

Centre for Environment Fisheries & Aquaculture Science



Belize – Waste Data report

Analysis of waste generation and disposal data collected in Belize

Author(s): Adele Petterd, Amardeep Wander, Helen Cooney

Issue Date: 20/09/2019



Source: APWC, Orange Walk dumpsite, 2019







Cefas Document Control

Submitted to:	Cefas
Date submitted:	20/09/2019
Project Manager:	Julia Baker
Report compiled by:	Asia Pacific Waste Consultants (APWC)
Quality control by:	
Approved by and date:	
Version:	Final

Version Control History					
Version	Author	Date	Comment		
Draft v1	Angela Nguyen, Adele Petterd, Amardeep Wander	30/07/2019	First draft		
Draft v2	Adele Petterd, Helen Cooney,	13/08/2019	Editorial updates		
Draft v3	Adele Petterd, Amardeep Wander	20/08/2019	Third Draft, addressed Cefas comments, added additional data for total waste generation,		
Final	Adele Petterd, Amardeep Wander	20/09/2019	Addressed final comments		





Executive Summary

The Commonwealth Litter Programme (CLiP) is an initiative delivered by the Centre for Environment Fisheries and Aquaculture Science (Cefas) and funded by the United Kingdom's Department for Environment, Food and Rural Affairs. The initiative supports developing countries across the Commonwealth in advancing national litter action plans focused on preventing plastics entering the oceans.

In 2019, CLiP contracted Asia Pacific Waste Consultants (APWC) to study waste management practices in Belize. This report presents the data, analysis and recommendations to gaps in the management of solid waste in Belize.

The APWC methodology assesses the amount of waste requiring immediate management – that is, the waste being placed in bags or drums. It also assesses household behaviours, based on interviews, in order to understand what happens to uncollected waste or why refuse is not placed in bags, including the reason for these behaviours.

The APWC team worked in Belize for three weeks during May and June 2019, covering the municipalities of Belize City, Belmopan, Orange Walk, Corozal, Dangriga and Toledo. Household and commercial waste samples were collected from each of the municipalities and were divided between urban agglomerates, settlements along the highway and rural settlements, based on previous work done in the region. A total of 210 household samples and 60 commercial samples were collected, of which 209 household samples and all commercial samples were able to be matched with interviews and used for analysis. APWC approached authorities for Ship Generated Waste categorisation but did not get any data.

The audit confirmed that waste generated between urban and rural areas differed. There was a high correlation between waste generation and the urban nature of the area sampled. On the other hand, household income or average weekly expenditure on groceries was not a predictor of waste generation. There is large variability in the volumes of waste in urban areas, with existing systems capturing 80 to 100 per cent of the urban agglomerates. In rural areas where there are no collection services, waste is being disposed of through burning, burying and dumping in uncontrolled dump sites. The Regional Sanitary Landfill at mile 24 on the George Price highway could reach capacity 30 years before previous estimates based on current waste-generation patterns. Recycling and composting of household food waste could add 10 to 15 years to its lifespan.

In rural areas, collection systems are poor, ad hoc or completely absent. As a result, all waste generated in rural areas is being disposed of through burning, burying and dumping in uncontrolled dump sites and illegal dumping is common. In these areas, beneficial reuse of household organic materials was observed and serves as a positive case study for other areas within Belize.

This report outlines recommended actions, ranging from regulatory to behavioural, with recommendation areas that can reduce the volumes of waste entering marine environments in the future while also improving the social and economic prospects of communities in Belize.





Table of Contents

1	Backgrou	und6
2	Scope .	
3	Country	Information8
	3.1	Solid Waste Management in Belize9
	3.2	Institutional framework for solid waste management14
4	Solid wa	ste generated in Belize
	4.1	Methodology and statistical significance22
	4.2	Household interviews
	4.3	Sample sorting27
	4.4	Ship waste collection29
	4.5	Work, Health and Safety
5	Waste da	ata – study limitations
6	Results .	
	6.1	Waste generation rates
	6.2	Total waste generated and landfill life35
	6.3	Household behaviours towards waste disposal43
	6.4	Waste composition44
	6.5	Waste service provision
7	Recycling	g in Belize55
	7.1.1	Resource Recovery Belize55
	7.1.2	The Belize Recycling Company56
	7.1.3	Transfer station recycling56
	7.1.4	Upcycling in Belize
	7.1.5	Proposed phase-out of single-use plastics56
8	Solid wa	ste management gap analysis57
9	Recomm	endations61
10	Reference	ces

Tables

Table 1:	Population of the towns and cities of Belize as of 2010	9
Table 2:	Multilateral agreement and conventions ratified by Belize	15
Table 3:	Samples collected from Belize	22
Table 4:	Household sorting categories	28
Table 5:	Total waste generation	36
Table 6:	Landfill lifespan if plastics and organics are removed for recycling	41
Table 7:	Total tonnages of material available per year by location in Belize	
Table 8:	Single-use soft plastics in waste	46





Table 9:	Refunds for different containers	47
Table 10:	Waste collection service provision	49
Table 11:	Fees and charges by council	52
Table 12:	Equipment available to councils	54
Table 13:	Gaps in waste management in Belize	57
Table 14:	Draft key recommendations for Belize waste management	61

