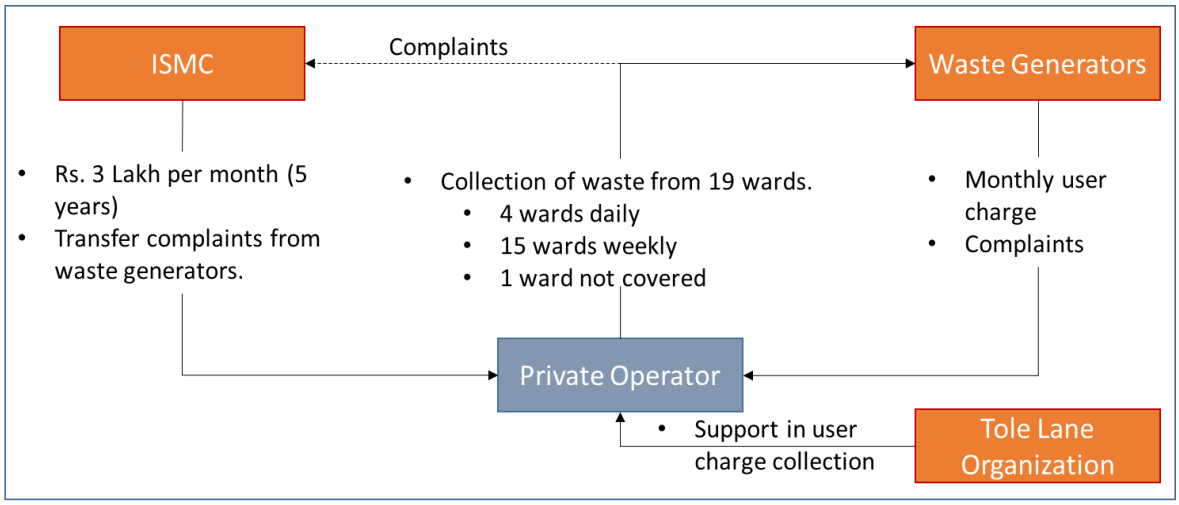
Figure 6: Contract structure of proposed waste-to-energy project



1.3.4 Roles and responsibilities of key stakeholders in SWM

At present, apart from the ISMC, which monitors the services of the private operator mainly based on the resolution of the complaints received from the waste generators, tole lane organizations (TLOs) also play a key role in local-level SWM in Itahari.

Figure 7: Role of stakeholders in SWM in Itahari



The private operator has been engaged with the ISMC through a formal long-term contract. However, the engagement between the TLO and the private operator is not known to be either formal or informal. Also, there is no proactive engagement of TLOs in supporting the waste management activities of the ISMC, though it is recommended.

SWM Committee in ISMC

ISMC has formed an internal SWM and monitoring committee, which is responsible for monitoring the activities related to SWM. This committee has 11 members and is chaired by the deputy mayor. The members of the committee are the chief administrative officer, representative from environment sub-committee, ward chairman, representative from industrial association, provincial traffic department office, recyclers' association, representative from WEMPL, chief - environment section.

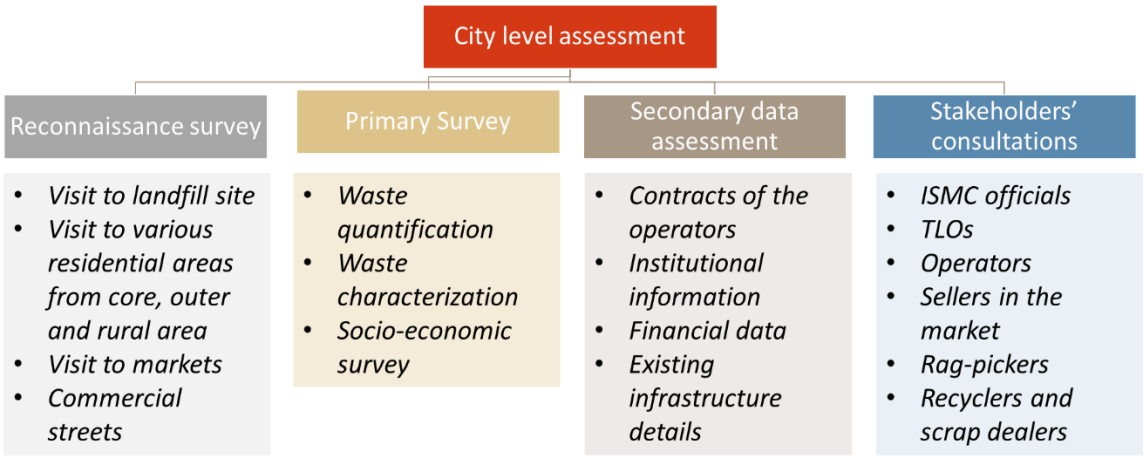
1.3.5 Local-level policy, rules, and regulations impacting SWM

The GoN has formulated the 'Solid Waste Management Act, 2068 (2011)' and the corresponding Solid Waste Management Rules, 2070 (2013) to guide the urban local level (ULL) in managing and monitoring the municipal solid waste generated within their respective jurisdiction. As per Article 51 (2) of the SWM Act, the local body concerned can formulate and implement the necessary guidelines for SWM. However, there are no regulations or policies prepared for SWM in Itahari except Pollution Prevention and Control Rules, 2075 (2018), which are applicable to issues related to industrial pollution in the city. Though the city has prepared this regulation in 2018, ISMC has not yet implemented these rules. However, Itahari city administration is in the process of framing local rules related to SWM on similar lines as the national SWM Act and SWM Rules.

1.4 Methodology of city-level assessment

The city-level assessment includes baseline assessment of the waste and waste generators, institutional and governance systems, technical assessment of the service-delivery model, municipal financial assessment and the environmental and social systems in place for safeguarding the environment and the informal sector. The assessment was done using a two-pronged approach, i.e., through surveys, reconnaissance and waste quantification, characterization and socioeconomic profiling and through consultations with various stakeholders and assessment of information received from the officials of the local government.

Figure 8: Methodology for city-level assessment



1.4.1 Reconnaissance survey

Prior to the reconnaissance survey, a discussion was carried out with the officials of the ISMC and it was agreed to visit each ward of the city to assess the current situation of waste management through a visual observation. Reconnaissance visits were carried out to various residential and commercial areas to observe waste management practices, i.e., storage of waste, segregation, waste-disposal mechanisms, cleanliness of the streets and public areas. A similar visit to the existing dumpsite was also carried out to obtain a deeper understanding of the current waste disposal practices. The market areas were visited to understand the waste generation and disposal pattern of the bulk generators.

1.4.2 Primary surveys

Assessment of per capita waste generation norms as well as understanding the physical and chemical character of waste was essential to design the service-improvement plan, more specifically, the infrastructure improvement plan in terms of collection, transportation, processing and disposal component of the SWM value chain. Understanding the profile of waste generators in terms of their perception regarding the current service delivery model, affordability of current user charges, their willingness to pay additional user charges for improved waste

management practices, and their sensitivity with respect to the waste management facility being developed in their vicinity was required to be assessed through questionnaire based socioeconomic surveys. A primary survey of 100 waste generators for waste quantification, characterization and assessment of the socioeconomic profile, and behavioral analysis of waste generators was carried out. These 100 waste generators were divided into 81 households/domestic generators, 11 commercial and 8 institutional waste generators and these are sampled from across ISMC, capturing various income levels.

Table 5: Sampling of primary surveys (waste and socioeconomic profiling survey)

Wards	Households			Commercial			Institutions	
	HIG	MIG	LIG	Hotels	Restaurants	Shops	Academic institutions	Offices
Core	14.00	10.00	9.00	3.00	2.00	3.00	2.00	2.00
Outer	10.00	9.00	9.00	1.00	1.00	1.00	2.00	2.00
Rural	6.00	8.00	6.00	-	-	-	-	-
Total	30.00	27.00	24.00	4.00	3.00	4.00	4.00	4.00
Grand Total	100.00							

Source: Primary survey conducted in October 2019

The same 100 waste generators were considered for the: (i) socioeconomic survey; and (ii) waste quantification and characterization survey.

1) ***Socioeconomic survey***—This was aimed at understanding the demographic profile, economic profile of the respondents, waste management practices, awareness of the waste generators about the SWM services in the city, affordability of SWM charges and their willingness to pay for the service being provided.

2) ***Waste characterization and quantification—***To normalize the variation in the quantity of waste generated, a three-day (two weekdays and one on weekend) sampling was undertaken from domestic waste generators and a two-day (a week day and a weekend) sampling from commercial and institutional waste generators. Quantification and characterization surveys were carried out at the source (upstream) as well as at the dumpsite (downstream) to understand the loss/leakage of waste from source to disposal.

1.4.3 Stakeholder consultations

Consultations were held with the officials of the ISMC to understand the institutional structure governing SWM, awareness generation and environment and social management practices used by the ISMC. Similar consultations were carried out with ragpickers to understand the engagement of the informal sector and their livelihood dependency linked to waste management. TLOs were also consulted to understand integration of TLOs in conducting information education and communication (IEC) practices, the role played by TLOs in the waste management value chain and their concerns regarding current service delivery models. Discussions were also held with

communities in the downstream of the disposal facility, which have been impacted by the disposal of waste and related activities in their vicinity. Waste recyclers were also approached to understand the extent of recycling activities in Itahari and quantum of material recovered before final disposal.

1.4.4 Secondary data analysis

CRIS' team collected the necessary information from ISMC pertaining to municipal finance, institutional and governance structure. A private operator was approached to understand the infrastructure and resources deployed for waste management services.

This methodology has been followed for ISMC's city-level assessment. Compliance with the regulatory set-up, 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 Itahari. The technical assessment encompasses service-delivery model and infrastructure availability in Itahari across the SWM activity chain. The 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 ISMC, with focus on SWM. Based on the assessment, gaps and issues in service delivery have been identified.

2.1 Technical assessment of infrastructure and service delivery

Assessment of waste management infrastructure in Itahari is done for municipal solid waste and other waste streams such as biomedical and construction and demolition waste. The assessment has been carried out across the activity chain based on: (a) reconnaissance survey, observation-based analysis; (b) primary survey; and (c) secondary information assessment. The following sections describe the SWM practices of the city and highlights the issues thereof.

A reconnaissance survey was done in the city to understand the key issues in each component of the value chain of waste management. In order to assess the quantity and character (physical and chemical) of waste, a primary survey was carried out. For secondary information assessment, detailed consultations were carried out with various stakeholders, i.e., officials from the ISMC, private operators engaged in management of solid waste generated in the city, waste recyclers, health institutions, TLOs, rag-pickers and impacted stakeholders such as the community from the villages near the existing dumpsite and educational institutions in the vicinity of the proposed waste processing facility.

To assess the waste generation profile of the city, 100 waste generators were covered in the primary waste characterization and a quantification survey. Same set of waste generators were covered under a questionnaire based survey for assessment of their socio-economic profile, affordability of current SWM user fee and willingness to pay for additional SWM fee, awareness and practices w.r.t SWM. These 100 waste generators covered 81 households/domestic generators, 11 commercial and 10 institutional waste generators and were sampled from across ISMC jurisdiction. (Refer to Annexure A.1).

2.1.1 Observations of reconnaissance visit

A reconnaissance survey was done across the city to identify the primary issues with waste generation and its management in Itahari. Following are the observations based on the reconnaissance visit conducted in the city.

Separation of recyclables during waste collection

Bags for collection of recyclables

Separation of recyclables

Separation of recyclables

Separation of recyclables

Waste collection activity was in progress during the site visit to the city. It was observed that helpers support collection of waste once the vehicle arrives at a designated location. The first activity they undertake is to collect waste in a trailer and separate material with economic value, i.e., recyclable material such as plastic, paper, glass bottles and metal. A substantial amount of time is spent in separating such materials. The time taken for separation of recyclables at each waste pick-up location delays overall waste collection activity and collection vehicles are able to make just one trip a day to the disposal site. To collect more recyclable waste, which is an additional income (shared between driver and helpers), they prioritize waste collection in areas where such waste is predominant, i.e., commercial areas, and then focus on others.

Waste being piled up to be collected

Un-attended waste (W-5)

Waste disposed in Khetikhola river (W 5 & 6)

Waste disposed on road side (W-5)

Waste stored for pick vehicle

During the visit to the city, it was observed that in the morning time, waste was lying on the sides of the road unattended, since the timing of waste disposal by the waste generators and the arrival of the waste collection vehicle did not match. Due to this mismatch, there are locations where waste generators leave waste in the open. If not attended to in a short span of time, there is a chance that these spots in the city could become mini dump sites. Such instances lead to waste disposal on the road side, more frequently on the roads passing through core wards with high population and commercial activity.

Storage of waste by waste generators in wards with weekly collection.


Storage of waste for a week - Commercial


Storage of waste for a week - residential


Storage of waste for a week - Commercial


Storage of waste for a week - residential

Residents and commercial units in rural wards of the city, where population density is low and waste collection happens once in a week, store their non-organic waste using plastic bags, cardboard boxes and plastic containers. The stored waste is given to the waste collection vehicle, as and when it arrives. However, in rural wards, it is observed that people use organic waste either to be converted into compost or to feed their cattle. It is observed that indiscriminate disposal of waste on sides of the streets and water channels is not practiced in rural wards.

Waste disposal in water canals across outer wards.


Waste disposed in Khetikhola river (W 5 & 6)


Waste disposed in canal


Waste floating in canal (W 12)


Waste disposal in water body near to WN 9

There are various water bodies and streams flowing from north to south through Itahari city. The sides of these water bodies have indiscriminately become a usual spot for waste disposal. It was also observed that there are certain commercial units that are dumping waste in the water body below an irrigation canal.

2.1.2 Municipal solid-waste profile

Profiling of municipal waste generated in Itahari as well as that of waste generators was done through primary surveys and questionnaire-based socioeconomic surveys, respectively. Primary surveys were done to estimate the total waste generation and arrive at a per-capita waste generation norm; the surveys were undertaken through waste-quantification surveys. Waste-sample collection from waste generators from each category were analyzed to assess the physical and chemical character of waste generated through established waste characterization methods, as agreed during the inception phase.

2.1.2.1 Assessment of waste generators

Households and commercial establishments (such as hotels, shops, restaurants, malls) and bulk waste generators such as vegetable and fruit markets, and weekly markets are major contributors

to waste generated in Itahari. For an overall understanding of the waste generators, a reconnaissance survey was carried out in various identified areas. The following are our observations:

Domestic waste generators	Domestic generators are primarily household dwellers in MIG, LIG and slum/rural areas. In most cases, domestic waste generation is primarily organic in nature. The dry domestic waste is sold to the walking recyclers at the household level. The organic waste in rural areas is kept within the premises and is fed to the cattle. In other areas, waste is stored for a couple of days and a collection agency comes and collects the waste from residents on a weekly basis.
Commercial and bulk generators	Bulk generators are markets from where a substantial quantity of organic waste is generated. These are Khanar market in ward number 10, RCT market, Tarhara market, and various weekly markets, such as Pokhli market, Labipur market and Pothrokhhi market. These weekly markets are organised by the vegetable, fish and other household consumable product vendors in various locations in Itahari. The market committee of ISMC has appointed a local contractor to collect all the market waste at a common place, either within the market or adjoining to the market. From this point, an ISMC-appointed waste collection and transportation operator agency takes the waste directly to the designated disposal site.

2.1.2.2 Waste quantification

For quantification of waste generated in Itahari, a primary waste survey from 100 different waste generators was conducted, wherein daily waste samples from each waste generator, as per the sampling plan presented in section 1.4.2, was used. An assessment of the survey results has revealed that the quantity of solid waste generated in Itahari is ~58 MT daily. Of the total waste generated, 48% of the waste is contributed by domestic waste generators, i.e. households, 19% waste is generated by commercial establishments and the rest is generated by bulk generators such as weekly and other regular markets and institutions. A waste-quantification exercise was also undertaken at the current waste disposal facility and it has been assessed that the site receives 26 MT of waste daily.

Table 6: Summary of waste quantification survey

Sr no	Particular	Quantity (MT/day)
A	**Primary waste quantification results**	
1	Estimated waste from households	28
2	Estimated waste from in bulk generators	11
3	Estimated waste from commercial establishments	19
4	Estimated waste from institutions/offices	01
B	**Total waste generation**	**58**
C	**Estimated current population of ISMC**	**157457**
D	**Estimated per capita waste generated per day (gram)**	**369**
E	**Average waste quantity received at the dump site**	**26**

Source: Primary survey, October 2019

2.1.2.3 Waste characterization

Physical classification of the waste generated in Itahari was done in six categories, i.e., organic, plastic, paper, glass, rubber, textile, metal and others (inert/dust/silt). Chemical parameters of the waste generated include moisture content, bulk density, organic content, calorific value, carbon-to-nitrogen ratio and total solids. For the assessment of physical and chemical characteristics of waste, samples of waste generated in the upstream and the waste received at the landfill facility were analyzed for assessing the physical and chemical characteristics.

Table 7: Summary of waste characterization survey

Sr no	Parameter	Unit	Point of waste generation	Downstream sample
A	**Physical composition**			
1	Organic	**%**	44.37%	65.15%
2	Plastic	**%**	4.82%	8.07%
3	Paper	**%**	5.79%	5.65%
4	Glass	**%**	36.05%	16.07%
5	Rubber	**%**	0.09%	0.65%
6	Textile	**%**	1.71%	2.32%
7	Metal	**%**	4.21%	2.09%
8	Others	**%**	2.95%	0.00%
B	**Chemical composition**			
1	Moisture content	%	64.06	58.37
2	Bulk density	kg/m^3	187.18	271.27
3	Organic content	%	44.36	61.15
4	Calorific value	Kcal/mg	1,893.00	2,016.00
5	Carbon/Nitrogen ratio		64.17	52.10
6	Total solid	%	35.94	41.63
7	Volatile Solids (VS)		79.26	67.11

Source: Primary survey, October 2019

2.1.3 Collection and transportation of waste

Waste management in Itahari is limited to collection and transportation of waste to the designated disposal site. Until 2018, Enviro Care Concern Pvt Ltd (ECCPL) was appointed for collection and transportation of waste to the designated disposal site for five years. The city has entered into a 20-year-long PPP contract with WEMPL, a company promoted by the same promotor of ECCPL. WEMPL is currently engaged for collection and transportation of waste from 19 out of 20 wards of Itahari. Ward 14, which is rural in nature and has a low population density, does not have any waste collection service. WEMPL collects waste from households, commercial areas, partly from bulk generators (weekly markets, vegetable markets, hospitals) and lifts carcasses, sweeps main roads and undertakes drain de-silting.

Waste is stored by the waste generators in primary storage bags/bins and is kept on the road, which is then collected by the helpers of each waste collection vehicle. Waste is collected either

on daily or weekly basis. Core wards, which are completely urbanized and have main markets and commercial areas, have a daily waste collection service. Outer and rural wards, which are semi-urban or rural in nature, have a weekly collection service.

2.1.3.1 Bin system for primary storage

There is no standard bin system for storage of waste at the primary level. Waste is stored at the household level (usually in plastic bags) and then directly disposed of in waste collection vehicles or dumped on the roadside. Additionally, it was observed that certain waste generators, such as hospitals and markets, store waste in plastic drums, which are kept on the roadside for the waste collection vehicle to pick up the waste. It was also observed that in certain commercial areas and rural wards some local-level organizations provided litter bins for storage of waste.

Primary storage of waste

Waste stored by eateries

In-organic waste stored in bags

Waste stored by malls

2.1.3.2 Bins for storage of waste from floating population

As waste is accumulated by the floating population visiting the main commercial areas, various local organizations, such as the local community in Bhawanipur village in ward number 2 and Liberal Society in ward number 5, have provided litter bins for disposal of waste generated by the floating population. As a result, the ISMC has decided to provide eco-friendly litter bins, which can be tied to the streetlight poles and electricity poles for ease in waste disposal. However, there is no standardization in the design of such bins as well as their provisioning across the city.

Litter Bins in Itahari

BhavaniPur ward

Commercial area

Provided by ISMC in Ward -6

2.1.3.3 Secondary collection points

There are no intermediate or secondary collection points (SCPs) or transfer stations in Itahari. The private operator had once proposed/planned to install a secondary collection point in Itahari. However, the community protested against this proposition and, due to the lack of favorable place to put up such an SCP, this proposal was not taken forward.

2.1.3.4 Collection and transportation schedule and task force

There are 10 waste collection vehicles that are deployed daily for collection of waste from the city of Itahari. On a daily basis, all vehicles collectively make 10-12 trips for disposal of waste on a daily basis. Waste collection starts from 6:30 am and disposal continues up to 4:00 pm. Each collection vehicle, a tractor-trailer, is driven by one driver and is accompanied by 3-4 helpers. The private operator has 11 drivers, who are supported by 49 helpers for collection of waste and disposal at a designated disposal site. However, non-hazardous waste from industry and healthcare establishments is collected by the private operator. The management of the private operator, including the waste management activity, is undertaken by a staff of 99 members.

Table 8: Staff strength of private operator

Sr no	Position	Male	Female	Total	Primary responsibility
1	Manager	011	-	01	Responsible for management of revenue collection activity
2	Supervisor	01	-	01	Supervision of waste management operations
3	Office staff	-	04	06	Day-to-day accounting and administrative task
4	Collectors	-	13	13	User charge collection
5	Drivers	11	-	11	Drivers for 10 waste collection vehicles
6	Helpers	51	-	51	Support waste collection activity
7	Sweepers	03	15	18	Sweeping of designated stretch of streets
	Total			99.00	

Source: Waste & Enviro Management Pvt Ltd, Itahari, Nepal

Except the collectors, all other staff are working on a full-time basis with the private operator. Collectors are appointed on a commission basis on the amount of user charge they collect on a monthly basis. Based on the discussion with the operator, if the cumulative amount of monthly collection by the respective collector is at least NPR 150,000 or above, the applicable commission to be paid to the collector would be 12% and, if the amount is less, the applicable commission to be paid to the collector would be 10%. Apart from the commission, they are also provided with a monthly allowance of NPR 1,500 and NPR 1,000 towards travel and food-related expenses, respectively.

2.1.3.5 Collection and transportation infrastructure

The private operator has 10 tractors attached with a box trailer with a capacity of three metric ton (3 MT), which are engaged in waste collection and transportation. They also have cycle trolleys for collection of waste in the city. Such trolleys have a capacity of collecting 400-500 kg of waste.

These waste collection vehicles move around the main roads in the designated wards and helpers with each vehicle pick up the waste kept by the waste generators and dump it in the trailer.

Waste collection vehicles

Waste Collection Vehicle

Trailer for waste storage

Tractor-Trailer

Each vehicle has been assigned 4-5 helpers to gather waste, which has been kept by the waste either in plastic bags, cardboard boxes or other primary storage. Once the collected waste is dumped in the vehicle, these helpers extract recyclable materials from the waste received. Such recyclable material is stored in separate large plastic bags attached to the waste collection vehicle. This activity of extraction of recyclable material continues for the entire day, and at the end of the day all the collected recyclables are sold to the local recyclers and the proceeds from such sale is distributed between the driver of the vehicle and all the helpers. While, this material extraction helps in reducing waste, the time taken for extraction of recyclables delays overall waste collection activity.

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2.1.3.6 Frequency of waste collection

ISMC has 20 administrative wards, of which, only four wards (5,6,9,10) have daily collection service of waste. Ward number 14, being a rural area with very limited quantity of waste generation, is not covered under waste-collection services. For all the remaining wards, a specific day within a week is assigned for collection of waste. A specific waste collection vehicle is assigned for these wards to collect the waste on weekly basis on a designated day.

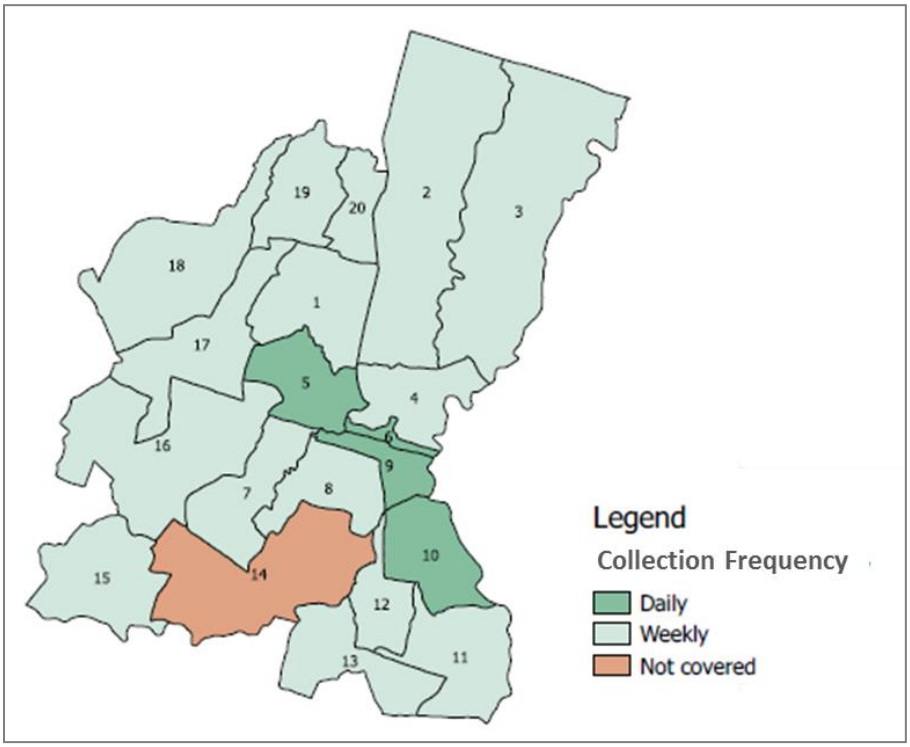
2.1.3.7 Street sweeping

The main roads and streets are swept daily from 3:00 am to 6:30 am. The main roads of ward numbers 4, 5, 6, 9, 13, and 20 are swept. Each sweeper is given a bead length of 300 meters. They only use a broom for sweeping. No mechanical or automatic road-sweeping machine is available in the city. Approximately a road length of 5.5 km is swept every day in Itahari. In commercial areas, businessmen and shop owners manage to sweep the road in front of their shops using their own means. However, no guideline is given to the road sweepers. When the waste collector arrives, a whistle is blown, so that people in the locality can bring their waste and hand it over to them.

2.1.3.8 Coverage and collection efficiency of service

Based on the review of vehicle-wise collection schedule of the waste collection service, it was understood that of all the wards, only four wards (ward numbers 5,6,9 and 10) have waste collection on daily basis, covering 21% of Itahari's population. All the remaining wards, except ward number 14, are covered through a weekly waste collection service covering close to 75% of the city's current population. The remaining 3% population residing in ward number 14 is not covered under the waste collection service as this ward is completely rural in nature.

Figure 9: Ward-wise waste collection frequency



Waste quantification and characterization surveys carried out during this assignment revealed that, total waste generated in Itahari is 58 tons per day. To assess the quantity of waste reaching the landfill facility, a three-day survey was carried out to determine the number of waste collection vehicles and quantity of waste reaching each dump site. Results of the waste quantification surveys undertaken at the dump site revealed that almost 26 ton of waste is dumped per day.

2.1.3.9 Waste value chain

Primary survey for the waste characterization and quantification was carried out to estimate the quantity of waste generated in Itahari. Also, the physical as well as chemical character of the waste generated and estimate of per capita daily waste generation norm which is used in estimating future waste generation trends and design solid waste management infrastructure was assessed through this primary survey.

