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State of Municipal Solid Waste Management in Negombo City, Sri Lanka

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The International Environmental Technology Centre works with developing countries to implement sustainable solutions to environmental challenges, with focus on holistic waste management.

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Executive Summary

Negombo City is one of the fastest growing tourist destinations in Sri Lanka. It is the major commercial and transport centre, and main health service provider for the region. However, municipal solid waste management is a pressing concern for Negombo due to expanding urbanization, increasing income, lack of public awareness, changes in consumption patterns, and inadequate waste management such as insufficient proper waste collection and coverage, shortage of transporting vehicles and laborers, insufficient land for waste treatment facilities and landfill, lack of proper training given to technical staff with regard to maintaining information, records and statistics for planning and monitoring of the waste management activities, illegal burning or disposal of waste, as well as improper maintenance of existing waste management system or facilities.

In response to a request for support from the Ministry of Mahaweli Development and Environment (MoMDE) as well as strong interest from Negombo City, IGES Centre Collaborating with UN Environment on Environmental Technologies (CCET) has been providing technical assistance towards the development of a waste management strategy for Negombo since March 2018. Concurrently, a quick study was conducted on Negombo's existing waste management systems and current practices including the waste flow, policies and regulations framework, in order to identify the gaps on waste management in the city.

Negombo City still manages waste in the conventional way by collecting waste from the source and dumping it in a final disposal site with very little recovery or treatment. The only recycling facility in the city is located in Muhandirampitiya where recyclables such as cardboard, paper, polythene, plastic, glass, coconut shells and metal are separated from the non-degradable waste brought to the centre. It is observed that non-degradable waste collected at the centre consist of low-grade recyclables amounting to minimal recovery of recyclables of about 2.37± 3.9 MT/month. The city also has a compost facility in Kurana with a capacity of 10 MT/day; however, the intake is limited to 6-8 MT/day as there have been public complaints and objections about the potential nuisance caused by flies and odor whenever Negombo Municipal Council (NMC) tries to increase the intake. Negombo experiences a bottleneck with regard to managing industrial waste due to the fact that small and medium-sized industries dispose of their industrial waste using the general MSW collection service carried out by Local Authorities. This is despite of the legal arrangement which states that industrial waste must not be disposed of into the general waste stream. Industrial waste generated in Negombo City is estimated to come to 6.33 MT/day. It is mandatory for all healthcare facilities to secure storage, transportation and disposal of all high-risk healthcare waste whereby generally all government and private sector healthcare facilities receive a service from the private sector to dispose of all high-risk healthcare waste. The total amount of waste generated from healthcare facilities is estimated to be 3.84 T/day out of which nearly half a tonne of waste is considered high risk waste that needs to be disposed of through private sector service providers. Hazardous waste generated from major industries is properly managed by those industries, but those from small waste generators such as households, commercial establishments and other services and institutes are not well regulated, and waste generally gets discharged into the MSW collection system in the form of non-degradable waste. It is estimated that NMC collects about 200 kg of hazardous waste per day, largely as mix components in general MSW. Construction and Demolition (C&D) waste is managed by those that generate it. Usually, the metals, wood, plastic and stone that can be found in the C&D waste are recycled, but non-recyclables are generally used as land reclamation material as an alternative to soil. Toilets in households, public places and all other establishments are built with sufficiently large soakage pits and when the soakage pits gets filled, NMC provides sewage collection service — this is a paid service. The collected sewage is treated in a sewage treatment plant adjunct to the compost facility. Wastewater from other sources is generally managed by generators.

This study confirms that there are many challenges in current waste management in Negombo at all stages of the lifecycle due to a range of technical, social, economic and institutional constraints. In this regard, the issues/concerns and recommendations of this report should be considered during the development of waste management strategy and action plans for the city. The strategy and action plan would assist NMC in implementing activities based on short-term, mid-term and long-term plans as stated in the city strategy to overcome the current waste management problems. Moreover, the proper implementation of activities under a waste management strategy and action plans can help the city to achieve sustainable waste management.

As Negombo is part of Western Province, the relevant organizations such as JICA, Waste Management Authority (Western Province) and others involved in the development of a master plan for waste management in Western Province will be consulted during the strategy development process to make sure that the developed strategy is in line with their future master plan for western province.

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Abbreviations and Acronyms

C&D	Construction and Demolition
CEA	Central Environmental Authority
CPHI	Chief Public Health Inspector
GN	Grama Niladhari
LA	Local Authority
MOH	Medical Officer of Health
MSW	Municipal Solid Waste
MT	metric tonnes
NEA	National Environmental Act
NMC	Negombo Municipal Council
PHI	Public Health Inspector
PS	Pradeshiya Sabha
TPD	tonnes per day
UC	Urban Councils
WMA-WP	Waste Management Authority-Western Province

1. Introduction

The purpose of this report is to assess present status of the solid waste management service carried out by Negombo Municipal Council, and then to understand any weaknesses and challenges to be overcome in order to uplift the existing system to a satisfactory level of service delivery.

1.1 City overview

1.1.1 Geography

Negombo is a major coastal city in Gampaha District, Western Province of Sri Lanka. It is located 35 km north of Colombo along the Colombo-Puttalum highway (A3). The city centre is 7 km away from the Katunayake Bandaranayke International Airport and Free Trade Zone. The Negombo Municipal Council (NMC) area is bounded to the north by Maha Oya, to the south by Diya Honda Ela, to the east by Roma Ela, and to the west by a lagoon and the Indian Ocean.

Negombo was declared a Municipal Council in 1949 and its administrative area was expanded in 1987 with the addition of Kochchikade Town Council area and Katana Village Council area, and again in 2002 with the addition of Thalahena.

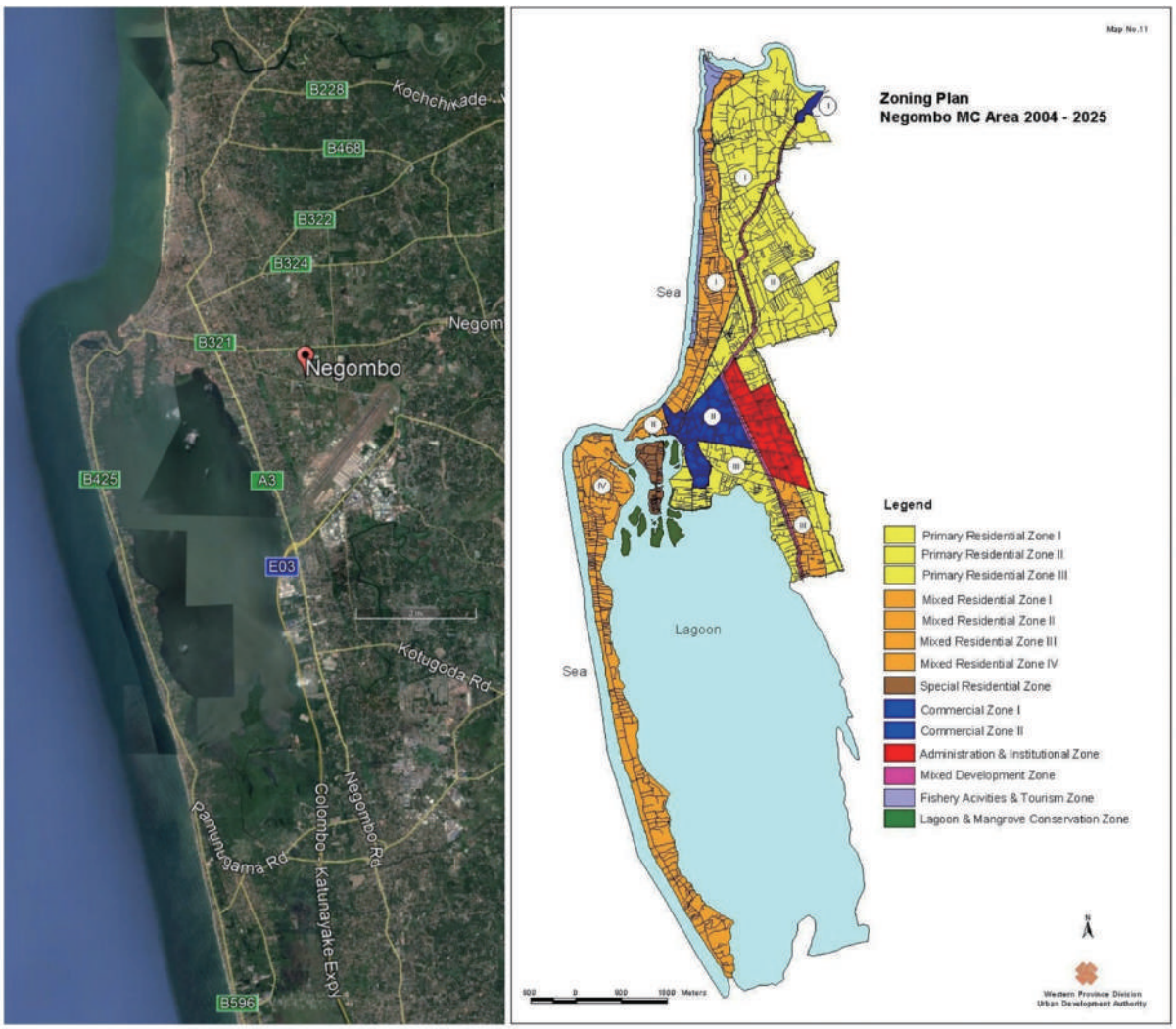


Figure 1-1: Location of Negombo City

Currently Negombo acts as one of the major commercial and transport centres, and as an educational facilitator and health service provider for the region that functions thanks to the rail and road network jointly with Gampaha District. There are well-established trunk roads and a railway which contribute to create the order of the city. Negombo has a good transport network, which enhances national, regional and local linkages (Figure 1-1). Moreover, surrounding major townships such as Minuwangoda, Ja Ela, Divulapitiya, Gampaha and Chillaw are directly connected to NMC area by a well-developed road network.

In the national context, Negombo is a second-order city and in accordance with the National Physical Plan, a hierarchy of urban centres for the western province, Negombo urban area is identified as a main functional economic town within the province (Table 1-1). Thus, the importance of Negombo is highlighted due to the following points:

- It is a major commercial and service centre for a large commercial, manufacturing and service area: just 7 km away from the Katunayake International airport, Katunayake Free Trade Zone and with direct road connections to other district town centres such as Puttalam, Kurunegala, Gampaha and Ja-Ela.
- It functions as a sub-regional growth centre of Colombo, being identified as one of five second-order towns in the Colombo region.
- It has a well-established tourist industry, being the entry and exit point for most international tourists coming to Sri Lanka.
- It is one of Sri Lanka's major fishery harbours.

Table 1-1: Basic fact sheet of Negombo Municipal Council

Item	Description
Province	Western Province of Sri Lanka
District	Gampaha
Local Authority Status	Municipal Council
Location	Negombo is situated about 35 km from Colombo, and 25 km from Gampaha (capital of Gampaha District)
Climate	27.8 °C average annual temperature 2500 mm average annual rainfall Elevation 0-3 m above MSL
Extent of the Authority Area	30.8 sq.km
No. of Council Wards	29
No. of Council Members	26
No. of families	38,991
No. of voters	108,490
Population (MC records)	161, 484 (~ 100,000 daily floating population)
Average Population Density	52.42 persons/ha
Major economic activities	Fisheries, tourism, commerce, services (Education & medical)

1.1.2 Demography and the political structure

The basic land use for NMC area is shown in Figure 1-2. The major land use is residential followed by commercial and tourism/ recreation-related activities.

Table 1-2: Population characteristics of Negombo MC

Ethnicity						
	Sinhala	**Tamil**	**Muslim**	**Berger**	**Other**	**Total**
Negombo	47,055	5,394	13,216	356	627	66,648
Kochchikade	49,013	6,184	9,079	423	372	65,071
Thalahena	29,507	147	52	17	42	29,765
Total	*125,575*	*11,725*	*22,347*	*796*	*1,041*	*161,484*
Religion						
	Buddhist	**Christian**	**Hindu**	**Islam**	**Other**	**Total**
Negombo	7,055	41,594	3,205	13,520	1,274	66,648
Kochchikade	8,843	41,649	5,010	9,098	471	65,071
Thalahena	462	27,987	76	52	1,188	29,765
Total	*16,360*	*111,230*	*8,291*	*22,670*	*2,933*	*161,484*

According to the census of 2011 available at NMC, the Negombo Municipal Area has a population of 161,484 — 77,758 men (48%) and 83,726 women (52%). The population density of the city varies widely. According to the estimates, the average population density of Negombo is 52.42 persons per hectare. However, in areas where fishing communities and low-income housing are located, the ward-level density may increase up to 190 persons per hectare. The lowest residential population density is recorded in the city centre where commercial and public sector service activities are located.

According to the Negombo Development Plan 2019 – 2030 (UDA Volume I, 2018), about 45% of the labour force works in the fishing industry, 35% of the labour force works is in the tourism industry and 20% in commerce and other service industries. However, estimates showed that 80% of the total working population is working outside the city limits.

The amount of waste generation in NMC has increased over the past two decades, as has been the case in many secondary cities in Sri Lanka (Table 1-3). Unless otherwise indicated, the population data shown in Table 1-3 is in reference to the official census and population reports (Department of Census & Statistics, 2012).

Table 1-3: A comparison of waste generation in NMC and several other comparable cities

	2003		2008		2011		2016		2017	
	Popul.	WG (TPD)	Popul.	WG (TPD)	Popul.	WG (TPD)	Popul.	WC* (TPD)	Popul.	WG (TPD)
Negombo MC	146,864	136 [i]	-	-	142,136	-	146,278	110 [vi]	147,457	-
Katana PS	-	-	-	-	-	-	233,854	20 [vii]	-	-
Katunayake-Seeduwa UC	-	-	-	-	-	-	59,281	55 [viii]	-	-
Gampaha MC	58,577	54 [i]	-	-	62,335	-	64,152	50 [vi]	64,668	-
Chilaw UC	24,539	23 [i]	26,808	27 [ii]	25,832	41 [iv]	22,527	53 [vi]	22,887	-
Kandy MC	111,116	131 [i]	122,622	112 [iii]	102,500	150 [v]	97,533	127 [vi]	98,746	-

Popul. - (Population): WG (TPD) - Waste Generation (Tonnes Per Day): WC (TPD) – Waste Collection (Tonnes Per Day): [i]Japan International Cooperation Agency, 2003: [ii]Japan International Cooperation Agency, 2011: [iii]North Western SWM Action Committee, 2008: [iv]CPU, 2001: [v]KMC Master Plan, 2013: [vi]NSWMSC, 2016: [vii] Katana Pradeshiya Sabha, 2016: [viii] Kokusai Kogyo Co., Ltd., 2016.

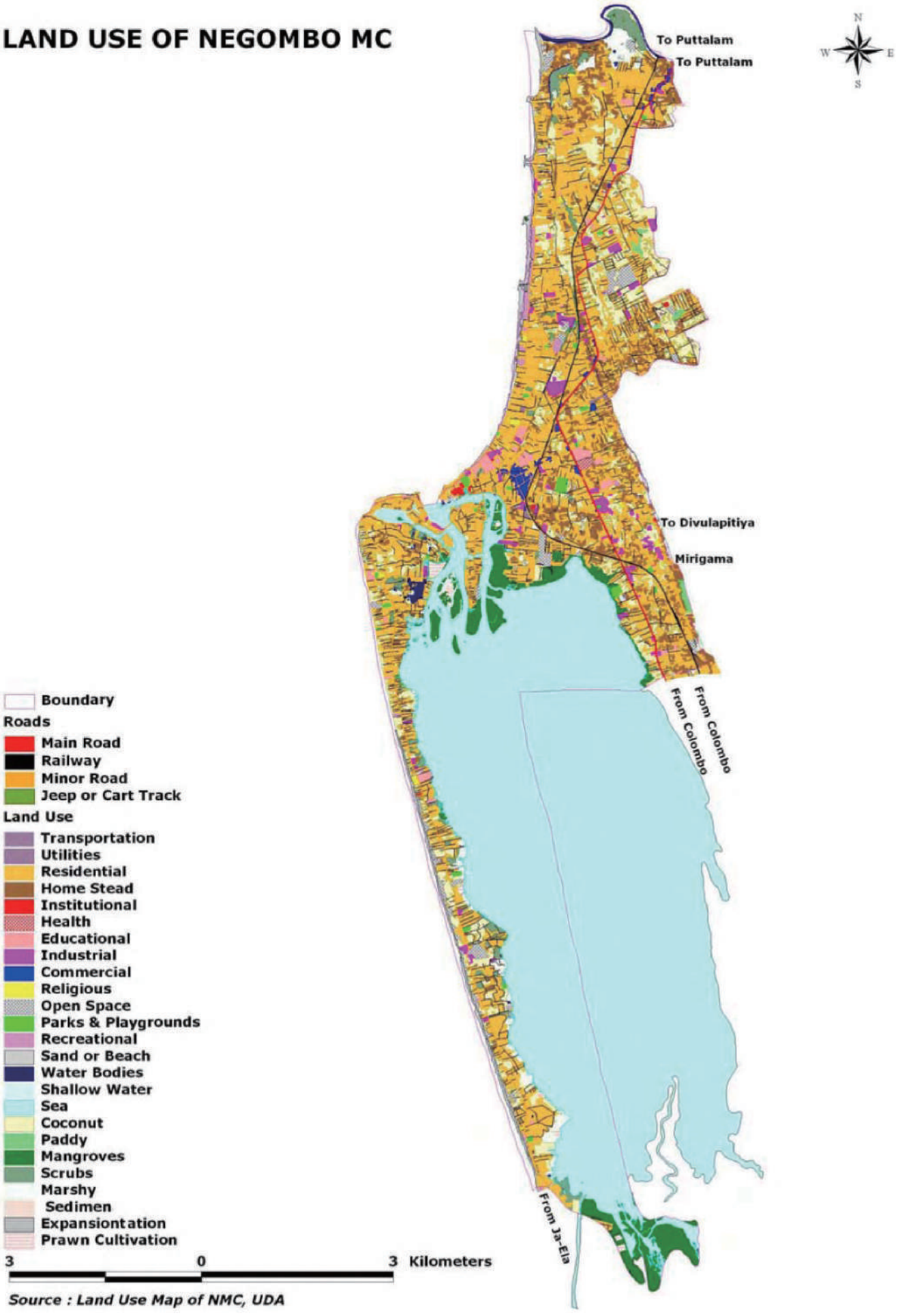


Figure 1-2: Land use pattern of Negombo MC area

As shown in Figure 1-3, the municipal area is politically divided to 29 Wards, consisting of 40 GN divisions.