Figures

Figure 1:	CLiP objectives	6
Figure 2:	SWMP I project timeline	10
Figure 3:	Project outcomes of SWMP I	11
Figure 4:	Project benefits	12
Figure 5:	Scope of SWMP II	13
Figure 6:	Belize membership to regional organisations	14
Figure 7:	Commercial samples collected in Belize	24
Figure 8:	Sorting location for Belize samples	27
Figure 9:	Waste data study limitations	31
Figure 10:	Per capita waste generation rates in Belize	32
Figure 11:	Population size vs household waste disposal	33
Figure 12:	Household disposal rate by town.	34
Figure 13:	Belize trends in population	35
Figure 14:	Landfill use as per APWC data + incoming waste tonnages to Mile 24 landfi	ill36
Figure 15:	Volumes of waste coming from different transfer stations	37
Figure 16:	Proposed transfer stations as per SWMP II	
Figure 17:	Landfill life based on a high-growth scenario and a low-growth scenario	42
Figure 18:	Disposal practices for general waste in Belize	43
Figure 19:	Overall composition of the waste stream by weight	44
Figure 20:	Household waste generation by city	45
Figure 21:	Organics composition by weight	46
Figure 22:	A Bowen & Bowen poster and detailed composition of plastics in the waste	e stream.48
Figure 23:	Detailed composition of glass and metals in the waste stream	48
Figure 24:	Household satisfaction vs frequency of collection	51
Figure 25:	Refunds offered by Bowen and Bowen in Belize	55

Images

Image 1:	Rubbish dumped along the southern highway in Belize. Image source: APWC	6
Image 2:	Sorting activities being undertaken by APWC staff with support from Council	7
Image 3:	Political map of Belize. Source Ezilon maps.	8
Image 4:	Communities surveyed in Belize	.23
Image 5:	Sample data collection sheet used by APWC staff to collect collection data	. 25
Image 6:	Conducting household interviews	.26
Image 7:	Notice by the Belize City mayor seeking support from the residents for interviews	. 27
Image 8:	Waste sorting at Belmopan City Council	. 29





Image 9:	Waste being disposed of at the tip face at Mile 24 sanitary landfill in Belize	. 30
Image 10:	Regional sanitary landfill sign at entrance	40
Image 11:	Single-use plastic items found in the waste stream in Belize	47
Image 12:	Large plastic drums filled with garbage have the potential to cause injury	.51
Image 13:	Waste burning at Belmopan and burnt-out waste at the Punta Gorda dumpsite	. 53
Image 14:	Broken down truck at Orange walk and the truck fleet at Belize Waste control	. 54





Acronyms

ACRONYMS		
APWC	Asia Pacific Waste Consultants	
BAHA	Belize Agricultural Health Authority	
BCI	Bayesian Credible Interval	
BSWaMA	Belize Solid Waste Management Authority	
ВТВ	Belize Tourist Board	
CARICOM	Caribbean Community	
Cefas	Centre for Environment Fisheries and Aquaculture Science	
CELAC	Community of Latin America and Caribbean States	
CLiP	Commonwealth Litter Programme	
DEFRA	Department for Environment, Food and Rural Affairs	
DOE	Department of the Environment	
GOB	Government of Belize	
HDPE	High-density polyethylene	
IDB	Inter-American Development Bank	
IMMABRE	International Merchant Marine Registry of Belize	
JQI	Japan Quality Infrastructure Initiative	
MARPOL 73/78	The International Convention for the Prevention of Pollution from Ships (Marine Pollution), 1973 as modified by the Protocol of 1978	
MGB	Mobile Garbage Bins	
MNRI	Ministry of Natural Resources and Immigration	
MSW	Municipal Solid Waste	
NEMO	National Energy Management Organisation	
NSWMSP	National Solid Waste Management Strategy and Plan	
OFID	OPEC Fund for International Development	
PET	Polyethylene terephthalate	
QHSE	Quality, health safety and environment	
SICA	Central American Integration System	
SIDS	Small Island Developing States	
SWM	Solid Waste Management	
SWMAA	Solid Waste Management Authority Act	
SWMP	Solid Waste Management Plan	
SMWP I	Solid Waste Manage Project I	
SMWP II	Solid Waste Manage Project II	
SWMS	Safe work method statements	
TS	Transfer Stations	





1 Background

The Commonwealth Marine Litter Programme (CLiP) is an initiative delivered by the Centre for Environment Fisheries and Aquaculture Science (Cefas) and funded by the United Kingdom's Department for Environment, Food and Rural Affairs (Defra). The initiative supports a number of developing countries across the Commonwealth in developing national litter action plans focusing on preventing plastics from entering oceans.

CLiP's main objectives are as follows:

Figure 1: CLiP objectives

prevent and reduce marine litter
and its impact on the marine
environment, public health and
safety

reduce the knock-on impact of marine litter on economies and communities, including vital industries, such as tourism and fisheries

enhance knowledge and understanding of marine litter, both in terms of distribution as well as impacts support Commonwealth countries in the development, implementation and co-ordination of programmes for marine litter reduction remove litter from the marine environment where practical

develop management approaches to marine litter that are consistent with international best practice

In May 2019, CLiP contracted Asia Pacific Waste Consultants (APWC) to carry out a fieldwork data collection service in collaboration with the local and national organisations in Belize to understand

land-based sources of marine litter as well as the systems that are currently in place to collect, transport and manage these wastes.

The activities covered the following areas:

- waste generation rates and composition, collection and transport systems, disposal systems, in-country recycling of resources;
- management of organic waste, e-waste and healthcare waste;
- litigation, enforcement, compliance, monitoring and prosecution of waste legislation.



Image 1: Rubbish dumped along the southern highway in Belize. *Image source: APWC*





2 Scope

This report provides a summary of the activities conducted by APWC team from May to July 2019 and outlines the findings of the data collection and gap analysis conducted on the effectiveness of waste collection, disposal services and infrastructure in Belize.

The analysis provides an overview of the waste generation rate in Belize, and the infrastructure and service provision for waste collection, transport and disposal. The report identifies gaps in the management of specific waste streams, including (but not limited to) organic wastes, plastics and e-waste. The report provides recommendations on how these gaps can be addressed. Modelling has been performed using data collected by the APWC team as well as the data available from the ongoing monitoring being performed by Belize Solid Waste Management Authority (BSWaMA) since 2015.