Basis the primary waste survey it is estimated that in Itahari, 58 MT of waste is generated daily. Of the total waste generated at the source, dry waste having an economic value is recovered across the SWM value chain. The first level of recovery happens at the source where the waste generators segregate dry materials such as plastic, paper, glass and metal which is sold to retail recycling agents who collect recyclable material from door-to-door. The second level of waste recovery happens during waste collection and transportation, wherein the workers engaged in collection of waste further recover recyclables during collection and transportation. This is sold to recyclers at the end of each work day. The third level of material recovery happens at the dumpsite where 8-10 ragpickers recover recyclables from the waste that is dumped at the disposal site. To understand the waste management practices followed by the waste generators in Itahari a socioeconomic profiling survey was carried out with the same set of waste generators, who were used for the waste quantification surveys. Analysis of the socioeconomic survey information reveals that of the total respondents from the wards, in the core area, 16% segregate their waste in wet and dry fractions, and similarly, 57% of the waste generators segregate their waste in the outer areas. Also, 16% of respondents from core wards, 66% from outer wards and 29% from the rural wards practice some way of composting the wet waste, which is generated at the source. When this information is looked at an aggregate level, it assessed that 30% of respondents practice some kind of waste segregation, and 41% practice home composting.

The waste, which is not segregated and recovered at the source, is the mixed waste to be collected by the private operator. In core wards, waste is collected daily, whereas in the rest of the wards, waste is collected on a weekly basis, except in ward number 14. It was observed that since waste is collected on weekly basis from the rural households, they use the organic waste to either feed the cattle or to convert it into compost. The commercial establishments, especially hotels and restaurants, separate the bottles and cardboards from the total waste and sell them to the recyclers. The institutional establishments use a small fraction of wet waste in gardens and part of dry waste such as paper is sold to the recyclers. Based on collection frequency and existing practices, Table 9 presents the recovery assumptions applied to the generated waste.

Table 9: Assumption for recovery of waste at source of generation

Area Source	Core		Outer		Rural	
	Wet	Dry	Wet	Dry	Wet	Dry
Households	16%	16%	66%	57%	29%	0%
Bulk	-	-	-	-	-	-
Commercial establishments	-	70%	-	30%	-	30%
Institutions and offices	-	50%	0%	50%	70%	50%

Source: CRIS assessment

In addition to the waste recovered at the source of generation, the primary socioeconomic survey revealed 48% of the respondents from the core city area practise open dumping or burning of waste. Similarly, 40% of respondents from the outer area and 52% respondents from the rural area follow such practices. Based on the responses received in the socioeconomic survey and results from waste characterization survey, the quantity of waste that is dumped in the open or burnt is assessed.

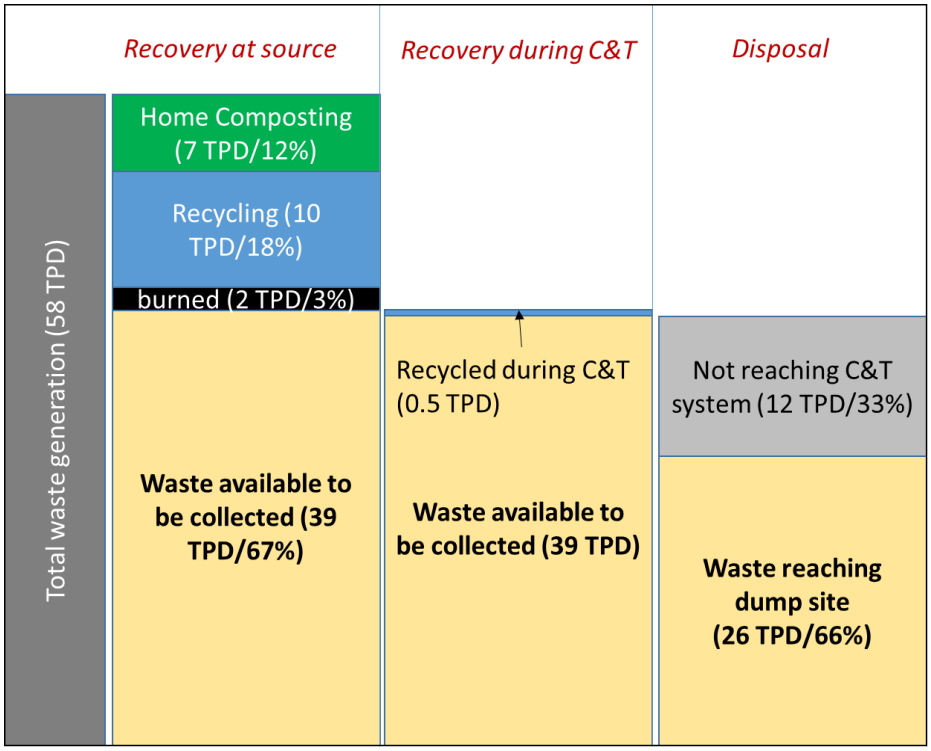
Table 10: Assessment of waste dumped in the open or burnt

Particular	Core	Outer	Rural
Respondents practice open dumping or burn the waste	48.00%	40.00%	52%
Burnable waste of dry waste (considering only paper and plastics are burned)	8.68%	24.95%	11.15%
Quantity of waste burned (TPD)	0.50	1.01	0.14
Total (TPD)		1.64	

Based on these assumptions, following is the waste diversion and flow:

- Seven TPD wet waste and 10 TPD dry waste are segregated and recovered at source. Recovery means the wet waste is used to produce compost or used to feed cattle. Dry waste is sold to individual or retail recyclers. The dry waste is composed of plastic, glass, and paper
- Additional 0.5 TPD recyclables are recovered by the workers engaged in collection and transportation, considering each waste collection recovers 50 kg recyclables daily
- As per the primary survey, about 46% of the respondents mentioned that they dump waste in any open field or burn, in case they do not give it to the waste collection vehicles. Based on this, 1.64 TPD waste is not given to the collection vehicles, and is either burnt or dumped in the open.

Figure 10: Waste flow diagram - Itahari



- As per the primary survey results, on average, 26 TPD waste reaches the disposal site. This means 13 TPD waste is not collected. Because of the frequency of collection, the waste is either stored within the premises or disposed in water bodies or nearby areas, and does not reach any waste collection stream.

2.1.4 Processing and treatment of waste

Itahari city does not have a processing or treatment facility in place till date. In the absence of any waste treatment or processing facility, whatever waste is collected from the city is taken to the designated dump site by the private operator.

2.1.4.1 Proposed waste-to-energy project

The ISMC had taken an initiative during 2016-17 to set up a 30 TPD waste-to-energy plant, through bio-methanation technology with support from AEPC. For this purpose ISMC has identified a site near Khanar market (please refer *Figure 11* below) at ward no 10, which would receive mixed waste from the city. The site is located three km north of the Itahari chowk and near Dumor Takka. It is adjacent to Budhi Khola (Budhi River) river bank. The area of the site is 2.37 hectares (3.5 bigha) and is identified by ISMC.

During the site visit, it was understood that there is a school within 500 meters from the site. The concession agreement for this project has been signed with Waste and Enviro Management Pvt Ltd (the same private operator engaged in collection and transportation). ISMC has the responsibility to facilitate the private operator with light, access road, three-phase electricity and community coordination for installation of the waste-to-energy plant at the proposed site. In addition to these, ISMC will pay NPR 3 lakh each month for a period of five years for de-siltation of drains and managing dead bodies of animals in the city to the private operator.

The proposed capacity of the plant is 30 TPD, which is designed for mixed waste with pre-sorting provision. The output of the plant would be gas and fertilizer (soil enricher). The gas generated from the plant will be sold to nearby hotels and industries (present in wards 4 and 6) in 100/200 liter capacity cylinders and the fertilizer would be provided to farmers, tea gardens of the Government of Nepal (at a subsidized rate). The Private Operator is required to share 1% of the annual gross sales with ISMC after 3 years of project commissioning till the rest of the concession period[3]. As per the agreement signed by the AEPC, ISMC and private operator, the operator is required to prepare a detailed design report (DDR) of the proposed project and submit it for technical approval from the AEPC. The DDR has been prepared and the key features are presented in the table below:

[3] Agreement further states that this figure of the royalty to be paid to the ISMC might change after five years upon mutual consent looking into profit/loss statement of the Private Operator.

Table 11: Key features of detailed design report for the proposed waste-to-energy project

Sr no	Parameter	Features
General		
1	Name of the project	Waste-to-energy, using anaerobic digestion (biogas) on a DBFOOT basis.
2	Location	Itahari Sub-Metropolitan City, Nepal
3	Project site	Ward 10. Khanar, Sunsari
4	Region	Eastern Development Region
5	Zone	Koshi
Population data		
6	Household	51,989
7	Commercial	1,699
8	Institutions	113
Estimated waste—2019		
9	Waste generation	37.06 tons/day
10	Collection efficiency	62%
11	Total waste collected	17.77 tons/day
Waste character—Base year		
12	Organic content	12.85 tons/day
13	Inorganic content	10.12 tons/day
14	Cow dung	3.75 tons/day
15	Poultry litter	6 tons /day
Plant details		
16	Plant capacity	30 ton /day
17	Expected quantity of crude gas	2525 m^3/day
18	Estimated natural gas	1050 m^3/day
19	Land area	4864 m^2
Financing sources		
20	Project cost	14.91 crore NPR
21	Equity contribution	2.83 crore NPR
22	Subsidy	5.22 crore NPR
23	Debt	6.71 crore NPR

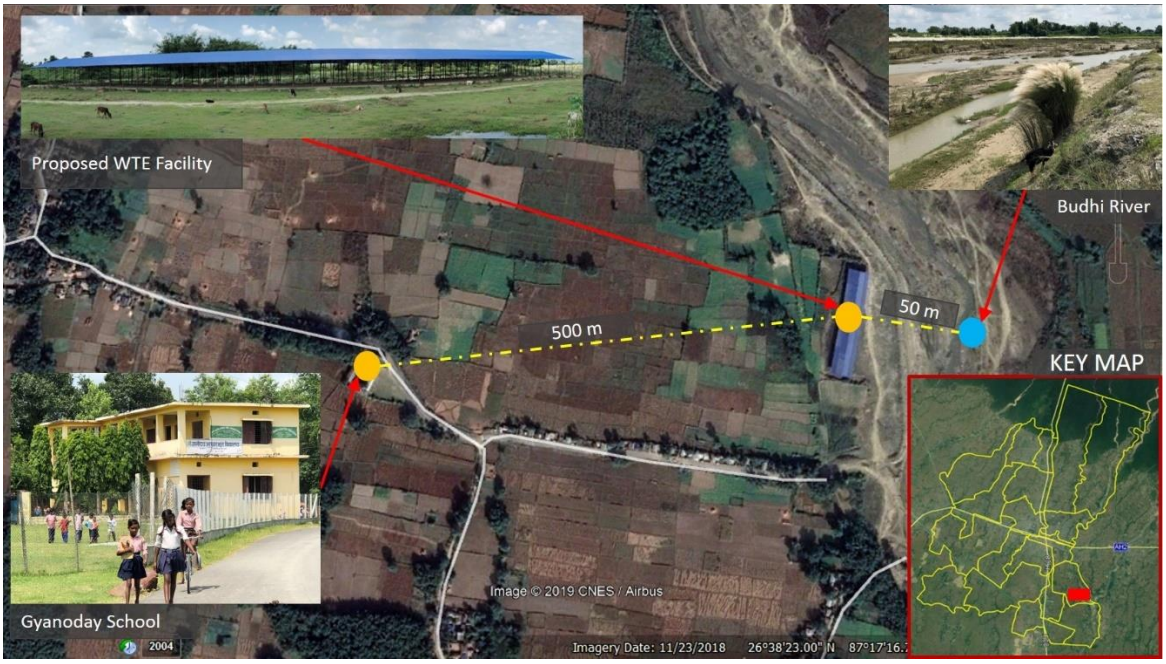
Source: Detailed Design Report, Waste to Energy Project, 2019

Although the establishment of this waste-to-energy plant was conceptualized and initiated long back and the concession agreement has been signed in 2018, the physical construction of the same has started in February 2020 upon approval of the project from AEPC.

Observation: The current identified site for the development of the waste-to-energy facility is on the bank of a river, and the distance between the project facility and the river is less than 50 meters. To continue utilizing this land for development of the waste-to-energy project facility, sufficient studies, measures and checks should be taken. During the site visit to the project facility, it was understood that the river expanded and the river water entered the project site two years ago during monsoon. Also, movement of waste vehicles in front of the school shall increasing the risk of accidents involving the students of the school; this risk will also have to be considered.

In the previous compost plant project, the boundary of the site was not defined and the boundary wall could not have been constructed. Now, it is expected that a three-side boundary wall will be constructed by ISMC and one side will be built by the private operator. The construction period of the plant has been planned as eight months, whereas the operation and maintenance (O&M) period will be for 20 years. During the period, no financial aid will be given by the ISMC to the private operator.

Figure 11: Location and setting of land for development of proposed waste-to-energy facility



2.1.4.2 Stakeholder's consultation with a school near the proposed waste-to-energy plant

As mentioned earlier, there is a school near the waste-to-energy plant. The school, Sri Gyanoday Adharmut Vidyalay, has 230 students (117 boys, 113 girls) with three male and eight female teaching staff. The school starts at 10 am and ends at 4 pm. It has classes from kindergarten to grade 8. It was observed that the school composts the organic waste generated in the premises and the resultant compost is utilized as manure for plantation within the school premises. The school's administration is aware of the upcoming plant in their vicinity and has raised the following concerns with the proposed project:

- Since the project is a centralized waste management facility, the number of vehicles plying on the road adjoining the school will increase drastically. Operating at high speed, these vehicles will constitute an accident risk for students at the school's start and end time
- Waste being collected and brought to the centralized facility will be mixed in nature and will generate a lot of odor while being transported to the facility. Any spillage of waste from the collection vehicles will create a health risk for the students

2.1.5 Disposal of waste

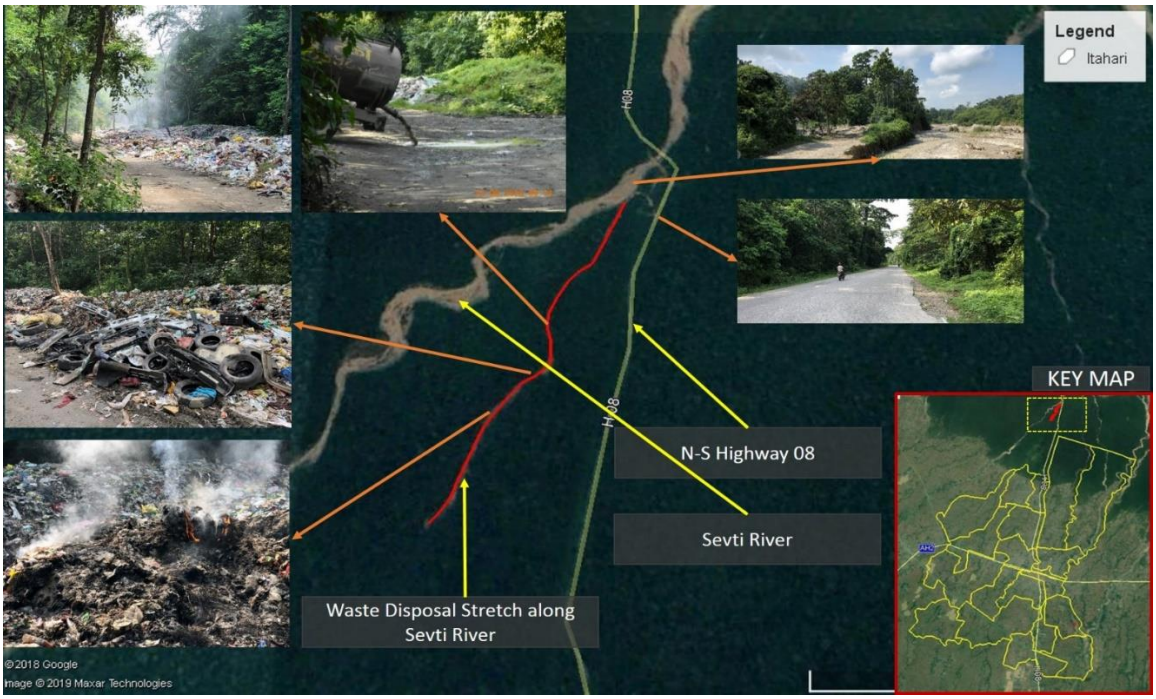
2.1.5.1 Historical disposal sites

Itahari city does not have any engineered landfill site. The current waste disposal site was identified five years back. Prior to that, in the absence of an organized waste collection and transportation system in the city, all waste was disposed indiscriminately on the roadside, in the forest, rivers or any available place. Once the capacity of these sites saturate or if nearby communities start objecting, they were covered with soil and closed. There are six such locations in Itahari. They are either used as a weekly market or parking lots now.

2.1.5.2 Present disposal site

As the ISMC exhausted all such sites for waste disposal, it identified land in a nearby forest, Char Koshe Jhari, which is 11 km away from Itahari Chowk, the city's center. This area is around 12 km wide along the Sevti River (known locally as *Sevti Khola*) that runs from the north to the south of the city. The mixed waste, which is not segregated at the source, is collected and dumped along a stream emerging from this river.

Figure 12: Details of the current disposal facility



2.1.5.3 On-site observation at disposal facility

The current disposal facility is ~11 km away from Itahari Chowk, along the North-South (Koshi) Highway. The access road to the site is unpaved and originates from the main highway. The site is a 4 km stretch along the water stream that runs parallel to the Sevti River (refer to Figure 12). The same access road is used by trucks that dispose fecal sludge along this stretch too. Waste is dumped on both the sides of the water stream, creating mounds on both sides. At present, the waste mount is 1.5 meter in height and approximately 3.5 meter in width. Waste is being dumped here for the past four-five years. On close observation, it was found the waste dumped here has a substantial share of plastic content.

Disposal of waste along the stretch of Sevti River

Access road to dump site and stretch of waste disposal	Waste mounds across stretch	Plastic waste piled up

Waste from across Itahari reaches the site. It includes all kinds of items discarded, such as sofa sets, televisions (e-waste), bags, and mattresses. Waste from small-scale industries—end-of-life material such as tires and non-recyclable scrap—also is dumped here.

Disposal of e-waste and bulk waste items at present disposal site


Tyre and other vehicle waste at dump site


E-waste at dump site


Disposed furniture at site


Other bulk waste at site

Waste is set on fire at various spots along the dump site. Ragpickers working at the site said local residents set fire to wires and other items with plastic insulation to extract the metal inside. The fire then spreads to the combustible waste around it. The resultant smoke is leading to health issues among the ragpickers working here. It was understood in the past there were conflicts between local residents (practicing open fire) and ragpickers regarding open burning of waste. However, such conflicts have stopped since ragpickers now avoid confrontations with the local residents.

Burning of waste at disposal site


uncontrolled burning of waste across stretch

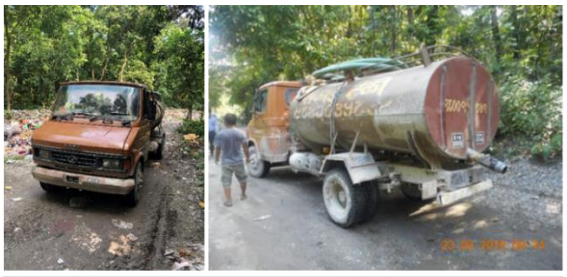

Burning of waste


Burning of waste for copper wire extraction


Wires after burning of waste

The site is also being used to dispose untreated fecal sludge collected from individual houses. Fecal sludge is collected by various private tanker operators from the city and is dumped here. It is estimated such tankers make approximately 30 trips to the site daily.

Discharge of fecal sludge at disposal site


Septage disposal vehicle at dump site


Direct disposal of septage at dump site and resultant leachate

Five-six ragpickers, including females, are seen working at the disposal site at any given point of time. They work without any personal protective equipment (PPE) and get injuries such as cuts by needle, glass or other metal items.

Ragpickers working at disposal site

Ragpicker working without any PPE

Ragpicker collecting recyclables

Ragpicker collecting recyclables

Female ragpickers

Observations:

- In Nepal, the forest and its resources are managed by nearby communities. The part of the forest used as disposal site falls under the Hash Posha community forest in ward number 1, and has an approximate area of 177 ha. Waste is disposed in a 4 km stretch along the left bank of the Sevti River. The waste mount has an average width of ~3.5 m and a height of 1.5 m. A village called Bhawanipur is located downstream, 4 km away. During the monsoon, a tributary of the river carries waste to this village. Though the villagers have protested several times, ISMC has managed to negotiate with them and continue the disposal of waste at the site. On a visit to the current disposal facility, we saw a lot of plastic waste dumped there.
  - It is also critical to mention that this site receives fecal sludge collected by various private septic tank cleaners. The liquid waste is disposed directly on the ground and contaminates the soil, ground water and surface water. About 30 tankers of such waste is disposed at the site every day
  - A visit to Bhawanipur revealed that burning of waste at the disposal site gives rise to a lot of smoke which reaches the village and creates health issues among the residents

2.1.5.4 Assessment of potential leachate generation

Itahari falls under the western development region of Nepal and receives an annual rainfall of 2,007 mm. The assessed approximate footprint of the current disposal site is 14,000 m^2. Considering the annual precipitation, four years of waste disposal at this site, and surface runoff factor of 65%, it is estimated that total leachate generated at the site would be close to 39,337 m^3 (details of this calculation in Annexure A.4).

2.1.5.5 Interview with a male ragpicker at disposal site

There are 12-13 ragpickers (both male and female) working at the waste disposal site, collecting recyclables. They have been working here for the past two years. Normally, they pick plastics, water bottles, and metal items and sell them to recyclers in the Itahari city market. They do not

collect any bulk recycling items. Local recyclers (known locally as *kabadiwalas—i.e. recycling material aggregators*) act as a link between ragpickers and recycling factories located at Dubchi, Bhadrapura, etc. Ragpickers work here five days in a week, collect the recyclables and sell the collection once a week to local recyclers. Their workhours are 8:00 am to 3:00 pm, with an hour's break. During the work, they do not take any food but drink water from the local tank. They estimate 2-3 kg of recyclable recovery from one truck of waste (~2 MT). They sell plastic bottle at NPR 12 per kg, plastic packets at NPR 15 per kg, glass bottles at NPR 12 a kg, aluminum tins at NPR 5 a kg, and cardboard boxes at NPR 5 a kg (on dry basis).

On average, each of them have three members and only one person earns through ragpicking (earnings ratio of 1:3). Their average daily earning from ragpicking is NPR 500 (~NPR 15,000 a month). After their work at the disposal site, they also do daily wage jobs such as making photograph frames, working at mirror shops, etc., which fetch them an additional income equivalent to what they earn from daily ragpicking. They do not use any PPE while working at the disposal site and get injuries, such as cut on their hands by syringe/ broken glasses, etc. frequency of such injuries is once or twice a month. They tried using pollution masks for 15 days but stopped using them as they are not habituated to use them daily, they do not frequently get their replacement once PPE are damaged and keeping PPE clean is a task for ragpickers. Before they started working at the disposal site, they never experienced any health issues. But nowadays they suffer from cold, cough and weakness about twice a year.

Ragpickers working at disposal site without any PPE

Working without any PPE

Working without any PPE

Rubbing tobacco in hands

The ragpickers do not have even a minimum level of awareness about the health and occupational hazards of their work. During waste collection, they rub tobacco on their hand with fingers and chew it. They are not organized as a community or under an association who could appraise them of various health issues or safety aspects of their work.

They said ISMC had order stoppage of waste burning at the site. However, people from *Panwara* (nearby community) violate this and set fire to the waste in order to extract copper from plastic insulated wires. Earlier, the ragpickers used to confront with the residents from *Panwara* community who adopted such practice of setting fire to extract metals but stopped as it did not help. The ragpickers have now stopped interacting with them. A few of the ragpickers are originally from Professor Colony in Bihar, India.

2.1.5.6 Interview with female ragpickers at disposal site

We also interviewed female ragpickers at the disposal site. It was understood they work three days a week owing to health issues. For the past three years, they have been picking recyclable waste from the disposal site and selling it at the Biratnagar recycling market. They collect plastic bottles and packets and metal items and mostly sell to local recyclers. Plastic bottles are sold for NPR 12 a kg, plastic packets for NPR 15 a kg and metal items for NPR 10 a kg. They are from joint families with eight members on average, including children. There are other earning members in the family as well. Unlike male ragpickers, they do not have any additional avenues of income and their monthly earning from ragpicking activity is ~NPR 10,000. According to them, cuts by syringe and broken glass are some common minor injuries they get while working at the dump site. They usually visit a doctor twice a year for common cold and if the injuries are major.

Young female-rag pickers working without any PPE

In the morning, they cook food and then come to the site. After returning home in the evening, they get involved in domestic work. They also send their kids to school. However, monsoon affects their livelihood from ragpicking.

2.1.6 Material recovery through informal recycling

There are 15-20 different vendors receiving recyclable waste through other small-scale recyclers or daily ragpickers. During the city visit, we interviewed the largest trader of recyclable waste material. In the following section, we present details of the interview and information on informal recycling in the city. Located in Narangopal Tole in ward number 6, *Dilip Kabadiwala* is the largest recycler in the city. He recycles 1200-1500 MT per month, most of which is metal (70% to 75%), followed by paper (20-25%) and plastic (1-2%). The remainder is glass beer bottles and aluminum beer cans (details in Annexure A.3).

Storage of recyclables

Broken glass bottle

Paper and card-board

Cans and bottles

Metal scrap

On average, *Dilip Kabadiwala* sells ~1,300 MT recyclables per month. If a material recovery facility (MRF) is introduced in the Ithari, his business would not get affected since he receives recyclables, mostly from the domestic level small walk-in ragpickers. Buying and selling rate of various items, as revealed in a market assessment through this vendor, are presented in Table 12 below:

Table 12: Rates of recyclables in Itahari

Sr no	Items	Unit	Buying rate (NPR)	Selling rate (NPR)
1	Beer bottle	per bottle	3.50	3.70
2	Metal	kg	29.00	30.00
3	Paper	kg	24.00	25.00
4	Plastic	kg	Varying	Varying
5	Tin	kg	80.00	85.00

Source: Primary interview

Observation: There are 15-20 recycling vendors in the city, but they are not as big as *Dilip Kabadiwala*. The introduction of 13% value-added tax (VAT) and 36% income tax (on selling price) have impacted the industry. When asked whether they would be interested in managing any city or a community-level material recovery facility, they responded stating that they are not interested in running such a facility as they are satisfied with their own business.

Economic potential of recyclables: The total waste generation in Itahari is 58 TPD, of this 3.74 TPD or 6.45% is plastic, 3.32 TPD or 5.72% is paper and 10.60 TPD or 26% is glass (predominantly beer bottles). If this is separated at the source itself, the potential revenue that can be generated from all three recyclable stream is approximately NPR 150,000 daily.

2.2 Assessment of other waste management

2.2.1 Construction and demolition waste

Construction and demolition (C&D) waste in the city is generated from the renovation work of existing built structures or conversion of existing residential property into commercial complexes. However, Itahari city does not have any organized system of C&D waste management. It does not have any dedicated storage or disposal facility for such waste.

Private contractors involved in construction or demolition of any property normally dump it in any low-lying areas, or on roadsides or in forest areas. Sometimes, if the quantity of such waste is huge, they seek the help of ISMC, who coordinates with the private collection and transportation operators. Private operators then authorize the C&D contractor to manage the waste.

2.2.2 Industrial waste

Itahari and its fringe areas have a couple of industrial establishments, such as shoe, cotton, candle, and food manufacturing industries. The industrial waste (mostly liquid) is disposed of in nearby

drains along the North-South Highway. As per the recent survey undertaken by ISMC, there are 148 small- and large-scale industries in the city.

Under the Environment Protection Act (EPA), ISMC stipulates that industries should manage hazardous waste at their own premises. Accordingly, industrial units have established their own hazardous waste treatment system in their premises. However, as a practice, most of them neutralize the waste, and then dispose it in the river.

2.2.3 Bio-medical waste

There are two big hospitals, Apex Hospital and Pasupati Hospital (15-bed) in the city. Apart from there these, there are 15-20 other healthcare establishments, mostly clinics. There is a system to segregate bio-medical waste at source and storage them at the units. Still this waste is seen substantially mixed with MSW. Although hospitals follow a three-bin system, it is collected in a single bag/ container/ vehicle. To understand biomedical waste management system in the city, we visited Apex Hospital and interacted with its staff.