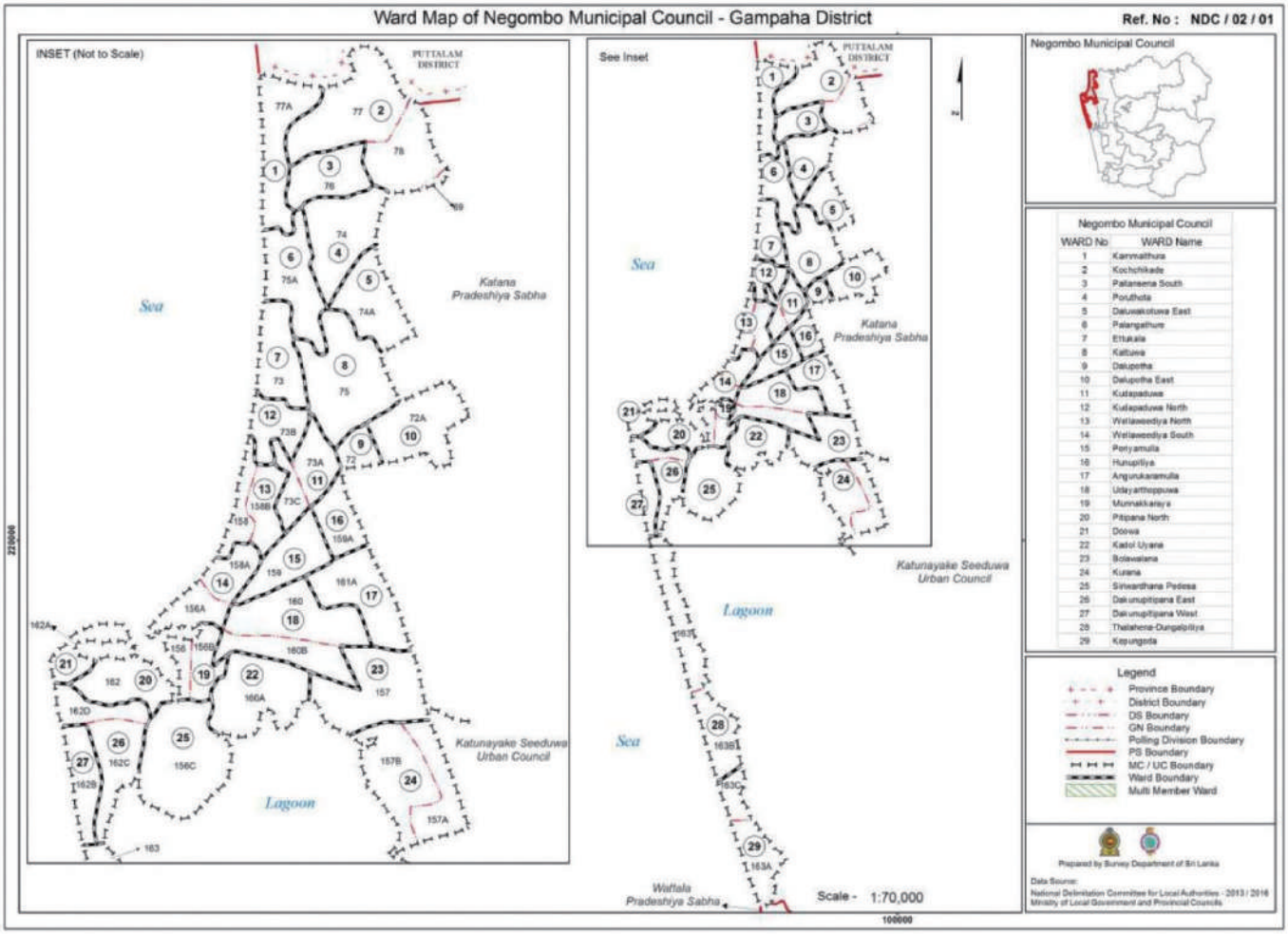


Figure 1-3: The twenty nine wards of Negombo MC (revised ward maps)

1.2 Methodology and data sources

In order to obtain general information on waste generation amounts, data and information were obtained from the waste management section of the Health Department, Works Department and Revenue Department of NMC. Some of the information available in the form of formal records and reports was treated as the most accurate secondary data, while data collected from official interviews with NMC officers was treated as verification data. Thus, the survey data was collected using several different methods:

a) Recording and compiling of published and verified data by NMC;
b) Reading and recording of unpublished & non-confidential data available at NMC; and
c) Official person-to-person interviews with relevant officers at NMC for verification of data.

The data collection was conducted from January to March, 2019. In addition, information from various published reports was referred to during the report compilation in March, 2019. The primary data was collected by interviewing officers (CPHI, PHIs, office staff and supervisors) via a structured questionnaire.

1.3 Sources of waste generation

Table 1-4 below shows the explanation for the collected numerical data.

Table 1-4: Type of information and data collected for estimation of waste generation

Source	Description
Household	**Number of households and population statistics** Objective is to estimate waste generates from domestic activities, including food preparation, cleaning, fuel burning, yard sweeping, gardening and other miscellaneous household waste items (e.g. old clothing, appliances, etc.).
Commercial	**Number and types of commercial establishment that has been registered at the NMC** Objective is to estimate waste generates from trade, service, processing and production enterprises, excluding hotels, markets and industries (covered separately).
Hotels/ restaurants/ Lodges	**Number and types of hotels, restaurants and lodges that offer accommodation, food and recreation for visitors** Objective was to estimate waste generated from tourist hotels within the city.
Markets/ Pola	**Number of stalls and types** Objective was to estimate waste generated from Pola & markets within the city.
Institutions	**Number and types of government and privet institutes** Objective was to estimate waste generated from institutions within the city. Waste from schools, other education centres, hospitals, central and provincial government offices, police, prison and religious institutions. Hospital waste includes some hazardous items.
Industries	**Number and type of industries** Objective was to estimate waste generated from any industries.
Public places	**Number and type of parks and public recreation facilities/ places** Objective was to estimate waste generated from public parks and other recreational spaces and facilities.
Drain cleaning	**Number of drain cleaning waste loads** Objective was to estimate waste generated from roadside drain cleaning activities.
Construction and demolition	**Number of loads or amount of generation** Waste originating from construction, rehabilitation and demolition activities, etc. This waste is not usually handled by local authority but is dealt with by the contractors involved. Typically, it is used as clean fill on other sites or in low-lying areas.
Hazardous (Special)	**Number of sources and type of hazardous waste** Hazardous waste originating from various sources, including household items (e.g. batteries, spray cans, etc.) and medical waste. These are described separately for each category as appropriate. The management of sharps, clinical, body parts and highly infectious waste from hospitals is a major concern in the province.

2. WASTE GENERATION AND COMPOSITION

2.1 Estimation of waste quantities from different sources

Table 2-1 below shows the basic estimation of waste from different generation sources described above. The generation rates for different sources were obtained from previously published reports (Japan International Cooperation Agency, 2003, North Western SWM Action Committee, 2008). If the generation source is unclear, rates were taken as approximate based on opinion from NMC officers. It is estimated that approximately 157.68 metric tonnes per day (MT/D) is generated within the NMC area.

Table 2-1: Estimates of waste generation from different sources within NMC area

Category	Source	Generation rate	Units	Population/ Sources	Amount (MT/D)	Amount (MT/D)
Residential	High, middle & low income	0.62	kg/P/D	161,484	100.77	100.77
Commercial	Large size hotel (restaurants)	51.90	kg/hotel	72	3.74	
	Medium size hotel (restaurants)	25.95	kg/hotel	54	1.40	
	Small size hotel (restaurants)	9.65	kg/hotel	187	1.80	
	Vegetable/fruit shops (large)	25.95	kg/shop	34	0.88	
	Fish/meat stalls	25.95	kg/shop	87	2.26	
	Grocery/retail shops (large)	43.25	kg/shop	14	0.61	17.52
	Grocery/retail shops	9.65	kg/shop	358	3.45	
	Miscellaneous trade shops	9.65	kg/shop	280	2.70	
	Pharmacies /Ayurveda products	9.65	kg/shop	36	0.35	
	Small & medium service industries	9.65	kg/shop	29	0.28	
	Recycling shops	9.65	kg/shop	5	0.05	
Tourist hotels	Large size tourist hotels	69.20	kg/restaurant	21	1.45	
	Middle size tourist hotels/lodge	43.25	kg/restaurant	131	5.67	7.29
	Small size tourist hotel/lodge	9.65	kg/restaurant	18	0.17	
Institutions	Schools	70.28	kg/school	41	2.88	
	Hospitals (government)	2475.00	kg/hospital	1	2.48	
	Hospitals (private)	202.85	kg/hospital	5	1.01	
	Medical/Ayurveda clinics	9.65	kg/clinic	36	0.35	
	Public office	19.04	kg/office	36	0.69	
	Bank/private office	19.04	kg/office	147	2.80	11.54
	Buddhist temples	17.30	kg/temple	6	0.10	
	Hindu temples	17.30	kg/temple	6	0.10	
	Mosques	17.30	kg/mosque	13	0.22	
	Churches	17.30	kg/church	49	0.85	
	Navy/Police/ Army basses	9.65	kg/institute	6	0.06	
Industries	Industries (large)	1490.00	kg/industry	2	2.98	
	Industries (medium)	96.00	kg/industry	30	2.88	6.33
	Small industries	9.65	kg/industry	49	0.47	
Pola & Markets	Pola	1440.00	kg/pola	5	7.20	
	Retail markets	649.30	kg/market	5	3.25	11.85
	Fish market	200.00	kg/market	7	1.40	
Public places	Public parks	150.00	kg/park	2	0.30	0.69
	Public centers/halls	9.65	kg/center	71	0.69	
Drain cleaning	Road/drain cleaning waste	600.00	kg (sum)	2	1.20	1.20
Hazardous	Household hazardous	200.00	kg (sum)	1	0.20	0.20
TOTAL					157.68	157.68

Waste generation rates (Table 2-1) were estimated from a combination of quantitative and interview surveys. Key points are summarised below:

- The average household waste generation rate of 0.62kg/person/day was considered an accurate estimate as the figure was derived from a direct measurement using a household survey (JICA study, 2003). However, changes in consumption patterns over the last 15 years are not reflected in this figure, so the value remains as an approximation.
- All other waste generation rates were in reference to available reports (JICA 2003; JICA 2016). However, some of the reports are outdated and sampling locations are different. Therefore, the waste generation rates shown in Table 2-1 are only approximate.
- Total waste generation from households is 100.77 MT/day which is equal to 63.9% of the total waste generation. The overall average waste generation rate is 0.9764 kg/person/day which includes household waste, institutional waste, commercial waste, and other waste shown in Table 2-1.
- Commercial waste generation is 17.52 MT/day (11% of MSW), with the general commercial waste generation rate of 9.65kg/enterprise/day. These quantities were referred from survey data for a mixture of large and small waste generators within the commercial areas of several cities (Japan International Cooperation Agency, 2003; North Western SWM Action Committee, 2008), together with NMC statistics for the total number of business centres. They are considered realistic, being supported by observations of business activities within Negombo city, with the high value being attributed to the relatively high number of restaurants, local hotels and bakeries in the Negombo and Kochchikade commercial areas.
- Market & daily fair (Pola) waste generation (11.85 MT/day, 7.5% of MSW) is based on estimates for each of the markets and Polas within NMC and equates to a market waste generation rate of 6.7kg/stall/day.
- Household and commercial hazardous waste generation is relatively small, comprising typical everyday items (e.g. spray cans, batteries, fluorescent tubes and razor blades (hairdressers), etc.) which are disposed of with normal garbage.

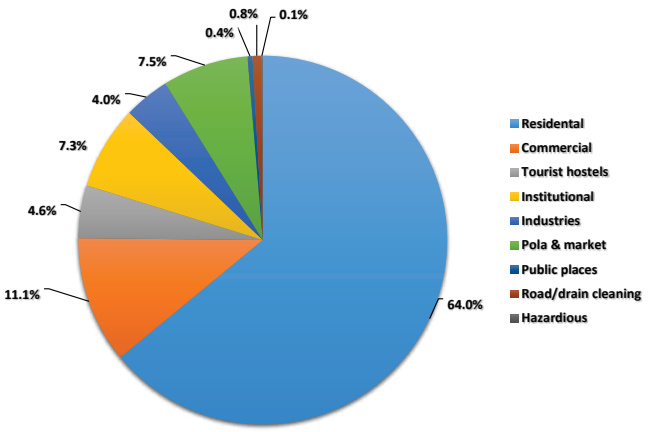


Figure 2-1: Contribution of different sectors to overall waste generation in Negombo MC area

2.1.1 Other waste generating sources

The waste recognised as "other" include clinical waste, hazardous waste, drain cleaning waste, as well as construction & demolition waste and a few other miscellaneous waste materials generated from industry and businesses. Generally, NMC is not directly involved in collection, transport and disposal of other types of waste, so it is difficult to get an accurate estimation of amounts. Therefore, the information shown in this section is drawn from personal interviews with NMC officers involved in waste management.

Table 2-2 below shows the other waste types generated within the NMC. The notable features of other waste estimates are:

- Industrial hazardous waste generation is also relatively small, except for boat manufacturing or repairing industries that produces mainly fiberglass waste, which is also collected by a private contractor for recycling or further processing.
- Significant quantities of hazardous healthcare waste is produced by the Negombo Base Hospital, with the other private hospitals and dispensaries within NMC producing smaller amounts of such waste.

The main factors affecting waste generation in Negombo are summarised below:

- Waste generation from commercial enterprises, hotels and markets increases approximately 50-100% during festivals (April/December/January) and other special occasions.
- Hotel waste generation also increases by 50-200% during the peak tourist season (November/December to March/April) and for special events (e.g. weddings, parties, conferences).
- Waste generation from the many Christian churches in Negombo increases several times during religious festivals.
- Market waste generation also shows some seasonal and weekly variations, the latter being due to the three Pola (daily or weekly fair) which are held on different days of the week - Green Road night Pola on Saturday, Kamachchodae Pola on Wednesday and Sunday, and Kochchikade Pola on Sunday.
- Seasonal variations, with increased waste generation increasing during the wet season (April-June and October-November), mainly due to increased garden waste.

Table 2-2: Amounts and sources of other waste types in NMC area

Type of waste	Description	Quantity (MT/D)
Construction & demolition	Construction & demolition wastes are generated from multiple sources; building sites, infrastructure projects and demolition activities. There is a high demand for construction waste to be used as an alternative land reclamation (filing) materials from households and land developers, thus only a very small quantity of construction wastes is mixed with ordinary MSW. The main source of construction & demolition waste presence in MSW is the household discharge in smaller quantities.	Total = 5.0 0.50 at dumpsite
Clinical waste	Clinical waste is generated from major hospitals and health clinics. The large generators (Eg. Government Hospital) have their own mechanism for treatment and disposal of clinical waste. However, smaller health clinics and dispensaries illegally dispose some amount of clinical and infectious waste into general waste collection which ended up at final disposal site.	Total = 2.0 0.10 at dumpsite
Industrial hazardous waste	There are no industries that produce large quantities of industrial hazardous waste in NMC area. However, small portion of hazardous waste generated from industries, commercial sector, institutional sector and is generally disposed with MSW, especially with non-biodegradable fraction.	0.05 at dumpsite
Electronic waste	E-waste generally include discarded electronic appliances and non-recyclable parts of electrical equipment. Although the NMC collects the E-waste, there is no proper mechanism to dispose or recycle the waste in an appropriate manner.	0.02 at dumpsite/ recycling centre

2.2 Waste stream and flow

Field investigation results in the proportions of waste being disposed of on-site by burning or burying within generators premises (Onsite disposal in Table 2-3), discharged for collection, directly hauled to landfill, composted on-site, sold or discharged to NMC collection for recycling by waste generators (Recycling in Table 2-3) at source or illegally dumped in unauthorised places (Illegal disposal in Table 2-3) are tabulated below in Table 2-3.

Table 2-3: Waste stream: estimated waste stream flow

Category	Generation	NMC collection		Onsite disposal		Onsite composting		Recycling		Illegal disposal	
	(MT/D)	%	MT/D	%	MT/D	%	MT/D	%	MT/D	%	MT/D
Residential	100.8	31.0	31.2	48.9	49.3	6.0	6.1	3.4	3.4	10.7	10.8
Commercial	17.5	92.1	16.1	4.2	0.7	0.0	0.0	3.7	0.7	0.0	0.0
Tourist hotels	7.3	37.1	2.7	12.2	0.9	0.5	0.0	50.2	1.8	0.0	0.0
Institutions	11.5	73.1	8.4	22.1	2.6	0.0	0.0	4.8	0.6	0.0	0.0
Industries	6.3	5.2	0.3	40.4	2.6	1.8	0.1	50.0	3.2	2.6	0.2
Pola & Markets	11.9	75.5	8.9	23.3	2.8	0.0	0.0	1.2	0.1	0.0	0.0
Public places	1.0	100.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Drain cleaning	1.2	100.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hazardous	0.2	100.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	157.7		70.0		58.9		6.2		9.8		11.0

Note: The percentage of different streams (NMC collection, onsite disposal, onsite composting, recycling and illegal disposal) was based on Japan International Cooperation Agency, 2003.

The estimations presented in Table 2-3 can only be used as approximations since the percentage distribution of waste discharge practices has changed over the last 15 years.

The introduction of source-segregated waste disposal and collection, promotion of recycling and public awareness on environment sanitation may have contributed to the changes. Therefore, the validity of approximations should be verified through an appropriate waste generation survey in NMC.

However, in absence of any waste stream data, the derived Figure 2-2 can be used as a general waste stream pattern for planning.

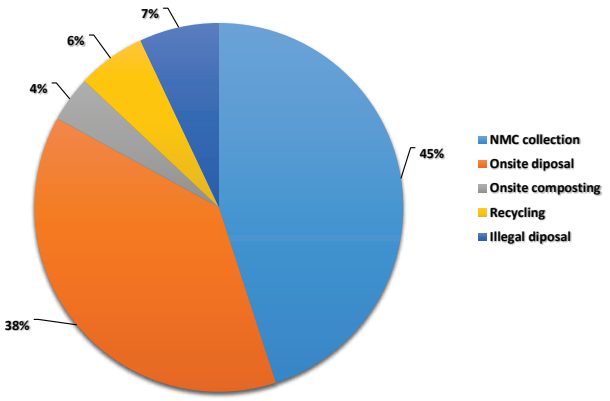


Figure 2-2: Contribution of different sectors for waste stream of Negombo MC

2.3 Municipal solid waste composition

The waste composition data and statistics are not readily available in NMC. However, a study conducted in 2002 by Japan International Cooperation Agency study team revealed a few interesting features of waste composition. The following Figure 2-3 shows the MSW composition using samples from waste collection trucks at the Ovitiyawatta dumpsite.

The composition of waste may have changed over a span of 15 years since the Japan International Cooperation Agency (2003) study. However, it is reasonable to assume that patterns remain similar as evident from recent studies in many other local authorities in Sri Lanka (JICA, 2016). The amount of different types of waste being disposed of at the dumpsite and their salient features are described below:

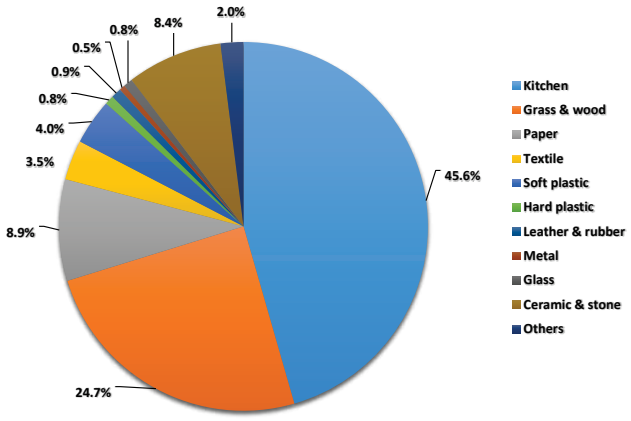


Figure 2-3: Composition of MSW disposed at Ovitiyawatta dumpsite, Negombo MC (Source: Japan International Cooperation Agency, 2003)

- The amount of organic material that can be composted is about 71%, excluding paper.
- Higher value recyclables (cardboard, glass, hard plastic and metal) account for only 2-5% of the waste to disposal, indicating almost all these items are already being recovered prior to discharge.
- The non-degradable portion mainly consists of lower value recyclables (contaminated paper, textiles, soft plastic) which is 12-16% of the waste with all three being present in reasonable quantities, indicating the recycling rates of these items are lower. Of these materials, paper and soft plastics have the most (but still limited) potential for increased recycling, particularly if this waste can be sorted at source and collected separately. Otherwise, once mixed with other garbage, it becomes contaminated and is much more difficult and expensive to recycle. However, it should be noted that the composition study in 2003 does not reflect the changes due to introduction of source segregated waste collection in the recent past (2017).
- The composition data presented here can only be used as a general guideline for an assessment because the information is outdated (JICA, 2003), or the referred studies are conducted in other LAs in Sri Lanka (JICA, 2016). A detail composition study should be regularly conducted to draw accurate figures.