The data was collected for the municipalities of Belize City, Belmopan, Orange Walk, Dangriga, Corozal, Toledo (rural) and Bullet Tree Falls. The data presented here is representative of the country but does not reflect the composition of waste in individual municipalities.



Image 2: Sorting activities being undertaken by APWC staff in Belmopan with support from Council





3 Country Information

Belize spans across 22,970 square kilometres, with its mainland measuring 290 kilometres long and 110 kilometres wide. Ninety-five per cent (95%) of Belize's land mass is concentrated on the mainland, with the remaining 5% comprising 1,060 islands and cays. The coastline stretches across 280 kilometres, incorporating the Belize Barrier Reef. The reef is the second largest in the world and the largest in the northern hemisphere. The total territory of Belize, including sea, is 46,620 square kilometres.

Approximately 374,681 people live within six provincial areas, with about 54% (or 202,191) living in rural areas. More than 10 distinct spoken languages were reported in the Belize 2010 census. English is the official language, with approximately 62.9% of the population indicating they were English speakers on the 2010 census. The two next most common languages are Spanish (56.6%) and Creole (44.6%). The system of government is a constitutional monarchy. The Cabinet, led by a prime minister, is the primary executive of



Image 3: Political map of Belize. Source Ezilon maps.

government. The chief of state is the Queen Elizabeth II of the United Kingdom, represented in the country by the Governor General.

Belize's economy is based primarily upon the services sector, which contributes 62.2% of Belize's GDP. Belize's second largest economic sector is industry (13.8%), followed by agriculture (9.7%). Belize's tourism industry contributes 12% to GDP. The population was until recently steadily increasing. In 2017 it was reported that the population was increasing by approximately 2.1%, however more recent studies have estimated a population decrease of 1.9% (GlobalEDGE, 2017 & 2018). The most recent census in Belize was conducted in 2010, the next census is due to be conducted in 2020.

The following table outlines the number of people living across each of the six provinces.





Table 1:	Population	of the	towns and	cities of	of Belize	as of 2	2010
10010 1.	i opalation	or the	co mis ana	creico (or Deniee	00.1	-0 + 0

Corozal (north)	Population
Corozal Town	10,287
Corozal (rural)	30,774
Orange Walk (north west)	Population
Orange Walk Town	13,708
Orange Walk (rural)	32,238
Belize (east and central)	Population
Belize City	57,169
San Pedro Town	11,767
Belize (rural)	26,355
Belmopan	13,939
Cayo (rural)	37,089
Stann Creek (south east)	Population
Dangriga	9,593
Stann Creek (rural)	24,731
Toledo (south)	Population
Punta Gorda	5,351
Toledo (rural)	25,434

Source: Statistical Institute of Belize, 2010 Census 2010

3.1 Solid Waste Management in Belize

Belize faces a number of challenges in the management of land-based sources of marine pollution. Historically, solid waste management (SWM) in Belize did not meet the needs of the country (IDB 2013). The absence of sanitary landfill and transfer stations, coupled with a lack of financial resources and clear objectives, increased risk to the environment, the health of the rapidly growing population as well as contributing to the deterioration of the marine ecosystems. Additionally, the tourism industry in Belize is attracting an increasing number of visitors, with tourist numbers rising from 341,125 in 2015 to 489,000 in 2018 (Belize Tourist Board (BTB) Statistic Digest, 2018). These arrivals place increased pressure on existing solid waste collection and disposal services and will continue to do so.

According to Belize's Department of the Environment (DOE), Belize produces at least 200,000 tonnes of municipal and other wastes annually, with 50 percent of that waste classified as municipal solid waste (MSW). Recycling is not commonly practised and non-biodegradable, low-cost convenience plastic packaging is prevalently used. Until 2009, solid waste collected in cities and towns throughout the country was discharged into open or partially controlled dump sites with no geological controls, resulting in the pollution of ground water, soil and air. The facilities lacked the appropriate technical and environmental controls and operated without adequate equipment and staff. Given that most of the population lives within 50 kilometres of the coastline, the waste disposal practices were concerning. In addition, the countries socio-economic dependence upon its natural resources, particularly for the agriculture and tourism sectors, requires stringent management of terrestrial and marine environments to ensure sustainable development is considered and applied.





In 2010 it was reported that 55 per cent of the population disposed of residential waste through the municipal collection or through private garbage trucks via twice-weekly services. Thirty per cent (30%) of households disposed of waste via dumping waste on land, into waterways or burning. The existing systems for managing solid waste in Belize were both financially and environmentally unstable. In 2013, IDB reported that town councils changed a monthly fixed fee for SWM collection obtained as part of property tax (approximately US\$2.50 per month [IDB, 2013]). The National Solid Waste Management Policy was developed by the Government of Belize (GOB) as a shared national vision for a sustainable solid waste management. The Belize Solid Waste Management Authority (BSWaMA) was formed by a Government Act in 1991 to ensure that solid waste generated in the country was managed in an environmentally sound manner. However, prior to 2008, only the Board of Directors of BSWaMA was functioning. The first positions were created in 2009 after a commitment for GOB to improve the performance of the sector. This commitment led to the approval of a Solid Waste Management Project by IDB in 2009.

3.1.1 Solid Waste Management Project I

Prior to Solid Waste Management Project, I (SMWP I), there was no safe disposal of MSW in Belize.