> *Apex Hospital* has been operational since 2007. It has a capacity of 25 beds. On average, it handles 200-225 OPD patients daily across departments. Of this, on average 40 are orthopedics, 40 medicine, 50 general, 40-50 emergency, 15-20 Guiney (Sunday & Wednesday) and 20-25 ENT specialists (Saturday & Wednesday). The OPD distribution depends on availability of specialist doctors.

The hospital runs for 24 hours in three shifts and there are two full-time and six part-time doctors, 16-17 nurses, four managerial staff and five lower level staff.

Segregation of medical waste at healthcare facility

The biomedical waste generated from the hospital includes syringes, needles, plasters, bandages, slightly pathological waste, used gloves and wrapping plastics. Needles, glasses and organic wastes are given to the outside vendor and disposed of from the hospital. The balance waste is treated inside the hospital in an incinerator. There are five dedicated female waste-handlers in the hospital who collect and segregate the waste in bins for different disposal pathways. However, they have not undergone any waste-handling training. They are given gloves and masks to handle the waste. Hazardous waste is kept inside the hospital and a vehicle comes to collect it daily. The

waste collecting agency charges around NPR 15,000-20,000 monthly for the service. The hospital has an incinerator which runs one hour per day (7:00-8:00 pm). It has two autoclaves (20 l and 16 l), sterilizer and needle destroyers.

The hospital does not display any precautionary messages for handlers of hazardous waste. The government has not formulated any guidelines for handling or management of biomedical waste.

The hospital management is of the opinion that the waste should be collected not once but twice a day so that the hospital can avoid storing a huge quantity of hazardous waste in its premises. Another issue is the waste not getting collected at all during festivals when the collecting staff have holidays.

2.2.4 Key issues in service delivery

Key issues with the current service delivery model of SWM in Itahari are unavailability of requisite capacity for service planning, unavailability of requisite infrastructure, absence of service delivery monitoring mechanism, and inadequacy of contracts signed with the private sector in addressing the concerns effectively. Also, lack of institutionalization of community engagement, information education and communication practices lead to lower service levels. Table 13 below summarizes value chain-wise issues with the current service delivery model.

Table 13: Summary of key concerns in existing service delivery model

Activities	Existing practices at Itahari	Identified gaps and issues
Segregation of waste at source	Prevalent predominantly in rural wards where households own cattle or convert waste into compost for agriculture. Recyclables (paper, plastic, metal etc.) are separated to be sold to retail recyclers who collect directly from households.	No organized mandate for waste segregation at source; it is more of a choice for the generators. There is a provision in current PPP contract but is not implemented. Segregation of organic waste is key to success of proposed waste to energy facility.
Collection	Daily collection covers only 21% of the population and weekly collection 75%; 4% is not covered at all. Currently the arrangement is kerbside collection and not door to door. Transportation is not efficient enough due to transit recycling by workers. Delay in collection leads to indiscriminate dumping on the roadsides.	The coverage of waste collection is not 100%. Even in the areas that are covered, collection frequency is an issue. Waste is not lifted on a daily basis and the frequency of waste collection is very low. Residents have expressed concern over the frequency and irregular timing/ scheduling of the collection vehicles. Under-capacity of equipment and vehicles. No tracking mechanism for waste collection vehicle. Not all major are roads covered by sweepers.

Activities	Existing practices at Itahari	Identified gaps and issues
Processing and treatment	No processing of collected waste before final disposal.	No processing and treatment facilities. Land identified for a waste-to-energy facility, which is still in the development stage.
Waste disposal	Waste from the markets is dumped in nearby water bodies. Dumping of unprocessed waste at the disposal site next to the Sevti River. Faecal sludge too is disposed at the same site, increasing the amount of leachate generated.	Unscientific dumping causes environmental and social hazard to the river and soil. A human settlement 4 km downstream of the current waste disposal facility is impacted.
Awareness level and enforcement	ISMC is not conducting programmes for creating awareness about better waste management. Activities are held at the TLO level.	Institutionalization of community-level group is required.
Other waste management	Biomedical waste is getting mixed with MSW.	When part of the medical waste mixes with the MSW stream, it can be a health hazard to the informal recycling sector. Need separate mechanism for collection and management of bio-medical waste.
POLICY AND REGULATIONS		
Local policy, rules/regulation related to SWM	There are no rules or regulations for SWM specific to Itahar. The only applicable rules are pollution prevention and control rules for industries.	The city has not formulated any rule or regulation to follow which can be used for establishing an efficient waste management system.
INSTITUTIONAL AND GOVERNANCE STRUCTURE		
Efficiency of current institutional structure	The environment section that monitors the SWM unit in the city has only one engineer. Only performance evaluation/monitoring mechanism is through complaints or observation.	No established monitoring mechanism for assessing the service performance. The city is entirely dependent on private contractors for any service-related issue. No service-level agreement between ISMC and private contractors. Payments are not linked to service quality.
ENVIRONMENT AND SOCIAL SAFEGUARDS		
Environment norms followed	There are no environment norms at local and federal levels that are followed. No mechanism has been institutionalized for monitoring environment parameters.	Environment impact is not monitored. ISMC should put in place environment norms that should be followed.

2.3 Assessment of municipal finances of the ISMC

2.3.1 Municipal financial assessment

ISMC keeps accounts using the cash-based single entry accounting system with the income and expenditure heads maintained on cash basis. All expenses towards regular operations and maintenance are treated as revenue expenses and those towards new projects/ investments as capital expenses. The accounting and budgeting system records the various line items of receipts, i.e., income and expenditure as per their department and ward offices. The Finance Ministry of the federal government of Nepal has developed the *integrated financial coding and classification and corresponding definition* 2074 (2017) of the income and expenditure class that needs to be followed by the federal, provincial, and local governments. It has also provided an integrated software for management of the financial data. ISMC has been following its financial information based on this manual.

Revenue sources of the ISMC can be broadly classified as internal and external. Funds from internal sources are receipts such as taxes, charges and fees, rents and other charges, etc. Funds from external sources include revenue grants from the provincial and federal governments, loans and contributions received for projects, etc.

The expenditure incurred for salaries and wages, general administration, provision for operation and maintenance of services, and servicing of debt, including the payment of interest and the repayment of loans, are classified as revenue expenditure. The expenditure incurred towards creation of assets and investments made towards new projects or purchases of equipment, etc., meant to create benefits for the ISMC over multiple years are classified as capital expenditure.

The following table presents the component of the municipal finance assessment and the source streams of the corresponding income or expenditure of the ISMC.

Table 14: Classification used for assessment of the ISMC's financials

Sr No	Component	Stream
Revenue receipts		
I	Own source revenue	Main streams of own source revenue are integrated property tax and other local taxes. Other local taxes include, house rent tax, health service tax, education service tax paid by academic institution, transport vehicle registration tax, tax for future service improvement, advertisement tax, and other entertainment tax.
II	Non-tax revenue	Non-tax revenue includes fees and charges levied by ISMC and rental income from municipal properties. Fees and charges levied by ISMC include cinema/ documentary income, business registration fees, vehicle license fees, income from government property maintained by ISMC, other service charges and sale, judicial registration charge, income from the education sector, transport sector income, other administrative service charges, parking charges, building permission fees, recommendation fees, birth/ death/ migration certificate fees, other fees, administrative penalties, other income, payment from stakeholders with regard to irregularities and application duty.

Sr No	Component	Stream
III	Assigned revenue	Assigned revenue to ISMC includes revenue grants received from the federal government; transfer of land tax and the stamp duty from the provincial government.
Revenue expense		
IV	Establishment	Establishment expenditure includes expense towards salary and allowances to staff, expenses towards skill development and training, and other expenses related to staff, i.e., medical expenses, meeting expenses, etc.
V	Administrative	Expense categories such as insurance renewal, stationary, publication management, printing charges, agreement service charges, etc., and rental expenses paid by ISMC are classified as administrative expenses.
VI	Operation and maintenance	Operation and maintenance expenses of the ISMC include water and electricity charges, maintenance of vehicles owned by the ISMC, maintenance works for ISMC-owned properties, charges paid to the SWM private operator, and other service charges.
VII	Program expense	Expenses related to running specific programs such as monitoring and evaluation, social security schemes, scholarship, etc., are classified as program expenses.
VIII	Interest payment	Interest payment on various loans is classified under the interest payment category.
Capital receipt		
IX	Capital grants	Tied grants received from the federal government for infrastructure projects are classified as capital grants.
X	Proceeds from loan	Loan taken for capital asset creation is classified as capital income under the category of loan.
XI	Proceeds from sale of asset	Any capital receipt from the sale of ISMC-owned capital assets is classified as capital income.
Capital expense		
XII	Capital expense	Expenses undertaken for creation of physical assets, i.e., roads, buildings, vehicles, etc., are classified as capital expense.

2.3.1.1 Budget analysis

We have reviewed the ISMC's finances in fiscals 2017, 2018 and 2019, for which its actual income and expenditure details were available. Both receipts and expenditures are classified under revenue and capital accounts as per their sources and uses.

ISMC's revenue receipts declined from NPR 855.96 lakh in fiscal 2017 to NPR 774.33 lakh in 2019, while its revenue expenditure grew from NPR 66.75 lakh to NPR 694.58 lakh. For each of these years, revenue receipt is higher than revenue expenditure, resulting in a revenue surplus. However, with revenue expenditure growing at a higher rate than revenue income, the surplus has decreased over the period of assessment.

During the period, capital income increased from NPR 157.93 lakh to NPR 475.16 lakh and capital expenditure rose marginally from NPR 340.60 lakh to NPR 348.54 lakh.

2.3.1.2 Assessment of revenue account

Revenue receipt

Revenue receipt has been classified into own source revenue (OSR), which comprises tax, non-tax and assigned revenues. Assigned revenue includes federal and provincial governments (stamp duty) and land tax transfer from province in case of Itahari. During the period, ISMC was largely dependent on revenue grants. However, share of revenue grants in total revenue came down from 89% to 37% during the period because in fiscal 2019, the provincial government started sharing revenue from stamp duty with local governments. Meanwhile, share of OSR in total revenue increased from 11% to 21%.

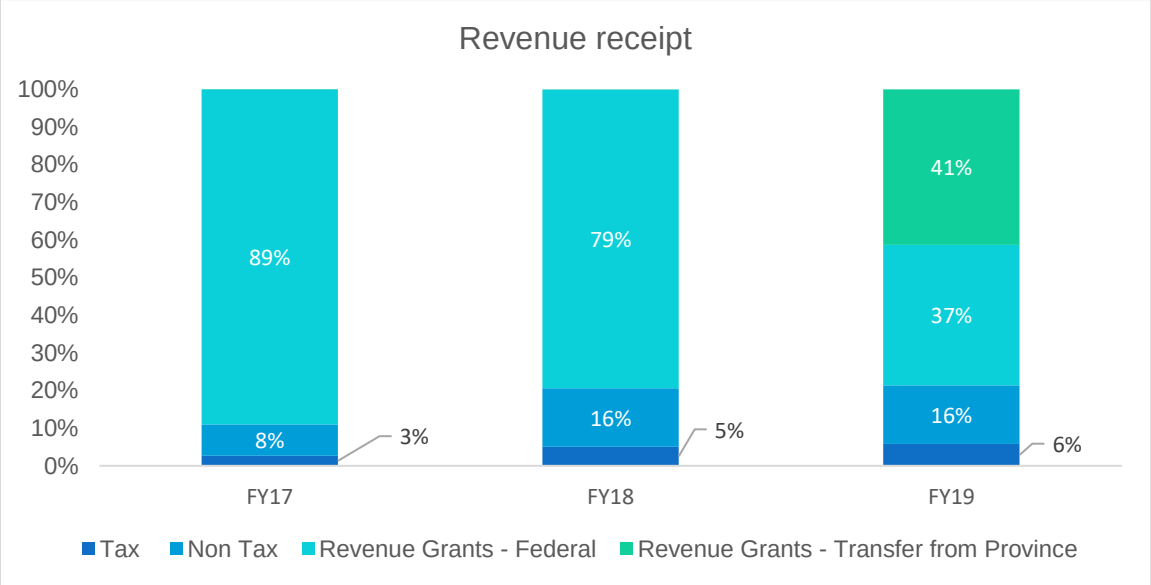
Table 15: Details of revenue receipts

Sr no	Particulars	2073-74 (FY17)	2074-75 (FY18)	2075-76 (FY19)	Average share in total
		All figures are in NPR Lakh			
	Own revenue				
i.	**Tax revenue**	**22.59**	**28.08**	**44.82**	**5%**
	Integrated property tax	18.69	25.75	25.29	3%
	Other taxes	3.90	2.33	19.53	1%
ii.	**Non-tax revenue**	**71.40**	**85.68**	**120.38**	**13%**
	Fees and service charges	60.65	85.68	115.18	12%
	Rental income	10.75	-	5.21	1%
A	**Total (i+ii)**	**93.99**	**113.76**	**165.20**	**18%**
	Assigned revenue				
	Income from stamp duty	-	-	134.68	6%
	Land tax transfer	0.51	0.47	185.31	8%
B	**Total**	0.51	0.47	319.99	14%
C	**Revenue grants**	761.45	438.08	289.14	69%
D	**Other income**	-	0.28	-	0%
E	**Total revenue (A+B+C+D)**	855.96	552.59	774.33	100%

Source: CRIS Analysis

The analysis of financials shows the ISMC is largely dependent on transfers from the federal and state governments for all operations. The share of assigned revenue in its total revenue during the three fiscals under review has been close to 80% (see Figure 13), which implies it is dependent on external transfers to perform basic operations, let alone making capital investments to improve service delivery. Also, the timelines for availability of such transfers and certainty on the quantum of receivables are essential for the city to assess its receivables and make investments it has planned.

Figure 13: Breakup of revenue receipts



Source: CRIS Analysis

Key observations from the analysis of revenue receipts are as follows:

Increased assigned revenue: Owing to recent changes in the governance structure, new revenue sources such as stamp duty transfer and land tax are available to local governments. The provisional government started sharing a portion of stamp duty with local governments from fiscal 2019 onwards, when Itahari received NPR 135 lakh on this count. The provisional government also increased Itahari's share in land tax revenue to 40% in the fiscal. As a result, land tax revenue increased from NPR 0.5 lakh in fiscal 2017 to NPR 185 lakh in fiscal 2019. Though these revenues are not from own sources, they are stable and predictable.

***Increased autonomy*:** Itahari got more power authority over its revenue streams due to the recent institutional changes. A prime example of this is revenue from house rent tax. Itahari revised house rent tax rate in fiscal 2019, which increased its revenue under this head almost six times from NPR 23 lakh in fiscal 2018 to NPR 132 lakh in fiscal 2019.

***Low revenue from service user charges*:** Fees and user charges on an average contribute 12% to ISMC's total revenue. Much of these incomes come from license, registrations and town planning charges. Breakup of other service charges is not available. Even if we were to assume the entire revenue to be from user charge, it is still a mere 3% of total fees and user charge revenue.

User charge for solid waste management: Nepalese city councils usually collect user charge from waste generators every month. However, in Itahari the SWM service is outsourced to a private operator, which collects and retains this as its income.

***High reliance on external revenue sources*:** Over the three fiscals under review, share of revenue from grants by the federal government fell from 89% to 37%. However, transfers from the provincial government have increased. In fiscal 2019, owing to the new revenue stream of stamp duty transfer and increased land tax, there was a rise in the contribution of assigned revenue to

41%. On an average, assigned revenue and revenue grants contribute 82% to ISMC's total revenue. Despite this, its reliance on external sources is high. This directly impacts resource allocation and financial planning as ISMC has no control over the source of a major portion of its income and grants can be unpredictable sometimes. It is essential that the timing and quantum of external income are reasonably certain.

***Decline in revenue*:** Itahari's revenue declined during the assessment period owing to a decrease in grants. While own revenue and assigned income have increased, grants saw a steeper decline.

Revenue expense

The ISMC does not offer any core services such as water supply, sewerage management, etc. So it does not have any expense on account of core services. Its revenue expenses are categorized as establishment expense (salary and wages), administrative expense, solid waste management-related expenditure (charges paid to the private operator for collection of special waste such as C&D, dead animal bodies, cleaning of clogged drains etc.), and interest and program expenditure.

Table 16: Details of revenue expense

Sr no	Particulars	2073-74 (FY17)	2074-75 (FY18)	2075-76 (FY19)	Growth (FY18)	Growth (FY19)
		All figures in NPR Lakh				
	Revenue expense					
1	Establishment expenditure	37.76	42.66	274.62	13%	544%
2	Administration expenditure	9.22	29.51	55.71	220%	89%
3	O&M cost	1.03	3.00	5.27	192%	76%
4	SWM (include cleaning charges)	13.85	11.49	5.66	-17%	-51%
5	Program expenditure	-	3.60	348.33		-*[4]
6	Interest cost	4.88	3.24	5.00	-34%	55%
F	**Total**	66.75	93.48	694.58		

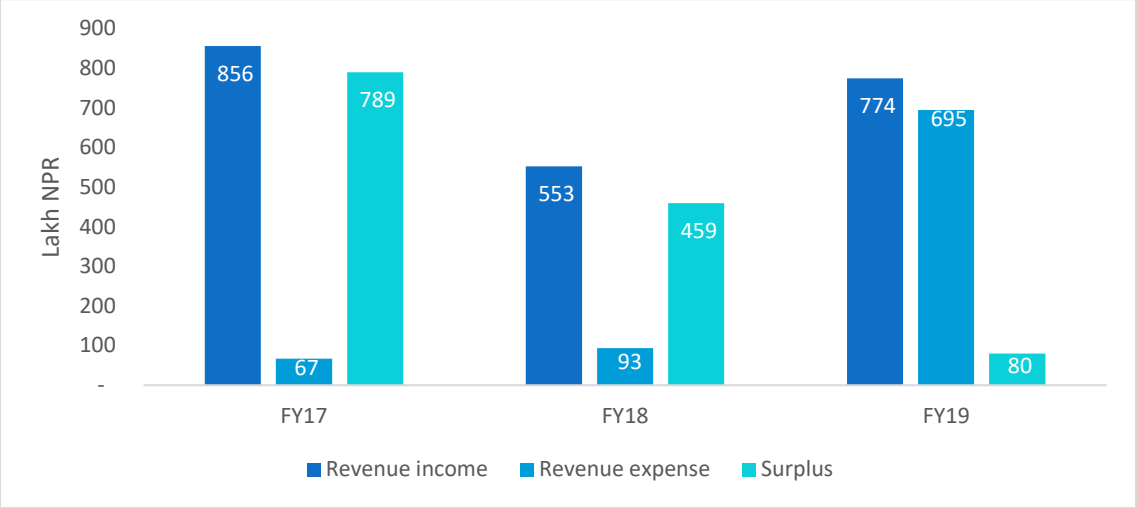
Source: CRIS analysis

Summary of revenue expense assessment: The ISMC's revenue expenditure during the assessment period grew at a higher rate than revenue income. Particularly so in fiscal 2019, when revenue expenditure grew more than five times the previous fiscal's. Owing to the increase in revenue expenditure and decline in revenue income, its surplus has declined over the period. The rise in revenue expenditure in fiscal 2019 is mainly owing to a steep increase in establishment expenditure from NPR 37.76 lakh in fiscal 2017 to NPR 274.62 lakh in fiscal 2019. On account of the recent institutional changes, Itahari has hired new staff to fulfil its additional responsibilities. This increased establishment expenditure significantly. Since this is a recurring expenditure, ISMC

[4] In fiscal 2019, ISMC has spent the grant received for social and health related programs which in comparison to the previous years is very high and thus the growth rate is not assessed considering it as an anomaly.

should see at least a commensurate increase in revenue income for it to not slip into cash deficit. The impact of the increased establishment expenditure can already evident as ISMC is finding its OSR inadequate to meet its revenue expenditure. Figure 14 provides the summary of Itahari's revenue account income, expense and surplus over fiscals 2017-2019.

Figure 14: Summary of revenue account analysis



Source: CRIS Analysis

2.3.1.3 Assessment of capital account

Capital receipt: Capital receipt includes the tied grants received from the federal government for specific purposes such as construction of roads and other infrastructure, social security infrastructure, etc. in the city and income received from the sale of capital assets. Capital grants form 97-99% of ISMC's capital income. In fiscals 2018 and 2019, ISMC also received income from sale of municipal assets, which formed 1-3% of its total capital income.

Capital expense: Capital expense is mainly incurred towards creation of assets, which is spent on construction of public works, equipment purchase, vehicle purchase, etc.

Table 17: Income and expense in capital account

Sr no	Particulars (lakh NPR)	2073-74 (FY17)	2074-75 (FY18)	2075-76 (FY19)	CAGR	Average share in total
I	**Capital income**					
	Grants	157.93	263.85	462.54	71%	99%
	Sale of assets	-	2.70	12.62		1%
	Loan	-	-	-		0%
	Total	157.93	266.55	475.16	73.46%	100%
II	**Capital expenditure**	340.60	322.34	348.54	1.16%	

Source: CRIS analysis

Expense towards SWM: SWM has been outsourced to a private operator through a 20-year PPP contract. Therefore, ISMC does not look into any capital investment for creating infrastructure for SWM.

2.3.1.4 Assessment of tied and untied grants ISMC received

Total grants (untied revenue grants and tied capital grants) received by the ISMC came down from NPR 919 lakh in fiscal 2017 to NPR 752 lakh in fiscal 2019. However, during the period, tied grants increased from NPR 158 lakh to NPR 462 lakh. This shows the flexibility of funds ISMC receives is gradually decreasing as the share of tied grants is increasing.

Table 18: Tied and untied grants

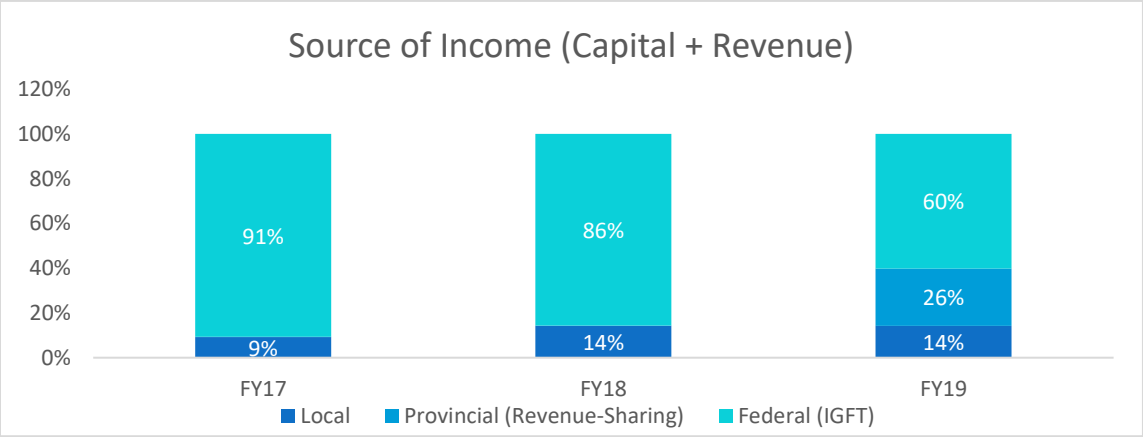
Sr no	Particulars	2073-74 (FY 17)	2074-75 (FY 18)	2075-76 (FY 19)
1	Total grant (NPR lakh)	919.38	701.93	751.68
2	Tied grant (NPR lakh)	157.93	263.85	462.54
3	Share of tied grants in total grants	17%	38%	62%

Source: CRIS analysis

2.3.1.5 The ISMC's sources of income

During the assessment period, share of revenue generated locally by ISMC in its total revenue (including capital and revenue incomes) has increased from 9% to 14%. The local revenue includes property tax and other taxes, fees and service charges, rental income, and proceeds from sale of capital assets of the local government. Similarly, since fiscal 2019, the ISMC has received revenue transfer from the provincial government in lieu of stamp duty and land tax. This transfer accounted for 26% of the ISMC's total income in fiscal 2019. Share of intergovernmental fiscal transfers (IGFT) in its total income reduced from 91% to 60% during the period but such transfers have remained its major source of revenue. Figure 15 gives breakup of ISMC's income from various sources.

Figure 15: Sources of income



Source: CRIS analysis

2.3.1.6 Per-capita income and expense assessment

The ISMC's per capita revenue income declined from NPR 544 to NPR 492 during the assessment period. In comparison, its revenue expense has increased from NPR 42 to NPR 441. At the same time, its capital income has increased from NPR 100 to NPR 302 and its capital expense remained in the range of NPR 220 per capita. The table below presents the per capita income and expense details of the ISMC's revenue and capital accounts.

Table 19: Per capita income and expense assessment

Head of assessment (per capita)	2073-74 FY 17	2074-75 FY 18	2075-76 FY 19
	Figures in NPR		
Revenue income	543.61	350.94	491.77
Revenue expense	42.39	59.37	441.13
Capital income	100.30	169.28	301.77
Capital expense	216.31	204.72	221.35

Source: CRIS analysis

2.3.2 Assessment of available subsidy for sanitation/SWM

The ISMC does not offer any subsidy for citizens in sanitation or SWM services. However, the Ministry of Population and Environment has a Renewable Energy Subsidy Policy, 2073 (2016). Under this, small-scale biogas plants set up by households and large-scale municipal waste-to-energy plants based on anaerobic digestion (bio-methanation) are provided subsidies.

2.3.2.1 Subsidy for domestic biogas plants

Subsidy per plant per household for domestic biogas plant using animal dung as the main fuel is as follows;

Region	Subsidy amount in (NPR)		
	2 m^3 plant	**4 m^3 plant**	**6 m^3 and above**
Mountain districts	25,000	30,000	35,000
Hill districts	20,000	25,000	30,000
Terai districts	16,000	20,000	24,000

Source: Renewable Energy Subsidy Policy, 2073 (2016)

For domestic biogas plants with capacity of 4 m^3 or less that use kitchen waste and other household bio-degradable waste, a subsidy of up to 50% of the total cost but not exceeding NPR 10,000 is given. The policy is aimed at improving urban environment and reducing consumption of imported fuel.

2.3.2.2 Subsidy for municipal waste to energy (biogas-based) plants

As per the policy, biogas plants with a capacity from 12.5-35 m^3 are categorized as small, 35-100 m^3 as medium and above 100 m^3 as large biogas plants. Subsidy is available to commercial biogas plants, institutional plants, community plants, and municipal scale plants.

Table 20: Subsidy for municipal waste-to-energy projects

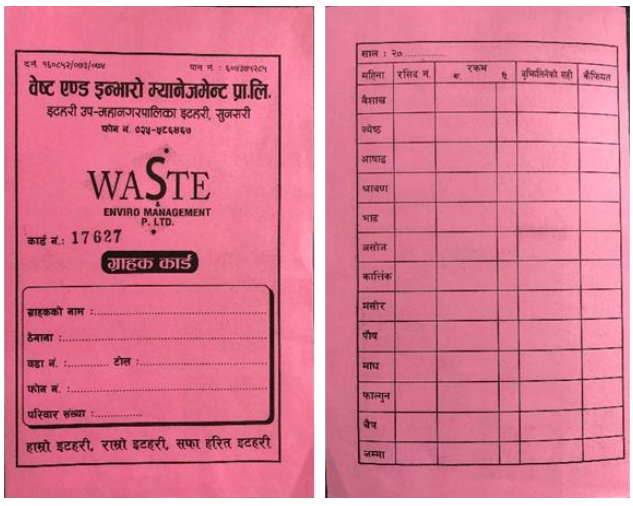
Biogas plant category	Subsidy amount in NPR						
	Thermal application per m^3 of biogas produced per day at normal temperature and pressure						Additional subsidy for electricity generation per kW (baseload for 24 hours)
Commercial	Terai			Hills			
	Small	Medium	Large	Small	Medium	Large	65,000
	20,000	25,000	30,000	24,000	30,000	36,000	
Institutional	57,000			68,000			185,000
Community	45,000			54,000			150,000
Municipal scale	**40% of the total cost, but not exceeding NPR 200,000**			**40% of the total cost, but not exceeding NPR 240,000**			**40% of total electrification cost, but not exceeding NPR 400,000**

Source: Renewable Energy Subsidy Policy, 2073 (2016)

The proposed waste-to-energy project in Itahari falls in the municipal scale category and gets the government subsidy.