3. WASTE COLLECTION AND TRANSPORTATION

This waste collection and transportation survey was commissioned to gather information related to all waste collection and transportation activities in Negombo MC. The purpose of this survey was to identify the following points:

a) Waste types and sources
b) Institutional setup
c) Collection method (e.g. primary collection, secondary collection, container collection etc.) and collection amount
d) Collection area and frequency
e) Collection fee
f) Collection vehicles
g) Maintenance of collection vehicles

3.1 Waste types and sources

The main sources of MSW considered in this report are households, commercial enterprises, hotels, markets, institutions, industries and "other sources" (parks, beaches, road sweeping and drain cleaning). Each of these sources is briefly described below in Table 3-1.

Table 3-1: Waste generation sources and definitions of waste

Source	Description
Household	Waste generated from domestic activities, including food preparation, cleaning, swill, backyard sweeping, gardening and other miscellaneous household wastes (e.g. old clothing etc.)
Commercial	Waste generated by trade, service, processing and production enterprises [Excluding hotels, markets and industries]
Hotels	Waste produced by tourist hotels, lodges and rest houses within the city
Markets	Waste from markets selling a high proportion of vegetables, fruit, meat and/or fish (e.g. central market, fish market, Lellama), including the Pola (daily fairs) held at various locations within NMC
Institutions	Waste from schools, other education centres, hospitals, central and provincial government offices, police stations, prisons and religious institutions [Hospital waste includes some hazardous items as discussed further under hazardous/special waste and later in this report]
Industries	Waste from major or minor industries such as sawmills (07) and other industries (79)
Other	Sweeping and other waste from public parks and beach park. Beach litter collected by the Hotel Association tractor. Road/drain cleaning waste, collected by NMC handcart labourers
Construction and demolition	Waste originating from construction, rehabilitation and demolition activities, etc. This waste is not usually handled by NMC but is collected and disposed by the contractors involved. Typically, it is used as clean fill on other sites or in low-lying areas. Hence, it is not considered further in this study
Hazardous (Special)	Hazardous waste originating from various sources, including household items (e.g. batteries, spray cans, etc.). These waste items are described separately for each category as appropriate

3.2 Institutional setup

The Health Department of NMC is responsible for waste management in Negombo City. Specific responsibilities include:

- Collection of MSW within NMA, including the planning of collection routes and daily scheduling of garbage collection vehicles
- Cleaning and garbage removal from public markets and public places
- Septic tank and toilet emptying services (public places, households, commercial, institutions etc.)
- Street and drain cleaning
- Collection of any SWM fees levied for the services provided
- Enforcement of local ordinances and national laws related to SWM
- Implementation of policies relating to waste minimization, recycling, public education/awareness, etc.
- Transportation of the collected MSW to the final disposal site
- Operation and management of the existing final disposal site at Ovitiyawatta

Since 2002, waste collection and transportation from Thalahena and Kochchikade zones as well as the entire management of Ovitiyawatta disposal site have been transferred to a private company. However, since January 2019 the private company has limited the area for collection to Thalahena. A brief summary of private sector involvement is presented later in this report.

The current waste management organisational structure (as of February 2019) is described below:

- The Council, mayor, and deputy mayor make up the governing authority of municipality. The commissioner and deputy commissioner are responsible for execution of policies, actions and overall administration of council revenue, properties and human resources.
- The Chairman and Health Committee serves as an advisory committee to the Council, dealing with all health issues, including SWM. It comprises six Council members, while the Medical Officer of Health (MOH) and PHIs also usually attend the meeting.
- The chief executive officer of the health department is Chief Medical Officer of Health (CMOH). The position is held by an officer of Government Medical Service (Medical Doctors). The Chief Public Health Inspector (CPHI) has overall responsibility for all of NMC's waste management activities, including SWM. At the next organisational level, there are twelve Public Health Inspectors, each responsible for different waste management activities and areas of the city, as shown in Figure 3-1. Beneath them, there are 20 supervisors, 33 drivers and 340 labourers (197 permanent, 143 temporary), who are assigned to different areas. There are also three administrative staff (Chief Clerk and two Clerks). However, duties related to SWM are only part of their duties because several other duties such as maintenance of health and sanitation in the city, disease prevention, public awareness on health related issues, operation of health clinics and safeguard of workers' health come under the health department.

The waste collection and all related works are administrated under the health department of the municipality. The structure and chain of commands are shown in the following Figure 3-1.

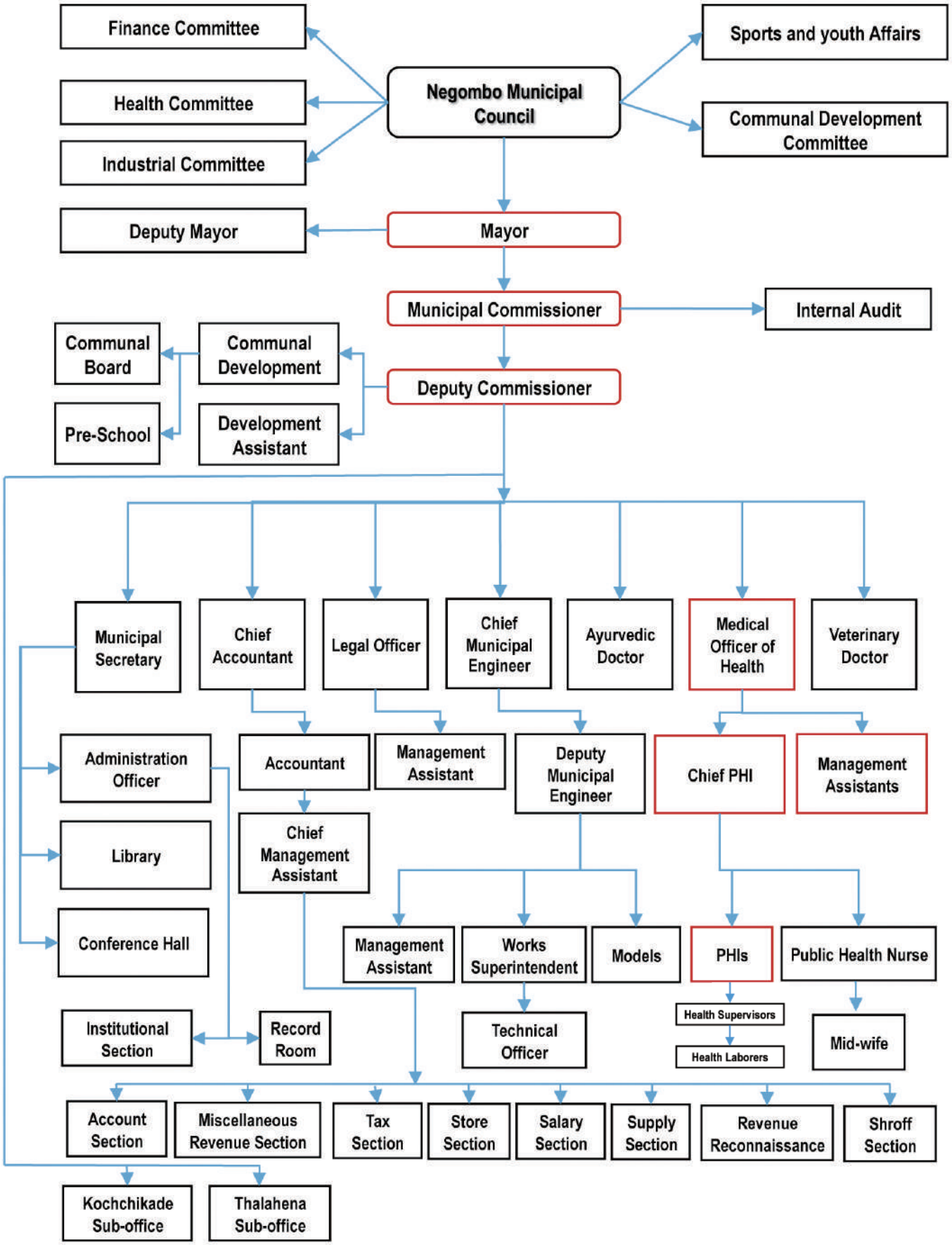


Figure 3-1: Organisational structure of the Negombo Municipal Council

3.3 Waste collection

3.3.1 Primary collection method and vehicle allocation

Primary collection is done by handcarts and also with larger collection vehicles; four-wheel tractor & trailers (4WT) and compactor trucks. Handcarts are primarily allocated for door-to-door collection in residential areas and also to collect waste from narrow lanes and congested areas of the city centre. The collection from each handcart is directly loaded into the collection vehicles at designated areas (called "special waste collection points"). There are also unmarked meeting points for handcarts and larger collection vehicles on each street or road. In addition to waste collection from the point of generation, one major duty of handcart labourers is to sweep the streets. Thus, waste from street sweeping is also collected with the door-to-door collection. Generally, door-to-door collection is either curbside or directly collected from residences/traders. The waste is usually packed in used grocery bags (or "shopping bags") or in garbage bags (20-30L, black). Additionally, a significant number of traders, especially eating houses (mainly serving rice & curry meals) and restaurants directly empty their garbage bins onto the handcart or into the larger collection vehicle.

NMC has allocated a fleet of vehicles for waste collection. The vehicle fleet is shown in the following Table 3-2.

Table 3-2: Vehicle fleet of the MSW department of NMC

Type of vehicle	Type	Unit	Condition
Handcarts	Steel handcart	20	All are good
4WL-Tractor	Tractor (trailer)	26 (28)	Working
Compactor trucks	Garbage truck (3T)	4	Working
Beach cleaning machine	Tractor mounted sweeper	1	Working
Gully bowser (small)	Tractor mounted (2,500L)	2	Working
Gully bowser	Truck (10,000L)	1	Working
Gully bowser (small)	Truck (4,500L)	1	On repair
Skid steer loader	BobCat	1	Working (composting facility)
Bulldozers	4D crawler type	2	Employed by contractor at disposal site

The municipality allocates most of the labour force for primary collection by handcarts and larger vehicles. The labour allocation has been scheduled; however, the number of labours allocated for a handcart and tractor/compactor are depend on number of labours report to duty.

Garbage collection crew and labourer equipment details are summarised in Table 3-3.

Table 3-3: Vehicle labourer and equipment details

Vehicle	Labourers	Equipment
Handcart	1-3	Gloves, rake, basket (s)
Compactor	1-3	Gloves, gumboots (1 set), rake, fork, ekel broom, 2 baskets
4WT	1-4	Gloves, gumboots (1 set), rake, fork, ekel broom, 2 baskets

The resource allocation for a collection zone depends on size of the area, anticipated waste amounts, road traffic condition and requirement for street sweeping. Table 3-4 below shows the resource allocation for different collection sources. It should be noted that the available information is not sufficient to show waste collection resource allocation for the entire municipality.

Table 3-4: Vehicle and labour allocation for waste collection zones

Zone	Vehicles	Collection & sweeping	Drain cleaning	Awareness	Mosquito control	Total
Kadolkele Zone I	4WT-1 4WT-2 Handcart (1)	11	4	2	2	19
Kudapaduwa	4WT-1 4WT-2	11	5	0	0	16
Munnakaraya & siriwardana place	4WT-1 4WT-2 Handcart (2)	9	3	2	2	16
Periyamulla I	4WT-1 4WT-2 Handcart (1)	8	5	0	0	13
Kurana I	4WT-1 Handcart (1)	6	5	0	0	11
Kurana II	4WT-1 Handcar (2)	7	5	0	0	12
Colombo Road	4WT-1	5	3	0	0	8
Periyamulla II	4WT-1 Handcart (2)	6	4	0	0	10
Bazar I	Compactor Handcart (3)	10	5	0	0	15
Angurukaramulla	4WT-1	5	0	0	0	5
Night collection	4WT-1 Handcart (3)	10	0	0	0	10
Drain cleaning	n/a	0	21	0	0	21
Beach cleaning	Beach cleaning machine	6	0	0	0	6
Gully service	Bowser (4)	13	0	0	0	13

3.3.2 Secondary collection

Secondary collection is done in two stages. The collection from handcarts directly load waste into collection vehicles at designated special waste collection points. All other transfer points are temporary in nature and loading is done when the handcart meets with the collection vehicle. Once the waste collection vehicle is filled with garbage or when the vehicle reaches the last point on the route, the collection is halted and the collection vehicles (4WT and compactors) are then driven directly to dumpsite.

3.3.3 Market and fisheries harbour

Garbage collection and cleaning of Negombo's public markets is administered by the Health Department, with four Supervisors and six labourers employed for this purpose.

A large portion of offal and fish waste generated from fisheries harbor and two fish markets are being collected by private companies. The collected fish waste is transported out of NMC area and is used for animal feed manufacturing. Personal interviews with fish market vendors revealed that the amount of fish waste varies dramatically depending on the season and fluctuation of the fish catch. However, it is estimated that 1-2 metric tonnes of fish waste is taken from the NMC markets to be used as animal feed.

Figure 3-2: Negombo fish market and processing of fish

3.3.4 Market and daily fair (Pola)

The Negombo market is a permanent building space with a number of stalls selling vegetables, fruit, meat, fish and other food. The Pola refers to a place that sales similar food items on specific days of the week. Pola is a temporary marketplace for vendors and customers. There are five fairs (Pola) in the NMC area and each Pola generates 0.5-2 tractor loads of waste in a day. The garbage handling during the Pola is rarely done; however, cleaning of Pola premises is regularly done by municipal workers at night or the following morning. It is a common to see piles of waste littering the Pola when it is operating.

Figure 3-3: Daily fair (Pola) and vicinity - Negombo MC

3.3.5 Beach cleaning

Negombo beach and beach park (also called Browns beach) is one of the major tourist attractions within NMC. There is a special waste management plan for the beach and other recreational facilities around the beach (Figure 3-4).

An adequate number of large litter bins (50L) are placed in the beach area and visitors are advised to dispose of their waste in the bins. In addition, NMC has employed a special beach cleaning machine to clean the sandy beach. There are six workers allocated for beach cleaning and they are responsible for collecting waste from bins and also from the beach cleaning machine. The collected waste is loaded to a tractor-trailer stationed at the beach park. Plastic wrapping, paper, plastic bottles and garden waste are the types of waste often collection in the beach area. It is estimated that the daily collection varies from 300 kg to 500 kg, depending on how many tourists are in the area. NMC delivers all collected waste to the final disposal site.

Figure 3-4: Waste management system at the beach park

3.3.6 Door-to-door collection and street sweeping

Door-to-door collection, particularly curbside collection is well established in residential areas. Residents and the municipality follow a schedule that has been well established for many years. Residents often segregate waste into degradable (household kitchen and garden waste) and non-degradable (including recyclable waste). However, it was observed that the collection crew pick up valuable recyclable items (metal, plastics, cardboard etc.) and store separately during routine collections.

Household street and drain cleaning are normally undertaken by labourers in conjunction with garbage collection services. NMC assigns two labourers per handcart for by-roads and three labourers per handcart for main roads and the city centre.

Figure 3-5: Waste collection: (a) curbside collection and (b) separation of valuable recyclable items by workers

3.4 Collection areas and frequency

The collection areas of the NMC are mainly divided based on vehicle access, thus the main collection routes are major roads and streets. Narrow and congested collection areas are connected to the main route through handcart collection. Apart from the bazar area, the collection for a particular road or street is done only once a day.

Bell collection, which was introduced back in 2003, is effectively used by the NMC in designated residential areas, particularly for recyclable waste collection.

3.4.1 Source-segregated waste collection

The regular schedule on weekdays collects segregated organic waste from designated areas. Part of the collected waste (6-8 MT/day) is taken to composting facility and the rest is directly transported to the dumpsite. Following tables (3-5, 3-6 and 3-7) show the regular collection routes and allocated resources for collection.

A source-segregated waste disposal and collection scheme was introduced in mid2017. All waste generators are required to separate waste as degradable, non-degradable and recyclable waste. The regular daily collection accepts only the separated organic waste. The non-degradable and recyclable waste are collected on a separate day, usually a Saturday.

3.4.2 Resource recovery - recyclable waste collection

Collection workers are allowed to pick up valuable (recyclable) items during the collection. Workers sell those items to different buyers in the city and the income is shared among the collection crew of the vehicle. The exact amount of resource recovery at this stage is unknown; however, the amount may be higher than the amount flow through NMC's formal recyclable collection procedure described below.

Source-segregated non-degradable waste is transported either to a dumpsite or to the NMC's resource recovery (recycling) centre in the city. Recyclable waste such as clean plastics, paper, cardboard,

Figure 3-6: Fleet of vehicles possessed by waste collection service provider

metals and glass are sorted and graded. The bulky materials such as plastic film (Polythene), PET bottles and paper are compressed using an electric bailing machine at the site.

The rest of the non-degradable materials that cannot be sold in open market are also bailed and NMC delivers the bailed waste to the Cement Manufacturing facility in Puttalum (Insee Ltd). The cement factory is not charged a tipping fee by NMC.

3.4.3 Privatisation of waste collection service

From 2002, NMC hires a private company (Seven Hills Pvt Ltd) to carry out its waste collection service. In 2002, the waste collection service for Kochchikade zone and dumpsite management were transferred to the private company. The selection was via an open tender procedure and the contract was for 2-3 years. There have been a short time when the service of the private company was halted (between 2005 and 2008).

In recent years, the private service company has been responsible for waste collection from Kochchikade zone, Thalahena zone, Bazar II area. Additionally, the company was given the task of managing the dumpsite.

However, since 2019 the private company's service is limited to Thalahena, Bazar II and dumpsite management. This is due to the fact that the NMC resumed its own waste collection service in Kochchikade zone.

The private contractor maintains a fleet of vehicles and hires workers to perform the waste collection service.

The collection service is supplied according to a schedule that has been developed incorporating the directions of NMC. Weekdays and Saturdays are allocated for degradable waste collection and non-degradable and recyclable waste is collected on Sundays. However, it should be noted that collection workers are allowed to pick up valuable recyclable items even during the organic waste collection without disturbing the collection duties.

Table 3-5: Resources available with private service supplier for waste collection

Zone	Resources		Zone	Resources		Zone	Resources	
Kochchikade	Labourers	40	Thalahena	Labourers	30	Dumpsite	Bulldozer	2
	Supervisors	3		Supervisors	3		Labourers	2
	Drivers	6		Drivers	4			
	4WT	6		4WT	4			
	Compactors	1		Compactors	1			

3.5 Waste collection fee

At present, Negombo MC levy a waste collection fee for large waste generators such as business enterprises and industries. As shown in Table 3-6, the waste collection fee is calculated based on the amount of waste discharged. In addition to the fee shown in Table 3-6, VAT and NBT is also levied.

Table 3-6: Waste collection fee scheme

Waste disposal (kg/Day)	Waste collection fee (Rs/month)
5-10	500
10-15	600
15-20	750
20-30	1,000
30-50	1,500
50-100	2,000
100-150	3,000
150-200	4,000
200-300	6,000
300-500	7,500
>500	10,000

The waste collection fee is collected from a number of business enterprises in each zone. Even though there are several large waste generators, the collection is limited to only a few establishments as shown in Table 3-7.