Prior 2009	$\left\{ \right.$	 Waste generated difficult to control and not treated when delivered to landfill sites. 0% households had access to safe disposal of waste at a sanitary landfill.
2009		 IDB approved SWMP loan. OPEC Fund for International Development (OFID), and the Government of Belize (GOB) financed \$USD14.9 million.
2010 - 2015	$\left\{ \right.$	 First Solid Waste Management Project. Project aimed to improve infrastructure for solid waste transfer and final disposal.
2011	\langle	•International tender for design, build and operate (period 8 years) regional sanitary landfill, four transfer stations, closure of four dump sites.
2012	\langle	• Construction of a sanitary landfill begins at Mile 24 of George Prince Highway.
August 2013	$\left\{ \right.$	 Mile 24 begins operations servicing urban districts of Belize and Cayo including Belize City, San Ignacio and Santa Elena and Benque Biejo. Dump sites in Western Corridor (Belize City, San Ignacio and Burrell Boom) closed and replaced with transfer stations.
October 2015		 Three additional transfer stations completed San Pedro, Caye Caulker and areas north of Belize City. 56,711 metric tons of MSW safely disposed at Mile 24; 30,653 households or 39% of population had access to safe disposal.
September 2016	\langle	•IDB loan approve \$US10 million.
2016 - 2021		 Phase 2 Solid Waste Management Project (SWMP II). Project aims to improve transport, recovery and final disposal of solid waste in towns and villages in Belize Northern and Southern corridors as well as in Belmopan.

Figure 2: SWMP I project timeline





The GOB received a US\$14.9 million grant in 2009 to undertake significant improvements to SWM practices in the country to address environmental pollution and enhance the image of Belize in the eco-tourism market through better management of its MSW.

The first phase of the SMWP I took place between 2009 to 2015. The objective of the project was to improve waste management practices and create a more sustainable and environmentally sound waste management system. A timeline of the project is shown in Figure 2.



Figure 3: Project outcomes of SWMP I

Source: Inter-American Development Bank (2016)

SWMP I was successful in executing and achieving both the project's aims and objectives. In addition to providing 39% of the population with access to safe disposal, the project also achieved additional benefits and created the basis for significant improvements, as listed in Figure 4.













Reduced environmental Significantly reducing Reduced vulnerability and human health impacts

the number of fire incidents

and increasing resilience tourist destinations to natural disasters and impacts of climate

Improve SWM in key

Figure 4: Project benefits

Source: Inter-American Development Bank (2016)

3.1.2 Lessons learned

Although SWMP I was successful in achieving its aims and objectives, there was a number of lessons learned from this project and other water and sanitation projects in Belize that have been considered in the design for the second phase of the project. These lessons include:

- 1. Clear and concise governance structure across all stakeholders is required in order to achieve an effective coverage and impact of SWM investments. The National Solid Waste Management Strategy and Plan (NSWMSP) developed under the SWMP I provides recommendations and actions to this effect.
- 2. Cost-recovery mechanisms must be achieved with co-ordinated gradual phase-in should be applied to ensure the medium and long-term sustainability of SWM infrastructure investments.
- 3. To prevent major delays, early identification of suitable land for investments should occur to ensure the process of land acquisition can commence at the design phase of the project.
- 4. Ensure waste generation composition studies are conducted during the project design to allow for proper sizing of facilities.

Belize Solid Waste Management Project Stage II 3.1.3

The project scope for SWMP I excluded communities outside the Western Corridor of Belize. In 2016, IDB approved US\$10 million (a further US\$200,000 through counterpart contribution) to undertake SWMP II, which will address SWM in the towns and communities located in the Northern (Orange Walk and Corozla) and Southern (Stann Creek and Toledo) corridors as well as in Belmopan. Figure 5 below highlights the objectives of SWMP II.







Close six dumpsites and acquire land at Corozal Town, Orange Walk Town, Belmopan, Dangriga, Independance/Placencia and Punta Gorda



Cover all major cities and towns in Belize including main tourist areas, expanding from 43% in 2015 to 86% in year 5



Construction six transfer stations and a new cell at Mile 24 Regional Sanitary Landfill



75,277 households with solid waste disposed in Sanitary landfill in Belize



Commingled recyclabes will be separated, compacted and prepared for shipping to end users and buyers



Capture approx. 58,385 tonnes of solid waste currently disposed in open dumps



Improve working conditions of 50 permanent informal recyclers

Figure 5: Scope of SWMP II

Source: Inter-American Development Bank (2016)

These districts do not have access to sanitary landfill and municipal collection is below the national average. The project hopes to the reduce environmental pollution through improved solid waste management practices in these emerging tourism destinations.

Additionally, in June 2019, a further US\$500,000 was granted from the IDB through the Japan Quality Infrastructure Initiative (JQI) for technical co-operation to implement a pilot project in selected tourist areas. The programme will promote source separation, composting and reuse and recycling. A system will also be designed to facilitate solid waste collection and transport in rural villages for disposal in the Mile 24 Regional Sanitary Landfill, as well as designs for route optimisation in urban areas.





3.2 Institutional framework for solid waste management

3.2.1 Membership to regional organisations

Belize's geographical location on the Caribbean coast of Central America provides a unique level of sub-regional integration. The GOB must adopt, implement and maintain policies which coincide with numerous regional organisations. Belize is considered a Small Island Developing State (SIDS) and is also a member of a number of regional organisations. It is the only country to hold full memberships of the Caribbean Community (CARICOM), the Community of Latin America and Caribbean States (CELAC) and the Central American Integration System (SICA). In addition, Belize holds numerous other memberships as outlined in Figure 6, considering the sub-regions of the Caribbean and Central America.

The Caribbean Community (CARICOM)	The Caribbean Public Health Agency (CARPHA)	The Community of Latin America and Caribbean States (CELAC)
The United Nations (UN)	The CARICOM Regional Organization for Standards and Quality (CROSQ)	The Caribbean Disaster Emergency Managment Agency (CDEMA)
The Bolivarian Alliance for the Amercias	The Commonwealth of Nations	The World Trade Organisation
The Food and Agriculture Organisation (FOA)	Central Amercian Intergration Systems (SICA)	Central America Fisheries and Aquculture Organisations (OSPESCA)
Figure 6: B	elize membership to regiona	al organisations





3.2.2 International agreements

The table below highlights all multilateral agreements ratified by Belize relevant to waste management for consideration by GOB.