2.3.3 Assessment of user charge modality

The ISMC has been a levying monthly user charge for SWM on waste generators of different categories. At present, there are 126 categories of waste generators each falling into small, medium or large categories. There is no set process for determining the user charge. Levying and collection of user charge is managed completely by 14 user charge collectors (all women) employed by WEMPL on commission basis (on the amount of user charge collected per month). For record prupose, the collectors issue sanitation cards with record of payments and payable (for a period of two years) to waste generators. There is no comprehensive data of waste generators in the city to assess category-wise number and potential revenue demand. It is estimated that the minimum user charge collected from residential waste generators is NPR 100 per floor. There are nine fixed rates charged per month for SWM services—NPR 100, NPR 150, NPR 200, NPR 250, NPR



Sanitation card

300, NPR 500, NPR 1,000, NPR 2,000 and NPR 5,000. These are charged from all 126 categories of waste generators. Each category of the waste generator is further divided in to small, medium and large according to size of the waste generator. In total, there are 378 categories of waste generators. Of these, 52% pay NPR 100 and NPR 200 per month, 37% NPR 200-500 and the balance 11% which are bulk waste generators pay NPR 1,000-5,000 (details in Annexure A.4).

How user charge is collected: From our interaction with the private operator, we understood that a sanitation card is issued to each waste generator. The card bears a number and all details of the waste generators concerned such as the name, address, ward number, name of the TLO, phone number, and month-wise user charges paid and receipt number for each monthly payment, signature of the waste generator and collector of user charge, etc. Each waste generator has to maintain and save this sanitation card for two years. Tax collectors employed by the private operator (all women) go door-to-door to collect user charges every month and the amount thus collected is deposited with the head office or is handed over to the manager of the private operator.

Modality for user charge revision: The environment committee proposes revision in rates of user charges based on consultations with stakeholders, TLOs, etc. Once the user charges are agreed upon within the committee, the new rates are forwarded to the city assembly for a final approval. The assembly approves the revision after discussion.

Current collection: As the private operator collects and retains the user charge entirely, there is no public information available on demand, collection and balance amount.

However, based on discussions with the staff of the private operator, total monthly collection from user charge is in the range of NPR 18 to 21 lakh. The operator has not carried out a comprehensive survey of waste generators and is not aware of the exact number of waste generators in Itahari. However, the Operator has issued around to 9,000 sanitation cards who pay SWM user fee. Considering 35864 households in Itahari (as per Census 2011), only 9000 waste generators are covered under collection of SWM user fee implying 25% coverage of SWM user fee. Also, since the user fee is collected by the private operator, ISMC has no control over the revenue generated from the service. It is essential that a comprehensive assessment of waste generators in Itahari is done through a primary survey. This will help estimate the revenue from SWM user charges more accurately.

2.3.4 Key issues with the ISMC's finances

The ISMC is largely dependent on grants from the federal and provincial governments for implementation of its capital investments. Though the SWM Act allows levying user charge for providing services, coverage of the existing user charge collection is unknown. The table below summarizes the key issues with ISMC's finances.

Table 21: Summary of key issues with the ISMC's finances

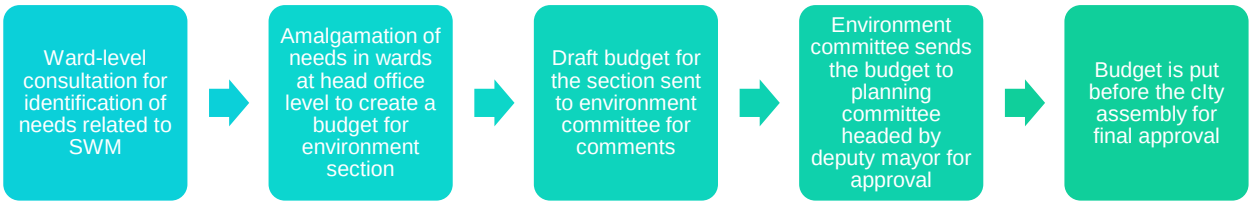
Activities	Key inferences	Identified gaps and issues
User charge	User charge is fixed by the municipal council. The charge is revised through consultations; there is no set timeline for revision. The charge is collected and retained by the private operator.	Coverage of user charge collection is not known. No comprehensive database of waste generators. There is no oversight on what is demanded and collected by the private operator. No demand collection and balance statements prepared—collection efficiency cannot be established.
OSR	OSR includes integrated property tax, house rent tax, health service tax, education tax, transport vehicle registration, future service improvement and advertisement (OSR is in the range of 3-6% of ISMC's revenue receipts). Assigned revenue (grants from the federal government and land tax transfer from the provincial government) form 80-90% of ISMC's revenue receipt.	OSR is comparatively less thus restricting the city's financial freedom. Assigned revenue makes ISMC dependent on provincial and federal governments. Uncertainty of grant transfer impacts financial planning and quality of service delivery. Contribution of tied grants has increased from 17% to 62%, reducing the financial freedom of the local body.
Sustainability of revenue account	Operating ratio has been below 1. However, in the recent assessment year it is close to 1.	Investible surplus from the revenue account is available but diminishing.
Capital and O&M expense on SWM	ISMC incurs no capital expenditure as service is outsourced through a fixed payment fee of NPR 300,000 per month and revenue source is user charges from waste collectors. Charges for desilting of canals, picking and disposing dead animals, etc. are paid separately to the private contractor.	Waste management as a service has been outsourced to a private operator, who is also responsible for capital investments in collection, transportation, and processing and treatment infrastructure. ISMC is providing only administrative support and monthly fixed payment. Any investment in service delivery improvement (outside the purview of the existing contract) will impact the current long-term contract ISMC has with the private operator. ISMC is dependent on the private operator for capital investments to improve service delivery.
Total grants to tied grants	Share of tied grants in to total grants received by has increased from 17% in FY 17 to 62% in FY 19.	Local governing bodies know better how to prioritize investments for local development. Having larger amount of un-tied grants gives the flexibility to the local governments plan and prioritize the investments.

2.4 Institutional assessment

The key parameters of institutional assessment are planning, implementation, operation and maintenance, monitoring and management.

2.4.1 Planning of services and infrastructure

As SWM as a service is outsourced through a 20-year PPP contract, the planning of services and infrastructure in Itahari is limited to holding general programs to create awareness about how to manage waste in general and hospital waste in particular, and cleaning of public spaces such as religious places and market areas. Ward-level organizations such as TLOs, NGOs, and Red Cross, along with general public, hold meetings for identifying needs in respective wards to improve waste management. The requirements identified in these meetings are then sent to the head office for amalgamation in the city level budget.



This process is further taken to the environment committee, planning committee and the city assembly for the final approval.

SWM as a service needs a comprehensive approach towards addressing the issues in the sector in Itahari. Looking at the current staff strength at the local level, it is estimated that capability to plan and improve the SWM system by setting up large-scale projects is lacking. Additionally, other stakeholders such as TLOs, NGOs and Community based organizations (CBO) are not being engaged in planning and improving the system.

2.4.2 Procurement and contract management

As already mentioned, SWM in Itahari has been outsourced to a private operator through a 20-year PPP contract. ISMC, with support from AEPC, is in the process of setting up a centralized waste-to-energy (biogas) plant for processing of organic waste generated in the city. AEPC appointed a technical consultant to conduct a feasibility study for a biogas project which was prepared and submitted in January 2017. After the approval of feasibility, AEPC and ISMC jointly structured the bidding document and issued the tender for selection of a developer for the project. In the competitive bidding conducted, WEMPL emerged winner to set up the facility.

A concession agreement was signed on April 27, 2018, between WEMPL, AEPC and ISMC. ISMC and AEPC are the joint concessioning authorities. WEMPL is responsible for collection and transportation of waste and procurement of vehicles to provide the services. Based on consultation with the city officials, it is understood that the staff of the local governing body do

not have the capability of designing appropriate contract structures for procurement through PPP mode. Moreover, the staff have not received any training on PPP designing and contract management. Thus, the city is largely dependent on external agencies such as AEPC for arranging the service delivery. Also, currently the city does not have capacity to undertake and manage the contract and monitor its provisions. Key reason for this is unavailability of requisite qualified staff in the local body.

Table 22: Salient features of the SWM PPP contract

Parameter	Details
Details of concession	ISMC, AEPC and WEMPL executed a concession agreement on April 27, 2018, granting WEMPL exclusive rights for the development, designing, engineering, financing, procuring, constructing and operating and maintaining a waste-to-energy facility at the land identified in the ward number 10 on design, build, finance, own, operate and transfer (DBFOOT) basis for a period of 20 years.
Salient terms of the concession	• The project is awarded on a 20-year term on DBFOOT basis • ISMC and AEPC have jointly issued this concession to WEMPL • AEPC has received grants from IBRD for scaling up the renewable energy project (SREP) and intends to use the proceeds for this project
Role of parties to concession agreement	**WEMPL** • Collect and segregate (organic and combustible) waste from the collected municipal waste from the current city jurisdiction and from the extended jurisdiction in case the jurisdiction is extended in future • Develop a waste-to-energy facility using anaerobic digestion technology/bio-methanation • Develop a suitable material recovery facility • Generate energy from combustible fraction of waste • Dispose not more than 25% of inert waste into landfill • Pay 1% royalty (on annual gross sales) post three years of commissioning till the end of the concession period **AEPC** • Assess and approve the project designs prepared by WEMPL • Share the cost of preparing the detailed project report on 50:50 basis (up to USD 10,000) • Provide subsidy towards the capital cost of the project as per agreed terms of the agreement • Recommend central ministries for waiver of import tariff and VAT on machinery and equipment and waiver of VAT on sale of energy and fertilizers **ISMC** • Provide current waste data and maps of all wards on GIS platform • Take lead in settling all social and political issues related to the project • Facilitate all legal compliances and negotiate all social and political issues • Arrange water and electricity for the WEMPL project (cost of water to be paid by the operator. However the contract is silent on who shall bear the cost of electricity for the project) • Arrangements for 11 KVA three-phase electricity connection from Nepal Electricity Agency (cost of electricity line installation to be paid by WEMPL)

Parameter	Details
	• Provide access road to the project site and construct a boundary wall on three sides of the land parcel • Waive off municipal taxes levied on the project • Identify land for disposal of inert waste • Provide bins for segregation of waste at source. Cost to be shared equally between waste generator, ISMC and WEMPL • During the concession period, ISMC is not to allow anyone other than the WEMPL to collect the waste from city • Recommend central ministries to waive off import tariff and VAT on machinery and equipment and waive off VAT on sale of energy and fertilizers • Pay NPR 300,000 (towards de-siltation of water channels and management of animal dead bodies) from November 2018 for a period of five years
Effectiveness, expiration and modification	• The agreement comes into force on the date of signing. • Unless terminated earlier, the agreement shall expire in 20 years • No variation on scope of the contract with respect to waste-to-energy generation
Contract period	• The contract shall come into force on the day of signing and shall remain valid for 20 years from the date of testing and commissioning, but no later than 2095/09/15 (September 15, 2038)
Suspension	• The concessionaire to be given 90 days cure period to rectify its failure to perform any of the obligations under the contract • Additional extension of up to 60 days may be given
Termination	**By concessioning authority** • The concessionaire fails to remedy a failure of performing the obligation even after giving notice • The agreement can be terminated if the concessionaire declares itself insolvent/bankrupt **By concessionaire** • If the concessioning authority fails to fulfill its obligation under the contract or other inputs, including obligated municipal waste, even after receiving notice from the concessionaire that such payments or inputs are overdue • 30 days' notice shall be given by the respective party for maturation of termination
Transfer on expiration of concession	• The concessionaire shall transfer the project within 30 days of expiry of the agreement in a working condition • Applicable charges for the transfer of ownership of land, plant, machinery and other assets shall be borne by ISMC • The concessionaire shall make available an inventory of assets
Insurance	• Goods and plants supplied under the contract shall be fully insured in a freely convertible currency against loss or damage incidental to manufacture or acquisition, transportation storage, delivery in a reliable manner
Dispute settlement	• Both parties shall make all efforts to resolve the disputes through an informal discussion • If the dispute is not resolved within 30 days, either party may refer the dispute to the arbitrator as per the governing laws of Nepal
Obligated waste quantity	• The authority shall be responsible for providing the obligated municipal waste quantity as per the final detailed design report

Parameter	Details
	• For the first five years, the municipality shall transport such waste to the project site and after that, the municipality shall make available such waste at the source level • Upon failure to provide availability of such waste, ISMC shall pay equivalent compensation amount to the concessionaire as agreed during negotiation
Environmental and social safeguard	• The Concessionaire shall – Ensure covered transportation of organic waste from households to the project site – Ensure full regard for safety of all persons on site and working for him – Provide signage, guard and warning signs for protection of works and other general public – Take all reasonable steps for protection of environment – Shall not use wood as fuel or as a means of heating during the operations – Shall not pollute or destroy or affect in any way the source of natural water in the vicinity of the project site – Adhere to all other obligations are recommended in the IEE and ESA report
Performance standards	• The Concessionaire shall ensure that not more than 25% of the inert waste being disposed in the landfill
Service after end date	• Upon written request from the authority (60 days prior to end of concession), the concessionaire shall provide assistance to the authority 60 days after the end date • Such assistance is to ensure smooth transition between the concessionaire and the subsequent operator appointed by the authority
Extension of contract	• The period of the contract may be extended by mutual agreement between parties. The authority shall notify such extension at least six months prior to the end date
Collection fees/ tipping charges and their mode of payment	• The concessionaire shall be paid a waste collection fee/ tipping fee of NPR 100 per floor of the house as was paid to the previous waste collection and transportation contractor
Change of law	• In case of financial implication to any party under this contract due to change of a law, all parties shall address the issue by minimizing the impact of such financial implication
Force majeure	• None of the parties shall be responsible for delay in contract due to any force majeure event which shall include, but is not limited to, riots, civil contractor, fire accident, or any other accident beyond the control of either party • Rights and obligations of either parties shall be suspended in case of force majeure

Source: Agreement signed between ISMC, AEPC and WEMPL

2.4.3 Monitoring the service

Collection and transportation of solid waste is contracted to a private operator with 10 waste collection vehicles. Unfortunately, an auditing or performance measurement process is absent to check the operator's operational and functional efficiency. Also, payment to the operator is not

linked to the performance. Hence, the operator has no compulsion to adhere to the contract requirements.

To understand whether waste is being lifted from streets or households, the ISMC depends on two modes: 1) complaints received from citizens, and 2) observations by the ISMC staff of unattended waste lying on the streets. Whenever a resident complains about non-collection of waste, ISMC staff asks the private operator to send vehicles for collection. However, the ISMC carries out such checks on a reactive basis.

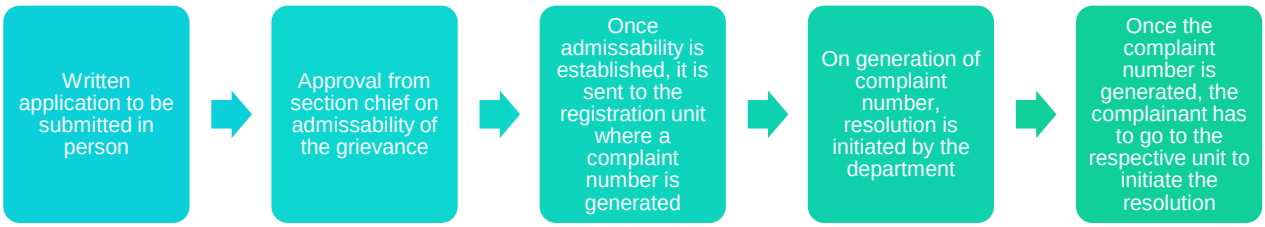
Payment structure for private operators: There are three revenue streams for private operators: 1) user charge collection from waste generators and 2) a fixed amount of NPR 3 lakh per month from the ISMC and 3) sale of gas and manure (by-products of the biomethanation plant). The private operator collects user charges and retains these. To receive a fixed amount as payment from the ISMC, the operator submits a monthly report to the sanitation branch. Once appraised and approved, it goes to the accounts section for final payment. However, the contract between the private operator and the ISMC does not have provisions for performance monitoring indicators and corresponding penalties on which the performance of the private operator is evaluated.

2.4.4 Health and safety norms

Across the value chain of waste management in Itahari, employees come in direct contact with waste generated in the city during primary collection (picking and dumping of waste in the collection vehicle), sorting of recyclables after dumping, collection of waste from streets, and disposal of waste at the dump site. There have been reports of workers suffering injuries owing to glass or needles and other harmful substance. However, discussions with the ISMC staff and the private operator revealed that health and safety norms are not followed by the employees of the private operator. Also, during the site visit, it was observed that workers across the current value chain of waste management in the city work with bare hands.

2.4.5 Grievance redressal system

Grievances received in written form are registered to be addressed by the respective departments. Discussion with the ISMC officials highlighted that complaints mostly pertain to waste collection vehicle not arriving at the same time and dumping of waste by different waste generators in open areas and water channels across the city. Owing to the complex mode of complaint registration and its resolution, only 2-3 complaints are received in a month.



Observations

- In a rather cumbersome process, the complainant has to approach multiple windows in the ISMC to merely register and expect initiation of a resolution process for the complaint
- Pre-approval of a complaint for its admissibility has become a hindrance in receiving complaints
- No monitoring of type of complaints, area/ location where there are more complaints
- Absence of two-way communication; no feedback is sought post complaint redressal
- No time-bound redressal of complaints
- Not all complaints are recorded in the register
- Complaint registration and redressal are not linked to the operator's performance

2.4.6 Key institutional issues regarding SWM

The ISMC has outsourced waste management to a private operator through a long-term contract. However, the current ISMC staff may lack adequate training and capacity-building to manage a 20-year PPP contract and deliver the obligations of the authority as provided in the contract.

Table 23: Summary of key institutional issues regarding SWM in the ISMC

Activities	Existing practices at Itahari	Identified gaps and issues
Staff strength	The environment section that monitors the SWM unit in the city has only one engineer	No established monitoring mechanism for assessing the service performance. The city is entirely dependent on private contractors for any service-related issue
Contract management of private operator	Only performance evaluation/ monitoring mechanism is through complaints or observations	No service-level agreement between the ISMC and the private contractor. Payments are not linked to service quality
Capacity of existing staff	Only one environmental engineer responsible for management of all operations of solid waste as well as to plan for future operations	Current staff not well trained for planning and management of SWM operations. No understanding on implementing the processing and treatment of waste—dependent on external agencies such as AEPC

2.5 Environmental, social and health safeguard

2.5.1 Environmental compliance

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

Assessment of the monitoring framework

The erstwhile Ministry of Population and Environment published sampling and analysis methods for environmental quality check in Nepal Gazette in 2060 (2004 AD) that provide guidance on designing sampling programs, sampling techniques, preservation and handling of samples, and wastewater sampling following the provisions of ISO standards 5667. There are no specific environmental standards for SWM. The leachate that is mixed with the adjacent waterbodies needs to be tested against 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 then Ministry of Population and Environment).

The Ministry of Forest and Environment (MoFE) sometimes collects water samples through the Department of Forest and Environment (DoFE) at the provinces to check compliance with environmental quality standards. However, there is no schedule of collecting samples and publishing these results.

An environmental monitoring framework is required for storage facilities (where waste is stored) or material recovery centers and the landfill/ disposal site. While transporting waste, 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), environmental impact assessment is to be carried out for landfills (100-10,000 ton per year) and transfer stations with more than 3 hectare of land, facilities for recycling and disposing with more than 2 hectare land, and composting facility with 1-5 hectare of land.

Compliance with environment standards

Compliance with environmental standards cannot be established as there is no process for checking the water quality (of Sevti River and other small streams) of the adjoining waterbodies. A monitoring framework designed by the MoFE and the counterpart department at provinces check the quality of discharge from such sites.

2.5.1.1 Prevailing monitoring frameworks

There are no environment monitoring mechanisms in the city apart from a committee that oversees control of indiscriminate dumping of waste by citizens, sticking of posters on electricity and streetlight poles, and spillage of waste by the ragpickers and recyclers. This committee was formed in September 2019, and is headed by the deputy mayor of the ISMC.

2.5.2 Social concerns

2.5.2.1 Consultation with tole lane organizations

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 of 100-150 households. Though TLOs are a widely accepted community engagement structure in the city's governance, they have not been delegated functional administrative powers—they function as supporters/ advisors. In order to function as a recognized entity, TLOs are required to register themselves with the ISMC with the chairman (appointed by the households from the respective TLO) as a single point of contact and representative of the respective TLO.

At present, 215[5] TLOs are registered with the ISMC and data is maintained with the administration and social development department. TLOs are required to hold at least one meeting a month to discuss and deliberate community level issues. Activities supported by TLOs range from generating awareness regarding financial planning, creating a community fund, generating awareness for better waste management practices, to formulating community rules for environmental awareness and implementation, supporting private waste collection contractors in collecting user charges, to resolution of conflicts within the community.

To understand the current engagement practice of TLOs in Itahari's SWM system, a consultation with the chairpersons of TLOs from ward numbers four and six was organized during the site visit. Based on discussion with the chairpersons, the following issues (for improvement of SWM) emerged:

- Waste from each generator needs to be collected daily instead of weekly to avoid odor.
- At present, waste is stored in plastic bags or rags from which leachate comes out and emits foul smell. To avoid such instances, the ISMC needs to provide primary storage bins to each waste generator.
- Segregation at the house level needs to be initiated/ imposed by the ISMC.
- No awareness generation activities have been undertaken by the ISMC in an organized manner till date. Hence, it is important for the ISMC to formulate a consistent mechanism to make citizens aware of SWM
- TLOs cannot levy legal penalty on citizens for throwing waste or not managing solid waste properly. Hence, they need the ISMC's intervention to issue a penalty clause or rule so that legal action can be taken
- TLOs need the ISMC to include their suggestions, views, experience, etc., while framing guidelines or rules for SWM in future.
- Source segregation may not be effective unless until there is a separate waste transportation mechanism

[5] TLOs are prevalent in wards 1 to 9, wherein ward number 5 has a maximum of 41 TLOs and ward 6 has 15 TLOs.

- A decentralized waste management system is not acceptable or recommended by TLOs, as there is scarcity of land/ space as per their knowledge of their wards
- TLOs are confident that they will be able to convince people to opt for source segregation, provided the ISMC gives them dual bins

2.5.2.2 Stakeholders' consultation in Bhawanipur village

The current waste disposal site is along the water stream that runs parallel to the Sevti River, which crosses Itahari. Since the disposal site is an unsecured facility, it could face various environmental hazards due to uncontrolled activities at the dump site. To understand the impact, a site visit to the Bhawanipur village downstream of the Sevti River was undertaken. Bhawanipur is located 4 km downstream of the current disposal site. Understanding the impact on health and human life due to dumping of waste upstream was critical. Residents and members of the Forest Committee[6] were consulted during the site visit. Issues faced by village residents are as follows:

- To continue dumping of waste at the current disposal site, more land is required which is unavailable. Resultantly, it is essential to reduce the volume of waste that is being disposed at the site and burning is the only option but this generates thick smoke
- Whenever waste is burnt at the disposal site, Bhawanipur, Bharmbhapur, Tarara, Kumar Samudiak, other villages and the forest are completely covered with smoke and poisonous gases. Over the past 2-3 years, villagers have been combating poor visibility, breathing problems, viral fever, etc.
- At 1.5 km downstream, near Aromel, a dam has been constructed (Rani Pohari) and the water is used for irrigation. This water was found to be contaminated
- From Sevti River, a stream passes through Bhawanipur locally known as Seri. During monsoon, this river carries syringes, plastic bottles, and other contaminated material
- Earlier, chital and other animals were sighted in Bhawanipur and the adjoining forest area. However, nowadays pollution has led to ecological imbalance
- The villagers are charged NPR 80-100 per household per month for waste collection. Owing to waste disposal in this area, their health has been deteriorating
- Sometimes businessmen take possession of some of the stretches of the forest and undertake different activities, which degrades the environment
- All these issues have been discussed with the ULL and highlighted by media

2.5.3 Key environmental and social concerns regarding SWM

- **Environmental issues**
  - It is observed that waste is disposed of in water bodies across the city in the absence of an efficient waste collection and transportation system
  - The current disposal facility in the forest area is next to a river, posing an environmental threat to water quality. Additionally, the ecology of the area is under threat
  - Downstream water reaching the village is found to be contaminated

[6] The Forest Committee is formed by the residents of the nearby settlements to deliberate and decide on the use of products from the forest and tackle issues related to pollution, restriction on wood cutting, etc.

- Indiscriminate burning of waste for extraction of metal waste is a public health hazard for the nearby communities
- There are no norms for monitoring environmental pollution due to indiscriminate waste disposal

- **Social issues**
  - 8-10 ragpicker families are dependent on pricking rags from the current disposal site
  - These workers often suffer skin-cuts from sharp metal/ glass objects while extracting recyclables from the disposal facilities

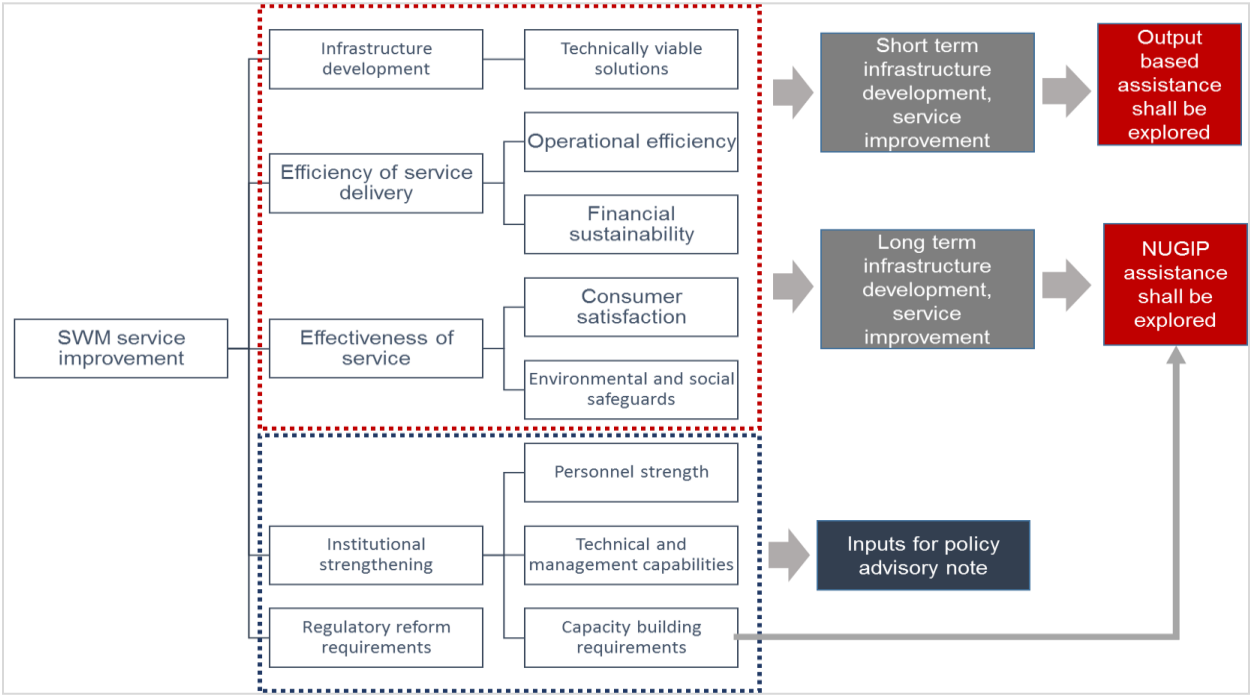
3 Service and Infrastructure Improvement Plan

This section looks at the service and infrastructure improvement plan (SIIP) for SWM. The plan has been devised to support Itahari in developing the necessary infrastructure by deploying institutional and service governance systems, establishing financial management systems for achieving sustainability, guiding policies and regulations, enhancing the private sector's role in improving service delivery, and adhering to environment and social safeguards while improving service delivery.