Table 3-7: Number and amount of waste collection fee paid by different enterprises in Negombo MC

Zone	No. of enterprises (shops, businesses etc.)	Income (Rs) in Year 2018
Colombo Road	42	35,650
Periyamulla I	8	16,000
Bazar I	13	7,350
Kudapaduwa	6	5,500
Periyamulla II	6	5,600
Kadolkele	10	6,800
Munnakkaraya	4	6,500
Kurana I	6	3,300
Angurukaramulla	5	2,700
Kurana II	4	2,500
TOTAL	104	91,900

Currently, the waste collection fee is not collected from enterprises in Kochchikade and Thalahena zones since the NMC has not yet implemented a scheme to collect such a fee. Although the waste collection service for Kochchikade and Thalahena zones was recently resumed by NMC, a full account of large waste generators is not yet available. In addition, available data formats do not accurately summarise the distribution and types of waste large waste generators.

4. RESOURCE RECOVERY

This section summarises the overall waste resource recovery system of NMC. At NMC, resource recovery is recognised as the diversion of food waste, recycling of non-degradable waste, and composting of degradable organic waste.

4.1 Diversion of food waste

Approximately 1-2 MT/day of food waste is collected by private collectors and piggery farmers in neighbouring villages/ cities. The collected food waste is sold as animal feed for the piggeries; however, the selling price undisclosed. Moreover, accurate data on this waste diversion is not available at NMC, thus it is difficult to conduct an accurate quantitative assessment.

4.2 Composting of degradable waste

Negombo MC started compost production from degradable waste in 2006. The facility began in a small shed next to a public ground in the Kurana area. At first, composting was started using garden waste on a small scale, and gradually the capacity and facilities

Figure 4-1: Degradable waste composting facility - Negombo MC

were increased to the present day, with a waste-receiving capacity of 10 MT/day. The expansion of the facility was made possible with financial aid received from *Pilisaru* project and WMA-WP.

At the beginning of composting project, segregated waste collection started from Kurana area and expanded to Kadolkele, Colombo Road, Angurukaramulla, Siriwardena Pedesa, Munnakkarai as well as one section at Kuda Paduwa, and Rajapaksha Park.

There are 10 labourers employed at the composting yard with nine of them employed as permanent labourers and one as a casual labourer. One Bobcat, two hullers (sieving machine) and a bag sealer are available at the composting yard as machinery.

Technically, the composting is processed through windrow composting. The total capacity of the compost yard is 10 MT/day, but actual intake is limited to 6-8 MT/day since the facility is located in a residential area adjacent to a public playground. In addition, NMC supplies more garden waste to the composting yard than food waste to reduce the risk of nuisance caused by flies and odour. Whenever NMC tries to increase the capacity, public complaints and objections arise. A parapet wall has been constructed along the periphery of the composting facility; however, the space available at the location does not support any further expansion. Operations are further downscaled during the rainy season to reduce the leachate pollution and public nuisance.

Although the estimated organic waste collection is 30-40 MT/day, only 20-25% of collected waste is taken to composting facility. The rest of collected degradable waste is still disposed of at the Ovitiyawatta dumpsite.

NMC stores all sales records in printed and digital formats. The composting facility was used as a demonstration site for school children and others. Alternatively, household composting and waste separation are promoted by community awareness programmes conducted by municipal workers, PHIs and overseers at the household level.

The produced compost is packed into bags. Compost is available in 5kg, 20kg and 50kg bags priced at 50 LKR, 160 LKR and 400 LKR respectively. Unpacked compost (bulk purchase) is sold at 6 LKR/kg to those who purchase more than 250kg at once. Un-sieved compost is sold at 4LKR/kg. Negombo MC has two sales outlets that are exclusively used for the sale of compost. However, at present, the sales outlet at Muhandirampitiya is not functioning properly. The main sales outlet is situated in front of the municipal council.

There is a steady demand for compost, mainly from small-scale farmers and households. It has been learnt that compost is mainly used for home gardening. The average compost production is 13.0±4.7 MT/month and sales amount to 12.4±4.1 MT/month. The compost production and sales records show variations that are mainly caused by limited production during the rainy season (Figure 4-3).

Figure 4-2: Compost sales outlet Negombo MC

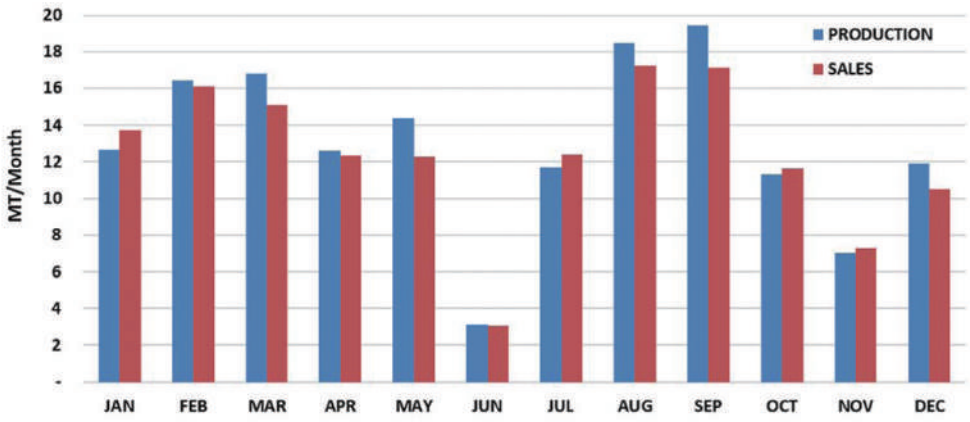


Figure 4-3: Compost production and sales for year 2018

4.3 Recyclable waste collection and recycling

4.3.1 Recycling Facility of Negombo MC

The recycling facility of Negombo MC is located in Muhandirampitiya. Materials that can be directly sold in open market such as cardboard, paper, polythene, plastic, glass, coconut shells and metal are separated from non-degradable waste disposed at the recycling centre. Generally, the non-degradable waste collection contains low-grade recyclables such as contaminated plastics, polythene and paper since the valuable recyclables are segregated at source and also during collection by NMC labourers. Table 4-1 shows the quantities of different recyclable items recovered and sold at the recycling centre. The average amount of recyclable material recovered comes to 2.37±3.9 MT/month.

Table 4-1: Recycle material sales record for year 2018

Item (kg)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Paper/ cardboard	12,762	11,135	11,443	12,517	10,833	10,233	11,130	15,558	15,895	16,883	17,410	20,320	166,119
Plastic/ Polythene	30,724	33,552	33,981	34,476	35,677	39,408	35,775	49,271	45,219	46,206	45,520	52,480	482,289
Glass/ Metal	11,940	10,927	12,898	9,972	13,281	12,312	12,740	11,706	12,148	12,618	12,946	13,328	146,816
Metal/ Iron	2,296	2,377	2,344	6,167	2,758	3,043	3,709	3,209	4,162	4,409	4,547	5,744	44,765
Others	810	600	750	700	875	800	828	900	1,592	1,690	1,687	1,940	13,172
TOTAL	58,532	58,591	61,416	63,832	63,424	65,796	64,182	80,644	79,016	81,806	82,110	93,812	853,161

An old municipal building with additional temporary shelters is used as the recycling centre at Muhandirampitiya. The centre has a bailing machine and simple steel tables to be used as sorting tables. The bailing machine is an electrical induction motor powered (5.5 kW) hydraulic compressor that can be used to compressed soft plastics, paper and non-recyclable soft materials.

Figure 4-4: Bailer and sorting table available at recycling centre, NMC

Sampath Piyasa next to recycling centre

Recycling centre

Recyclable waste sorting table

Non-recyclable waste bails

Recyclable recovery from non-degradable waste

Recyclable waste store

Figure 4-5: Recycling material processing centre of Negombo MC

4.3.2 Disposal of non-degradable waste at cement factory

All the non-degradable waste left after recovery of recyclables is bailed into cubic blocks (0.125 m^3) and store onsite. The weight of each bail varies from 30-50 kg and the production rate varies according to material supply that may range from 10-20 bails per week. A portion of this non-recyclable yet combustible waste that is to be used as supplementary fuel, is taken to INSEE cement factory in Puttalum, located 100 km away from Negombo. The quantities taken to the cement factory are shown in Table 4-2. The municipality bears the transportation costs but, no charge is levied to the cement factory. The cement factory has a limited capacity to accept this residual combustible waste, so disposal at the cement factory is a limited option for non-degradable waste disposal.

Table 4-2: Amount of combustible waste disposed at cement factory

Month	Combustible waste dispose at cement factory (MT)
January	0.00
February	9.14
March	9.24
April	35.48
May	25.34
June	21.14
July	2.73
August	0.00
September	2.72
October	3.00
November	4.10
December	8.00
Total	120.89

5. FINAL DISPOSAL SITE

5.1 Introduction to final disposal site

5.1.1 Ovitiyawatta final disposal site

The final disposal site is located at Ovitiyawatta, at about 8.0 km from the city centre (Figure 5-1). The dumpsite lies within Kochchikade ward, Pallansena North GN division (no. 77) of Negombo Divisional Secretariat administration limits. Ovitiyawatta waste disposal site is one of the largest MSW dumpsite in the Western Province of Sri Lanka and one of the oldest MSW dumpsite in Sri Lanka. The current disposal site at Ovitiyawatta is situated on private land near the Maha Oya (a river called Maha), and has been in use since 1985.

Figure 5-1: Location of Ovitiyawatta MSW disposal site of NMC

Ovitiyawatta dumpsite was previously a clay mining floodplain area adjacent to Maha Oya. Residents around the site stated that there were several large excavated pits at the site. The excavated pits were as deep as 10m. The site has vegetation characteristics of a wetland and is an area that retains water, which gets flooded during the rainy season. The land is a private property and the owner has made the site available to the Municipal Council for the disposal of solid waste. Evidence suggests that waste disposal operations started in the late 1990's or early in 2000. The owner has already made use of a part of the garbage filled site for low-income housing after the site was covered with a layer of gravel on the garbage filled land. There was a part of the filled site that has been blocked out for housing sales (Figure 5-2).

The site has been in use primarily as an open dump operated by a private service contractor. The private service contractor uses one or two bulldozers to spread and compact the waste. A thin soil cover of about 15-30 cm is applied on the compacted waste but with no other environmental protection measures being taken. This has resulted in environmental and public nuisance problems including odour, flies, pests, smoke, leachate, etc., with nearby residents being badly affected. Several public protests have taken place concerning this, the last one was in December 2002.

Owitiyawatta dump site (2004)

Owitiyawatta dump site (2010)

Owitiyawatta dump site (2013)

Owitiyawatta dump site (2018)

Owitiyawatta dump site (2018)

Figure 5-2: Historical evolution and surrounding land use of Ovitiyawatta dump site

5.1.2 Area of site and layout of land

This final disposal site at Ovitiyawatta is located about 1 km away from Kochchikade junction of the Peliyagoda-Puttalam (A3) highway. According to official records at NMC, the area of the final waste disposal site is about 12 hectares (30 acres); however, the active filling area is approximately 2.5 hectares (8 acres). The closet proximity to residence is around 10 m from the site boundary on the west and south of the site. The land is having a flat terrain with a mild slope toward the storm water drains radially from higher elevation of the dump to surrounding low lands.

As shown in Figure 5-3, the site is connected to the main road through series of by-roads. Some of the roads are well-developed tarmac roads while the roads within the sites are laid with gravel. The entrance road is divided to two sub-access roads running towards the active dumpsite and the rest of the land made up of coconut plantations. All internal access routes are temporally constructed roads using soil and C&D waste.

The active filling area rises up to 10-15 m above ground level.

5.1.3 Waste receiving and disposal

The waste received at the dumpsite is recorded as the number of waste loads since a weighbridge facility is not available at the site. All non-compostable and non-recyclable waste collected is discharged at the dumpsite. This include collection by the municipality (from 13 zones until December 2018) and by a private contractor (Bazar II, Thalahena and Kochchikade). A brief analysis based on available records is shown in Figure 5-5. The waste loads were converted to tonnage assuming each vehicle load carries 6.1 m^3 of waste with a bulk density of 380 kg/m^3. The records are summarised monthly by the municipality. However, it should be noted that the amounts may change slightly as a portion of non-compostable and non-recyclable waste is also disposed at the site.

The amount collected and disposed at the site reaches a peak of nearly 2,400 MT/month during the festive season (November-January) while a comparatively lower amount of 1,500-1,800 MT/month is recorded between February and April. The overall monthly average disposal is 2,040 ± 280 MT/month which is equal to a daily average of 68 ± 9 MT/day.

The management of the dumpsite has a pre-schedule plan for waste disposal. The site supervisor gives instructions to those operating the waste collection vehicles and waste handling machinery at the disposal area.

One of the biggest challenges in management is to ensure that dumping vehicles have access to the active filling area during the heavy rainy season. Therefore, site management uses an additional crawler excavator to handle waste during the rainy season.

Figure 5-3: Layout of the Ovitiyawatta final disposal site

Access road to site

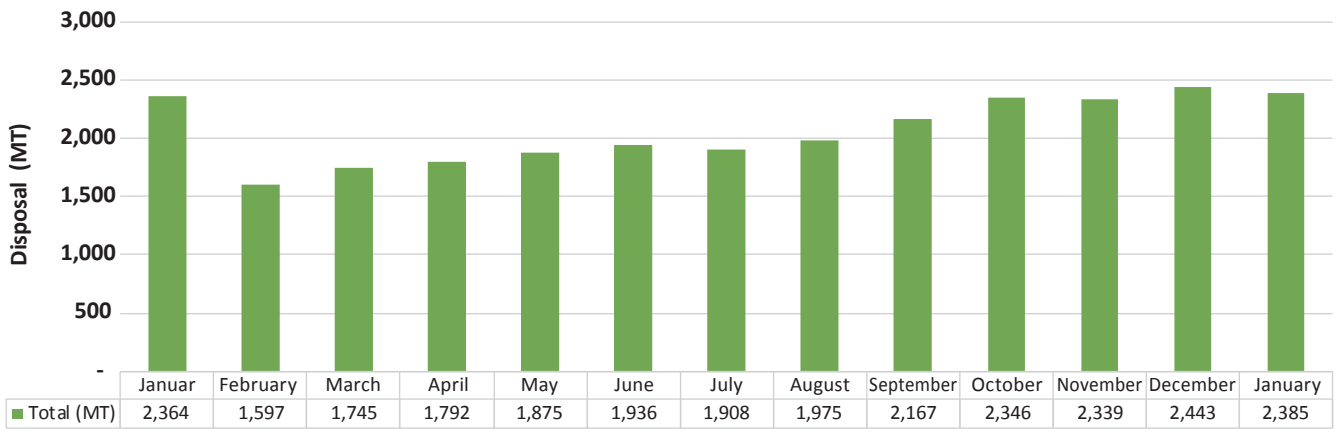
Surrounding land use

Bordering Maha oya on north

Soil cover

Active filling area showing waste unloading, scavenging and leveling activities

Figure 5-4: Waste discharge and management practices of Ovitiyawatta dumpsite, Negombo MC



	Januar	February	March	April	May	June	July	August	September	October	November	December	January
Total (MT)	2,364	1,597	1,745	1,792	1,875	1,936	1,908	1,975	2,167	2,346	2,339	2,443	2,385

Figure 5-5: Average monthly waste discharge amount at Ovitiyawatta dumpsite from January 2018 to January 2019

5.2 Management of Ovitiyawatta dumpsite

The dumpsite is located within the Negombo MC limits, but the land is under private ownership and site management is handled by a private contractor (Seven Hills Pvt Ltd) which provides a waste collection service for Bazar II, Thalahena and Kochchikade.

At present, the dumpsite is managed by a site supervisor who is also responsible for management of collection service.

The crawler excavators available at the site are mainly used for disposal site management. The machines work about 6 hours at the site. In addition, 1-2 labourers are allocated to the site when the machine is in operation to assist the operator. Excavators clear the waste unloading area by compressing the unloaded waste to form a flat surface. Only one excavator works during the dry period, but additional machines are used during the rainy season.

According to the site manager and witnesses at the site, a few (3-5) scavengers collect recyclable materials such as metal, hard plastics and firewood at the site.

5.2.1 Leachate and landfill gas management

There is no specific mechanism for leachate management at the site. Leachate from the former dumpsite (old waste fill) and active filling may easily penetrate the underground water table. The evidence states that contaminated (black-grey water flume) water seeps into Maha Oya during the rainy season; seepage is not visible during the dry spell.

However, it is apparent that a considerable amount of leachate penetrates the soil and contaminates the groundwater resources.

The practice of open dumping along the Maha Oya could bring about disastrous consequences to the area due to a reduction in wetland areas which constitute an important part of the city's ecosystem as well as due to the reduction of water retention capacity during heavy rains, which increases the possibility of flooding. Despite public awareness and protests against these practices, they still continue because the Municipal Council has no other alternative in regard to the disposal of solid waste.

Table 5: Current conditions, operations and management of final disposal site

1	Current conditions of final disposal site and its surroundings	
1.1	Disposal method and structure	• Incoming waste loads from all sources (tractors, compactors and trucks) are recorded at the site • Trucks and tractors are directed to active unloading area and instructed to unload with the assistance from a labourer • All other MSW collection vehicles empty their waste at the dumpsite. No specific control measures apply for selection of dumping area. Thus, Open Dumping is practiced. • All other waste is dumped on the ground and compacted using an excavator. During rainy season, an additional crawler excavator is used to assist the bulldozer.
1.2	Soil-covering	• As a clause of contract agreement with Negombo MC, the private contractor who handles the dumpsite regularly covers the waste with a minimum 5 inches of soil (600 loads/ month). • However, soil and construction waste is occasionally used to make temporally access/roads on the dump
1.3	Land owner	• Ownership is private. There is no lease agreement; but the landowner reclaimed the clay mined pits by disposing of waste.
1.4	Waste dumping area	• Approximately 30 acres (~ 12 hectares) has already been allocated for the site. Nearly 90 % of the site is filled with waste of which more than 60% is old dumping area. A part of old dumping grounds has already been reclaimed for low income housing and the rest of old dumping areas are fully covered by a layer of soil. The elevation of old dumpsite is same as surrounding lands.
1.5	Leachate and gas management	• No proper leachate collection system. • Leachate and surface water flow towards the low-lying areas of the site and also towards the Maha Oya • There are no structures or mechanisms for gas emission control from old or active dumping areas
1.6	Scavenging	• Some scavengers (waste pickers) work at the site. Waste pickers are allowed to enter the site; but there is not much readily marketable waste.
1.7	Scattering waste, smoke, fire, offensive odor, animals	• Waste is dumped on designated areas on the dumping site • Scattering and blowing out of waste is observed during dry season as soil covering is not practiced daily • No fire and smoke witness at the dumpsite during the observation • Occasionally, offensive odours come from the active dumping area; however, no odour control measures are used • Cattle and dogs freely scavenge on the waste

2	Operation and Management of final disposal site	
2.1	Environmental Protect License and Environmental Clearance	• None
2.2	Personnel	• 1 supervisor – (Part-time position)
		• 1-2 labourers– (Permanent positions)
2.3	Operation vehicles, their maintenances and drivers	• 1-2 crawler excavators
		• 1 four wheel tractor/ truck for oil transport
2.4	Weighbridge	• None
2.5	Waste collection data	• Daily record is available for incoming vehicles
2.6	Supervisory method	• General planning and supervision carried out by private contractor which is responsible for management
		• Monitoring and supervision is done by Mayor, commissioner, MOH and PHIs of Negombo MC. PHIs regularly inspect the site and instruct the private contractor on necessary actions. Site supervisors are responsible for coordinating with the municipality and landowner for solving daily management issues as well as other contingency matters.
		• Site supervisor is responsible for daily operations of all facilities
3	Waste amount to final disposal site (Daily, monthly, annually)	• A summary is shown in Figure 1-5.
4	Adverse impact nearby residences	• Odour, dust and waste scattering through wind are the man nuisances for residents around the dumpsite
		• Residents also complain about fly and insect problems
		• Dust emission during the dry season is a problem for residents around the dumpsite
		• Residents in downstream areas mentioned that they do not use their dug-wells for drinking as they suspect the wells are contaminated with leachate/seepage from dumpsite.
5	Implementation status of geological, topographic and EIA survey for new final disposal site	• None
6	Progress situation for new final disposal site	• None
7	Court case	• None

6. MANAGEMENT OF OTHER WASTE

This chapter provides a brief overview of generation, collection, treatment, recycling and final disposal of other types of wastes that are not generally recognised as municipal solid waste. This waste includes industrial waste, healthcare waste (medical waste), hazardous waste, and also liquid wastes (mainly wastewater and sewage).