Table 2: Multilateral agreement and conventions ratified by Belize

Multilateral agreements and conventions	Status
Basel Convention on Controlling Transboundary Movements of Hazardous Wastes	Ratified
and Their Disposal	
Rotterdam Convention	Ratified
Stockholm Convention on Persistent Organic Pollutants	Ratified
Montreal Protocol	Ratified
MARPOL 73/78: International Convention for the Prevention of Pollution from	Ratified
Ships, 1973 as modified by the Protocol of 1978 (Annexes I, II, III, IV, V, and VI)	
Protocol to the International Convention on Civil Liability for Oil Pollution Damage	Ratified
of 29 November 1969 (1976)	
International Convention on Civil Liability for Oil Pollution Damage 1969 (renewed	Ratified
1992)	
International Convention on the Protocol of 1976 to Amend the International Fund	Ratified
for Compensation for Oil Pollution Damage, 1971	
Protocol of 1992 to Amend the International Convention on the Establishment of	Ratified
an International Fund for Compensation for Oil Pollution Damage, 1971	
International Convention on Civil Liability for Bunker Oil Pollution Damage	Ratified
(BUNKER) 2001	
Cotonou Agreement	Ratified
Kyoto Protocol to the United Nations Framework on Climate Change	Ratified
Source: Various	





3.2.3 National regulation, strategy and legislation

Belize has several policies, legislations, strategies and multilateral agreements that address SWM and control of pollution. The following tables outline the regulations and strategies pertinent to SWM in Belize.

_	Solid Waste Management Authority Act 2000, Part 3 - Functions of authority section 13 (SWMAA)
	Authority of Ministry of Natural Resources and Immigration
	• Most important legal instrument governing the solid waste sector.
	•Establishes Belize's Solid Waste Management as an authority with power to provide for the collection and disposal of solid waste in declared areas and in accordance with regulations issued under the Act. However, APWC consultation shows that the collection is currently the responsibility of the local governments.
	• Provides for the vesting of solid waste management facilities in the Solid Waste Management Authority (SWaMA).
	•It establishes the structure and functions of the SWaMA, a corporate body with independent legal status under the purview of the Ministry of Natural Resources and Immigration (MNRI).
	•SWaMA is responsible for providing arrangements for the collection and disposal of solid waste within a service area.
	•One of SWaMA's main responsibilities is to assist local councils and their sanitation departments on a range of activities, including:
	 design and enforcement of regulatory requirements for solid waste management systems;
	 legal support and advice on drafting and renewal of contractual agreements with service providers;
	3)design and implementation of waste separation programs at the source; and
	4)advice on marketing strategies for waste recycling.
-	Hazardous Waste Regulations 2009
	•Covers the definitions of 'hazardous waste' as well what is and is not included in the term.
	•Covers the required procedures and operations of a Hazardous Waste Management Facility as well as storage, transportation, treatment and disposal of hazardous waste procedures.

- •Details landfill disposal prohibitions and the classification of hazardous waste.
- •Stipulates the actions required if a breach of these regulations occurs, including investigations, offences and penalties incurred.





Environmental Tax Act 2003 Chapter 64:01 Revised Edition 2003

- •Imposes an ad velorum tax of 2% on all goods imported into Belize.
- •Some goods, such as medicines and essentials, such as rice, milk and baby formula, are exempt from the tax including goods that are re-exported.
- Section 7 of the Act states proceeds shall be placed into a special fund to resource the following activities through BSWaMA:
 - 1) to develop a national solid waste management program;
 - 2) to defray the cost of the disposal of refuse generated by the use of goods;
 - 3) to assist in the collection and disposal of garbage throughout Belize;
 - 4) to clean up rivers and canals and other internal waterways;
 - 5) for the preservation and enhancement of the environment; and
 - 6) for strengthening the institutional capacity of the Department of the Environment.
- However, revenues from this tax are currently absorbed into the GOB general revenue budget and are not earmarked or allocated for the purposes stated in the Act.
- •WTO has raised concerns that the tax is discriminatory as it assumes that all imports are environmentally unfriendly whereas all domestic products do not incur any such tax. Therefore, the administration of the tax is inconsistent with GATT article III.

Summary Jurisdiction (Offences) Act Chapter 98, revised 2003

- •This Act details the authority permissible to administer violation tickets to those who have been observed to be littering.
- •This Act also details the processes in the event that the person refuses the violation ticket and the subsequent activities that should take place.
- •Additionally, this Act also details that the Permanent Secretary to the Ministry (being responsible for the environment) is responsible for printing and distributing violation tickets.
- •The Act also details a fine of \$100, unless stated otherwise, is paid for the offence. Tickets issued to corporate bodies are to be fined \$500.
- •The Act also covers when the fine is to be paid as well as the outcomes and procedures for unpaid fines.

Returnable Containers Act 2009

- •Outlines acceptable procedures and containers that may be returned to the container's original source for a refund ranging from 5 to 15 cents, depending on the container's size and material.
- Covers the procedures around the acceptance of containers, the circumstances around the refusal of containers, refund value, regulation authority and offence circumstances.
- Formulated to address littering, however, is rarely enforced.





Town Councils (Control of Refuse) By-Laws 2005 (Under the Public Health Act 2003

- •Establishes structure and duties of the town councils in Belize and assigns town councils the responsibility for co-ordination and managing the collection and removal of all solid waste from all residential or commercial areas in its town.
- •At village level, Section 23 of the Village Council Act provides that the council may enact by-laws for the cleanliness of streets and other public places.
- •Covers the processes and procedures regarding resident and council involvement in the collection of waste.
- •Outlines service collection fees as provided by the council.
- •Describes the expectations from residents including providing a 'suitable receptacle with a secured cover for the containment of garbage'.
- •Councils have the ability to force residents to pay for extra collection services that are extraneous to what is stipulated in the by-laws.
- •The by-laws also cover all the behaviour and treatment of waste that may result in a fine with subsequent procedures on how the fine is administered to the action that will be taken in an event that the fine is not paid.