3.1 Conceptualizing the SIIP framework

Infrastructure investments for improvement in infrastructure and service levels could form a part of the Nepal Urban Governance and Infrastructure Project (NUGIP), which will be explored under the service improvement plan (SIP). Under the proposed NUGIP, a strong and consistent capacity-building program will also be explored to institutionalize operations.

Figure 16: SIP development framework



The improvement plan aims to:

1) ***Bridge the infrastructure gap:*** This includes technically viable solutions, leveraging the existing infrastructure such as the waste collection vehicles and landfill site.
2) ***Bring in efficiency in service delivery:*** Operational and financial efficiency by ensuring reliable and equitable service across the city.
3) ***Improve consumer connect and effectiveness of the service:*** Measured through consumers' satisfaction and strong compliance with environmental quality requirements and health standards.

3.2 Infrastructure improvement plan

3.2.1 Demand assessment: Waste generation projections and requirement analysis

In order to improve the service, the activity chain needs to be enhanced. While making the proposal, we have estimated waste generation in Itahari based on population growth in core, outer and rural wards of the city. The city needs to develop infrastructure and boost management strength in a phased manner to handle waste. Further, the infrastructure improvement plan for the entire value chain of SWM for waste generated in 2030 is considered as design quantities.

Table 24: Estimation of waste generation for designing the SIIP

Design year	Estimated quantity of waste generation (MT[7]/day)			
	Core	Outer	Rural	Total
2020	35.92	30.42	7.00	73.34
2030	**50.59**	**42.84**	**9.86**	**103.29**
2040	69.11	58.53	13.47	141.11

3.2.2 Principles of SIP

While formulating the SIP and design philosophy, the following key principles were considered:

- Integration of the existing infrastructure into the proposed system
- Synchronization of an existing scheme or plan with the proposed system
- Optimization of land utilization (minimum disposal)
- Reduction of manual handling
- Compliance with rules and environmental and social safeguards
- Technological flexibility and options
- Defined performance parameters

[7] MT refers to metric ton for measurement of weight of the waste that needs to be handled daily.

- Robust monitoring and tracking system

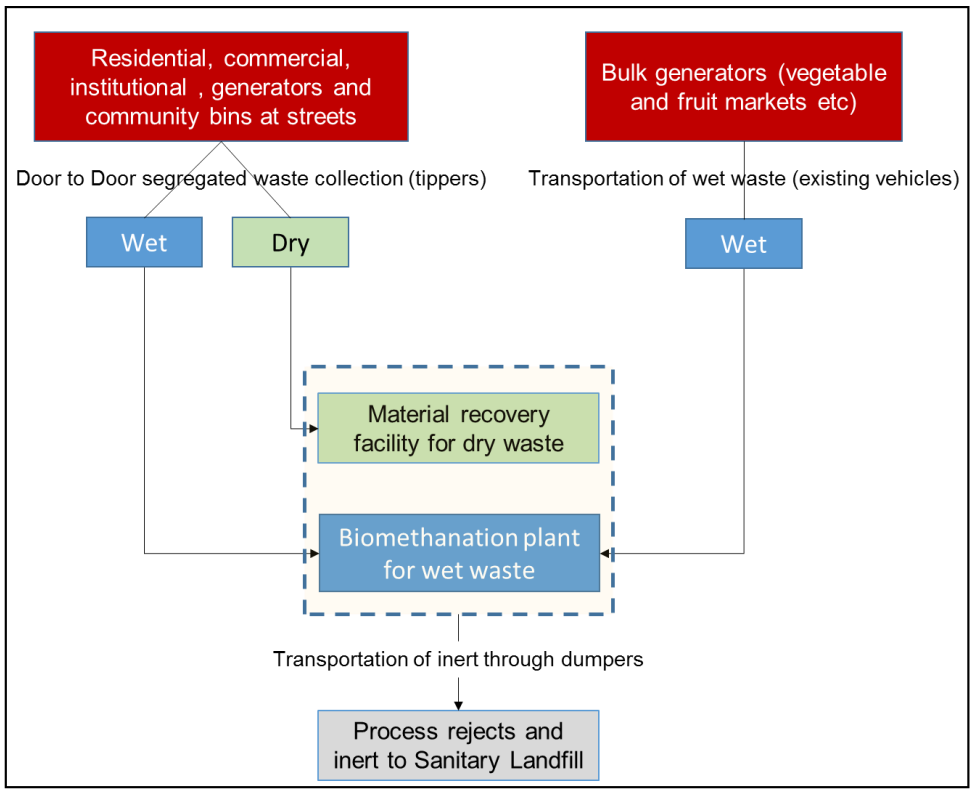
3.2.3 Proposed service delivery model

Itahari currently has a centralized system of waste management in which a private operator collects waste from the entire city. The same private operator has entered into a 20-year contract for development of a waste processing facility (including a waste-to-energy unit and a material recovery facility) and continues collecting and transporting waste. We have made the proposal after assessing the centralized and decentralized systems of waste management.

(a.) ***Centralized system:*** Under this model, waste from the city is brought to one point for treatment and processing and then sent for disposal. For this, large infrastructure has to be built in order to cater to the entire city. Hence, requirements of land (single plot) and capital are high. Economies of scale can be achieved as the quantity of waste handled will be large. However, such large-scale developments in a densely populated area could face local resistance.

(b.) ***Decentralized system:*** This is a distributive system in which waste is handled in the vicinity of the source of generation itself. Such systems can be built on small plots available in the neighborhoods. They use simple and low-cost technology to handle waste locally. Also, since they require only small facilities they are not very cost intensive.

Figure 17: Proposed service delivery model for Itahari



Since the ISMC has already contracted a private operator for 20 years to develop a centralized waste management facility, we propose a service delivery model that can augment this already proposed facility. We aim to establish infrastructure to bridge the gaps in the existing SWM value chain.

The objective of the service delivery model is to reduce the volume of waste reaching the landfill by minimizing waste and increasing recycling. The model seeks to establish segregated waste collection and transportation to improve efficiency of the proposed waste treatment and processing facilities. The key design elements of the plan are:

- ***Proposed waste streams:*** Waste is to be collected from every house after segregation at the source. Dry waste from bulk and non-bulk generators will reach the centralized MRF. Wet waste generated by bulk generators will be collected separately by vehicles currently in use and transported to the centralized waste-to-energy (bio-methanation) facility
- ***Waste from bulk and non-bulk generators collected separately:*** Waste from non-bulk generators will be collected from every house after segregation and transported. Bulk organic waste generators, such as markets, will dump their waste in big containers for collection.
- ***Centralized waste-to-energy (anaerobic digestion) facility:*** This is a bio-methanation-based waste-to-energy facility designed for wet waste processing. Its capacity of 50 TPD will be designed to meet demand for 10 years (until 2030) with an option to augment it to meet the demand increase for another 10 years (until 2040)
- ***Centralized MRF:*** Dry waste from the entire city will reach the centralized MRF where recyclables such as glass, bottle, paper, plastic, cardboard, and thermocol will be segregated
- ***Sanitary landfill site:*** A sanitary landfill facility will be developed for disposal of the process rejects and inert substance from the waste-to-energy unit and MRF
- ***Remediation of the existing disposal facility:*** Land being used for the current disposal facility will be reclaimed by deploying bio-mining of waste
- ***100% collection:*** Necessary vehicles and other equipment are to be procured to ensure 100% collection and efficient transportation of waste to these facilities

3.2.4 Proposed infrastructure improvements

Based on city-level assessments and consultations, we propose a system to improve the service delivery and augment the associated infrastructure that can complement the system in use and proposed in Itahari. The key concepts of the service and infrastructure improvement plan for the city are:

- Implementation of the mandatory segregation of waste at the source into wet (biodegradable) and dry (non-biodegradable) waste to achieve maximum recovery of resources
- Designing the system according to the requirements of the SWM Act and rules by setting up treatment and disposal facilities for solid waste and restricting landfilling to only inert substance and rejects from waste processing, which are not suitable for either recycling or processing
- Establishing an efficient door-to-door waste collection system with maximum participation of the communities and waste generators

- 100% collection and transportation of the waste generated
- Reduce manual handling of waste by automating the entire waste collection and transportation
- Prioritizing ease of access to waste generators and handlers by establishing an effective and efficient waste collection system through measures such as keeping a bin per km in densely populated areas, and an appropriate transportation infrastructure
- Daily transportation of waste to the processing and disposal facilities and optimizing the system (for instance, restricting running time of a vehicle to 6-8bhours a day will increase its life while reducing its O&M cost)
- Effective monitoring system in place to ensure the sustainability of the proposed system

3.2.4.1 Primary storage infrastructure

The existing contract between the ISMC and the private operator has a provision to provide primary storage bins to store waste in a segregated manner. It is proposed that the ISMC shall operationalize this provision and provide bins to all households. For bulk generators, such as vegetable and fruit markets, weekly markets, etc. the proposal is to provide 1100 liter capacity high density poly ethylene (HDPE) bins to collect and store organic/ wet waste. A total of 53 such bins will be provided, of which 26 will be given to bulk waste generators in the core area, 22 to those in the outer area and five to those in the rural area.

3.2.4.2 Collection and transportation infrastructure

For collection and transportation of waste from the source of generation, the current as well as the new fleet of vehicles will be used. Hydraulic tippers with separate storage for dry and wet waste will be utilized to collect waste from residential, commercial and institutional areas, and transport to the centralized processing and treatment site. In order to collect organic waste from the markets and transport to the centralized location, WEMPL's existing fleet will be used. After treatment, the process rejects and inert material will be sent to the sanitary landfill in 8.5 cubic meter (cum) box tipper vehicles. Detailed calculation of the number of such vehicles required is given in Annexure B.1.

Table 25: Proposed waste collection and transportation infrastructure

Sr no	Type of vehicles	Number of vehicles to be deployed		
		Core	Outer	Rural
1	Waste collection vehicles for non-bulk waste generators	9	10	5
2	Existing waste collection vehicles for bulk waste generators (all wards)	10		
3	Total waste collection and transportation vehicles	34		

Source: CRIS assessment

3.2.4.3 Processing and treatment of waste

Itahari does not have a waste treatment and processing facility. However, as mentioned earlier in the report, the city has entered into a long-term agreement for developing a bio-methanation-based waste-to-energy facility and an MRF. These units can be used for processing waste in our proposed project, too. However, based on our primary estimates of waste generated now and in the future, the capacities of the proposed facilities have been reassessed. The sub-sections below assess various technologies available for processing of urban solid waste:

(a.) **Technologies for processing municipal waste:** Technology is used to reduce volume and toxicity of waste make it easier to dispose of. Selection of treatment methods is based on composition, quantity and form of waste. Various technologies are available to process waste in an environment-friendly manner. Detailed explanation is given in 0.

Table 26: Available technologies for processing of municipal waste

Sr 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 (bio-methanation)
3A	**Physical processing technologies**	Refuse-derived fuel (RDF)
3B		Densification/palletization

Source: CRIS: Literature research

(b.) **Suitability assessment of waste processing technologies:** Treatment methods are selected based on the composition, quantity and form of waste. Technology to be used for processing waste is decided based on the following parameters:

- *Reliability*: How successful has a particular technology been in treating similar type of waste in the past; can it process the entire waste that a city generates
- *Waste suitability*: Whether technology is suitable for the physical composition and chemical characteristics of waste
- *Economic viability*: Whether investment in technology will be economically viable for ULL; whether ULL has the capacity to meet the O&M cost of technology
- *Environment and social impacts*: Whether the environmental and social impact of technology is minimal; whether it conforms to the regulatory requirements

Based on these parameters, the waste treatment and processing technology that is proposed to be used by the private operator is evaluated.

Table 27: Suitability analysis for technology selection in the ISMC

Sr no	Technology	Suitability	Waste characteristics	Comments
1	Bio-methanation	Kitchen/ restaurant waste	Organic content > 40% Moisture content > 50%	Requires segregation at the source 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 for municipal solid waste
4	Pyrolysis	Woody biomass	Moisture content < 25% Calorific value > 2000 kcal/kg	Requires skilled personnel Sufficient operational experience must before the plant becomes operational fully 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 Requires skilled personnel to control the processes Pilot plant required before full-scale operation Proper segregation must before treatment
6	Composting	Economic, simple	Organic waste, landscaping and garden waste	Successfully running in developing countries; capacities varying between 30 TPD and more than 650 TPD

Source: CRIS assessment

Based on the suitability assessment of the waste processing technologies, it is understood that the currently proposed bio-methanation unit and MRF at the same location are appropriate for managing the waste generated in Itahari.

Table 28: Waste projections for designing the centralized facilities

Sr no	Items	Year		
		2020	2030	2040
1	Waste (TPD)	73.340	103.294	141.108
2	Average wet fraction (%)	52.89%	52.89%	52.89%
3	Dry fraction (%)	47.11%	47.11%	47.11%
4	Wet waste (TPD)	38.79	54.63	74.63
5	Dry waste (TPD)	34.55	48.66	66.48

Source: CRIS primary assessment

Capacities of the facilities have been decided based on the projected waste generation in future and quantity of wet and dry waste likely to be processed at the bio-methanation unit and MRF. The sub-sections below present the details of the bio-methanation unit and MRF.

3.2.4.4 Bio-methanation facility

As discussed in the previous section, the project will involve strict segregation of waste into dry and wet. The centralized bio-methanation facility will be designed for wet waste. Initially, the plant will have the capacity to meet demand for 10 years (until 2030), with an option to enhance it for another 10 years (until 2040). Table 29 presents the capacity assessment of the plant based on the primary waste quantity and characterization surveys. Design details of the proposed bio-methanation plant is given in Annexure B.3.

3.2.4.5 Co-treatment of fecal sludge in the bio-methanation

The ISMC does not have any sewage collection system and the households rely on on-site sanitation systems i.e. septic tanks. A study undertaken by the Environment and Public Health Organization, Nepal in 2018 revealed that 91% of the excreta are unsafely managed while 9% of the excreta are safely managed and there is no treatment facility for treating this sludge[8]. The faecal sludge collected from emptying these septic tanks is dumped at the disposal site along with municipal solid waste by the private contractors.

Anaerobic digestion (i.e. bio-methanation) is one of the technology which can be key technology in treating the faecal sludge that is being generated in Itahari and reduce the environmental and public health impacts due to its unsafe disposal. It is recommended that the option of co-treatment of faecal sludge along with biodegradable organic waste in the proposed bio-methantion (anaerobic digestion) shall be explored. A detailed technical feasibility assessment for co-treatment of faecal sludge and organic waste in the proposed facility is recommended to be taken up by ISMC.

[8] Environment and Public Health Organization (ENPHO) 2018, Shit Flow Diagram for Itahari, Kathmandu, Nepal

Table 29: Capacity assessment of bio-methanation plant

Sr no	Items	Year		
		2020	2030	2040
1	Wet waste diversion at domestic level (%)	10%	10%	10%
2	Wet waste diversion at domestic level (TPD)	4.00	6.00	8.00
3	Wet waste available for treatment (TPD)	35.00	49.00	67.00
4	Capacity of bio-methanation plant (TPD)	35.00	50.00	70.00

Source: CRIS primary assessment

3.2.4.6 Material recovery facility

Dry waste will be sent to the centralized MRF, proposed to be set up at the same location as the bio-methanation plant. At the MRF, different types of dry waste will be segregated into recyclable streams such as broken color glasses, bottles and paper, which can be converted into bails, plastics, card boards, thermocol, PET bottles, etc. A detailed design of the MRF is provided in Annexure B.4.

Table 30: Capacity assessment of MRF

Sr no	Items	Year		
		2020	2030	2040
1	Dry waste quantity (TPD)	34.55	48.66	66.48
2	MRF (TPD)	35.00	49.00	67.00
3	Designed size of the plant (TPD)	35	50	70

Source: CRIS primary assessment

3.2.4.7 Land requirement for centralized waste treatment and processing facility

The centralized facility has been proposed near Khanar at ward 10. The site is located 3 km north of Itahari Chowk. It is adjacent to Budhi river bank (*refer to Figure 11 in Section 2.1.4.1*).

Table 31: Assessment of land requirement for centralized waste processing and treatment facility

Sr no	Item	2020	2030	2040
	Bio-methanation plant			
1	Capacity of the bio-methanation plant (TPD)	35.00	50.00	70.00
2	Area required for bio-methanation plant (hectare)	0.28	0.40	0.57
	Material recovery facility			
3	Capacity of the MRF (TPD)	35.00	50.00	70.00
4	Area required for MRF (acre)	0.13	0.18	0.26
	Area required			
5	Total area requirement (hectare)	0.41	0.59	0.83
6	Circulation, road, infrastructure, greenbelt (@30%), (hectare)	0.13	0.18	0.25
8	Total area requirement (hectare)	0.54	0.77	1.07
9	Land area available (hectare)	2.37	2.37	2.37
10	Total area requirement (Nepali bigha[9])	0.79	1.13	1.58
11	Land available (Nepali bigha)	3.00	3.00	3.00

Source: CRIS primary assessment

The above table clarifies that the available allotted land to the current private operator is more than required for the development of a centralized bio-methanation plant and MRF.

3.2.4.8 Sanitary landfill facility

Inert substances and rejects generated from all centralized facilities will be sent to the centralized secured landfill. The landfill design comprises an active period, and a closure and post closure period. For this site, the active period is designed as 20 years. Landfilling activity will be undertaken in a phased manner for 20 years. Each phase comprises five years from the base year 2020 until 2040.The quantum of inert of the incoming waste at the site and rejects of the waste processing facilities will be filled in the proposed landfill. As per primary calculations, 26.48 MT per day is estimated to be sent daily to the landfill facility for final disposal, amounting to annual waste of 1.93 lakh MT. Total area required for the site over the design life will be 3.05 hectare. Detailed design assessment of the sanitary landfill site is provided in Annexure B.5.

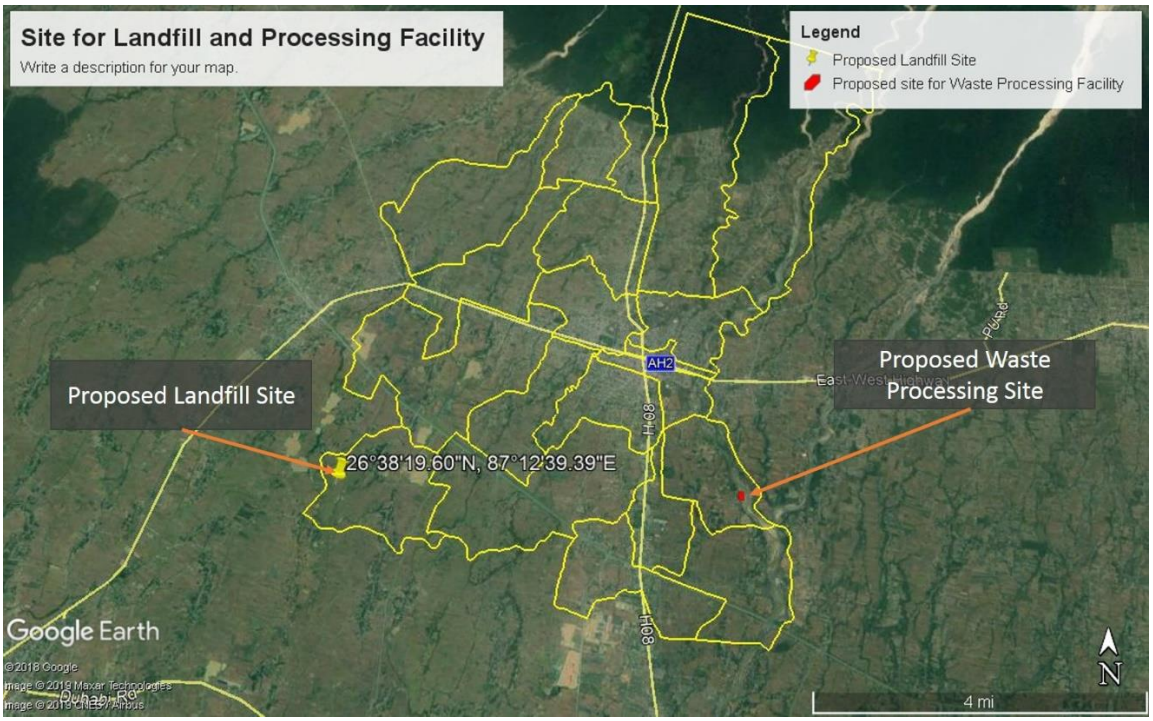
3.2.4.9 Initial environmental screening of land identified for development of landfill

Preliminary assessment of the land parcels identified by the ISMC officials was carried out. The candidate site, identified at ward 15, is a private land near Akomba village and was considered for final evaluation. The site falls under Bisrampur village. On the way to the site, a lot of kuchha houses were seen. However, there is no settlement within 300-500 meter from the identified

[9] 1 Nepali bigha = 6772.63 m^2

landsite. The Garan River is about 20 meters away. However, it is not being used for irrigation, as villagers have enough water from the Sansari Morang irrigation canal. There is no water body (pond or lakes). Also, no flood history has been reported (verbal discussion). Land identified for development of the landfill facility is ~2 km away from the highway.

Figure 18: Map showing location of the proposed landfill and waste processing facility



3.2.4.10 Rehabilitation of the existing disposal site

The existing disposal site at Charkoshe Jhari which falls within the forest needs to be closed for use to negate any further negative impact on its surrounding environment. There are two options for closure of the existing site i.e. scientific closure and rehabilitation of the site through bio-mining.

Bio-mining is a process where utilizable and valuable residual material is recovered from the accumulated mixed waste, dumped unscientifically in the current disposal site. The bio-mining technology separates the entire waste into two parts – 1) combustible part and 2) 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 biodegradable waste (including animal bodies) gets stabilized and any other hazardous waste e.g. medical waste is separated out. The entire process is machine driven and there are very limited chances of contamination from the waste and no manual handling (or direct contact of waste with human body) is occurred.

In addition, through Bio-mining process, both the material recovery as well as reclamation of land is possible. Whereas in the simple closure the accumulated waste remains at the same location without extraction of utilizable material. Moreover, the land could not be utilized for any purpose

other than a greenery. Therefore, bio-mining process of closure of existing dumpsite followed by land reclamation has been recommended for Itahari.

Thus, the current disposal site needs to be bio-mined to extract utilizable materials such as combustible items, etc. and reclaim the land. The inert material generated from the bio-mining process to be disposed in the proposed landfill facility. As per the assessment, about 21,000 m^3 of legacy waste is estimated to be extracted from the existing disposal site.

Table 32: Quantity assessment for bio-mining of legacy waste at the existing disposal site

Sr no	Head	Unit	Value
1	Stretch of the disposal site	m	4000
2	Average width on both sides	m	3.5
3	Average height of waste dump	m	1.5
4	Volume of waste to be bio-mined	m^3	21000

Source: CRIS primary assessment

Process of bio-mining: Bio-mining/ land reclamation is a process whereby previously landfilled solid wastes are excavated and processed. This involves a series of mechanical operations designed to recover one or all of the following: recyclable materials, a combustible fraction, soil, and landfill space. In this option, material recovered from the landfill is technically termed as bio-mining, 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 be used as filling material after excavation, during construction work at the reclaimed land. Thus, the cost of filling soil can be reduced
- Combustible waste from the landfill, if any, can be used for production of refuse derived fuel (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

3.3 Strengthening financial capability

This section details the project cost for SWM service improvement plan for Itahari. The cost components are worked out for collection and transportation infrastructure, a bio-methanation plant, a material recovery facility, sanitary landfill, and rehabilitation of the existing waste disposal (*Charkoshe Jhari*) site. Details of capital costs for collection and transportation infrastructure as well as processing and disposal infrastructure are provided in Annexure B.6 and 0.

3.3.1 Capital and O&M requirements

3.3.1.1 Capital cost

Based on the infrastructure improvement plan presented in the previous section, it is assessed that the capital investment for infrastructure upgradation for SWM service in Itahari would be USD 2.15 million. It is assessed that capital investment for the infrastructure required for collection and transportation of waste, development of a centralized material recovery facility, development of a sanitary landfill facility, and rehabilitation of the existing disposal site would be undertaken by the ISMC. Development of the bio-methanation plant will be taken up by the existing private operator under the prevailing contract.

Table 33: Summary of capital costs for proposed infrastructure improvement

Sr no	Proposed infrastructure component	Amount (USD million)	Amount (NPR lakh)[10]	% of total
1	Collection and transportation	0.36	390.92	17%
2	Bio-methanation plant	-	-	-
3	MRF	0.56	619.34	26%
4	Sanitary landfill	1.09	1194.40	50%
5	Rehabilitation of disposal site	0.15	161.55	7%
	Total project cost	**2.15**	**2366.21**	

Source: CRIS assessment

3.3.1.2 O&M cost

Based on the capital investment requirement, O&M cost for the service components assessed works out to USD 121,318 per annum considering all system components, including the proposed bio-methanation plant and material recovery facility which is to be developed and operated by a private operator.

Table 34: Summary of O&M cost

Sr no	Component	Annual O&M cost (USD)	Annual O&M cost (NPR lakh[11])
1	Sanitary landfill	32,102	35.31
2	Bio-methanation plant	25,500	28.05
3	Material recovery facility	28,152	30.97
4	Collection and transportation	35,536	39.09
5	**Total annual O&M cost**	**121,318**	**133.45**

Source: CRIS assessment

[10] 1 USD = 110 NPR

[11] 1 USD = 110 NPR

3.3.2 ISMC's investment capacity

Looking at the investment needs to improve SWM in Itahari, an assessment has been made of the funding available for creation of a corpus for capital investments as well as own source revenue that can be utilized for covering O&M cost of the current and the newly deployed infrastructure.

- ***Contribution for capital investments:*** For infrastructure upgradation of SWM service, the ISMC will seek project-specific grants from the federal government
- ***Contribution for O&M cost:*** The ISMC has been levying user fee for the cost incurred for managing the waste generated in the city. No comprehensive information is available on the number of waste generators from whom the user fee is being collected as the levying and collection of user fee is managed by the private operator. Data available on households and other waste generators from the municipal profile (available with the ISMC) is used to assess the potential of user fee that can be collected on a monthly basis. It is assessed that in the case of user fee collection (through issuance of sanitation cards to each waste generator), there is a potential to collect NPR 23 lakh per month considering only 60% collection efficiency, which will cover the annual O&M requirements of the newly proposed system

3.3.3 SWM user charge modality

3.3.3.1 Current user charges and potential revenue through SWM charges

As per the municipal profile prepared by the ISMC, there are 35,864 households in the ISMC (as per census 2011). Based on discussions with the private operator (responsible for waste management and collection of user charges from waste generators), 9,000 sanitation cards have been issued. Based on the socioeconomic survey carried out under this study, Table 35 presents the user charges paid by domestic waste generators.

Table 35: Sanitation charges paid by the respondents

Sr no	Monthly user charge range (NPR)	Frequency of respondents (%)		
		Domestic	Institutional	Commercial
1	Less than 100	0	13	0
2	100-199	69	50	91
3	200-299	7	0	0
4	More than 300	4	25	9
5	No response	20	13	0

Source: CRIS primary socioeconomic survey

Based on discussions with the private operator responsible for collection and retention of user charges collected from waste generators, NPR 18-21 lakh per month is estimated to be collected from waste generators. However, comparing the number of households and sanitation cards issued, there appears to be a need to increase the coverage of issuance of sanitation cards along with extending to uncovered areas and increasing the revenue base of SWM user charges. User charges have the potential to collect NPR 45 lakh revenue.

3.3.3.2 User charge compared with income and expenditure of domestic waste generators

As a part of the socioeconomic survey, monthly income and expenditure of the domestic waste generators were assessed along with the amount of user charge they pay for collection of solid waste from their door step.