6.1 Industrial waste

The sources and amounts of industrial waste generated from NMC is presented in section 2.1.1. It is estimated that a total of 6.33 metric tonnes of industrial waste are generated in a day. In Sri Lankan waste management policy and regulation framework, industrial waste is not managed by local authorities, which means that information on industrial waste generation, collection, treatment & processing, and disposal is not available from local authorities. However, a registry of small and medium-scale industries is maintained by NMC as local authorities are vested with powers to issue Environmental Protection Licenses for such industries.

Among the industrial waste generation sources, agro-industrial waste such as timber milling, fish processing and food processing waste is considered as less harmful organic waste. Timber processing waste is a common source of firewood for bakeries, hotels and households in the city. Sawdust is often burned on-site in kilns. Biodegradable and reusable organic waste (eg. fish and food processing waste) is often given out for secondary processing and value addition (eg. poultry feed).

However, except for some main industries, accurate information on waste generation from small and medium-scale industries are not readily available from NMC. Despite legal arrangements that do not permit disposal of industrial waste into general waste stream, it is a common practice that small and medium-scale industries dispose of their waste using the general MSW collection service carried out by local authorities. This remains a source of hazardous waste found in MSW (Esakku et al., 2007).

6.2 Healthcare waste

The waste generated by Health Care Facilities (HCFs) is known as ‘Clinical waste’, ‘Health care waste’, ‘Infectious waste’ and ‘Medical/Hospital waste’. However, these terms may have similar meanings or be subsets of one another, which substantially inhibits using and comparing data from different countries. In the Sri Lankan context, hospital waste includes all type of waste generated by HCFs, such as hospitals, clinics, physician offices and other medical laboratories and research facilities. However, medical waste is always considered as a subcategory of healthcare waste, which potentially indicates infectious waste, apart from sharps. This type of waste contains infectious waste, toxic chemicals and heavy metals, and may contain substances that are genotoxic or radioactive. Generally, a small portion of total healthcare waste is considered infectious. As described by the WHO, out of the total amount of waste generated by health-care activities, about 85% is general, non-hazardous waste. The remaining 15% is considered hazardous material that may be infectious, toxic or radioactive. Moreover, not all waste can be addressed as clinical waste; there are some categories of waste which do not fall in the definition of clinical waste. However, to overcome this problem, healthcare waste can be classified as non-clinical waste (non-regulated healthcare waste, also defined as general waste), and clinical waste (special waste, regulated healthcare waste). Non-clinical waste is defined as any waste that does not pose any risk to human health or the environment. Examples of non-clinical waste include packaging materials such as cardboard, office paper, leftover food, cans etc. Those types of waste are often discharged into general MSW collection of Local Authorities.

Management of healthcare waste in Sri Lanka is governed by directives from the Ministry of Health. The Ministry of Health has introduced and implemented a stringent set of rules for source-separated waste disposal targeting all healthcare facilities in the country. Colour coding makes it easier for medical staff and hospital workers to put waste items into the correct container, and to maintain segregation of the waste during transport, storage, treatment and disposal. Colour coding also provides a visual indication of the potential risk posed by the waste in that container (Figure 6).

Government-owned and all other privately owned hospitals separate medical waste from the general waste stream at the waste generation points. Thereafter, they are stored and disposed of separately.

It is mandatory for all healthcare facilities to securely store, transport and dispose all high-risk waste such as infectious waste, sharp waste, cytotoxic and pharmaceutical waste. Negombo general hospital facilities securely dispose of high-risk healthcare waste. There are several private sector healthcare waste management service providers who provide the service for a fee. Generally, all government and private sector healthcare facilities hire such private sector services to dispose of high-risk healthcare waste.

In Negombo, general waste generated from healthcare facilities (e.g. garbage, food waste, paper, cardboard, ordinary plastic containers and plastic films) are collected by MSW collection vehicles under hospital management. It is estimated that the total amount of waste generated from healthcare facilities is 3.84 Metric tonnes/d, out of which nearly half a tonne of waste is considered high risk waste which needs to be disposed of by private sector service providers.

Figure 6-1: Colour coding system for source segregated waste disposal at hospital premises

6.3 Hazardous waste

The government of Sri Lanka formulated regulations for the Management of Hazardous Waste in 1996 as an amendment to the National Environmental (Protection & Quality) Regulation No. 1 of 1990. This was done by publishing Part II in the Gazette Extra Ordinary No. 924/13 dated 23 May, 1996 as an extension of the Environmental Protection Licensing procedure. However, some of the regulations introduced in 1996 could not be effectively implemented due to insufficient technical knowledge and infrastructure to identify hazardous waste in field investigations. Therefore, this regulation was further amended as National Environmental (Protection & Quality) regulation No. 01 of 2008 by the Gazette notification No. 1534/18 with a prescribed list of waste, referred to as "scheduled waste" to facilitate easy identification of such waste types. Consequently, there is a well regulated policy and legal framework for identification of sources of hazardous waste, and also regulations and guidance to govern the management of hazardous waste in all segments of the waste management scheme.

Accordingly, hazardous waste generated from major industries and also in large quantities from other sources, is well managed by environmental licensing procedure. However, hazardous waste generated from small waste generators such as households, commercial establishments and other services and institutes, is not well regulated under the current regulatory framework. Therefore, small quantities of hazardous waste generated from those sources are generally discharged into MSW collection system.

In the NMC area, most household hazardous waste is collected along with non-degradable waste collection. A small amount of other hazardous waste is collected by recyclers. However, precise information on waste flow is not available. It is estimated that NMC collects about 200kg per day of hazardous waste in the non-degradable waste collection. A small portion of hazardous waste, containing recyclable items such as metals, plastics and glasses, is recovered as recyclable items. The rest of the hazardous waste is disposed of at the dumpsite.

6.4 Construction and demolition (C&D) waste

At present, the collection, transport, processing and disposal of C&D waste are indirectly regulated by different laws in the absence of a direct regulation on C&D waste. Moreover, C&D waste is not recognised as a component of general MSW, so a C&D waste management service is not provided by the local authorities. However, a considerable amount of roadside drain cleaning waste is generated by cleansing activities carried out by local authorities. The NMC also collect soil and debris amount to 1.2 MT/day from drain cleaning, which is consequently disposed of at Owitiyawatta dumpsite or on other vacant lands.

All other C&D waste is managed by generators such as households, builders and contractors. Often, all recyclable C&D waste such as metals, timber and wood, plastics and stones are generally recycled. The non-usable C&D is generally used as land reclamation material, as an alternative to soil. A small amount of C&D waste is used at the dumpsite as an alternative cover soil (5-10 tonnes per month).

6.5 Wastewater and sewage

As stipulated by the Municipal Ordinance and Local Authority act, sewerage collection and disposal are mandatory public services that should be provided by the Local Authority. As of many Local Authorities, NMC has dedicated service for sewage collection and safe disposal. In general, toilets in households, public places and all other establishments are built with sufficiently large soakage pits. In cases where the capacity of soakage exceeds or filled with water during rainy season, NMC provides sewage collection service for a fee. The NMC's record showed that about 4,000 collection trips are carried out annually, with annual fees amounting to LKR 8,719, 311 (USD 50,000 for 2018. The collected sewage is treated in a sewage treatment plant adjacent to the compost facility.

Wastewater from other sources is generally managed by generators. On-site preliminary treatment systems are common for most large generators such as hotels and restaurants; however, many small-scale generators dispose of wastewater (kitchen, processing and greywater) into storm water collection systems or backyard gardens.

At present, Negombo MC has no centralised sewerage collection and disposal system and this is identified as one of the main issues in the city's wastewater management in the Negombo MC area so a Development Plan of Negombo has been proposed to solve this priority issue. The proposed new project of Sanitation and Hygiene Initiative for Towns in South West of Sri Lanka has incorporated Sewerage Management plan of Negombo to provide sewerage facilities and improve sanitary facilities in Negombo MC area (Urban Development Authority, 2018). The National Water Supply and Drainage Board acts as the major government body and the project is to be funded by AFD - French Development Agency and the European Union. The project aims to divide Negombo MC area into two stages: the first stage will be implemented initially in 2020 incorporating the coastal area with hotels. The total estimated cost of the Project is 20 billion with 75,000 targeted beneficiaries.

6.6 Emissions from Waste

Several greenhouse gases (GHGs)/short-lived climate pollutants (SLCPs) are emitted during management of municipal solid waste from collection to final disposal of the waste (Premakumara, 2018). Methane (CH4) and black carbon (BC) are major pollutants emitted from the waste management sector (Premakumara, 2018). BC has much higher Global Warming Potential (GWP) in terms of CO_2 equivalent, across 100 years time horizon. These emissions from the waste sector can be reduced through proper waste management. Similarly, GHGs/SLCPs are also emitted from Negombo City waste management sector due to improper waste management. Based on Table 2-3, it can be understood that the total waste generation in Negombo is 157.7 MT/D and more than 50% of waste is uncollected and is illegally dumped into the surrounding polluting environment, emitting GHGs/SLCPs. Further, about 80% of the total collected waste is disposed of at the final disposal site emitting various GHGs/SLCPs.

Figure 6-2 shows the GHGs/SLCPs emissions from the current waste management sector in Negombo. In the current situation of waste management in Negombo City, about half of the waste is collected and only about 16 MT of collected waste is recycled/ recovered. Out of this 16 MT, 6 MT of organic waste is used for composting, and the remaining 10 MT are inorganic materials such

as metal, plastic, paper etc. which are recycled. Remaining, about 80% of the collected waste is openly dumped at the final disposal site. The uncollected waste, which accounts for 72MT, is dumped in and around the environment without any treatment. Out of total uncollected waste, it is assumed that 50% of uncollected waste is openly burned.

The results in Figure 6-2 (a) and (b) shows that the potential climate impact from GHG and BC emissions per tonne of generated waste in Negombo City is 981 kg of CO_2-eq/tonne and 106.76 kg of CO_2-eq/tonne respectively. Figure 6-2 (c) and (d) estimates the net GHG and BC emissions from yearly generated waste in Negombo as 56,466.85 tonnes of CO_2-eq/yearly generated waste and 6,145.16 tonnes of CO_2-eq/yearly generated waste respectively. The estimation of climate impact from waste management sector in the city was done based on lifecycle assessment (LCA) methodology using an Emission Quantification Tool (EQT) developed by the Institute for Global Environmental Strategies (IGES) in line with the IPCC (2006). Table 6 shows the waste categories and their respective values for the estimation of emissions from the current waste management sector in Negombo.

Table 6: The waste categories and their respective values for the estimation of emissions from the current waste management sector in Negombo

Category	Scenario 1 (BAU)
Total waste generation	157.7 MT/D
Collection	86 MT/D
Composting	6 MT/D
AD	0
Recycling	10 MT/D
Final disposal	Open dump

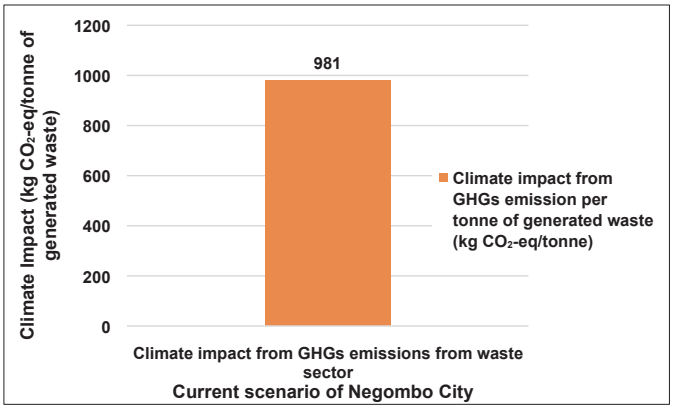


Figure 6-2: (a) The GHG emissions per tonne of generated waste in Negombo City

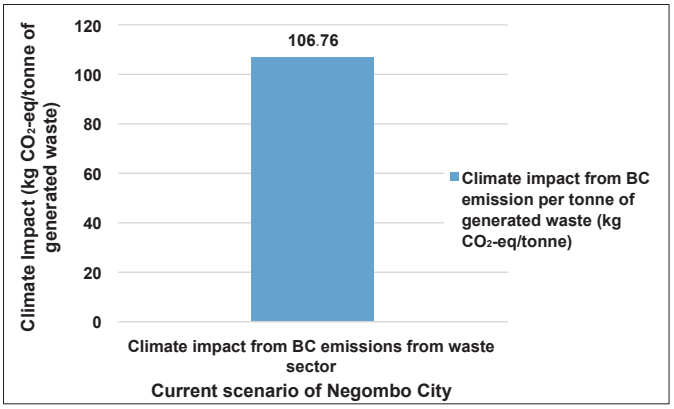


Figure 6-2: (b) The BC emissions per tonne of generated waste in Negombo City

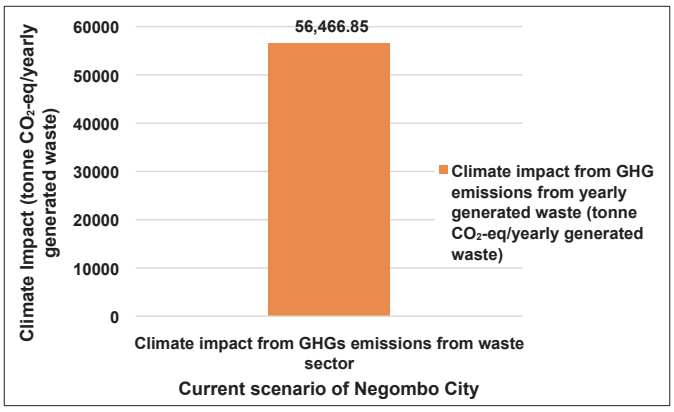


Figure 6-2: (c) The net GHG emissions from yearly generated waste in Negombo City

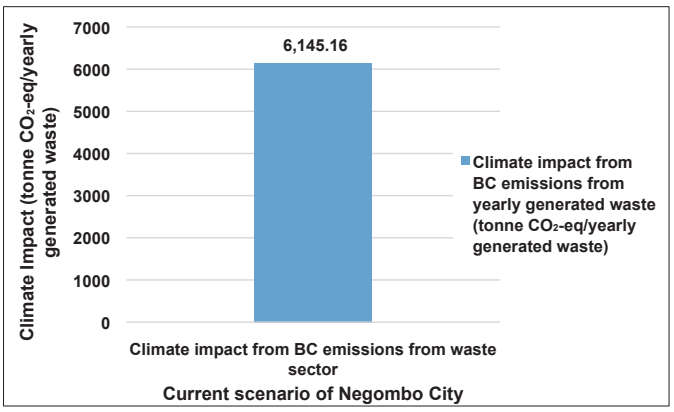


Figure 6-2: (d) The net BC emissions from yearly generated waste in Negombo City

7. CAPACITY BUILDING AND PUBLIC AWARENESS

Training and awareness programmes pave the way to bridging the knowledge gap, which aims at better practices. Public participation is an integral component of successful waste management in any city. Modifications of routine practices or adopting novel methods of waste disposal require awareness from the public to obtain their cooperation. Public awareness programmes play a key role in dissemination information and it is required to train people in-order to get the desired outcome. Sharing successful stories with other groups/cities will benefit them to achieve better results.

7.1 Activities of NMC

NMC carry out training programmes for their employees and community. Improving employee capacity is the prime objective of NMC training programmes. The list of training programmes for each category of employees was prepared by the administration section of NMC at the beginning of the year. In certain cases, the administration section seeks opinions from officials in the health section in deciding training programmes. Apart from the annual programme, other recommended training programmes are also conducted as required.

Community awareness programmes are conducted by the health section on source reduction, source separation, resource recovery (e.g composting), mosquito prevention and nutrition management. The programmes mainly target labourers involved in community awareness programmes. They cover 40-50 houses per day. Labourers who are involved in household (HH) awareness programmes, were trained by the PHIs on communication skills and subject knowledge. Other than the community awareness programmes, university students and school children visit the compost facility for research and educational purposes.

NMC is in the process of developing environmental committees called "Haritha Mithuro" which means "*friends of the environment*" to promote the 3R concept among residents of NMC and also among the daily migrating population (Negombo Municipal Council, 2018). These committees comprise Grama Niladari, Samurdi development officers, economic development officers, environment police, community police unit, PHI, health supervisors, political and religious leaders and residents in GN division / village.

In addition to this, religious leaders such as church incumbents are

Figure 7: Captions of public awareness programmes conducted by Negombo MC

well informed about NMC's waste management programmes so the churches act as messengers to raise awareness among residents. Maternity clinics, school programmes and public announcement systems are also used to inform the public on composting and waste separation activities.

Table 7: Regular training and awareness programmes conducted by Negombo MC

Training programme	Target Group
Capacity development of supervisors and other workers in health division	Supervisors and other workers in health section
Training on waste management - Conducted by waste management authority	Employees in health section
Train the community awareness group	Labourers in health section
National Vocational Training (NVQ) level 2 training	Labourers in health section
Onsite demonstration on compost production	School children, university students, and community
Dengue and other mosquito prevention programmes	Community, school children
Training on nutrition	People at maternity clinics
Non-communicable diseases	Community
Skin diseases	Community
Establish and train village committees on waste management "parisara mithuro", "haritha mthuro"	Environmental committees

7.2 Activities of NGOs in awareness raising and waste management

This section elaborates on the contributions of NGOs, public interest groups, CBOs and Sanasa Co-operative society in environmental programmes. At present Janathakshan Gurantee Limited, CBOs and public interest groups as well as SANASA Cooperative Society actively contribute to NMC waste management programmes.

Janathakshan (JT) is one of the key NGO works carried out in collaboration with NMC in recent years. JT mainly focused on reduction of of polythene and plastic usage, and recycling in NMC area. JT promotes usage of water dispensers instead of PET bottles in hotels, and introduced a star rating system for supermarkets to reduce usage of polythene. JT established environment committees in two wards in collaboration with NMC and works with these communities in developing waste management plans at the ward level, as well as introducing methods for recycling of PET bottles. JT also conducted waste composition analysis on behalf of NMC to facilitate the development of waste management plan; however, the final report has not be released.

Sri Wimukthi Women's Society is a grass-root organisation engaged in money lending among women's groups. They are involved in organising village level Shramadhana (clean-up) campaigns for Dengue prevention and environmental protection.

SANASA Society (a Cooperative Lending Society) in NMC area is engaged in collecting and selling non-degradable waste from households and it is also involved with NMC in organising community awareness programmes.

The volunteer groups operate independently on environmental protection programmes such as beach cleaning etc. According to the information received almost all the above organisations are service-oriented rather than capital investments.

7.3 Contribution of religious institutes towards public awareness-raising

There are 45 Catholic churches and four Methodist churches in the NMC area. As the majority of the population in NMC area are Catholics/Christians, they usually visit the church for Sunday prayer. The NMC uses that opportunity to disseminate information on waste management and explains any changes made in the waste collection plan. The NMC formally informs the priest and obtains prior approval to make announcements at the church. According to the perception of the PHI, NMC receives greater support from churches on dissemination of information. Societies connected to the church are also supportive and organise shramadana campaigns and awareness programmes.