Environmental Protection Act 2009

- •Established by the Department of the Environment (DOE) in 1992, entrusting responsibility to monitor and implement the Act and its regulations as well as enforce the provisions of the Act and regulations.
- •Grants the DOE broad regulatory and enforcement authority for the prevention and control of environmental pollution, conservation and management of natural resources, and environmental impact assessment.
- •Entrusts the DOE with a broad range of functions relating to the protection of the environment, including:
 - 1) assessment of water pollution;
 - 2) co-ordination of activities relating to the discharge of wastes;
 - 3) licensing of activities that may cause water pollution;
 - 4) registration of sources of pollution;
 - 5) carrying out of research and investigations as to the causes;
 - 6) nature and extent of water pollution; and the
 - 7) necessary prevention and control measures.
- •Amended in April 2009 to:
 - provide for greater environmental control and management of the petroleum industry;
 - make improved provisions for the protection of the Belize Barrier Reef System;
 - establish an environmental management fund;
 - provide for out-of-court settlement in appropriate cases, and
 - provide for the issue of violation tickets for pollution offences.
- •The DOE is responsible for the enforcement of several regulations made under the Environmental Protection Act. These include the Environmental Impact Assessment Regulations (S.I. 107 of 1995), the Environmental Protection (Effluent Limitations) Regulations (S.I. 94 of 1995) and the Pollution Regulations (S.I. 56 of 1996).





Town Councils Act 2000

- •Residential and commercial solid wastes are also governed by the Town Council Act Chapter 87 of 2000 ('the Town Council Act'), and the Village Council Act.
- •Establishes the structure and duties of the town councils in Belize
- •Article 30 (b) of the Town Councils Act assigns town councils the responsibility for coordinating and managing the 'collection and removal of all garbage material from all residential or commercial areas in its town'.
- •At the village level, Section 23 of the Village Council Act provides that the Council may make by-laws for the cleanliness of streets and other public places.
- •Recently SWaMA has started working in conjunction with town councils to improve the quality of the services they provide.

Pollution Regulations 1996 & Amendment 2009

- •The DOE, through the Pollution Regulations, has developed mechanisms to monitor and control air, noise, water, and land pollution.
- •Prohibits releasing contaminants into the environment, unless done so with a permit issued by the Department of the Environment and at acceptable levels of contaminants from certain installations.
- •Prohibits industries operating and emitting contaminants into the environment, without a permit from the DOE.
- •Powers of the DOE to control pollution includes the requirement that owners, occupiers and other agents clean up and abate pollution.
- •In order to encourage voluntary compliance, the Department of the Environment is empowered to develop an environmental incentive programme, as well as a "facility environmental audit programme" as a comprehensive investigation and evaluation system designed for the detecting and preventing of violations of environmental requirements or the commission of pollution-related offences.
- •Amendments in 2012 addressed commitments made under the Montreal Protocol on ozone-depleting substances. The major changes made were the prohibition on the imports of equipment using ozone-depleting substances and the establishment of a licensing system for the importation of these substances.
- Pollution regulations were amended in 2009 to allow Belize to strengthen a requirement of the Montreal Protocol related to the licensing system for the importation of refrigerants into the country for data-gathering purposes only. This amendment also complements the Act in addressing the petroleum industry, including refining.

Public Health Act 2000

- •The Act gives statutory powers to the Ministry of Health to investigate public health and related complaints, monitor sewage and solid waste and prosecute public health offenders.
- Prohibits individuals from throwing rubbish into ash pits.

Nuisance Act 2000

•Under the Nuisance Act the court may empower the Belize City Council or any town board to enter a place where the nuisance is located and take remedial action to abate the nuisance.





Environmental Protection (Pollution from Plastics) Regulations 2019

- •A proposal for a planned phase-out of single-use disposable bags and single-use disposable 'sytrofoam' and plastic food utensils by 22 April 2019.
- A measure to reduce the waste generated by single-use disposable plastics at source by restricting their entry into the system.
- Create a pathway for Belize to transition to biodegradable and reusable alternatives that are affordable and easily available.
- The draft regulations to this effect are in circulation at the time of writing of this report.

National Solid Waste Management Policy 2015

- •Sets out the GOB's vision and strategic objectives for the prevention and management of wastes and the policies that will be applied for achieving them.
- Provides a framework within which various organisations can make contributions to the overall goal of better waste management through more and efficient use of resources and make better and informed choices and decisions for how to manage waste.
- •Identifies the roles of individuals and how they can make a contribution to the overall waste management goals for Belize.
- •The goal of the policy is to ensure a system for managing solid wastes in Belize that is financially and environmentally sustainable and contributes to improved quality of life.

The following tables outline the departments that are responsible for these acts and other SWM.

SWM in Belize is a multi-level government operation with contribution from the central government ministries, subordinated agencies, local government, private sector, the public and non-governmental organisations. All these bodies integrate and operate to not only collect and organise the waste, but also to formulate and enforce legislation to ensure waste is managed effectively.