Table 36: User charges compared with monthly household income and expense

Sr no	Administrative wards	User charge as % of monthly income			User charge as % of monthly expense		
		HIG[12]	*MIG*	*LIG*	*HIG*	*MIG*	*LIG*
1	Core	0.27%	0.18%	0.53%	0.42%	0.32%	0.51%
2	Outer	0.11%	0.32%	0.40%	0.24%	0.53%	0.62%
3	Rural	0.20%	0.34%	0.41%	0.34%	0.45%	0.60%

Source: CRIS primary socioeconomic survey

3.3.3.3 Affordability of user charges and willingness to pay

Affordability: Of the 81 domestic waste generators surveyed for assessing their socioeconomic profile, 100% responded on whether the current monthly user charges they are paying (for availing the waste management service from the private operator) are affordable or not. Results of the affordability assessment reveal that for high income group (HIG) and middle income group (MIG) of domestic waste generators in core wards, SWM charges are affordable. User charges paid by domestic waste generators in the outer area are not affordable for close to 60% of the respondents. However, close to 80% of the respondent domestic waste generators in the rural wards state that current user charges are affordable.

Table 37: Affordability of user charge (affordable to % of respondents)

Wards	HIG	MIG	LIG
Core	100	100	38
Outer	45	40	33
Rural	88	71	100

Source: CRIS primary socioeconomic survey

Willingness: On assessment of the willingness to pay more for an improved SWM service, 98% of the respondents find the current user charges affordable and are willing to pay more for improved services. However, domestic waste generators from the low income group (LIG) category (monthly income 20,000 or less) are not willing to pay more. Of the waste generators who find the current user charges affordable and are willing to pay more for the improved services, 8% are

[12] Households having monthly income less than NPR 20000 are classified as LIG, households having monthly income between NPR 20000 and NPR 40000 are classified as MIG and households having monthly income more than NPR 40000 are classified as HIG.

willing to pay up to 10% more, 66% are willing to pay from 10% to 30% more, 18% are willing to pay from 30% to 50% more, and 8% are willing to pay more than 50% of the current user charges.

3.3.3.4 Rationalization of user charges

As presented in Section 3.3.3.2, HIG households pay 0.42% of their monthly expense as user fee for SWM services. Similarly, MIG households pay 0.32% and LIG pay 0.51% of their monthly expense. However, due to improved service delivery, the ISMC will have to bear additional O&M cost that needs to be recovered. An assessment of the user fee indicates that increase in coverage of user fee collection is sufficient to recover O&M cost.

Table 38: Proposed slabs for SWM charges for domestic waste generators

Economic classes of user groups	Distribution	User charge % of monthly expense	Total HHs	Average expense (NPR)	Current user charge (NPR)	User charge % of monthly expense (proposed)	Proposed user charge /month	Collection (lakh NPR)	Monthly collection at 60% efficiency
LIG	32%	0.58	11476	19,963	116	0.10	20.00	2.30	1.38
MIG	42%	0.43	15063	27,468	118	0.10	30.00	4.52	2.71
HIG	26%	0.33	9325	39,522	130	0.20	80.00	7.46	4.48

Source: CRIS primary socioeconomic survey

The charges proposed are similar to those being currently paid by domestic waste generators or lesser. It is estimated that only by increasing the coverage of user fee collection, 80% of the annual estimated O&M cost can be recovered. Principles of tariff determination need to follow pro-poor cost rationalization, i.e. subsidizing the charges for the LIG group further by loading more on the non-domestic units. However, improvement in coverage of SWM charges is a gradual process and will take time. Thus, while considering improving the coverage and collection efficiency, ISMC needs to first focus on improving the coverage and gradually decrease the SWM charges ensuring the target of 100% O&M cost recovery.

3.3.3.5 Modality for the billing and collection system

The ISMC levies charges on the waste generators category-wise. The key parameters to derive the charges include access to the building, built-up area, structural specification, etc. Further, these rates vary across the city based on the location, i.e. core, outer and rural. Based on these parameters, SWM charges are assessed for domestic and non-domestic waste generators. This makes the system complex.

The SWM Act 2068 (2011 AD) prescribes levy charges based on the quantity of waste generated. This cannot be implemented because of the difficulties of measuring the quantum of waste generated by each household.

We recommend that the current system should continue, but the categories should be merged to simplify billing and collection. Domestic, commercial, industrial and institutional/ public use could

be the four identified user groups and the rates could vary based on the location, i.e. core, outer and rural.

Institutionalization of demand generation and collection of SWM charges

An efficient billing and collection system for waste management services would require the following:

i) Comprehensive updated database of the waste generators to ensure coverage

ii) Assess the receivables in a timely manner

iii) Initiate drives to maximize collection of charges. This could also introduce various incentive mechanisms for the waste generators to pay on time

iv) Tracking debtors and maximize arrear collection

In the present system, the sanitation card used to record the date of user fee payment of each waste generator is issued by the private operator. It is proposed that the ISMC should undertake a compressive survey of waste generators to assess the potential of revenue generation through SWM user fee. Additionally, the responsibility of collection of user charge needs to be vested with the staff (the property tax department could be given the responsibility) of the ISMC. Based on the property identification number, these sanitation cards are to 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 a sanitation card. As SWM charges will be based on a flat rate, the card shall mention the amount to be paid by the waste generators each month. Ward-wise demand can be generated by the ISMC jointly with the private operator responsible for the collection of user fees.

The responsibility of collection of charges, considering the existing human resource availability with the ISMC, could be vested with the private operator as is done in the present system for a short future. However, in the long run the ISMC needs to devise a mechanism to take the responsibility of billing and collection of SWM user charges from the waste generators for fair and transparent revenue management.

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 Itahari, the primary objective is to improve the coverage of levying rationalized SWM charges and ensure maximum collection. Post implementation of this, the city needs gradually move to further sophisticated technologies of automated billing.

3.4 Improvements in institutional and governance systems

3.4.1 Institutional structuring

As already discussed in the city level assessment section, the institutional arrangement of Itahari sub-metropolitan city needs strengthening in terms of conservancy capability and capacity. It involves adequately decentralizing the administration, delegating adequate powers at the decentralized level by including professionals into the administration and providing adequate training to the existing staff. NGO/private sector and TLO participation also needs to be encouraged to make SWM service competitive and efficient. The existing sanitation branch (Figure 4) is proposed to be strengthened with the additional human resources with designated responsibility for management and monitoring of SWM service. Proposed organizational set-up is presented in

Figure 19. Apart from a separate SWM unit, requisite staff for management and monitoring of services is recommended.

Table 39: Existing staffing pattern of the ISMC's sanitation branch

Sr no	Designation	Current posts	Filled	Vacant
1	Administrator	1	0	1
2	Environment engineer	1	1	0
3	Deputy administrator	1	0	1
4	Clerk	1	0	1

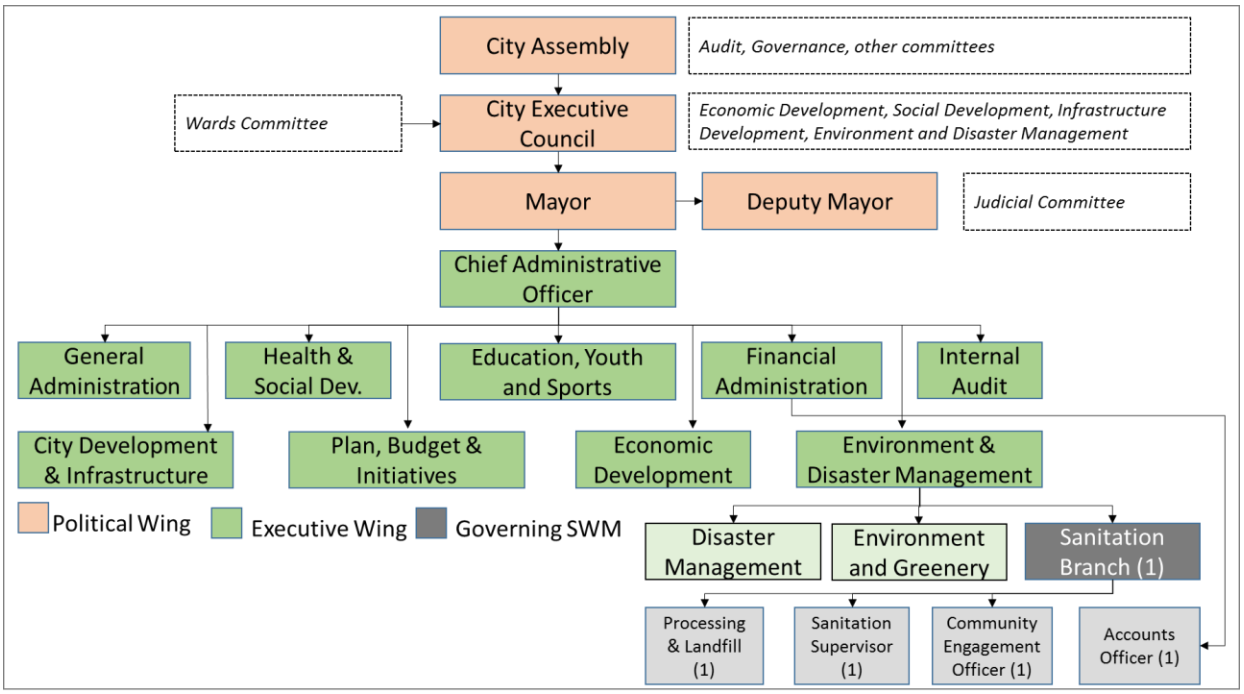
Source: ISMC

Table 40: Proposed staffing pattern of sanitation branch of ISMC

Sr no	Designation	New positions	Role
1	Environment/SWM engineer—section in charge	Existing	Complete responsibility of service delivery monitoring along with planning and development for future. Also, one-point contact for the existing private operator. Parodic review of complaints received.
2	Environment engineer—processing and landfill facility	1	Management of landfill site development and its operations. Monitoring of private operator's managing processing facility.
3	Sanitation supervisor	1	Supervision of waste collection and transportation activity in the feature city. To be supported by respective ward officers and support staff. Also work with the CEO to engage with community for ensuring segregation of waste at source.

Sr no	Designation	New positions	Role
4	Community engagement officer (CEO)	Existing administrator	Engagement with TLOs and other community-based groups to generate awareness and ensure segregation of waste at source.
5	Accounts officer—user charge	Existing deputy administrator	Undertake comprehensive survey of all waste generators and generate demand for user charge. Coordinate with the tax department for collection of user fee.
6	Support staff	1 existing clerk	Support engineering and non-engineering staff
	Total	3	

Figure 19: Proposed Institutional Structure Governing SWM in Itahari



3.4.1.1 Decentralization of administration

In the ISMC, decentralization of SWM service needs to be proposed at the ward level.

Ward and toll level administration

Ward level administration should be responsible for ensuring storage of segregated waste at source, primary collection of waste, street sweeping, and transferring of waste to the designated auto tippers. Cleaning of each street (lane by lane), markets and public space should be regularly supervised by ward level supervisors. The presence of all SWM officers of the ward in the field in the morning is essential. A grievance redressal system should be put in place in each ward. Ward level efforts could be made in the following ways:

- Create public awareness at the ward and TLO level, form residents' association/ neighborhood committees to ensure public participation in source segregation of recyclable waste and depose of domestic waste in the handcarts on time during primary collection
- Interface with people and officials, and help in redressal of public grievances on SWM at the ward level
- Support the effort of cost recovery for the services rendered and encourage NGO participation

City level administration

TLOs should supervise and support ward level administration. The concerned SWM department should be responsible for the upkeep of vehicles, setting up and maintenance of processing plants as well as for managing the disposal sites in an environmentally acceptable manner.

The concerned SWM department should also be responsible for the procurement of vehicles, equipment, land for processing, and disposal of waste. As a head office, it should take policy decisions and co-ordinate the activities of all the wards and be answerable to the chief executive officer and elected body for the efficient functioning of the department. It should look after the recruitment of manpower, human resources development and training, etc.

3.4.2 Outcome-based planning and budgeting for SWM

In order to have a structured approach for service delivery improvement, the ISMC first needs to prepare a 10-year comprehensive waste management plan, which should be updated once the period is over. The plan should cover all components of service planning, such as provision for ensuring segregation of waste at the source, collection and transportation of the waste, processing and disposal of the waste, recycling plan, 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 waste management plan preparation process needs to clearly define the sector priorities - short, medium and long term. Each of the identified priorities as an outcome from the waste management plan preparation process should then guide the budget preparation process for improving the SWM sector once the comprehensive waste management plan is approved for implementation by the Council of the ISMC. The budget planning process needs to ensure the envisaged outcome is implemented within the planned year of implementation.

3.4.3 Complaint management system

A complaint redressal system is required for citizens to voice their grievances regarding provision of SWM services, and promote efficiency and transparency at the ISMC level. ISMC, through an analysis of the complaints or grievances it receives, will be able to identify lacunae and bridge gaps in SWM service delivery. The time taken for resolution of grievances and the action taken are also to be monitored and recorded through this system.

3.4.3.1 Elements of proposed complaint management system

- ***Complaint management system***: A computerized central complaint management system should be networked and the complaints could be recorded through a register. A grievance

redressal officer from the SWM/Administration Department at the senior level should be responsible for recording and monitoring the complaints, and also for taking necessary action for redressal

- ***Medium of complaint registration:*** Multiple channels or a combination of channels can be adopted for receiving complaints, e.g., phone calls to a centralized customer service or complaint number, SMS messages to notified mobile numbers, automated generated complaints sent to commissioners for their records, walk-in complaint registration, and online complaint registration through email
- ***Complaint registration and recording system:*** This system should: 1) assign a unique ID for each complaint generated; 2) record contact details of the complainant; 3) record details of the physical location (zone, ward, area) relevant to the complaint; 4) assign the complaint to the concerned official in the MSWM department or cell; 5) record the stipulated time within which the complaint should be redressed; 6) provide an acknowledgement receipt to the complainant with all the above details for manual as well as online complaints; and 7) provide a complaint reference number with an SMS of its registration for telephone-based complainants
- ***Resolution certificate:*** Field officers of the ISMC or private operators, after resolving the complaint, should take a resolution certificate from the complainant and subsequently inform the complaint cell. The complaint should thereafter be treated as resolved
- ***Complaint resolution and feedback:*** The designated official for complaint resolution in the SWM unit or cell should be made aware of complaints received on a daily basis. Feedback could be taken through telephone, internet, or SMS
- ***Pending complaints:*** Complaints that are not resolved in a stipulated time should be deemed pending. The reason for the pending complaint should be recorded, and the designated officer and the complainant should be informed of this. Such pending complaints should automatically be escalated to higher officials for monitoring and directions
- ***Reporting and complaint analysis:*** A daily status report of complaint redressal should be prepared by an officer and submitted to the SWM engineer for further direction. The complaint management system should generate periodic, area-wise reports on the number of complaints received, the nature of complaints, the time taken for resolution, etc. The report should highlight critical issues, such as most frequently received complaints, frequently delayed responses, repetition of complaints (if any), time for resolution of complaints, etc. The weekly analysis of all complaints received should be reported to the Head of Municipal Council. Status of the complaints should be put in the public domain and updated on a daily basis to ensure transparency of the system

3.4.4 Local SWM bylaws

In order to have a comprehensive waste management, ISMC is required to prepare the local bylaws for SWM. The local bylaws need to be comprehensive, and should cover all components related to the local waste-management value chain. These provisions should cover obligation of waste generators, i.e. littering, segregation and composting, obligations of local levels with respect to waste management, community engagement, management of waste-related data, separate management of other waste (construction and demolition, bio-medical, industrial, e-waste, etc.), SWM user fee (tariff determination, means of levy and collection of charges,

preparation of revenue demand, collection and balance statement from user fees, penal provisions for nonpayment, and modality of revision of user fees), complaint management system, environmental quality monitoring mechanism, and penal provisions for contravention of local bylaws. A consultative process with the relevant stakeholders at the local level should be adopted in framing of such bylaws.

3.4.5 Capacity-building requirements

Human resources development is critical for internal capacity-building for the ISMC. Training, motivation, incentives for outstanding service, and disincentives for those who fail to perform are essential for human resources development. Concerted efforts are required to be made by the ISMC and the private operator jointly to inculcate among its officers and staff a sense of pride in the work they do, and to motivate them to perform and give their optimum output to improve the level of services in Itahari and ISMC's image. Training and capacity-building areas are identified depending on the role and responsibility assigned to the employee.

Table 41: Role-wise capacity-building areas identified for the ISMC 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 provisions for SWM service provision and its 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 • Public-private partnership 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 • 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	Classroom, workshops, expert lectures and exposure visits

Sr no	Role of staff	Capacity-building areas	Mode of training
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*** • Operations of landfill facilities • Landfill gas systems (capture, handling operation, 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 • Bio-medical 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 ***Environment and social norms*** • Global practices in environment norms across the SWM value chain • Air, water and surface pollution due to unmanaged solid waste • Disaster resilience and vulnerability assessment of the current and proposed SWM systems	Certificate courses, classroom training, workshops, expert lectures, and exposure visits

Sr no	Role of staff	Capacity-building areas	Mode of training
3	Worker engaged in sanitation and SWM	• Importance of sanitation in urban areas • Present scenario of SWM system in Itahari, 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	Classroom as well as on-field
4	Community engagement and IEC	***Awareness and engagement*** • Engaging with citizens—Best practices and modes • Best practices of developing information, education and communication material for generating awareness about SWM • Developing feedback systems for awareness programs • SWM—Impact on health and environment ***Social aspects*** • Engaging with the informal sector in waste management—Social aspects and livelihood dependency • Institutionalizing the informal sector in waste management—Best practices	Classroom and workshops
5	Financial management	• Modalities for tariff setting for SWM user charge • Administration of municipal revenue and revenue audit • Ring fencing of municipal budgets	Classroom with case examples

3.5 Private sector engagement

Providing services with respect to SWM through private sector participation is widely adopted by local governments globally. This section provides the scope for involving a private sector player to provide SWM services, either in part or in full. At the end of this section, a framework comprising factors guiding the scope of the project is provided.

3.5.1 Scope for private sector engagement

There are several models through which local governments engage with the private sector in managing the entire or a component of the SWM value chain. However, typically the contract through which the private sector is engaged is assessed from three perspectives: i) engage the private sector for human resource-intensive activities, such as street sweeping, and collection and

transportation of waste; ii) engage the private sector for deployment of technology for processing and disposal of waste; and iii) engage the private sector for handling the entire SWM chain, where the local government does not possess the requisite capabilities.

Table 42: Private sector engagement in waste management

Sr no	Engagement of private sector for	Applicability in case of
1	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 for processing facility • Lack of market linkages for recyclables and by-products [compost, refuse derived fuel (RDF), power, etc.] • Availability of land for setting up processing facility and sanitary landfill
2	Collection and transportation	• Inadequate manpower and equipment for collection and transportation • Inadequate technical and managerial expertise for sustainable waste management • Lack of funds for initial capital investment for equipment, vehicles, etc.
3	Setting up waste processing	• Landfill site over 30 km away from the city, thereby requiring decentralized waste processing
4	Waste processing and landfill facilities	• Inadequate technical and managerial expertise for sustainable waste processing and disposal • Inadequate funds for initial capital investment for setting up processing and disposal facilities • Lack of market linkages for recyclables and by-products (compost, RDF, power, etc.)

3.5.2 Models for private sector engagement

As discussed, private sector engagement for SWM can be either for the entire SWM value chain or a part of it, based on the institutional, financial, and technological capability of the local level unit. Based on the scope of work for the private sector, contracts need to be structured in a way that define distribution of risks and responsibilities between the private sector and the local level unit. Specifications of the contracting parameters vary among various forms of contracts. Therefore, it is imperative to assess the various models of contracting and risk allocation for successful execution of the contracts.

3.5.2.1 Contracting options

Contracts through which private sector is engaged are typically either pure service contracts, or management contracts, or long term concessions given for the management of the service. Of these contracts, service contracts are given for the least duration, and concessions are given for the longest period. Key facets of any contract include asset ownership, O&M responsibility, capital investment responsibility, and contract terms. These parameters need to be carefully designed for the various contracts.

Table 43: Model of contracting and responsibility allocation

Options	Service contract *(collect, transport, cleaning, disposal of MSW)*	Management contract *(collect, transport, cleaning, disposal of MSW)*	BOOT/ concession (integrated MSWM/ waste processing)
Asset ownership	Ownership with ULL, other than investment by private service provider in transportation fleet	Ownership with ULL, other than investment by the private service provider in transportation fleet and related equipment	Ownership with private developer during contract period, other than the land, which is to be transferred back to the ULL at the end of the contract
O&M	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 the private service provider	By the private developer, other than the land
Commercial risk	ULL or state agency	Partly with the private service provider and with ULL	Completely with the private developer
Duration	1-2 years	3-8 years	Above 10 years

3.5.2.2 Risk identification and allocation

Based on the model identified, risks associated with the contract need to be assessed. The risk allocation needs to be balanced between the project proponent and the private party. The objective of the ULL is to achieve economy in operations and effectiveness of service delivery, whereas for the private party, the key objective is to achieve efficiency in order to maximize profitability.

Table 44: Risk identification and allocation matrix

Type of risk	Event of occurrence	Implication	Risk allocation		
			Service contract	Management contract	BOOT/ concession
Design risk	• Design fault while preparing detailed designs • Inconsistent assumptions taken while preparing tender documents • Faulty design consideration by PPP operator	This would adversely affect desired out-come and cost structure of the project, and the financial outcome expected from PPP intervention	ULL and/or state agency	Private developer	Private developer

Type of risk	Event of occurrence	Implication	Risk allocation		
			Service contract	Management contract	BOOT/ concession
Construction risk	• Due to inefficient working practice by the private service provider • Delay in asset transfer from ULL and/or state agency	This will result in cost escalation and time overrun, thus affecting timely service delivery, and affect quality. It will also affect project financials	To be borne by both parties as per provision of the contract	To be borne by the private developer, other than asset transfer delay	
Operation risk	• Change in project scope during the operation period by the project sponsor • Mobilization delays in manpower/ equipment • Due to labor unrest and imprudent management practices • Financial mismanagement and significant increase in input cost	Project objective will not be achieved, operating cost will increase, and/or revenue realization will reduce from the project	To be borne by the private developer, other than the 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	Financial objective of the project not achieved	ULL and/or state agency	Partly by ULL and private player, as per provision of the contract	
Financial risk	• This will arise due to improper capital structure resulting in high debt component and fluctuation in interest rate	Not able to service financial obligations	ULL and/or state agency	Private developer	Private developer

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

3.5.3 Private sector engagement for SWM in Itahari

ISMC has signed a long-term concession agreement for the development of a waste-to-energy facility, and collection as well as transportation of waste up to the waste processing facility. However the agreement between ISMC and the Concessionaire is silent on development and management of a sanitary landfill for disposal of inert and thus it is assessed that ISMC is required to develop such sanitary landfill.

Based on the service and infrastructure improvement plan, and considering the limited institutional capacity of the ISMC, it is suggested that construction of the landfill facility to be undertaken by the ISMC, which could then be outsource it as a separate management contract to a private operator for management of the sanitary landfill facility.

Modalities for these two contracts are:

Items	Description
	Collection, transportation of waste and sweeping of streets **Disposal of waste**
Type of Contract	• Management contract
Contract Duration	• Contract period can be between 7-1o years (assuming one replacement cycle of the equipment to be used in landfill operations) and can be renewed based on performance.

Items	Description
Asset ownership	• ISMC will construct and own all facilities • Private operator might have to deploy necessary equipment for efficient functioning
Responsibility matrix	• ISMC will construct the facilities and handover to the private operator only for O&M • ISMC will be responsible for contract monitoring and management • O&M of landfill will be the responsibility of the private contractor. The facilities are to be handed over to the ISMC post contract period • 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 • Compliance with regulatory requirement will be the responsibility of the private operator
Risk allocation	• Inadequate waste generation for optimum operation of the facilities can be the responsibility of the ISMC • The private player needs to be penalized for mobilization delays, especially manpower • Major replacements will follow contract provisions • Delay in asset transfers will rest with the ISMC • If the project scope changes, then both parties need to mutually agree on the change, and in case of additional work, ISMC needs to bear the excess cost
Commercials	• The private operator will be paid a monthly management fee agreed in the contract. • ISMC needs to penalize the private operator based on performance, as per the contract provisions

3.5.3.1 Inclusion of informal sector in waste management through private sector

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 this 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[13]. 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 Itahari 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

[13]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

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 Itahari. 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.

3.6 Environmental, health and safety considerations

As per **Environmental Protection Act 2019** and **Environmental Protection Rules 1997**, 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 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 5-10 hectares
- Activities relating to compost plants in an area from 5-10 hectares
- Operation of sewerage schemes of 5 million liters a day (MLD)

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

- Filling of land with 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 of more than 10 hectares
- Activities relating to compost plants in an area of over 10 hectares
- Burying of waste emitted from an urban area with population of over 10,000

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- Activities relating to compost plants in an area from 5-10 hectares
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- Burying of waste emitted from an urban area with population of over 10,000

Currently, the Government of Nepal does not have norms for identification of land that can be developed into a sanitary landfill for the disposal of municipal waste, post processing or without any processing. Considering the negative impact on the environment owing to land, water and air pollution in developing these facilities, it is essential that the land for such facilities are identified in such a way that any negative impact on the environment is reduced to the extent possible. This section provides various measures to be taken or plans to be prepared to ensure that the SWM operations are carried out in an environmentally sustainable and safe manner.

Environment management practices to reduce the negative impact on the environment need to be ensured through:

- Appropriate norms for identification of land to be used for development of SWM facilities, more specifically the sanitary landfill, and the waste processing and treatment facilities (refer to Section 3.6.1)
- Preparing and implementing various environment management plans during operation, closure and post-closure of the waste management facilities (refer to Section 3.6.2)
- Consider potential occupational health hazards and undertake safety measures (refer to Section 3.6.3)

3.6.1 Site selection norms

Site selection norms are based on global available standards when siting processing, treatment and disposal facilities. The following table provides a snapshot of the environmentally sensitive indicators ISMC need consider while finalizing the land for the centralized facility, including the sanitary landfill site.

Table 45: Parameters that ISMC could evaluate to select land for development of SWM facilities

Sr no	Aspects	Criteria	Key consideration
1	Environmental	Inland waterbodies - Lake/ pond	200 m from lake/pond
2		Inland waterbodies - River/ streams	100 m from river/stream
3.		Flood plain	No land fill within 100-year flood plain
4.		Highway	Away by 200 m
5.		Wetlands	No landfill within wetland
6.		Groundwater table	Groundwater table > 2 m
7.		Forest area (reserved, protected, etc.)	The site needs to be located as per Forest Act of Nepal,; 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 are living 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/disposal within 20 km radius
13.		Water supply schemes/ wells	Minimum 500 m away
14.		Access	There should not be any access cutting across the 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 with people residing in neighboring areas

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

3.6.2 Environment 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. At various stages of the operation, various plans are to be prepared and implemented.

Table 46: Planning for operation, closure and post closure of SWM facilities

Sr no	Monitoring and management requirements	Way forward	Details
	Operation phase		
1.	The leachate generated from the waste is contaminated and contains suspended and dissolved materials. This needs to be managed onsite before discharging	Leachate management plan	Annexure C.1
3.	The precipitated water in the centralized facility needs to be channelized and discharged safely	Storm water management plan	Annexure C.3
4.	In landfill sites, organic waste is broken down by enzymes produced by bacteria. Considerable heat is generated by the reaction, with methane, carbon dioxide, nitrogen, oxygen, hydrogen sulphide, 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, hence, has the potential of damaging vegetation	Landfill gas management	Some of the measures that can be taken to manage the gases are: • Controlled passive venting and uncontrolled release • Controlled collection and treatment
	Closure phase		
5.	During the closure phase, the main emission is dust. Hence, measures are required to keep dust emission within control	Air quality monitoring and control measures	Annexure C.5
6.	The existing dumpsite at Charkoshe Jhari has been operational since 2015. Odor will be a major issue during closure of the dumpsite	Odor control and management	Annexure C.6
7.	During closure, noise issue arises from equipment and vehicles	Noise management	Annexure C.7
8.	Dust, 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 pertaining to the cutting of trees, if any
	Post closure phase		
9.	After closure of the dumpsite, the probability of groundwater contamination could remain. During the monsoon season, surface water, if mixed with residue waste,	Groundwater monitoring plan	Groundwater monitoring system (monitoring wells) will be installed at all landfill disposal facilities0

Sr no	Monitoring and management requirements	Way forward	Details
10.	could lead to further contamination downstream. Issues of gas coming out from the closed landfill also remains at times. These require sampling (refer Annexure C.8)-based continuous monitoring and management	Surface water monitoring plan	0
11.		Quality of leachate after treatment	Annexure C.12
12.		Ambient air quality monitoring	Annexure C.11
13.	Post closure, use of DG sets and plying of vehicles are responsible for noise	Noise management	Annexure C.7

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. SWM is entirely mandated to local levels and is the core priority for the newly formed ULLs.