8. FINANCING SOLID WASTE MANAGEMENT

This section focused on financial aspects of SWM in NMC. Waste services were financed by NMC's annual budget allocation (Negombo Municipal Council, 2019). The annual budget forecasts income (revenue) and expenditure for a particular year. The budget is structured in such a way that each department of operations predicts its revenue and expenditure. For instance, NMC budget structure as of year 2019 is shown in Table 8-1 below. The estimated budget for the solid waste management is allocated under health services (Programme No 2) along with other health services. There is no direct budget line or programme exclusively for SWM. Instead, the SWM budget is shown as a project under the health budget programme.

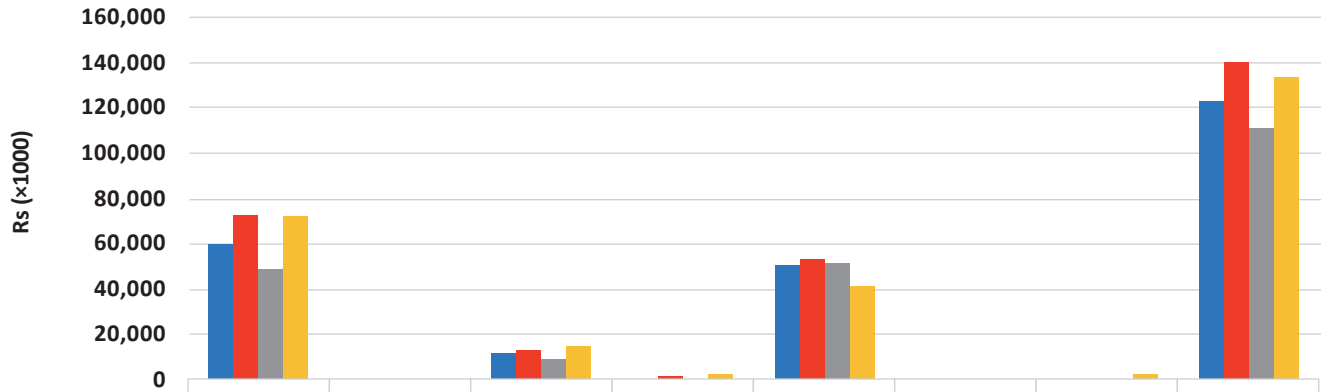
Table 8-1: Health service budget structure, Negombo MC (Negombo Municipal Council, 2019)

Programme 2 Health Services	Project 1 - General administration
	Project 2 - Disease prevention services
	Project 3 - Curative services
	Project 4 - Hygiene of foods
	Project 5 - Drainage cleaning
	Project 6 - Maternity health services
	Project 8 - Solid waste collection
	Project 9 - Other health services and crematorium

8.1 Annual budget of NMC

The officer in charge of the accounts section prepares the budget estimates with the necessary information obtained from sectional heads. Budget estimates are based on actual values from the previous year/s and experience, adding 10-15% additional allowance for the following year. Additionally, a budget revision (Revised budget) is carried out in the middle of each fiscal year based on actual expenditure during the first six months. Then, the annual revised budget is projected mid-year by multiplying the revised budget by a factor of two. Figure 8-1 illustrates the budget lines and allocation from year 2017 to 2019.

As shown in Figure 8-1, budget lines show an upward trend each year. The budget estimate is prepared for the forthcoming financial year, often an estimate based on the previous year's



	Personal Emoluments	Travelling	Supplies & Equipment	Repair and maintenance of capital assets	Transportation, communication and utility services	Grants and Subsidies	Pension and benefits	Total
2017 - Actual	60,393,300	50,000	11,097,800	281,200	50,303,600	4,200	0	122,130,100
2018 - BUDGET	72,500,000	150,000	13,050,000	1,100,000	52,910,000	12,000	1,000	139,723,000
2018 - REV.BUDGET	48,798,100	103,200	9,576,500	815,700	51,788,200	4,200	0	111,085,900
2019 - ESTIMATE	72,350,000	150,000	15,400,000	2,200,000	41,810,000	22,000	1,609,000	133,541,000

Figure 8-1: Budget lines and allocation for health services (Negombo Municipal Council, 2019)

actual expenditure calculated at the end of each fiscal year. Budget revisions are made to accommodate any changes that can be happened within a fiscal year which was not anticipated during the earlier estimation. It is unclear whether these budget lines serve the action plan developed by NMC. The action plan can trigger capital investments such as development of common composting facilities, biogas, temporary storage, Sampath piyasa, introduction of a market for recyclables as well as training and awareness programmes.

There were mismatches found between primary data and secondary data found in the 2019 budget. For instance, it is required to have clarification on the workforce attached to NMC health section.

The five-year action plan focused more on communication, community mobilisation, implementation of composting facilities, biogas, temporary storage facilities for recyclables, development of linkages with rivet vendors, and introduction of market facilities for recyclables. The budget describes transport and communication as utility services and so it is difficult to capture the real allocation for communication.

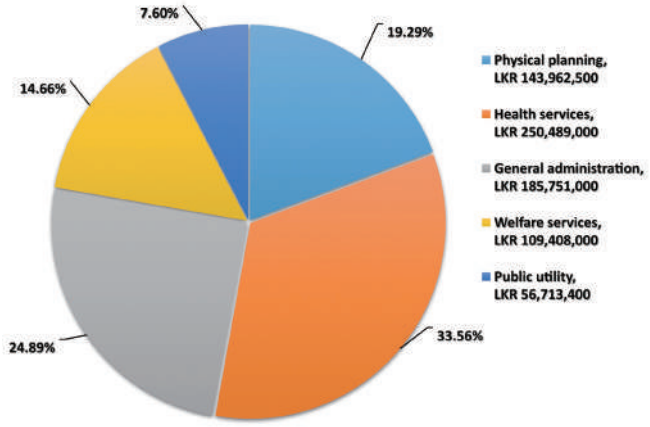


Figure 8-2: Negombo MC's budgetary allocation for different services and sections in year 2019

Figure 8-2 illustrates the NMC budget allocation for different services offered. Accordingly, 24% of the total budget allocated for improve health services, including solid waste management. However, it should be noted that out of the total expenditure, a large portion of budgetary allocation is for salaries, wages and pension payments. Thus, MSW service is recognised as the largest service provided by NMC.

Table 8-2: Detail SWM budget structure (Negombo Municipal Council, 2019)

SWM Annual Budget structure	Revenue Heads			
Definition of budget items	Recurrent income		Recurrent Expenditure	
	310	Assessment & tax	410	Salaries and wedges
	320	Rents	420	Travelling
	330	Licence	430	Supplies and requests
	340	Fees for services	440	Repairs and maintenance of capital assets
	350	Warrant cost & Penalties	450	Transportation, communication and utility services
	360	Other income	460	Interest
	370	Revenue grants	470	Grants and Subsidies
			480	Pension and benefits
Budget contents	Typical			
Budget calculation method	There are no specific methods of budget calculation. Forecasting was done using previous year records.			
Budget analysis method	Monthly reports were prepared using actual income, expenditure of the month and estimated one. Monthly reports are submitted to the financial committee for analysis and final reports were submitted to the council/ management committee to obtain the recommendations.			
Pros and Cons of Budget	Pros:			
	Could estimate the salaries of employees			
	Cons:			
	There were no specific methods of budget calculation			
	There is no accurate method to estimate budget items			
	Certain projections made irrespective of the action plan			
	Took rough estimations in budget allocations			
	There are no separate budget lines to indicate compost sales, gully services			

8.1.1 Detailed MSW budget structure

The detailed SWM budget structure is shown in Table 8-2.

As shown in Figure 8.3, the budget allocation for health department is further separated into several categories.

Out of total health service budget, 53% is spent on waste collection and the second highest expenditure is drainage cleaning at 15% of the total health budget allocation. The solid waste collection budget is 12.72% of the total budgetary expenditure allocation for 2019.

Budget allocation for solid waste collection is further sub-divided into different activities relating to solid waste management. As shown in Figure 8.4, the largest portion is allocated for personal emoluments which include salaries and wages. In addition, 6% and 1% of the solid waste budget are allocated for overtime & holiday payments and pension & benefits, respectively. The transport budget includes a smaller allocation for communication and utility services, totaling 31% of solid waste budgetary allocation. Consequently, there is hardly any direct budgetary allocation for recycling, composting and final disposal site management. Therefore, such facilities should run as separate projects where any additional expenditure should be sourced within the municipality or external donor funds.

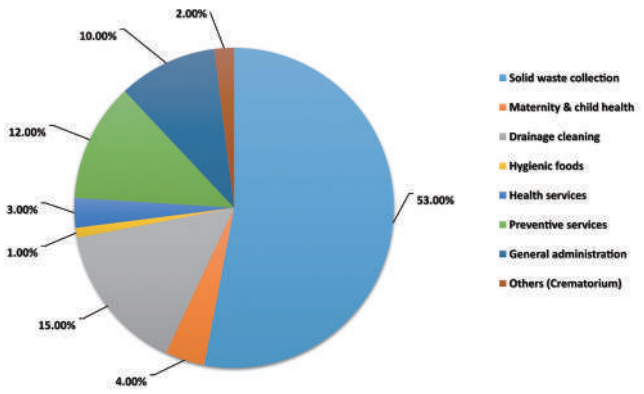


Figure 8-3: Estimated budgetary allocation for different services within the total health department budget (NMC Budget Report, 2019)

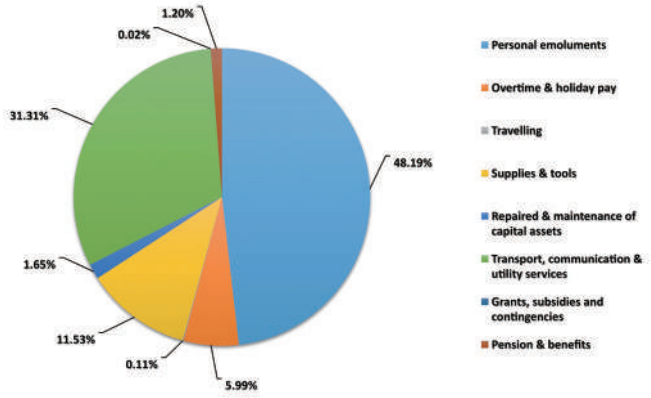


Figure 8-4: Estimated budgetary allocation for different types of expenditure within the total solid waste collection budget (NMC Budget Report, 2019)

8.2 Recurrent revenue of NMC

Figure 8-5 below shows the sourcing of recurrent revenues from different revenue subjects. The highest contribution (85%) for the recurrent revenue is accounted for the general administration. Out of the total general administration recurrent revenues, 39% is from revenue grants (government funds), 32% from other income sources and 20% from assessment and tax. Health services contribute 8% to the total recurrent revenue. Trade licenses, daily/ weekly fair fees collected from vendors and environmental licenses

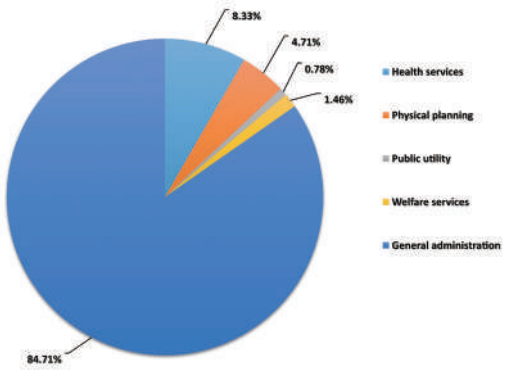


Figure 8-5: Estimated revenue income under different revenue votes as a percentage of total revenue of NMC (NMC Budget Report, 2019)

fee from small industries mainly contribute to the revenue of health services.

As shown in Figure 8-6, out of the total license fees of NMC, 90% is collected under health services. There is about 12% revenue contribution from the health services to NMCs total service revenues. Warrant costs, penalties, other income and assessment tax provide minor contributions to the total municipal revenues.

The revenue from health services falls under the following major revenue heads: assessment and taxes, licenses, fees for services, warrant costs and penalties, revenue grants and other incomes. Some of the major revenue heads are further subdivided to sub-revenue heads. Figure 8-7 (a) shows the contribution to major revenue heads while Figure 8-7(b-d) show the contributions from sub-revenue heads.

The revenue from weekly fairs (Pola) fees is a major contribution to the license fee revenue head of health services that is about 74% of the total license revenue (Figure 8-7, b). About 57% of the service fee revenue head from collecting waste comes from

commercial establishments (Figure 8-7, c). However direct waste collection fees from commercial establishments contribute only 3% to health service revenues and only 0.25% to the total municipal revenues. Revenue from compost and recyclables sales contributes 1.95% to the health service revenues and merely 0.16% to the total municipal revenues.

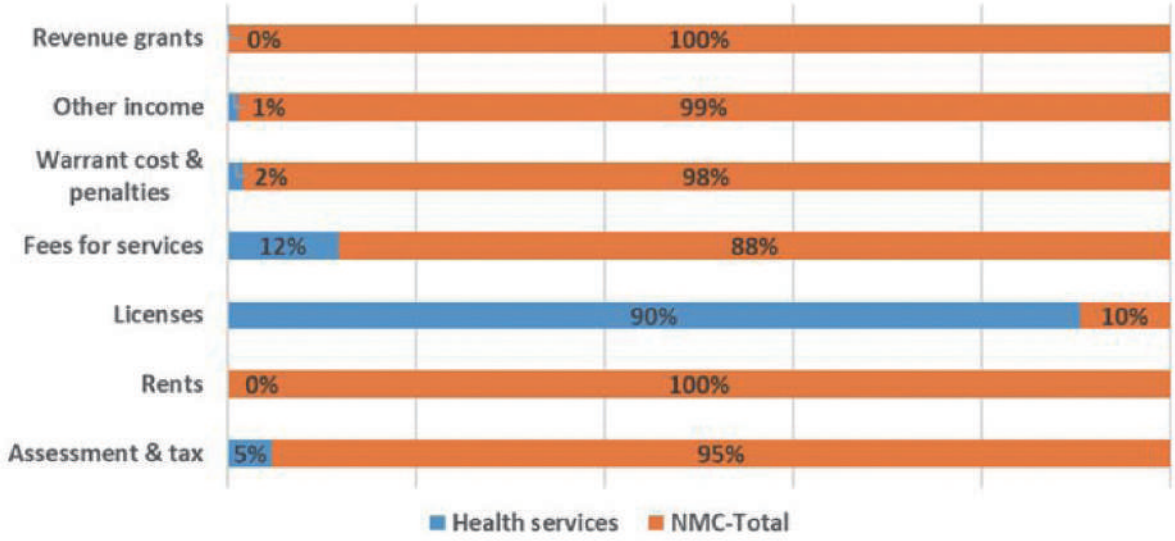


Figure 8-6: Estimated revenue income (in LKR) from health services compared to total revenue of NMC (NMC Budget Report, 2019)

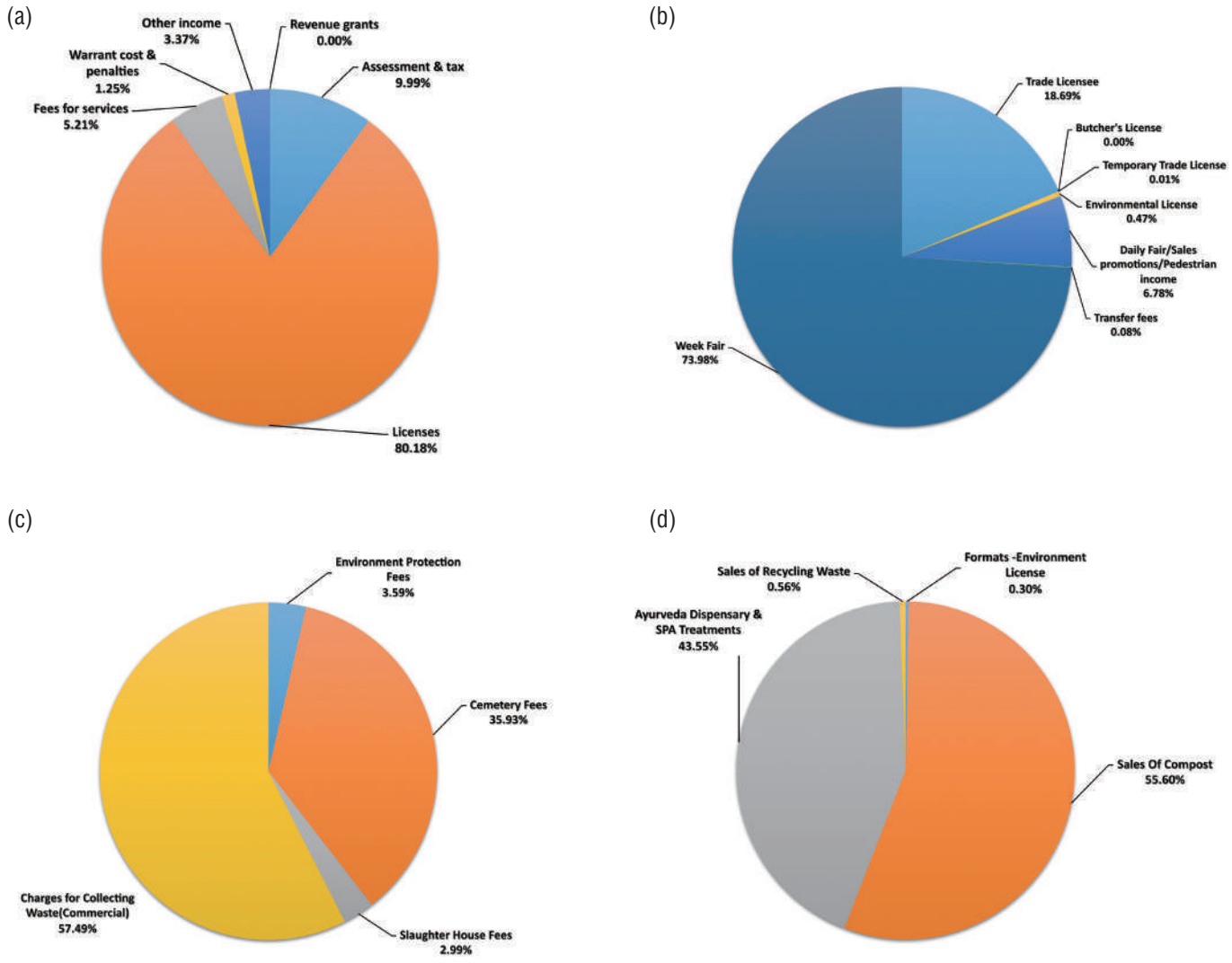


Figure 8-7: (a) Contributions from major revenue heads, (b) contributions from sub-revenue heads to licenses revenue head, (c) contributions from sub-revenue heads to fees for services revenue head and (d) contributions from other sub-revenue heads to other revenue heads of estimated health service revenue for year 2019.

9. POLICIES AND LEGAL FRAMEWORK

9.1 Chronology of waste management policy and legislation in Sri Lanka

The first piece of legislation pertaining to waste management in Sri Lanka was introduced way back in the colonial period (in 1862) when the British ruled the country. The first law was implemented through the Nuisances Ordinance (15 of 1862) which was subsequently amended (61 of 1939; 3 of 1946; 57 of 1946). The Ordinance gave powers to city government and government sanitary inspectors to inspect, regulate and control public nuisances, particularly inappropriate garbage disposal. Several key functions of the Ordinance are still in force where powers are enforced by PHI. The rest of the legislations were introduced in 1939 and 1947 through the Urban Council Act and Municipal Council Act, respectively. However, during the establishment of Provincial Councils in 1987, most of the political administrative legislations were amended and reformed.