Central Government Ministries - Formation of polices & enactment/enforcement of legislation

- Ministry of Natural Resources and Agriculture Management of natural resources; Responsible for BSWaMA and BAHA
- Ministry of Forestry, Fisheries and Sustainable Development Enforcement of the Environmental Protection Act, Returnable Containers Act & Hazardous Waste Regulations (through DOW); Protected areas management; responsible for DOE.
- Ministry of Health Enforcement of the Public Health Act; Control of infectious diseases and contamination arising for SWM activities; Management of healthcare and other hazardous wastes.
- Ministry of Energy, Science & Technology and Public Utilities National Policy on Energy; Enforcement of the Public Utilities Commission Act (through the Public Utilities Commission); Promotion of energy recovery from waste (biomass).
- Ministry of Finance and Economic Development Generation and allocation of financial resources for public SWM infrastructure and services; Enforcement of the Environmental Tax Act (through the Controller of Customs); Servicing the IDB load for Belize SWM project.
- Ministry of Labour, Local Government, Rural Development, NEMO and Immigration National Policy on Local Governance; Enforcement & oversight of the system of local government; Responsible NEMO
- Ministry of Education, Youth & Sports Inclusion of SWM and environmental protection in educational curricula

Central Government – Implementation of policies/legislation enacted by Central Government

- Belize Solid Waste Management Authority (BSWaMA) Overall responsibility for SWM in Belize; Planning, provision & operation of infrastructure for MSW transport & disposal.
- Belize Agricultural Health Authority (BAHA) Control of disposal of condemned food, infected animals, international garbage, quarantine waste & similar wastes.
- **Department of Environment (DOE)** Control of Environmental pollution; Enforcement of legislation related to SWM; preservation, protection and improvement of the environment
- Computer of Customers Administration of the Environmental Tax Act.
- Public Utilities Commission Economic regulation of the electricity, water and telecommunications sectors.
- National Energy Management Organisation (NEMO) Management and co-ordination of preparation for, and response to, national emergencies such as floods and hurricanes. Organising clearance and removal of debris in the event of national disasters.
- Statistical Institute of Belize Statistics on population, trade and economy; Statistics on solid waste

Local Government – Local governance in cities, towns & villages

- City Councils (2) & Town councils (7) Co-ordination, control management & Regulation of the collection and removal of all garbage material from all residential or commercial areas.
- Community council (13) & Village councils (180) Enactment & enforcement of By-Laws for the cleanliness of streets and other public places; Maintenance of streets, drains and sanitation in general.
- National Association of Village Councils Representation of Village Councils at national level.
- •Belize Mayors' Association Representation of City and town councils at national level.

Source: (Integrated Skills, 2013)





4 Solid waste generated in Belize

4.1 Methodology and statistical significance

The aim of the project is to understand the current 'state of waste management systems and practices' and suggest robust, local and real solutions for Belize to reduce health and environmental risks arising from inadequate management of solid waste. The audit methodology was designed to ensure the waste generation rates are calculated at a national level, including the amount and type of waste which is not adequately managed (or mis-managed).

4.1.1 Household sampling distribution

In Belize, it was difficult to get a clear indication of the urban versus the rural population split in terms of waste management. Based on information collected during previous projects, the following split was used:

- Urban agglomerates: These areas could host a centralised waste management facility (landfill, transfer station), whereby (primarily) the capital town in each district was taken as a basis and assessed which other communities are located within 10 km (in maximum distance to be travelled by a collection vehicle after finishing the collection route) from the town.
- Settlements on highways at a distance > 10 kilometers from the capital district town.
- Isolated Settlements: These mostly include villages.

As many areas as possible were visited for sample collection purposes within the time constraints, but in order to get national generation rates, the aim was to collect representative urban, highway settlements and isolated settlement samples for the country. These samples are not representative of the individual towns from which they were collected but contribute to national generation rates. Samples were also collected from commercial premises in each of the towns visited.

Area	Household Samples	Commercial samples	Collection system in place	Urban/ Rural
Belmopan***	30	10***	Yes	Urban Agglomerate
Mahogany Heights	10	0	Yes	Settlement
Dangriga	30	5	Yes	Urban Agglomerate
Corozal	10	5	Yes	Urban Agglomerate
Belize City	50**	30	Yes	Urban Agglomerate
Orange Walk	30**	0	Yes	Urban Agglomerate
Bullet Tree Falls (Cayo)	20	0	No	Settlement
Toledo rural	30*	5	No	Isolated settlement
Total	210 (207)	60 (58)		

Table 3: Samples collected from Belize

* 1 household sample from Toledo rural was incomplete

** 1 household sample each from Belize and Orange Walk was excluded for being an outlier in estimated waste quantity

*** 2 commercial samples were excluded from Belmopan for being outliers in estimated waste quantities





The council staff from each town were asked to mark out high-, middle- and low-income areas in each municipality on a map and the total sample was split between these areas. Once in an area, streets were selected randomly. No more than five samples were collected from each street. The actual allocation of households as low, middle or low income was done on the basis of their response to the interviews.

The sample collection from each city was limited by the ease of collection of samples, the ability to transport samples, as well as the presence and absence of collection systems. The APWC team was in Belize for two-and-a-half weeks and assessed waste from eight communities. The number of samples collected from each site, as well as the collection system available, is listed in Table 3.



Image 4: Communities surveyed in Belize





4.1.2 Commercial sampling distribution

In addition to the household samples, 60 commercial samples were collected. Commercial premises were divided into four major categories and the sample number from each is shown in Figure 7.



Commerical Premises Types

Figure 7: Commercial samples collected in Belize

Domestic waste samples were collected household by household to determine the waste generation and disposal rate per household.

Waste collection methods had to be modified based on the locality being assessed.

4.1.3 Collections from areas with a house-to-house collection system

APWC approached the respective municipality in each town to assist with the collection of waste immediately before it was picked up by the waste trucks. In Belize City, permission was first sought from the mayor. The APWC crew worked with the contractor, Belize Waste Control, to collect all samples. In all urban localities with collection services, APWC collected waste prior to the arrival of the council collection truck. The households were not informed about the audit prior to the sample collection to ensure they did not change their behaviour in anticipation of the audit. However, the





APWC staff undertaking interviews carried letters from council to inform households about the audit prior to the interview.

Each collection team comprised the following staff:

- APWC collection supervisor
- APWC collection runner
- Local staff member to ensure smooth running of collections.