Rapid growth of cities in Nepal has posed several challenges for local level municipal authorities. Identification of suitable land for construction of waste management infrastructure in cities is one of the challenge municipal authorities are facing. Lack of proper/ updated land use plan with urban authorities is a stumbling block in implementing solid waste management projects.

Currently disposal of waste in open dumpsites without any treatment is practiced even if it is impacting 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 fugitive emissions, i.e., emissions of 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 tabulated in the table below.

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 should be maintained between areas dedicated for waste disposal and the nearest surface water
Ontario, Canada	Buffer area should 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 m 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 (c.) The buffer area is sufficient to ensure that potential effects of the landfilling operation do not have unacceptable impact outside the site
Malaysia	500 m
South Africa	Buffer zone min 200-50 0m
Bangladesh	250 m 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 to be min 500 m, nearest commercial or industrial building, 250 m, and nearest property boundary is min 100 m
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 30 m
Malaysia	Production of compost from organic waste - 500m
Devon City Council (UK)	Buffer distance of 500 m
China	300 m 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 (different criteria for hilly and terai regions), but in no case the buffer zone distance should be less than 250 meters.

Provisions of buffer zone

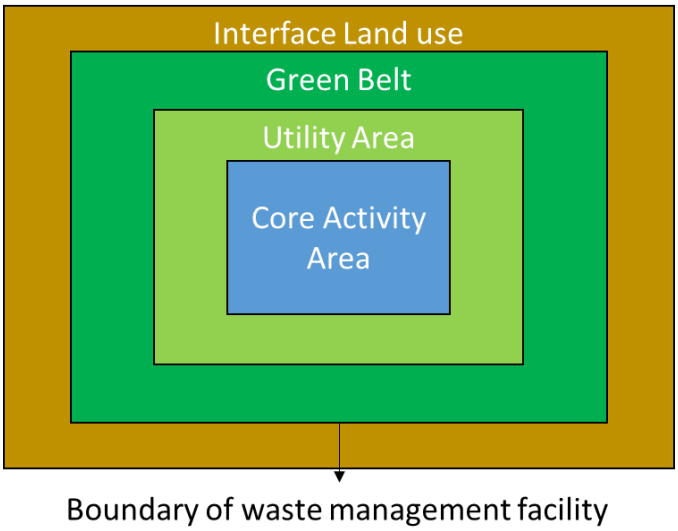
Buffer zone around the core waste management area consists of utility area and green belts. Further, depending on feasibility of planning, the interface land use between the boundary of the waste management facility and sensitive receptors, i.e., human habitations, can also be developed as an additional 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 Figure 19.

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

Figure 20: Layout of the buffer zone



- ***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, 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

3.6.4.1 Environmental and health safety norms

Associated risks

The organization will continuously identify the occupational health and safety (OHS) hazards and the associated risks to facilitate setting of OHS objectives and targets, control risks, and to maintain up-to-date information. While identifying OHS hazards and risks during the initial OHS review, the following criteria should be considered:

- All activities where previous record of incidents, accidents occurred
- Inputs from regular plant visits and meetings
- All activities, routine and non-routine, where substantial hazards and risks are involved, including contracted and company's own activities/facilities
- Evaluation of feedback from investigation of previous incidents/accidents
- Examination of all existing OHS procedures and practices
- While identifying significant OHS risks, consideration will also be given to:
  - Chemical hazards
  - Physical hazards, biological hazards
  - Monotonous work
  - Hazards due to layout and design deficiency
- Prepare a register of OHS hazards and associated risks, which will include department and facility layout charts

3.6.4.2 Employee health and safety

- Define and communicate role, responsibilities and authority for effective functioning of EHS and social management systems
- Organization will comply with relevant applicable policies, such as environmental, quality and fund standard guidelines
- Will define roles, responsibilities and authorities w.r.t EHS and applicable social guidelines from statutory bodies
- Monitor effective implementation, compliance to rules/acts
- Initial training needs to be addressed, and provide awareness and competence
- Calibration and maintenance of EHS equipment
- Maintenance of updated on-site emergency plan
- Handling and investigation of incidents/ accidents, non-conformities, taking action to mitigate impact, and completing corrective and preventive actions
- Conduct internal EHS and social compliance audits

3.6.4.2.1 Training and awareness

To lay down the procedure for identification of training needs, and provide appropriate training to all employees and contract employees to ensure effective implementation of EHS and social management systems at all levels and functions. The organization will identify the necessary training needs for all levels and functions.

3.6.4.3 Emergency preparedness and response plan

To establish and maintain procedures in order to identify potential accidents/ emergency situations, and to prevent, control and mitigate the associated environmental impact and occupational health and safety risks, and to test the effectiveness of the procedures. Also, if required, review/revise the procedures periodically. Some key measures include:

- Maintain fire extinguishers in working condition. Provide training to employees on fire fighting
- Explosion prevention
- Explosive mitigation
- Corrective and preventive action
- Avoidance of major spillage of chemical

Some general measures are:

- Vehicle speed will be restricted to 15 km/hour at the site to minimize dust generation
- Appropriate measures will be employed to minimize windblown litter and dust during transportation, by either covering the trucks or transporting the waste in enclosed containers
- Heavy goods vehicles holding areas are to be provided for vehicles waiting to deliver loads at the work sites so as to avoid queuing on other connecting roads
- Fixed noise sources to be located more than 50 m away from the site fencing

- Site workers working near high noise equipment to use protective devices such as ear muffs/plugs
- Maintain clearance between electric lines and work spaces/nearest service lines, and ensure enough space for maintenance
- Adequate precautions need to be taken to prevent accidents from machines; all machines used need to conform to relevant Nepal standards
- Protective footwear and goggles to all workers employed for mixing materials, such as cement, concrete, etc.
- Welder's protective eye shields to be provided to workers engaged in welding works
- Contractor to supply all necessary safety appliances, such as safety goggles, helmets, safety belts, earplugs, mask, etc., to workers and staff
- For the safety of workers at the site, regulations concerning fire safety need to be followed. Some of the requirements include:
  - Installation of fire extinguishers
  - Provision of water sprinklers along unpaved roads and emergency exits
  - Proper labeling of exits and place of fire protective system installation
  - Train personal to use fire control systems
  - Display of phone numbers of city/local fire services, nearest hospital, ambulance facility, etc.
  - A readily available first-aid unit, including adequate supply of sterilized dressing material and appliances, as per Factories Rules in every work zone
  - 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 and subsequent response to that. Nepal is located in the Himalayan belt and thus, geo-tectonically the country is prone to earthquakes. Nepal has been exposed to various 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, Itahari, 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, 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 Itahari, 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 parts of the population since they are already exposed in 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 PPE, 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 Itahari is managed by Private Operator, ISMC need to issue the guidelines for waste management workers. ISMC need to direct 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 they put on their regular work gloves.
- ***Availability of disinfectant:*** ISMC 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 Itahari 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, and accumulation of waste, washing and disinfection and street cleaning services.

3.7 Citizen engagement and IEC framework

Success of the proposals for improvement of SWM service delivery in Itahari can be measured through the extent of cooperation from residents, effectiveness of the proposed system, and operational efficiency. While effectiveness of the proposal and operational efficiency can be improved through institutional and governance systems, and capacity building, cooperation of the people can be achieved through regular information, education and communication (IEC) programs. During such campaigns, strategies for waste reduction, reuse and recycling also be propagated for deriving long-term benefits.

Awareness regarding the negative impact of improper SWM on the environment and general public health is not on the priority list of the general public. The typical approach towards waste generated is 'out of sight, out of mind' and 'not in my backyard' attitude. Though there are 215 TLO organizations in Itahari, community participation is not very active for generating awareness for better SWM. Segregation of waste at the source is not practiced religiously, and the waste is burnt in the open to get rid of the smell and junk.

A socioeconomic survey showed that close to 60% of the domestic waste generators felt that it is not their duty to comply with SWM rules in their city.

Also, perception of what happens to the waste was assessed during the socioeconomic survey. Though close to 90% of the residents were aware that waste is being sent to the disposal site, they were, however, unaware about the negative impact on the environment because of unscientific disposal. Such ignorance has led to waste often being disposed on fertile soil and water bodies, thereby contaminating the environment. There are also cases where waste clogs the drains.

3.7.1 Approach to citizen engagement and awareness generation

3.7.1.1 Stakeholder mapping for awareness generation

As waste generators are the primary stakeholders in the value chain of waste management, the success of the proposal depends on building meaningful partnership with all relevant stakeholders. Active involvement of the following community groups is essential, especially in primary collection:

- Representative from tole lane[14] organizations
- Affected local individuals, communities or households and project beneficiaries
- Elected officials of the ISMC

[14] Tole lane organization are community groups created between 80-150 households.

- Representatives from business and industries associations
- Concerned non-governmental organizations, community-based organization and different user groups
- Political party representatives and local parliamentarians
- Influential local leaders from the affected areas, such as informal or traditional community heads, school teachers, healers, social and religious leaders, and other notable women and men
- Social workers and marginal group workers, such associations or organizations dedicated to the upliftment of the poor, landless, women, children and other vulnerable groups
- Private operators engaged in waste management activities
- Representatives from associations (resident welfare, hotel owners, merchant's union, restaurant and commercial associations)

The ISMC needs to organize these groups through a series of interactive meetings with the office bearers before a phased program for community awareness is launched. The primary areas of focus for community awareness are:

- Awareness of the perils of the present practice, and their role in keeping the surroundings clean
- Discouraging people from littering on the streets
- Segregation of waste at the source and storage in two bins
- Primary collection from the doorstep
- Popularizing the 4R strategy—reduce, reuse, recycle, recover
- Discouraging use of plastics
- Developing methodology for reaching schools to create awareness among children

3.7.1.2 Activities for awareness generation

For the successful implementation of any SWM initiative, it is essential to explain to the people how the local body proposes to tackle the problem, and the extent of public participation expected to keep the city clean and improve the quality of life in the city.

The approach to an IEC plan could be:

- Organize sanitary workers and train them for providing professional services in SWM
- Provide training and capacity development support to guarantee efficient, quality and timely waste management services, including door-to-door collection of the waste
- Mobilize resident communities, TLOs, etc., and create awareness about the importance of waste segregation and discourage dumping of waste in back lanes and open plots

- Conduct awareness and information campaigns, organize thematic drives, meetings, etc., as instructed by officials and consultants
- Train field staff of ISMC in SWM and door-to-door collection, route rationalizing of vehicles and planning, and getting the plan approved from officials and the consultant
- Create awareness with regard to segregation of the waste at the source among the citizens and the staff of the ISMC, provide the required training, and organize meetings in consultation with TLOs and citizens
- Promote primary and secondary collection of waste and cleaning of entire ward area, i.e., door-to-door collection in assigned wards, collection and removal of roadside waste, collection and cleaning of waste bins, cleaning of drains and mullahs, and cleaning of entire ward area and back lanes
- Report weekly to ISMC officials and TLOs at the ward level

Table 47: Activities for community awareness generation

Sr no	Activity	Sub-activity
1	**Preparation and designing of promotional materials**	Design flex and hoardings
		Design pamphlets
		Make voice recording based on local themes
		Design uniforms
		Design small hoardings and promotional materials
		Perform street plays
		Plan vehicle routes
		Design logos
2	**Meeting with all stakeholders of SWM activities**	Meet TLOs/citizens and organize SWM campaigns
		Meet hotel and resort associations and organize SWM campaigns
		Meet schools and colleges and organize SWM campaigns
		Meet market associations and organize SWM campaigns
		Meet municipal staff and organize SWM campaigns
		Share and promote waste management videos/best practices
		Organize weekly rallies with TLO for SWM
		Meet women's groups and self-help groups
		Distribute pamphlets to households and perform street plays
3	**Door-to-door waste collection**	Household/sops and public awareness for uses of two/three dustbin for segregation of solid waste
		Household /shops and other common collection places
		Household awareness for waste segregation
		Promote door-to-door waste collection with segregation
		Train waste collectors on door-to-door waste collection
		Obtain feedback and suggestion from stakeholders
		Prepare and share report with the ISMC weekly

Sr no	Activity	Sub-activity
4	**Street cleaning**	Collect information of all roads/market areas
		Study present system
		Design route map for proper cleaning in consultation with the ISMC
		Train sanitary workers in street cleaning. Provide help in assigning responsibility to sanitary workers with time scheduling
		Training of sanitary workers for cleaning of water channels and drains
		Assign responsibility to sanitary workers
		Clean street drains daily
		Undertake proper collection of drain waste and assign responsibility to sanitary workers
5	**Preparation and submission of progress report to ISMC office**	Prepare qualitative report for each ward on monthly basis and submit it to the ISMC
		Prepare quantitative report for each ward on monthly basis and submit it to the ISMC
		Prepare budget utilization report for each ward on monthly basis and submit it to the ISMC
		Create awareness among TLOs, local residents, women's groups, children
		Identify locations for constructing of new community /public toilets, suggest up-gradation if required of existing community /public toilets

3.7.1.3 Mode of engagement with citizen

The IEC material developed should be utilized for engaging with citizens on a regular basis. The socioeconomic survey of waste generators revealed that 48% of the respondents favored community gathering as a preferred mode of engagement, followed by television, radio and others. Considering the current fabric of community groups and TLOs available in Itahari, it is proposed that the primary mode of engagement for awareness generation should be direct local-level community gathering. Table 48 presents engagement modes for generation of awareness about SWM in Itahari.

Table 48: Modes and means of engagement with citizens for awareness generation

Mode of engagement	Means of engagement	frequency of engagement
Focused engagement with target groups (ward-level communities, TLOs)	• Group meetings in the community • Workshops • Exhibitions • Lecture series • Panel discussions etc.	**Year 1** Group meetings and community gatherings on weekly basis. Exhibitions, panel discussions and lecture series on monthly basis. Citizen comments, feedback and improvement of target outcomes to be measured by the community engagement officer of ISMC (please refer Section 3.4.1of this report). **Year 2 onwards** Group meetings on quarterly basis and other means of engagement at least once a year.
Mass communication	• Use of print media (newspapers) • Use of local television channels (through talks of prominent personalities, political representatives) • Small videos to be played in movie theatres before shows • Street plays, puppet shows, etc. • Use of hoardings • Primary school curriculum to cover the subject	**Year 1** Monthly basis. Community engagement officer to assess effectiveness of the mode of communication and accordingly design the frequency.

3.8 Phasing of interventions

ISMC needs to approach implementation of the interventions suggested under the SIIP in a step-wise manner. An indicative phasing of implementing the interventions is presented in the table below.

Table 49: Phasing of interventions

Phasing	Institutional	Regulatory	Service delivery	Financial
Short term (0-1 year)	• Establish and staff SWM unit • Prepare capacity building plan • Prepare strategy for institutionalization of community groups and informal sector.	• Prepare draft bylaws for SWM • Undertake consultation on draft bylaws • Prepare OHS norms for informal sector and its monitoring mechanism • Design draft complaints redressal mechanism to be adopted by ISMC	• Identification of land for development of sanitary landfill • Set-up performance parameters for the private operator across the SWM value chain • Prepare monitoring mechanism for service delivery improvement through private operator	• Undertake comprehensive data base of waste generators • Rationalize categories of waste generators from current 126 to maximum 5-10
Medium term (1-2 years)	• Set up draft process for preparation, adoption and monitoring of outcome-based budgeting for SWM • Development of long term IEC framework	• Adopt bylaws and operationalize monitoring mechanism	• Prepare detailed project report for development of sanitary landfill facility and bio-remediation of existing dump site at *Charkose Jhadi*	• Generate demand statement for user charges • Prepare and maintain separate accounts for SWM • Set financial performance parameters for private operator
Long term (2-4 years)	• Monitor performance of private operator through SWM unit	• Monitor adherence to the provision of the local bylaw and generate its annual compliance report	• All projects envisaged under SIIP and approved by the ISMC are implemented, and not more than 25% waste is reaching the landfill	• Ensure at least 80% cost recovery for SWM either through private operator or through ISMC

3.9 Performance monitoring framework for SIIP

Itahari sub-metropolitan city needs to adopt a systematic approach towards improvement of SWM service delivery. Implementation of the SIIP needs to be targeted through short-, medium- and long-term strategies. The implementation also needs to be made equitable and sustainable through structured institutional strengthening and improvement in financial capabilities. Thus, monitoring the efficiency of operations and effectiveness of service delivery are the two key areas for the ISMC to ensure proper implementation of the SIIP.

Service & Infrastructure Improvement Plan (SIIP) covers capital investments, institutional improvements within ISMC and slates the capacity building areas to sustain the improved service delivery. It is envisaged that the capital investments and the capacity building needs would be covered under the NUGIP[15], and institutional and governance improvements can be achieved through an output-based aid (OBA). Key areas for monitoring under the OBA are:

- ***Service delivery performance*** - Encompasses the performance of all operations of SWM value chain, i.e., segregation at source, collection and transportation of waste, treatment, and disposal of waste
- ***Efficient financial management*** **-** Refers to the 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 ISMC to upkeep service delivery

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 assess the status of service delivery, scope for improvement, and clear identification of tasks to be carried out. Tables 50-52 present a tentative list of qualitative and quantitative indicators for each parameter identified based on which an OBA can be structured.

Table 50: Indicators for improving 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-à-vis the requirements]*	**Extent of segregation at the household level** *[One-time sample survey to be conducted by ward committee to assess the 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 the quantity of waste being segregated by households]*

[15] NUGIP is a Category B project, if SWM Projects or any component of the Project falls under Category—A, it cannot be funded under NUGIP.

Key parameters	Performance indicators [*description*]		
	Year 1	**Year 2-3**	**Year 4-5**
	Conducting awareness programs *[Schedule of capacity building activities prepared- Y/N;* *Trainings conducted as per schedule- Y/N;* *Awareness generating communications have been made- Y/N]*	**Conducting 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]*	**Conducting 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 the total waste generated (%)]*	**Waste collection efficiency** *[Total waste collected to the 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 the total waste collected at the MRF (%)]*
	Possession of land for commencing construction *[Land preparation for the construction of MRF, compost plant, sanitary landfill-Y/N]*	**Extent of recovery at the MRF** *[Quantity of various category of waste segregated from the total waste collected at the MRF (%)]*	**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 the total waste generated (%)]*

Table 51: Indicators for improved financial management for SWM services

Key parameters	Performance indicators [*Description*]		
	Year 1	**Year 2-3**	**Year 4-5**
Coverage of sanitation cards	**Preparation of waste generators database** *[A comprehensive database to be prepared for all the properties of the city- Y/N]*	**Coverage of sanitation cards** *[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 cards** *[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 cards *[Cross verification of existing sanitation cards against waste generator database (%)]*		

Key parameters	Performance indicators [*Description*]		
	Year 1	**Year 2-3**	**Year 4-5**
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 total demand estimated (%)]*	**Collection efficiency of charges** *[Total SWM charges collected to total demand estimated (%)]*	**Collection efficiency of charges** *[Total SWM charges collected to total demand estimated (%)]*
		Preparation of DCB statement *[Preparation of demand-collection-balance statement to assess the arrears for each financial year- Y/N]*	**Preparation of DCB statement** *[Preparation of demand-collection-balance statement to assess the arrears for each financial year- Y/N]*
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 income expenditure data for all the line items, as applicable- Y/N]*	**Updated records of SWM revenue and expenditure** *[Timely entry of 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 52: Indicators for 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 bio-methanation plant *[Measured at the weighbridge installed at the facility; data to be maintained daily and reported monthly]*	**Reporting of total waste reaching bio-methanation plant** *[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 set up necessary institutional processes- Y/N]*	**Complaints received per 1,000 households** *[Tracking of complaints registered in the complaint management system, to be measured ward wise]*	**Complaints received per 1,000 households** *[Tracking of complaints registered in the complaint management system to be measured ward wise]*

Key parameters	Performance indicators [*Description*]		
	Year 1	**Year 2-3**	**Year 4-5**
		Efficiency of redressal of complaints *[No. of complaints redressed within the stipulated time vis-a-vis the total number of complaints received in the same time period; Customer feedback is also to be assessed]*	**Efficiency of redressal of complaints** *[No. of complaints redressed within the stipulated time vis-a-vis the total number of complaints received in the same time period; 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 (%)]*
		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 (%)]*

3.10 Conclusion

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

Key functions to be performed by the ISMC are:

Function

- Prepare a comprehensive waste management plan

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

Functionary

- To perform the above-mentioned functions, the ISMC needs to be adequately staffed with all the technical manpower and other requisites as discussed in the report. TLOs and other community groups should 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, through a 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 ISMC can also seek capacity building support to operationalize the implementation of the functions. In order to bring private sector financing and efficiency, private sector participation can be explored

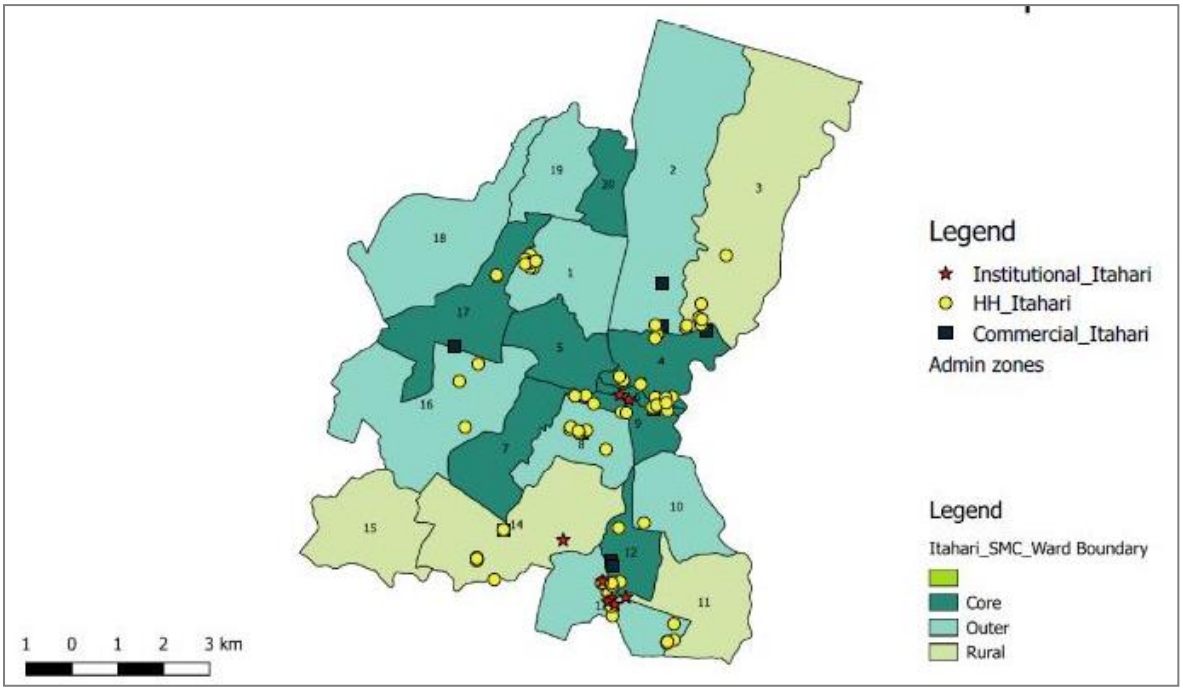
Annexure A : Primary survey and field observations

This annex presents information pertaining to the primary survey conducted to study the socioeconomic profile of waste generators and quantification and characterization of the waste that is being generated in Itahari. This also summarizes the discussions CRIS team conducted with representatives from TLOs of the city.

Annexure A.1 : Sample distribution of waste generators and number of samples

Category	Description	No of waste generators	No of samples
Residential units	Core	30.00	90.00
	Outer area	27.00	81.00
	Rural area	24.00	72.00
Commercial units	Retail	4.00	8.00
	Restaurants/ hotels	3.00	6.00
Institutional units	Banks	4.00	8.00
	Educational and child care	4.00	8.00
	Other	4.00	8.00
Total no. of units		**100.00**	**281.00**

Annexure A.2 : Geographical distribution of samples



Source: Primary survey, October 2019

Annexure A.3 : Consultations with stakeholders—Main recyclers

Dilip Kabadiwali is the largest recycling material collector in Itahari. During the interview it was understood that apart from him there are 15 other small scale recyclers in Itahari. On an average he received 5000 beer bottles per day, 20 tons of plastic, 200-300 tons of paper, 1-2 ton beer cans and 700-800 tons of recyclable metal per month. He has employed 4-5 people for weighing and arranging the material received at his recycling facility.

Dilip Kabadiwala (Narangopal Tole in ward six) was interviewed during the site visit to understand the scale of recycling operations. On monthly basis this recycler recycles close to 900 to 100 tons of recyclable per month, mainly of which is metal (70% to 75%), paper (20-25%), plastic (1-2%) and remaining minor fraction is glass beer bottles and aluminum cans of beer.

Bulk items such as e-waste, computer parts, wood, tyre etc. cannot be accommodated due to scarcity of space. During festival seasons, such as Viswakarma puja, Dasera, Diwali etc. waste receipt is more, as people clean their houses. However, bottle quantity remains same throughout the year.

Daily 3-4 trucks are sent of recyclable material are sent to the industries which buy recyclables from this recycler. In this establishment he has 4-5 staff who are associated in his business. The operation includes receiving of materials, shifting to the storage yard (if required for a day or two), then sending to the recycling industries. Mostly they received sorted or segregated recyclable materials. However, sometime they also segregate if required. Daily around 40-50 vendors come to this recycler to sell their items. Out of that 50% are stick vendors (sub dealers) and rest are small vendors.