At present in Sri Lanka, the basic legal framework required for municipal solid waste management (MSWM) is provided under an umbrella of Central Government, Provincial Council (PC) and Local Authority (LA) regulations and legislations. The 13th Amendment to the constitution (1987) and the Provincial Councils Act No. 42 of 1987, Sections 129, 130 and 131 of the Municipal Councils Ordinance (1980), Sections 118, 119 and 120 of the Urban Councils Ordinance, No. 61 of 1989, Sections 41 and 93 to 95 of the Pradeshiya Saba Act, No. 15 of 1987 are the key pieces of legislation pertaining to waste management in local authorities.

According to the Municipal Council (MC) Ordinance, the Urban Councils (UC) Ordinance and the Pradeshiya Sabha (PS) Act, all MSW generated within the boundary of LAs is their property, and

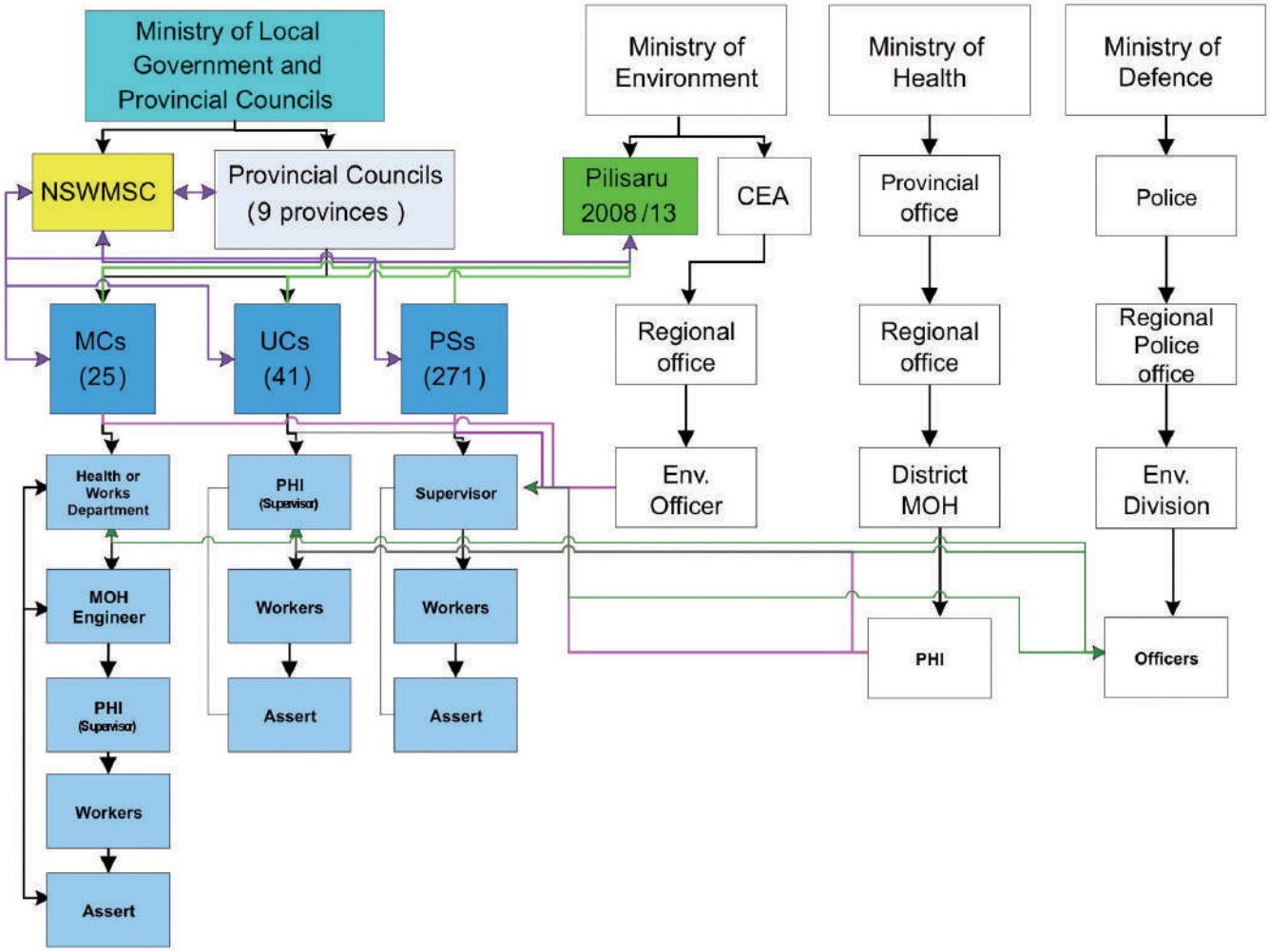


Figure 9: Institutional framework for MSW management in Sri Lanka

they are mandated to remove and dispose of such waste materials without causing any nuisance to the public. These government enactments provided the provisions and regulation for selecting a suitable land for the waste processing and disposal and help with development within the frame of law and regulations.

The Municipal Council Ordinance specified that it is the responsibility of a Municipal Council to ensure that streets are kept clean, hygienic and free of curbside refuse. It further states that the Municipal Council is responsible for collecting waste disposed from residences. It also emphasises that the waste collected needs to be disposed of in a suitable manner. Therefore, it is vital for the Negombo Municipal Council to collect all solid waste at the household level in an organised manner with a comprehensive waste collection plan to include households that do not receive waste collection services currently. The Municipality is also responsible in planning proper infrastructure to dispose of solid waste in a suitable manner. Thus, establishment of a properly designed integrated waste management system that comprises waste collection, transport, processing, treatment and secure disposal is essential and obligatory.

The National Environmental Act, No. 47 of 1980 (NEA) was enforced with the aim of establishing regulatory authority for environment monitoring and regulation. The CEA was established under the NEA, and the approval, monitoring and regulation of all environmentally sensitive activities were supposed to be administrated by the CEA. The provisions of the Act vindicate and explain how to launch projects without damagin the environment.

9.2 Recent development in waste management sector

During the period of 2001-2010, a successful effort was made to improve the overall MSW management conditions in Sri Lanka through cooperation with the Japanese government (e.g. JICA). As a result of preliminary studies, two MSW dumpsites were rehabilitated; one of them was considered the first ever semi-engineered landfill in Sri Lanka. Furthermore, the National Solid Waste Management Support Center was established to provide technical and financial support for LA's to upgrade MSW management. Also, in 2008, under the chairmanship of the Ministry of Environment and the CEA along with the participation of other government organisations, private institutions, NGOs and various technical experts; Pilisaru, a national level programme for upgrading the MSW management sector was started. Pilisaru programme promotes the 3R's concept and resources recovery from MSW prior to final disposal. By the end of 2018, approximately 145 LA's were provided with financial and technical support for the development of their MSW sector. The major tangible outcome of the Pilisaru programme was the establishment of composting facilities in more than 130 LAs in Sri Lanka.

The Urban Development Authority Act also suggests that the solid waste generated at the household level must be reduced and disposed of in a proper manner. This Act also emphasises the fact that efficient collection is mandatory within the Municipal Council area.

Hazardous Waste Management Regulations ensure that distinct precautions, licenses and approvals have to be obtained from the Central Environment Authority for handling and disposal of all hazardous wastes. Unfortunately, this does not include healthcare or biomedical waste.

9.3 National waste management policy

As a response to much needed national policy on holistic waste management, the first National Policy on Waste Management was formulated and introduced by the Ministry of Environment in 2007. The second amendment to the policy was developed and released for public comment in 2018. However, it got the cabinet approval in 2019. The policy covers solid, liquid and gaseous waste aiming at providing directions within a broader framework with focused policy statements to offer guidance to legally mandated government institutions, other service providers and all other institutions in the country. The mandatory community involvement in managing waste is recognised as a significant input to ensure that waste managers perform their duties with the highest degree of responsibility and accountability throughout the country. In view of Constitutional obligations, every person in Sri Lanka is obliged to protect the natural environment and conserve its riches.

The new policy amendment recognised that different agencies practiced different waste management activities with various degrees of success and failure. Any failures were mainly due to the absence of adequate and acceptable infrastructure facilities including conflict-free final disposal facilities within an agreed integrated waste management system throughout the country.

Moreover, the new amendment defines and introduce several major

waste streams such as electrical and electronic waste (e-waste), healthcare waste, construction and demolished waste, and other hazardous waste. Those have been considered in this policy as waste materials that need priority attention in addition to MSW. The policy further acknowledges that various actions have been taken in the recent past by the government to develop infrastructure facilities for the treatment of this type of waste. Healthcare waste treatment facilities have been established island-wide and appropriate clustering will be able to cater to the requirements of the government sector. The possibility of extending waste treatment services to other institutions could also be explored in order to utilise the available capacities considering the extensive investment costs required for establishment of hazardous healthcare waste treatment and disposal facilities. Specific and related sub-sectorial policies and strategies are necessary to achieve this. However, dedicated hazardous waste final disposal facilities are required to dispose of the ash generated after incineration in an environmentally-sound manner as it is categorised as hazardous waste. At present, the available disposal facilities are not adequate to deal with all the hazardous waste generated in the country.

The policy emphasises that it is necessary to assess where, what and how much waste is generated to confirm the cause of waste generation and promotion of efficient and maximum resource circulation, as well as preventing and minimising waste throughout the country through robust coordination and reporting systems.

9.4 Waste Management Authority - Western Province

The Waste Management Authority of the Western Province (WMA-WP) was established under a statute No: 09 of 1999, to ensure a cleaner environment and enable wellbeing of the people as well as of flora and fauna in the province. However, the Authority actively commenced its operations in July 2004 with recruitment of staff for the approved carder. As provided by the provincial statute, WMA-WP has administrative, monitoring and regulatory powers in managing solid waste within Western Province of Sri Lanka.

To address the present state of waste management of the Province, innovative strategies for administration, technical and legal applications have been identified by the Authority. The "Waste Management Zonal Concept" is one of the strategies identified by the Authority to overcome the present shortcomings of the administration system in waste management of the Province. Under this concept, the WMA-WP introduced 07 "Waste Management Zones", clustering all 45 Local Authorities into (06) Municipal Councils and Kalutara Urban Council. This concept facilitates sharing of available resources among the Local Authorities of each zone and encourages them to work as groups in waste management.

The "Seven Steps of Waste Management" is another strategy identified by the WMA to streamline existing practices of waste management in the Province. Under this, required rules, by-laws and guidelines have been formulated for waste segregation, collection, cleaning, transportation, and transferring, processing and final disposal of waste The objective of this exercise was to strengthen the existing legal structure of the province with respect to the management of "Municipal Solid Waste" by introducing "Municipal Solid Waste Management Rules" for the execution of the above mentioned "Seven Waste Management Steps" through "Seven Waste Management Zones" of the Western Province. This will give extra strength by regulating the management and handling of Municipal solid waste within the Province. This strategy was technically and financially supported by USAID- USAEP and the Central Government of Sri Lanka.

In addition, Western Province is working with JICA on development of Master plan on waste management for Western Province in coordination with National Solid Waste Management Support Center (NSWMSC), Ministry of Provincial Councils and other relevant organizations. The Master plan is supposed to be developed in about 3 years' time starting from February 2018.

Negombo Municipal Council is within the Negombo Zone of the Western Province waste management zonation.

9.5 National Solid Waste Management Support Center

The Ministry of Local Government and Provincial Councils (MoLGPC) established the National Solid Waste Management Support Center (NSWMC) in 2007 based on the recommendation by "JICA Study on Improvement of Solid Waste Management in Secondary Cities (2002-2003)" in order to assist local governments to improve the solid waste management problem (JICA, 2016).

The NSWMC is responsible for providing variety of manuals and guidelines to facilitate LAs to implement proper SWM, providing technical assistance on solid waste management to LAs, collecting and studying information on the current SWM practices and the practices in LAs and foreign countries and providing useful information to LAs. It is also responsible for facilitating LAs to

get technical and financial assistance from NGOs and donors; promoting, evaluating, and making recommendations to the National Strategy for Solid Waste Management and collect and analyze the waste management data of LAs. Therefore, NSWMC plays a vital role in management of solid waste in administrative areas of Local Authorities.

10. GAP ANALYSIS

This section presents a comprehensive analysis of the major challenges faced by the Negombo MC in delivering an effective and efficient waste management service to citizens. The analysis further extended to identify the gaps and weaknesses that hinder achievement of objectives set out in the NMC's 5-year plan known as "Green City". A brief baseline survey was carried out for the waste management sector in order to assess the present situation of waste management services. The outcome of the baseline survey has been presented in previous chapters.

The approach taken for carrying out the proposed gap analysis is to answer the following key questions:

- Which data are still needed for assessing the current waste generation and recovery/ disposal situation in NMC by sector and types of waste?
- Which data are necessary for making more accurate projections of future changes in waste stream?
- What are the major obstacles in achieving the desired level of physical resources, human resources and financial targets within a 5-year framework?
- What are the key changes required to realise the ultimate goal of Resource Circular Economy?

10.1 Data and information gaps

Negombo MC uses a typical conventional book-keeping method to record all the information related to waste management sector. Specific data entry formats have been printed out for information recording and only a monthly summary is entered to digital (Microsoft Word) data entry forms. Table 10 below summarises the current data and information recording system adopted by NMC.

As shown in Table 10-1, daily labour attendance is recorded in books by the supervisors. The workers first report to the site office before starting work. The daily waste collection programme is recorded in a formatted sheet. In this form, the type of vehicle, vehicle number, name of the drivers, details of route cleared, number of loads, remarks, names and the signatures of the supervisors are available. The data recording process is supervised and approved by the development officer. Worker's attendance books are presented to NMC at the end of the month. Attendance is approved by the chief management assistant before calculating the monthly salary. Daily records of fuel and lubricant issued for each vehicle are also recorded in a book. Repair and maintenance records for each vehicle are recorded in each vehicle's log book. Expenditure for the skid steer loader at the composting site is recorded in a separate file. Gully suck waste collection records and charges are also recorded in a separated book. Route log record keeping is the responsibility of vehicle drivers and supervisors. The daily labour and vehicle allocations are available at each sub-office, and the records are forwarded to the council at the end of each month.

The waste collection vehicle records, detailing the number of trips to the disposal site, are also available at the final disposal facility and composting facility. However, filling factor, type of waste, collection sources and any other relevant information are not recorded at the site. Gully suck collection is also recorded as number of loads.

Table 10: SWM related data keeping and information management by NMC

No	Description	Digital data	Book records	Frequency	Available at	Use
1.0	Waste generation & composition					
1.1	Household population statistics	No (Sampath Pathikada)	No (individual revenue license entries)	As required, not update regularly	Revenue section	Account section for budget estimates
1.2	Commercial and service sector statistics	No	No (individual revenue license entries)	As required, not update regularly	Revenue section	Account section for budget estimates
1.3	Industry, health services and other sectors	No	No (individual revenue license entries)		Revenue section	Account section for budget estimates

1.4	Waste composition	No (baseline-Japan International Cooperation Agency, 2003)	No	A recent survey has been conducted, but records are not yet analysed	Health/ Solid Waste Section	No
1.5	Waste stream/ Flow	No (baseline-Japan International Cooperation Agency, 2003)	No	No	No	No
2.0	Collection and transport					
2.1	Daily waste collecting vehicle allocation	No (fixed schedule)	Yes (book keeping)	Daily	Health section	Management/ supervision
2.2	Fuel and lubricant	No	Yes (book keeping)	Daily	Health/ works section	Account section
2.3	Vehicle repair and maintenance	No	Yes (book keeping)	As required	Health/ works section	Account section
2.4	Labour attendance	No (monthly summary)	Yes (book keeping)	Daily	Converted to monthly report at Health section	Account section for salary
2.5	Special collection service for a fee	No (monthly summary)	Yes (book keeping)	As per service	Health section	Receipt to account section
2.6	Vehicle log books	No	Yes	As required	Health/ works section	Service & maintenance
2.7	Gully service	No (monthly summary)	Yes (book keeping)	As per service	Health section	Receipt to account section
2.8	Non-degradable collection	No (monthly summary)	Yes (book keeping)	As allocated	Health section	No
2.9	Other waste collection services (Market, parks etc.)	No (monthly summary)	Yes (book keeping)	As allocated/ scheduled	Health section	No
2.10	Privet sector collection service	No (monthly summary)	Yes (book keeping)	Monthly	Health section	Account section for payment
3.0	Recycling and composting					
3.1	Recyclable collection (quantity)	No	No	No	No	No
3.2	Recyclable sale (quantity/ income)	No (monthly summary)	Yes (book keeping)	As required	Health section	Account section
3.3	Organic waste collection (quantity)	No (monthly summary)	Yes (book keeping)	As required	Health section	No
3.4	Compost sales	No (monthly summary)	Yes (book keeping)	As required	Health section	Account section
3.5	Non-recyclable send to cement factory	No (monthly summary)	Yes (book keeping)	As required	Health section	No
3.6	Compost/ recyclable stocks	No (monthly summary)	Yes (book keeping)	As required	Health section	Account section
4.0	Final disposal site					
4.1	Waste disposal quantities	No (monthly summary)	Yes (book keeping at final disposal site)	Monthly	Health section	Account section for payment (private sector)
4.2	Scavengers	No	No	No	No	No
4.3	Cover soil application	No	Yes (book keeping at final disposal site)	Monthly	Health section	Account section for payment (private sector)
4.4	Machinery use at dumpsite	No	Yes (book keeping at final disposal site)	As required	Health section	Account section

10.1.1 Lack of information, records and statistics

- As it is commonly observed in many Local Authorities, Negombo MC do not maintain and update even the basic statistics such as city population, land use, number and distribution of commercial, industrial and institutional establishments. However, records on financial transactions, salary, wages, payments, use of goods, tools and fuel are well maintained, typically as book records. It was observed that records are maintained as a proof of transactions or use of goods and services rather than source of information and data for analysis, planning and monitoring of the activities.
- The functional records are available for workers, vehicle & fuel use, tools & equipment. However, updated records on typical waste generation statistics such as generation rates, compositions, method of discharge are barely found. The specific waste generation and collection characteristics such as zone-wise, ward-wise and street-wise volumes of waste handled and collected, waste collection routes and network, allocation of resources for zones and areas are available in the form of book records and simple maps; however, that information is not up to date nor is it precise.
- Vehicle weighing facilities are not available in Negombo MC. Thus, all waste amount figures stored either at the Local Authority or at the waste processing & disposal facilities are rough estimates. Whenever waste quantity figures are shown as tonnage, these have been estimated based on record keeper's experience and knowledge. A common factor to convert waste volumes to weight is the apparent density of waste, mostly set as 1500 kg per tractor load. However, various academic research and studies have shown that an accurate density figure can only be drawn by considering the type of waste, size of the vehicle, degree of compaction in the vehicle, method of loading and storing waste in the vehicle, and the filled volume (filling factor). Moreover, most of the records are kept by low-level workers, such as labourers or work supervisors, who may have not gained sufficient knowledge or training on such detailed estimations. Therefore, most of the waste generation, collection, treatment and disposal statistics from NMC are simple estimates, sometimes far from the actual amounts.
- In a broader context, Central and Provincial Government and Government agencies maintain solid waste databases, often derived from information supplied by individual Local Authorities. However, a mechanism for verification and validation does not exist. Decision-making with such inaccurate data and statistics may aggravate the issue rather than solving it.

10.2 Gaps and challenges in collection & transportation

The solid waste generated within Negombo city is collected via the municipal waste collection system as well as by a private collection service. It is assumed that around 80% of residences, commercial establishments and industries are covered by this system. There are 29 Council Wards and the collection system is planned in a manner that covers all the wards.

It is said that residences and commercial institutions in most of wards separate organic waste and either dispose onsite or dispose via municipal collection. Despite the presence of these systems, some waste is directly dumped on the roadside. The waste collectors also sweep up the waste that is dumped on the roadside and all this collected waste is sent to the dumping site by vehicles. Small storage sites and temporary dumping sites result in scattered garbage around the city – mostly due to animals disturbing the waste.