Annexure A.4 : Assessment of leachate generation potential

Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Rainfall (mm)	6	7	16	51	140	340	571	423	339	103	7	4	2007

Source: https://en.climate-data.org/asia/nepal/western-development-region/itahari-29979

Table 53: Assessment of leachate generation at the disposal site in Itahari

Sr no	Head	Unit	Value
1	Stretch of disposal	m	4,000
2	Average width on both the sides	m	3.5
3	Footprint of the surface of the disposal site	m^2	14000
4	Annual precipitation	m/year	2.007
5	Annual accumulation of precipitation in the footprint area	m^3/year	28098

6	Landfill operational since	Year	2015
7	Design year (base)	Year	2019
8	No of years of accumulation	No of years	4
9	Evaporated and escaped through surface runoff (factor)	factor	0.65
10	Subsurface percolation and effective accumulation of leachate	m^3	39337
11	**Total leachate generation in the disposal site**	**m^3**	**39337**

Annexure A.5 Classification of user charges collected from waste generators

Table 54: User charges for SWM in Itahari (in NPR)

Sr no	Type of waste generator	2074 (2017)		
		Small	Medium	Large
1	Single-floor residence	100		
2	Single-room miscellaneous shop	100		
3	Miscellaneous wholesale shop	250		
4	Small tea shop	100	150	
5	Cosmetics wholesale shop	200		
6	Beauty parlor (small and big)	100		
7	Sweets shop	250		
8	Ice cream parlor (small and big)	200	500	1,000
9	Bakery industry (small and large)	200	500	1,000
10	Bakery shop	100		
11	Restaurant	250		
12	Hotel (lunch and tiffin)	150	250	
13	Vehicle repair shop on footpath	150		
14	Street vendor	100		
15	Footpath shoe maker and shiner	100		
16	Hotel/lodge (small and large)	250	500	1,000
17	Pan shop	100		
18	Cold drink shop (small and large)	100	150	
19	Liquor wholesale shop	250		
20	Pepsi, Coca-Cola dealer	500		
21	Gas cylinder retail office	200		
22	Hospital (small, medium, large)	1,000	2000	3,000
23	Clinic/lab/pathology (small and large)	500	1000	
24	Pharmacy (small, medium, large)	100	150	200
25	Ayurveda medical shop	100		

Sr no	Type of waste generator	2074 (2017)		
		Small	Medium	Large
26	Ayurveda medical shop, lab and doctor	500		
27	Animal medical shop (small, medium and large)	100	150	200
28	Agriculture fertilizer shop (small, medium and large)	100	150	200
29	Homeopathic medical shop	100		
30	Baoding school (small, medium, large)	300	500	1,000
31	School	500		
32	College	500		
33	Child care school	150		
34	Saloon (small and large)	150		
35	Government office	300		
36	Bank	300		
37	Finance company	300		
38	Insurance company	300		
39	Saving and credit co-operative (small and large)	150	300	
40	Organization (NGO)	300	500	
41	Organization (INGO)	500	1,000	
42	Motorcycle garage (small)	300	500	
43	Motorcycle garage (large)	500	1,000	
44	Car garage	500	1000	
45	Cycle/rickshaw servicing center	200	300	
46	Cycle selling shop	300		
47	Petrol pump	500	700	1,000
48	Party halls	2,000	3,000	5,000
49	Fresh house (meat shop)	250	300	500
50	Buff (meat shop)	500	1,000	
51	Bangur (meat shop, small, large)	200	500	
52	Khasi, goat (meat shop, small and large)	200	500	
53	Fish shop (small, medium, large)	200	300	500
54	Glass shop (small, medium, large)	300	500	600
55	Press (small, medium, large)	200	300	400
56	Book shop (small, medium, large)	200	300	400
57	Stationery store (small, medium, large)	200	300	500
58	Hardware shop (small, medium, large)	200	300	500
59	Kitchen shop (small, medium, large)	100	150	200
60	FM Radio center	100		

Sr no	Type of waste generator	2074 (2017)		
		Small	Medium	Large
61	Newspaper	100		
62	Radio, TV, mobile, computer repair center	200		
63	Radio, TV, mobile, computer shop	150		
64	Watch repair center	100		
65	Watch shop	100		
66	Cyber café (small, medium)	100	200	
67	tele Communication shop	100		
68	Travel agency	150		
69	Motorcycle showroom	500	1000	
70	Tractor showroom	200	500	
71	Vehicle showroom (small, large)	300	500	
72	Solar shop	200	300	
73	Fruit shop (small, medium, large)	100	200	500
74	Manpower	150	200	300
75	Vegetable shop (small, medium, large)	100	150	200
76	Potato, onion wholesale shop	200		
77	Clothes shop (small, medium, large)	100	150	200
78	Readymade clothes shop (small, medium, large)	100	150	200
79	Tailoring shop (small, medium, large)	100	150	200
80	Machinery equipment shop	100	200	
81	Motorcycle parts shop (small, large)	100	200	
82	Various motor shop	150	250	
83	Vehicle parts shop (small, large)	100	200	
84	TV, fridge dealer (small, large)	100	200	
85	Shoe store (small, medium, large)	100	150	200
86	Booking counter	100		
87	Cinema hall	500	1,000	
88	Aluminum shop (wholesale)	500	1,000	2,000
89	Aluminum furniture center	300		
90	Gold and silver shop	100		
91	Gold and silver factory	100		
92	Furniture factory (small, large)	100	200	
93	Furniture shop (small, large)	100	150	200
94	Grill factory (small, large)	150	200	300
95	Noodles, bhujiya, daalmoth factory (small, large)	500	1000	

Sr no	Type of waste generator	2074 (2017)		
		Small	Medium	Large
96	Animal skin factory (small, large)	500	1000	
97	Bag factory (small, large)	200	400	500
98	Thukpa factory (small, large)	250	400	500
99	Candle factory (small, large)	150	250	500
100	Carpet factory (small, large)	150	250	500
101	photocopy shop (small, large)	150	250	500
102	Nursery (small, large)	100	200	300
103	Wood mill (small, large)	100	200	
104	Rice mill (small, large)	100	200	2,000
105	Oil mill (small, Large)	100	200	2,000
106	Bag shop	100		
107	Bag shop (wholesale)	200		
108	Carpet shop	200		
109	Currency exchange center	150		
110	Skill and training center	500		
111	Seminar hall (small, large)	500	2,000	
112	Dance class	100	250	
113	Music class	100		
114	Security office	150	500	1000
115	Consultancy	200	500	
116	Computer institute	200	500	
117	Photo studio	100		
118	Photo lab	150		
119	Recycler shop (kabadi) center	500	1000	
120	Repairing center (small, large)	150	250	1000
121	Driving center	250		
122	Consultancy	250		
123	Legal firm	200		
124	Poultry dealer	250	500	1000
125	Printing shop (Flex printing)	150	250	500
126	Art class	100		

Annexure B : Service delivery improvement - Details of proposed infrastructure

Annexure B.1 : Assessment of collection and transportation infrastructure

Sr no	Head	Core		Outer		Rural	
		Wet waste	Dry waste	Wet waste	Dry waste	Wet waste	Dry waste
A	**Basic considerations**						
1	Vehicle proposed	Hydraulic tipper vehicle					
2	Type	Dual compartment					
3	Capacity (m^3)	3.3	3.3	3.3	3.3	3.3	3.3
4	Bulk density of waste	0.229	0.229	0.229	0.229	0.229	0.229
5	Average vehicle speed (km/h)	12	12	12	12	12	12
6	One-way average distance to travel (km)	10	10	12	12	20	20
7	To & fro distance travel time (min)	100	100	120	120	200	200
8	Average collection & tipping time (min)	20	20	35	35	45	45
9	Total time for one cycle	120	120	155	155	245	245
10	Operational hours (hour)	8	8	8	8	8	8
11	No of feasible trip by each tipper (nos)	4	4	3	3	1	1
B	**Vehicle equivalency**						
12	*Households*	3.66	2.00	4.14	2.26	2.86	0.04
13	*Commercial establishments*	0.97	2.90	1.10	3.27	0.76	2.26
14	*Institutions and offices*	0.05	0.10	0.05	0.11	0.04	0.08
C	**No of vehicles required**						
15	*Households*	5.67		6.40		2.90	
16	*Commercial establishments*	3.87		4.37		2.26	
17	*Institutions and offices*	0.14		0.11		0.11	
18	**Tipper vehicles required**	**9**		**10**		**5**	
19	**Total no of vehicles**	**24**					

Annexure B.2 : Waste processing technologies

Processes	Description
Incineration (mass burn)	It can be defined as a combustion process that uses excess oxygen and/or air to burn the solid waste at high temperature (>700°C). It is the most commonly used thermal technology 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, but usually about 650°C) are employed compared with gasification. But similar to gasification, this technology is yet to be proven for mixed MSW.
Plasma arc gasification	This process converts organic or fossil-based carbonaceous materials into carbon monoxide, hydrogen, and carbon dioxide. This is achieved by reacting 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 a fuel. The technology is still in its nascent stage as far as operational experience with MSW is concerned. In a high-temperature pyrolysis process, organic waste solids (carbon-based materials) are converted to a synthesis gas, while inorganic materials and minerals produce a rock-like glassy by-product, called vitrified slag. The high temperature of this process is created by an electric arc in a torch, whereby gas is converted into plasma. The process involving a reactor with a plasma torch processing organic portion of waste solids (carbon-based materials) is 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 MSW and plastic waste. However, this technology is extremely expensive and requires a very high degree of sophistication and process control, and is rarely used for mixed MSW.
Aerobic digestion (composting)	It is a process of decomposition of organic matter/organic waste (leaves, food waste, paper, etc.) in the 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 with thermal treatment methods, this method is less expensive, but requires more land. Further, due to operational nuisance related to composting, high volume of rejects generation (~30% of incoming waste), and lack of market for sale of compost, this method is now 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 bio fertilizer and biogas. Anaerobic digestion is a reliable technology for the treatment of wet organic waste.
RDF	Under this, MSW is subject to various physical processes that reduce the quantity of total feedstock, increase its heating value, and provide a feedstock. It may be densified or palletized into homogeneous fuel pellets and transported and combusted as a supplementary fuel in utility boilers.
Densification/ palletization	This process converts combustible waste into fuel pallets.

Source: Secondary research

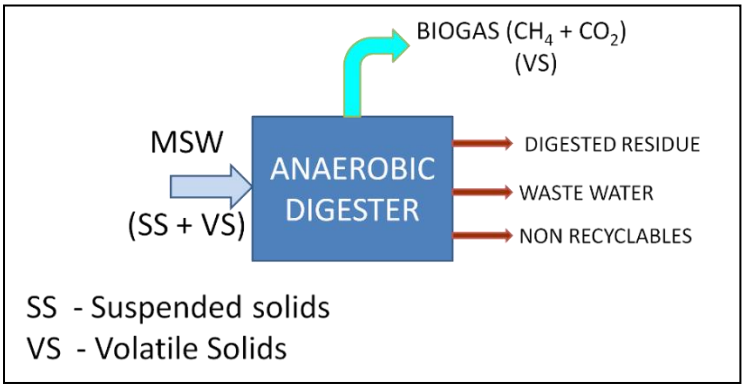
Annexure B.3 Design of bio-methanation facility

Anaerobic digestion p*rocess*

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 primarily comprises 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, is sent to the landfill for final disposal.



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 microbes 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 consist primarily of methane and carbon dioxide.

Bio-methanation technology details for Itahari

Thermophilic anaerobic digestion technology is an advanced biological process used for processing the organic fraction of waste. It is suitable for high solids, accompanied with effective mixing and design of reactor.

Pre-treatment: The organic waste would be fed into the pulverizer/homogenizer where it will be homogenized and sieved/shredded to size < 10 mm. After a retention time of a few hours in the pulverizer/homogenizer, the waste would be fed into the anaerobic digestion unit.

Digestion: The anaerobic digestion unit would be provided with recirculation. After passing through the anaerobic digestion unit, the digested residue would be extracted from the bottom of the unit and the biogas generated would be collected from the top.

Biogas production: Biogas generated through the biomethanation process would be used for power generation.

Power generation from biogas: The gas stored in the gas holders would be 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 would be utilized from the gross generated power.

Slurry dewatering: The residue left after the anaerobic digestion would be dewatered and dried. The dried solid can further be sold as organic compost.

Table 55: Overview of biomethanation technology for Itahari

Sr no	Item	Salient features of the technology
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	Around 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/ton/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 work (only civil foundation/shed), lower execution time

Annexure B.4 : Design of dry waste processing facility: MRF

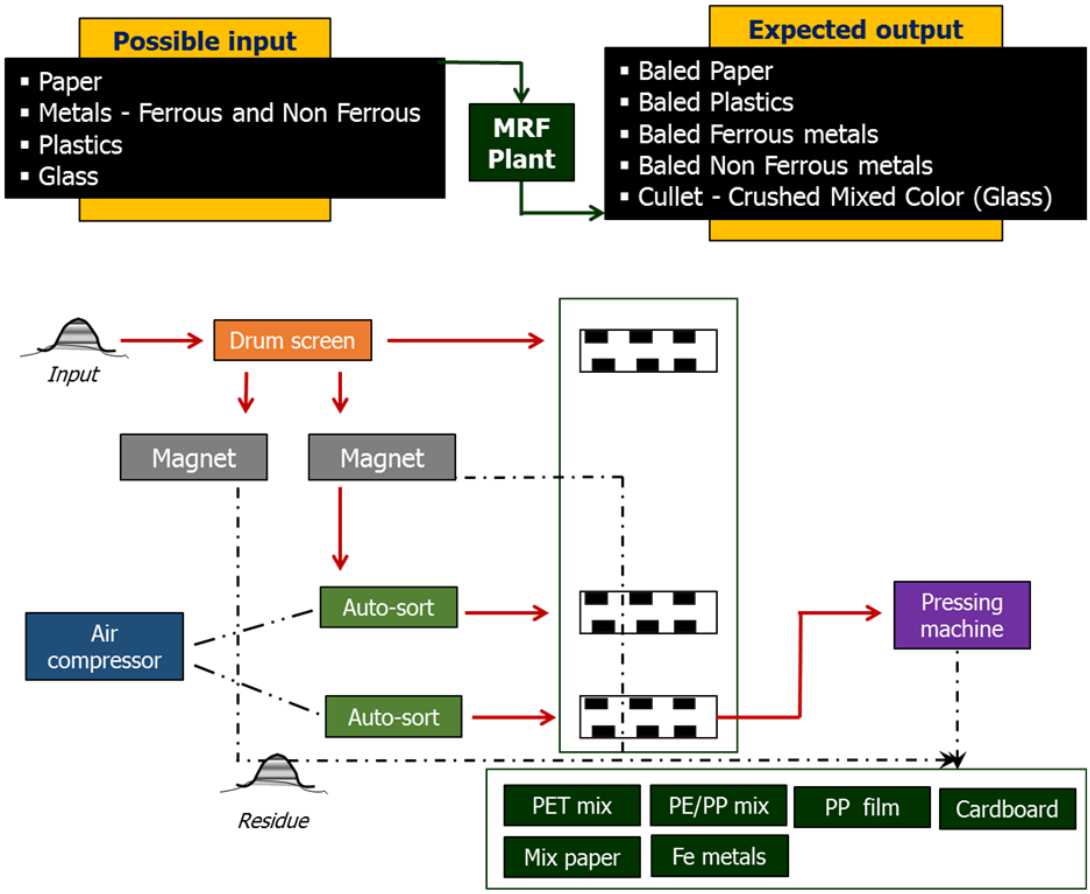
The dry part of the waste stream is collected and transported to the processing facility and then to the MRF. The technology is discussed in detail below.

Design basis for MRF facility

A typical MRF is located inside a warehouse-type building with concrete flooring and enclosed by a perimeter fence for security. It has the following components: (i) receiving or tipping area, (ii) sorting/processing area, (iii) storage area for recyclables, (iv) residual storage area, (v) equipment area, (vi) space for an office and (vii) loading area for residuals and processed recyclables. It should also have basic connections for water and electricity and adequate space for the entry and exit of waste trucks. Provisions for washing and a septic tank must be included. The warehouse should be designed have minimum number of columns that could interfere with the efficient movement of materials and equipment, and facilitate the installation of higher ceilings. Receiving areas

should have the capacity to receive at least two days' worth of the MRF's processing capacity in anticipation of equipment breakdown and to provide materials for the second-shift operation, if required. The process flow diagram of the facility is as given below.

Figure 21: Process flow of MRF facility



Annexure B.5 : Design of sanitary landfill facility

Site selection criteria for landfill facility

Sr no	Criteria	Details
1	Lake/pond	200 m away from lake/pond
2	River/streams	100m away from river/stream
3.	Flood plain	No landfill within a 100-year flood plain
4	Highway	200 m away from highways
5	Public parks	300 m away from public parks
6	Wet lands	No landfill within wet lands
7	Habitation	500 m away from the notified habitation area
8	Groundwater table	Ground water table > 2 m

Sr no	Criteria	Details
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
11	Water supply schemes/ wells	Minimum 500 m away

Landfill design concept

Landfill design involves development of concept and adoption of suitable procedures and safety considerations. Landfill is a combination of different components wherein each of the components has to be designed separately. Design concepts for the following components have been developed:

- Assessment of landfill volume and area required
- Landfill life
- Evaluation of concept development plan—footprint of landfill site
- Design of leachate collection system
- Design of liner system
- Assessment of landfill gas generation
- Design of landfill gas collection system
- Design of final cover system

Landfill design requirements

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/s
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

Bottom liner system

Percolation of leachate from waste in the landfill to the subsoil can be prevented by using a suitable protective or liner system. The system is a combination of drainage and barrier layers. Barrier materials include natural clay, amended soils, and flexible geomembrane. The drainage layer and leachate collection system are placed over the composite liner system.

Effectiveness of the barrier layer basically depends on the hydraulic conductivity of the clay/amended soil liner and the geomembrane density. The clay/amended soil liner is effective only if it is compacted properly and the geomembrane liner is effective only if its density or mass per unit area (minimum thickness is specified) is sufficient to withstand punctures. Following are the specifications recommended for the landfill site 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 10^{-2} cm/s

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

Landfill gas management

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 comparable to food digestion. Considerable heat is generated by these reactions, with methane, carbon dioxide, nitrogen, oxygen, hydrogen sulfite, carbon dioxide and other gases as byproducts. Methane and carbon dioxide are the principle gases produced with almost 50:50 share. Methane is explosive when present in the air in concentrations of 5-15%. Landfills generate gases with a pressure sufficient to damage the final and the vegetative covers. Also, because only limited amount of oxygen is present in a landfill, when methane concentration reaches this critical level, there is a little danger that the landfill will explode. Following gas management strategies can be adopted to avoid this:

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

As the landfill in Itahari is fundamentally secured and will receive only inert matter, gas generation is anticipated to be very less. Therefore, only a passive gas venting system is proposed.

Design of final cover system

The 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 will be adopted depending on the gas management system. The final cover system must comprise a vegetative layer supported by barrier and gas venting layers:

- 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

Final cover system design and specifications

Vegetative layer	0.45 m
Barrier layer of clay with permeability 1×10^{-7} cm/s	0.60 m
Gas venting layer of granular material with permeability 1×10^{-2} cm/s	0.45 m
MSW	25 m
Drainage layer of permeability not greater than 1×10^{-2} cm/s	0.30 m
HDPE geomembrane liner	1.5 mm
Compacted clay permeability not greater than 1×10^{-7} cm/s	0.90 m

Inert waste volume and landfill capacity

The quantum of inert matter of the incoming waste at the site will be filled in the proposed landfill. The detailed calculations for the estimated landfill capacity and area have been given in Table 56 below.

Table 56: Landfill area calculations

Sr no	Site calculation by area method	Unit	Quantity
1	Average waste receipt	TPD	26.48
2	No of years	-	20.00
3	Total waste receipt in 20 years	tons	193,292.75
4	Achievable waste density in landfill	tons/m^3	0.85
	Waste characteristics		
6	*% inert rejects to landfill*	%	100.00
7	Waste to landfill (W) during the 10-year period	tons	193,293
8	Volume of waste	m^3	227,403.2
9	Height of landfill (H)	m	12
10	Depth of landfill (D)	m	2.5
11	Slope above ground level (as 1:n1)		4

Sr no	Site calculation by area method	Unit	Quantity
12	Slope below ground level (as 1:n2)		2.5
13	Area at the ground level (A)	m^3	30,526
14	Area in ha	ha	3.05
15	Area in sq. m	sq. m	30,526
16	Area in acre	acre	7.54
17			
18	Area in bigha	bigha	4.51
19	Area in ropani	ropani	60.09
20	Width	m	160.00
21	Length	m	190.00

Source: CRIS assessment

Annexure B.6 : Details of capital cost—Collection and transportation infrastructure

This section presents the estimated cost for procurement of collection and transportation vehicles and equipment. It should be noted that, the estimation includes only items that are to be procured newly. The cost of existing infrastructure that could be utilizable has been excluded. Existing collection and transportation infrastructure will be clubbed with the proposed system, which will reduce the capital cost for the project.

Sr no	Item	Quantity (nos)	Rate ($)	Amount ($ million)
1	Closed tipper vehicle for waste collection	24	11,190	0.27
2	Existing trailers for bulk generator, with customized cover	10	-	
3	Bins for bulk waste storage at markets (1,100 L capacity)	53	490	0.03
4	8.5 m^3 box tipper vehicle for inert matter transportation to landfill	2	30,424	0.06
	Total			**0.36**

Annexure B.7 : Details of capital cost—Processing and disposal infrastructure

Sr no	Heads	Quantity	Unit	Rate ($)	Amount ($ million)
A	**Biomethanation plant**				
1	Capital cost for biomethanation plant	50.00	TPD	22,381	1.12
2	Infrastructure and utility with contingency etc.	1	LS	15% of A(1)	0.17
	Total (A)				***1.29***
B	**MRF**				
	Capital cost for MRF plant	50.00	TPD	9,792	0.49
	Infrastructure and utility with contingency etc.	1	LS	15% of B(1)	0.07
	Total (B)				***0.56***
C	**Sanitary landfill**				
1	Construction of sanitary landfill	27	TPD	34,970	0.94
2	Admin building, parking, infrastructure, utility, etc.	1	LS	-	0.14
	Total (C)				1.09
D	**Rehabilitation current dumping site**				
	Bio mining and disposal of inert from legacy waste	21,000	m^3	7.00	0.15
	Total (D)			**-**	***0.15***
	Grand total				***3.08***

Annexure C : Environment and social management plans

Annexure C.1 : Leachate management plan

Leachate is generated from storm water and moisture. Leachate is considered to be a contaminated liquid, as it contains many dissolved and suspended materials. The fundamental approach in controlling leachate is to first confine leachate to the limits of the landfill, and then collect and dispose it safely. The leachate must be collected through a system of collection pipes, and provision 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.

Main components of the leachate collection system are: drainage layer and conveyance system. Leachate conveyance system comprises a network of perforated HDPE pipes through which the leachate is collected in a sump.

The leachate collection system is a network of 100-mm-diameter feeder pipes at 20 m spacing, connected to a 150-mm-diameter header pipe. HDPE perforated pipes with sufficient strength (minimum 6 kgf) are used; these are safe from particulate and biological clogging and deflections. The main header pipe of 250-mm diameter is connected to the leachate collection sump. Leachate collection networks face major operational problems due to clogging and choking of pipes.

Annexure C.2 : Management plan against clogging of leachate pipes

Leachate pipes are susceptible to particulate and biological clogging similar to the drainage layer material. Proper maintenance and design of pipe systems can mitigate these and ensure proper functioning. Leachate trenches help improve the collection efficiency of the system. Leachate pipe back-flushing or break through water after leachate head builds up are some of the options that needs to be explored under operations.

Annexure C.3 : Storm water management plan

Surface water management is required to ensure that rainwater runoff does not drain into the landfill area from surrounding areas and there is no waterlogging/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) will cater to the storm water of the adjoined area. Each segment will also carry the storm water of all previous segments. It has been endeavored to keep the slope of the segment as per the finished natural gradient, wherever possible.

The design scheme should take into consideration all the storm water that would accumulate during precipitation from the entire waste management facility. For this purpose, peripheral drains will be constructed along the road and internal drains adjoining individual facilities. The drains will be with respect to the finished ground level wherever possible and/or provided with sufficient longitudinal slopes in order to enable the gravity flow of water. The water will be conveyed to the lowest gradient area of the site and disposed into the existing nallah at the northwestern side of the site.

In order to achieve that, following management plan shall be adopted:

- Rainwater running off slopes above and outside the landfill area should be intercepted and channeled to water courses, to prevent it from entering the operational area of the site. A low-permeability lining must be provided to prevent leakage into the closed landfill
- Rain falling on active waste handling area (during closure period) should be collected separately and managed as leachate through the leachate collection drain and leachate collection sumps
- Rainfall on final covers should be diverted through drainage channels to a settling pond to remove suspended silt, prior to discharge
- Any drainage channel or drain constructed on the resorted landfill surface should be able to accommodate settlement, resist erosion, and cope with localized storm conditions

Annexure C.4 : Landfill gas management plan

Landfill gas is generated during waste biodegradation. In landfill sites, organic waste is broken down by enzymes produced by bacteria, similar to food digestion. Considerable heat is generated by these reactions with the release of methane, carbon dioxide, nitrogen, oxygen, hydrogen sulfide, carbon dioxide and other gases. Methane and carbon dioxide are the principal gases produced with about 50:50 share.

Methane is explosive when present in the air in concentrations of 5-15%. Landfills generate gases with a pressure sufficient to damage the final and vegetative covers. Also, because only limited amount of oxygen are present in a landfill, when methane concentration reaches this critical level, there is a little danger that the landfill will explode. To prevent this, following gas management strategies can be adopted:

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

Annexure C.5 : Air environment management norms during closure phase

During the closure phase, the main air emission anticipated is dust. The most cost-effective dust suppressant is water. Water can be applied using water trucks, handheld sprays, and automatic sprinkler systems. Following procedural changes in construction activities are suggested to reduce dust emission:

Idling time reduction - Equipment are generally left idling while the operators are on 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. Employing idling control technologies, which automatically shut off the engine after a preset time, can reduce emissions without the intervention of operators.

Improved maintenance - Significant emission reductions can be achieved through regular equipment maintenance. Contractors will be required to provide maintenance records for their fleet as part of the contract bid, 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 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 C.6 : Odor control and management plan

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

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

Annexure C.7 : Noise management plan

Closure phase

To mitigate the impact of noise from vehicles and equipment during the closure phase, following measures are recommended:

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 very close to noise-generating machinery.

Post-closure phase

During the post-closure phase of the project, sources of noise pollution from landfill mainly include the diesel generator (DG) set and vehicles. To mitigate the impact of noise arising during the closure phase, following measures are recommended:

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

- Development of a peripheral green belt is expected to reduce noise impact from the project activities
- To control noise pollution due to vibrations, necessary spacing between individual vibration-producing equipment must be provided, which will reduce vibrations generated at individual units
- Vibration generating sources and their platforms must be maintained properly to mitigate vibrations

Annexure C.8 : Sampling specification for environmental monitoring—Post closure

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 sampling at the upstream and one grab sampling at the downstream of the water body near the landfill site, every month
3	Ground water quality	One sampling at up-gradient side and three samplings at down-gradient side of the closed landfill site, every month
4	Quantity and quality of gas generated	24-hour continuous stack monitoring at selected vent, every month
5	Ambient air quality	48-hour continuous ambient air quality monitoring at one location in upwind and three locations in downwind directions, every month

Annexure C.9 Groundwater monitoring plan

After closure of the proposed disposal site, it will be monitored for ground water quality. The ground-water monitoring system (monitoring wells) will be installed at all landfill disposal facilities which have the potential for generating leachate.

Annexure C.10 : Surface water monitoring plan

A surface water monitoring system should be installed at the landfill site to test for contamination from the surface runoff from the landfill. Provision should be made for collection of surface runoff in sumps and final drainage. Under no circumstances should the runoff water come in contact with 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 during the rainy season. Hence, it is important to keep the drains clean to accommodate rainwater to avoid flooding and dispose it off to the proposed site. All efforts should be made to avoid failure of the drainage system due to choking of drains by earth, plastic bags, dry leaves, and other foreign matter. The system should be properly maintained and inspected throughout the year. Storm water parameters, such as given in the table below, need to be monitored on a regular basis.

Sr no	Parameters	Desirable limit (mg/L, except for 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

Annexure C.11 : Ambient air quality monitoring plan

Ambient air quality needs in the vicinity of the closed disposal site needs to 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 as 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 micron)	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	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

Annexure C.12 : Quality of leachate after treatment

Leachate quality after treatment should be monitored for the following parameters:

Sr no	Parameter	Sr no	Parameter
1	Suspended solids, mg/L, max	11	Cadmium (as Cd) mg/L, max
2	Dissolved solids (inorganic) mg/L	12	Total chromium (as Cr), mg/L
3	pH	13	Copper (as Cu), mg/L
4	Ammoniacal nitrogen (as N), mg/L	14	Zinc A (as Zn), mg/L
5	Total Kjeldahl nitrogen as N, mg/L	15	Nickel (as Ni), mg/L
6	BOD, mg/L (3 days @27°C)	16	Cyanide (as CN), mg/L
7	Chemical oxygen demand, mg/L	17	Chloride (as CI), mg/L
8	Arsenic (as As), mg/L, max	18	Fluoride (as F), mg/L
9	Mercury (as Hg) mg/L, max	19	Phenolic compounds (C_6H_5OH), mg/L
10	Lead (as Pb), mg/L, max		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