As a practice, the waste collectors sweep and collect street side waste into larger heaps ("sweepings") to be collected by the tractors which follow. The only intermediate collection points that exist are open dumps where waste collected by handcarts and other methods is collected to facilitate loading into larger vehicles. One such intermediate dump is located close to the weekly Pola where the waste collected by the handcarts is brought together for collection by a 4-wheel tractor trailer. This practice has led to the presence of scattered garbage around the city limits which are often disturbed by animals (dogs, cows, goats etc.) resulting in poor sanitary conditions.

10.2.1 Waste collection & transport

- A number of residences are still not served by the municipal collection services
- There seems to be a shortage of transporting vehicles and labourers in the municipal service and machinery breakdowns are frequent
- The bell collection system implemented earlier is not functioning properly in all wards
- Usage of inappropriate waste handling equipment by workers results in an unsafe environment for them. This is due to the lack of attention by officials
- Lack of transferring stations causes delays in transporting waste, especially in Thalahena zone
- Public awareness and public participation/cooperation seems inadequate or ineffective to ensure a better service

10.3 Weaknesses and gaps in recycling

Resource recovery centres are in operation where a certain portion of the recyclable material such as plastics, paper and metal are separated, and the separated material is sold to recyclers. Residents in the relevant areas are required to separate their waste into recyclable and non-recyclable waste streams to be collected by the NMC waste collectors separately. The recyclable waste is then taken to the centres where they are sorted and stored until they are sold to recyclers.

There is a well-established informal scavenging system operating within the NMC which provides the basis for the recovery of a considerable portion of valuable resources. The scavenging operations can be distinguished at three levels. The first level of recovery is carried out by the NMC waste collecting employees who remove valuable material such as metals, cardboard and plastics from the waste stream during the collection process itself. The second level of recovery occurs at the resources recovery centres. The third level of recovery, or more accurately scavenging, occurres once the waste is dumped at the Ovitiyawatta dumpsite. Scavengers living in the vicinity sort out the remaining valuable resources from the waste stream.

In addition to this, there is a traditional system of individual waste collectors going door-to-door collecting plastic, paper metal, glass and other marketable resources. These collectors are generally known as "Botal Pattara Karayas" (collectors of bottles and paper). There are several more privately-owned small-scale plastic recycling centres in Negombo and suburban areas. They collect polythene and plastics from the residents within NMC. They take the plastic to a factory owned by them in order to make plastic goods.

10.3.1 Resources recovery and recycling

- It is evident from the type of waste disposed at dumpsite that source segregation is not very effective, resulting in many recoverable resources ending up at dumpsites
- NMC allows waste collection workers and other scavengers to recover recyclables from the waste stream. The practice is much valued, but a lack of actual figures for the amount of recyclables flowing through this informal sector make it difficult to assess the waste flow in the city. Thus, an informal recycling flow should be assessed and closely monitored, while also encouraging them.
- At the resource recovery centres, sorting operations are carried out manually which is inefficient in terms of time and labour
- Manual sorting may eventually lead to health problems among the workers

10.4 Composting

The main objective of any processing/treatment technology is to reduce the final amount of waste to disposal. The existing composting facility is located in a highly residential area and has limited capacity for expansion or processing of problematic waste such as food & market waste.

Considering that the composition of source segregated degradable waste is very suitable for composting and that the amount of waste going to the Ovitiyawtta dumpsite is high, NMC should seriously investigate the feasibility of establishing another medium-large scale composting or biogas facility.

Another alternative is to share a cluster of composting facilities that is located in a nearby local authority as land resources are very limited within Negombo MC.

10.5 Final disposal

The final disposal system used by Negombo Municipal Council is an open dumpsite on privately owned land. The site has been used for many years and the remaining capacity of the land is limited to approximately 2.5 acres that is barely sufficient for the next 3-5 years. NMC is facing difficulties with the expansion and development as it is leased from a private owner. NMC does not have its own land to develop a landfill facility.

The system of waste disposal at the dumpsite is a mix between controlled tipping and open dumping. Solid waste collected by tractors is brought to the disposal site and dumped at a suitable location. This waste is then covered with a thin layer of soil. However, the management of the site is handled by a private service provider.

The landfill site is situated along the bank of the 'Maha Oya' river

which is a major freshwater source in the country. On rainy days, the dumpsite site becomes muddy and unstable. Even though the solid waste is covered by a layer of soil, it is penetrated by rain water and leachate is generated. Even on dry days, this leachate can be seen collected in a small ravine between the dumping areas. This leachate is neither collected nor blocked from entering the waterway. The water quality downstream of the dumpsite has degraded due to pollution by this leachate.

The dumpsite is also a feeding ground for birds, cows, dogs and other animals. The buried waste is pulled or dug out of the ground causing poor sanitary conditions at the site. The situation at the dumping site is further aggravated when it rains because the top soil is washed away and waste and mud is exposed causing bad odour.

10.5.1 Final disposal

- Only open dumping is available which is unsanitary given the close proximity of a freshwater source
- The dumpsite capacity is almost full and finding alternative land for disposal will be a challenge in the near future
- Leachate flow contaminates the groundwater table and the adjoining river
- Odour is a problem for the surrounding area
- Mosquitos and other harmful insects breed at the dumpsite
- The ecosystem is severely affected by open dumping (e.g. trees are dying)

10.6 Cost assessment of SWM services

The disbursement for SWM is a heavy drain on the budget of the Municipal Council. Therefore, making maximum use of available resources is vital for effective solid waste management. Privately-managed systems are not that popular, so it is vital to develop infrastructure.

Proper purchasing of equipment should be carried out. According to sources and information made available by the NMC, the total income generation of the Council has increased during the past few years. This finance is covered by a subsidy provided through the Local Government and the Municipal Council budget.

The income generated from MSW services amounts to only 8% of the recurrent revenue generated though the total services offered by the Council. However, the recurrent expenditure for MSW services amounts to 34% of the total expenditure. This results in solid waste management costs being covered by money which could be allocated for development projects in the NMC. According to sources, the cost of solid waste management has increased to 133 million/year in the 2019 budget from 20 million/year in the 2003 budget (Japan International Cooperation Agency, 2003). The highest expenditure in solid waste management is for labour costs. Additionally, the cost of fuel and equipment has increased with time. The highest costs are incurred by the collection and transportation of waste.

10.7 Training and awareness

There were no proper training needs assessment for NMC employees and community when conducting the training and awareness programme. Further, there was a lack of monitoring and follow-up mechanisms for the training programmes. The monitoring framework focused on the quantity of training conducted rather than its quality and impact. Specifically, the following weaknesses were identified:

- Poor planing of training programmes e.g. setting objectives, adult training principles
- Inappropriate design and development of training materials
- Insufficient use of mass media and electronic media in information dissemination
- Lack of proper recordings of the training programmes

10.8 Gap analysis - Overall waste management sector

- Current SWM management structure does not reflect the significance of SWM within NMC. It should be much stronger, with more authority being given to the responsible people. There should also be adequate human, facility and financial resources allocated for SWM works because many NMC employees are engaged in SWM works, with NMC spending

much of its budget on SWM

- Shortage of senior staff dedicated to SWM works, while the inter-disciplinary nature of SWM makes it difficult for one person to handle SWM alone
- A lack of short, medium and long-term development plans. Goals, objectives and associated measures for improving SWM are not discussed, approved and implemented, resulting in a system where most staff focus on addressing day–to-day issues, and activities are uncoordinated, often leading to confusion and poor motivation
- Poor labour management, with absenteeism running at around 15-20%, while some labourers suffer from poor health and/or work under the influence of alcohol
- Poor cooperation with other departments involved indirectly in SWM
- Poor public-LA relations, characterised by a lack of clear instructions to the public detailing citizens' responsibilities, waste discharge rules, fines, etc. There is also weak enforcement of bylaws, and there is political interference
- High SWM expenditure
- Difficulties in finding out how much money is actually spent on SWM and SWM cost breakdown (e.g. administration, collection, disposal, etc.)
- A great deal of garden and building waste is disposed of at the roadside, collection points or on vacant land. Often, the garden waste is burnt
- Many drains are full of or blocked with garbage, causing nuisance or health problems
- The lagoon and sea, valuable assets for Negombo, are being damaged by illegal dumping

Understanding the issues and concerns of Negombo MC, it is evident that a straightforward approach cannot be developed to solve all issues, and to improve the existing conditions. Instead, NMC should aim for success through different mechanisms which may be site-specific and context-specific.

11. CONCLUSIONS AND RECOMMENDATIONS

The study reveals that solid waste management in Negombo is a major challenge and there are many gaps and shortcomings in the current waste management system. The city still follows the traditional way of waste management for collection of waste from source, and dumping it at the final disposal site with much less recovery and treatment (Singh, 2019). The city should consider moving from this traditional waste management system to a more sustainable approach by introducing an integrated waste management system based on waste management hirerarchy as shown in Figure 10. In addition, Negombo could consider introducing proper waste separation at source, reduction/stoppage of waste burning and illegal disposal, figuring out ways to expand composting and recycling facilities to divert waste from landfill, introducing the polluter pays principle, and utilizing available waste management funds in a more efficient manner. Some of the challenges and recommendations for Negombo's waste management system are as follows:

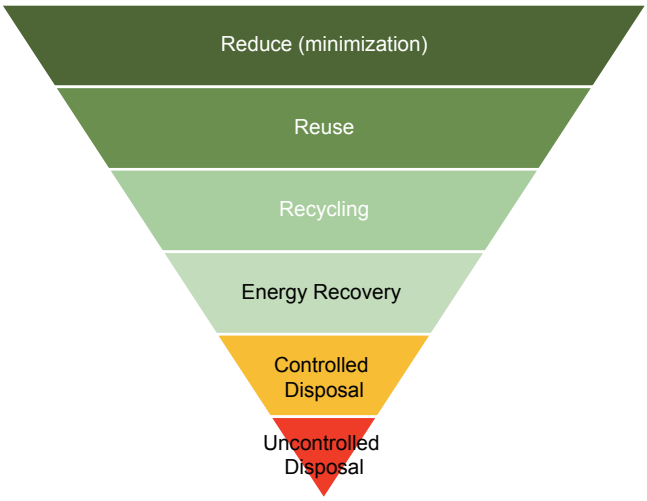


Figure 11: Waste Management Hierarchy

11.1 Reduction

It has been observed that the city does not focus on reduction of waste at the source like most developing countries. However, waste reduction at source is the most preferable and one of the most effective methods of waste management, with the addition of reduction of waste going to the landfill as well as protecting more natural resources for future generations and contributing to a cleaner environment.

Recommendations

- Controls on the use of disposable food containers
- Promotion of actions for the use of reusable goods such as making handicrafts from waste materials including plastics, paper and metals etc.
- Discouraging purchase of unnecessary goods as well as overpackaged goods
- Encouraging purchase of items in returnable containers and returning the containers once empty
- Use of recycling bags for shopping
- Reduction of food waste through every stages from harvesting, processing, packaging and transportation to the end stage of consumers (the consumers should consider minimizing food waste)
- Discouraging the disposal of materials/goods that can be reused, and instead finding and giving those materials to someone who needs them
- Discouraging the disposal of items which can easily be repaired such as electrical goods
- Reduction in unnecessary packaging by manufacturer and producers

11.2 Source segregation

Negombo City has already initiated source segregation of waste into degradable, non-degradable and recyclables. However, by observing waste disposed at the dumpsite, it is apparent that source segregation is not very effective, leaving many recoverable resources to be disposed of at the dumpsite (Singh, 2019). NMC should consider ways to improve source segregation and recycling so that less waste goes to the landfill, thereby contributing to a longer lifespan and also encouraging more resource recovery.

Recommendations

- Public awareness on source segregation with the concept of 3Rs (reduce, reuse and recycle)
- Separation of collection bins or plastics (different colours) to collect segregated waste
- Hands-on training on source segregation especially targeting school children
- Establishment of facilities to treat the collected segregated waste
- Preparation of proper guidelines on waste separation in the form of a pamphlet in all three languages (English, Sinhala and Tamil) and distributing this to the public

11.3 Waste generation

It is estimated that about 157.68 MT/day of waste is generated within Negombo municipal area from different sources such as households, the commercial sector, markets, daily fair, tourist hotels, institutions, industries, public places, drain cleaning as well as hazardous waste from households. Out of the total generated waste, 69.9 MT/day of waste is collected by NMC, 58.8 MT/day is either burned or buried at the location where it is generated, 6.2 MT/day is composted, 9.7 MT/day is recycled and 10.9 MT/day is illegally dumped. NMC could consider how to reduce/stop the waste being burned or buried as well as illegally dumped as this causes environmental pollution.

Recommendations

- Generated waste should be properly segregated by producers, and handed over to collectors on designated collection days and times
- Strict fines should be applied to those who burn or dump the waste illegally into the surrounding environment
- Medical and hazardous waste from respective institutions should be treated and managed by the institutions where it is generated rather than mixing it with general municipal waste

11.4 Collection

The health department of NMC is responsible for waste management including waste collection in city. Those entities which are generating waste are required to separate waste into degradable, non-degradable and recyclables whereby mostly separated organic waste is collected on weekdays and non-degradables and recyclables are collected on Saturday. The NMC imposes a waste collection fee for large waste generators such as business enterprises and industries. The collection areas are mainly divided depending on vehicle access, and the waste is collected mainly by four-wheel tractors, trailers (4WT) and compactor trucks along main collection route such as major roads and streets. However, waste collection from narrow and congested areas is carried out using handcarts, and these are then connected to the main route where waste from handcarts is loaded into vehicles at designated special waste collection points. The bell collection system is used by collectors from NMC. However it was observed from ward meetings that in many wards the bell system is out of order due to the fact that people do not know the timing of collection and tend to store waste at collection points after the collection vehicle has gone (Singh, 2019). Moreover, it was also observed that collectors do not collect bulky waste such as tree branches, and these are then left beside the road uncollected.

Recommendations

- Maintain bell system by regular monitoring so that the malfunctioning system can be repaired or replaced as necessary
- Inform people about collection days and time
- Allocate certain days a month to collect bulky waste
- Prepare pamphlets notifying about collection etc.
- Proper monitoring of collection routes and collection of waste on designated days to make sure the waste is properly collected
- Proper maintenance of collection vehicles so that the vehicles meet the guidelines set under the National Environmental Regulations for Mobile Air Quality (Air Emission, Fuel and Vehicle Importation Standards)

11.5 Composition and recycling

The amount of collected organic waste that can be composted is about 71% of the total waste composition. The non-degradable component consists of 12-16% with lower value recyclables such as contaminated paper, textiles, soft plastics based on the composition survey at the Ovitiyawatta landfill. NMC should explore the possibility of recycling and recovering materials from the non-degradable component of waste going to the landfill. NMC does not have any formal recycling system, but the city does have a well-established informal recycling system. The informal recycling in Negombo takes place on three levels, with the first level of recovery being carried out by NMC waste collection workers who are allowed to pick up valuable materials during the collecting process which they sell to different buyers in the city. The second level of recovery takes place at resource recovery centers where people can bring their recyclable waste directly or they can separate their waste into recyclables which is then collected by NMC workers and brought to the resource recovery centers. Mostly, the non-degradable waste collection contains low-grade recyclables such as contaminated plastics, polythene and paper as most of the valuable recyclables are segregated at source and also during collection by NMC laborers. The third level of recovery occurs once the waste is dumped at Ovitiyawatta dumpsite where scavengers living in the vicinity sort out the remaining valuable resources from the waste stream. In addition to this, there is also the traditional system of individual waste collectors going door-to-door and collect recyclables such as plastic, paper, metal, glass and other marketable resources.

Regarding organic component, about 8-10 tonnes of organic waste is treated at the only available compost facility. Most of the remaining organic waste is taken to the Ovitiyawatta landfill site and dumped along with other residual waste, despite being collected separately from households. The city has the potential to expand the capacity of the existing compost facility, or to establish a new compost plant and bio-gas plant to treat and manage 24-30 tonnes of segregated organic waste which currently is going to landfill. As NMC has very limited land where it can locate these waste treatment facilities, it could consider having cluster treatment facilities with other cities nearby which have more land available. It has been found that household composting is practiced on a very small scale, with only a few houses continuing to practice in their backyard so this is also something that has the potential to be further expanded.

Recommendations

- Expansion of the existing recycling facility and improvement in collection of segregated waste to recover the non-degradable waste including recyclable plastics and polythene going to the landfill
- Ban on thin plastic material listed under Regulations on Prohibition of Manufacture of Polythene or any Product of 20 micron or below thickness
- Ensuring that compost meets all nutrient requirements and physical properties as specified in the standard set by the Municipal Solid Waste and Agricultural waste for production of compost
- Expansion of household composting through proper training on compost-making and public awareness on the 3Rs (reduce, reuse and recycle) and environmental management
- Exploring the possibility to expand the current composting facility from 10 tonnes to 15-20 tonnes per day by allocating more funds and employing better management
- Exploring the feasibility of establishing cluster bio-gas plants in collaboration with 2 or 3 surrounding cities with a capacity of about 30 tonnes per day
- Exploring the feasibility of establishing cluster composting facilities in collaboration with 2 or 3 cities with a capacity of about 30 tonnes per day

11.6 Final disposal

The final disposal system used by NMC is an open dumpsite on privately-owned land which has been used for many years. The remaining capacity of the land is limited to approximately 2.5 acres which is thought to be sufficient only for the next 3 to 5 years. As NMC does not have its own land for development of a final disposal facility, NMC would like to consider having a cluster landfill with neighboring cities.

Recommendations

- Control and management of leachate from the current landfill site so that it meets the general standards for discharge of effluents into inland surface waters
- Proper practice of soil covering the waste dumped at the landfill
- Formalization of an informal sector by incorporating informal recyclers into the waste collection system of NMC. Measures may include introduction of register/ permit schemes to understand the number of informal people working in the waste sector so that city and private recycling companies can coordinate with them for better and more efficient management of recyclables
- Exploring the feasibility of establishing cluster sanitary landfill in-collaboration with 8 to 10 surrounding cities with a lifespan of 20-30 years

11.7 Others

Some of the other problems related to solid waste management in Negombo City are increasing volume of waste, lack of information and data on current waste management systems, proper management of allocated budget on waste management, limited infrastructure and technologies, poor management of waste among household and business, mixing of healthcare waste and hazardous waste with municipal waste, and lack of proper training on needs assessment for NMC employees and community when conducting training and awareness programmes.

Recommendations

- Maintenance and updating of information and data on waste management and recording of this in digital format
- Proper management of facilities and financial resources allocated for SWM in the city by proper allocation of responsibility to staff working on WM and monitoring their activities
- Exploring low-cost technologies utilizing local resources which can be used for waste management in Negombo City
- Allocation of more resources including finance and expertise for investing in new technologies
- Encouragement of research and particle application in new technologies
- Promotion of projects on waste management based on Public and Private Partnership
- Proper public awareness on sanitation, 3Rs, environmental management and environmental and health impacts of dumping healthcare waste and hazardous waste in landfills along with municipal waste without prior treatment
- Introduction of management methods for hazardous waste at the household and commercial level
- Development of a proper training plan based on training needs assessment
- Proper Training of Trainers (TOT) programmes for trainers i.e. laborers
- Maintenance of a proper record on training programmes.

All these above issues/concerns should be considered during development of a city strategy and action plan on waste management for Negombo. The developed strategy will support NMC in implementing the action plan in line with short-term, mid-term and long-term action plans identified in the city strategy (Singh, 2019). This will aim to address the above problems so as to improve current waste management using a more holistic approach for sustainable waste management in Negombo City.

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