Image 5: Sample data collection sheet used by APWC staff to collect collection data

APWC collection supervisor collected the following data for each house sampled:

- GPS location
- Number of bags per household
- Interview tag provided
- Photo

The sample collection recording sheet template is provided at Appendix A. At the end of each day, the sample collection sheet was scanned and sent to the APWC office in Sydney for data

entry as per the permissions granted through the Cefas research permit as a subcontractor. The methodology remained consistent for both households and commercial premises.

The major challenge in collecting waste per household was ensuring that the household or commercial premises could be readily identified by the interviewers later. A tagging system was employed, whereby a sample number was attached to each house via a coloured thread or ribbon. The collection supervisor also had a conversation (where possible) with the residents to ensure that the house wasn't subdivided and that the correct house was being tagged. The next day, the interviewers arrived at the location using GPS co-ordinates and a photograph, as well as the ribbon/thread tag identification. In cases where the collection had been undertaken early in the morning, the interviewers ensured that the households were not subdivided and the correct household was being interviewed.

4.1.4 Collections from areas with no collection service

Communities in two different areas were sampled as representative of areas with no collection system. In order to achieve the sampling required in these villages and communities, three separate visits were required to ensure the requisite sample size could be achieved. The method used is as follows:

 a) On day one, APWC staff approached a community representative and sought support to undertake waste data collection in their village. After permission was given, the requirements of the sampling process were explained and advice was sought as to the best day to provide bags for sampling to the community;





- b) APWC returned on the appointed day and provided each household with a bag to use to dispose of their waste from that day onwards. Households were requested not to dispose of any bulky or problem waste that they were having trouble disposing of into the black bags.
- c) The bags were collected the next day and discarded. Households were provided with a fresh bag.
- d) The APWC team returned after five days to retrieve the bags from each household. As each household brought their waste bag, the bag was labelled and provided to the sorting team.

4.1.5 Collections from commercial premises and litter

Commercial samples were only obtained from premises that had a collection service. The methodology of collection was the same as that used during the household sample collection for houses with a collection service.

Street litter samples were only collected from Belize city because in Belize City, litter is swept up into easily identifiable orange bags and the bags are placed along the roads for collection along with the normal garbage collection service. Litter samples in orange bags were collected along the harbor front in Belize City.

4.2 Household interviews

Interviews were conducted with all households from which waste was collected. The interviews were conducted using the interview sheet provided at Appendix B. As noted in section 4.2, each household location was captured using GPS, a photograph was taken, and a colourful ribbon with sample number on it was attached to help identify each household.

APWC notes that interviews in urban areas were challenging because people were at work during the day. Therefore, most of the interviewing was undertaken in the evenings and early mornings or on weekends.

The APWC methodology assesses the amount of waste requiring immediate management, that is, the waste being placed in bags or drums. It also assesses household behaviours based on interviews in order to understand what happens to uncollected waste or why



Image 6: Conducting household interviews

refuse is not placed in bags, including the reason for these behaviours.





The standard APWC procedure is to seek voluntary participation by households in the interview process. The participation rate was high in Belize and APWC was able to match most of the households. APWC would like to extend our sincere thanks to the staff at Belmopan City Council who



Image 7: Notice by the Belize City mayor seeking support from the residents for interviews

accompanied our collection staff, as well as the interview team that gained support for the project and helped translate.

All interview sheets were in English and local staff members were trained to undertake the interview rather than use the translated interview sheet and notes. All interviews were undertaken in groups of two led by local staff accompanied by an APWC employee. The household interviews were the most time-consuming part of the data collection process, with each interview taking approximately 20 minutes to half an hour as waste in an emotive issue and the interviews allow people to express their opinions candidly. APWC deployed up to four teams with eight staff at times to ensure that all interviews were completed on time.

It was sometimes difficult to convince people that the interviewers were working under the authority of the council. The interviewers carried both a letter of support (see Image 7) from the council as well as the council announcing the interviews on social media.

4.3 Sample sorting

All waste in Belize was collected in plastic bags. Once collected, the bags were labelled and brought to the local sorting facility at Belmopan. The audit for Belmopan, Orange Walk, Corozal, Belize City, Mahogany Heights and Bullet Tree Falls was conducted at the Belmopan City Council premises.

Sample collection location	Sample sorting location	
Belize City	Belmopan	
Belmopan	Belmopan	
Orange Walk	Belmopan	
Dangriga	Belmopan	
Corozal	Belmopan	
Bullet tree falls	Belmopan	
Toledo rural	Punta Gorda	







Bag tags were used to identify all samples. Samples were lined up in order to ensure none were missing. All samples were cross-referenced with the collection sheet to ensure consistency between sample collection and sorting.

After checking all samples were present and in order, the collection supervisor scanned the collection sheets and emailed them to APWC headquarters. The physical sheets were handed over to the sorting supervisor to ensure all data was kept at the same place.

Material from each bag was sorted separately into the 49 categories, listed below in Table 4.

Consolidation	Category	Consolidation	Category
	Aluminium cans		Feminine hygiene
tal	Aluminium recyclable	e	Pharmaceutical
Σ	Steel cans	Hygier	Nappies
	Metal other		Medical waste
60	Fishing/seafood, metal		Other sanitary waste
Fishin	Fishing/seafood, plastic	cs	Food
	Water pouches	gani	Wood/timber
7 9	Cardboard	ō	Other organics
r anc	Cigarette butts		Hazardous
ape ardt	Liquid paperboard (LPB)		Textiles
4 U	Paper		White goods
	PET bottles		Ceramics
	HDPE bottles	_	Animal faeces
	Expanded polystyrene	Othe	Containerised used oil (volume and weight)
stic	Plastic bags		EOL renewable energy equipment
Pla	Plastic oil containers		End-of-life vehicles
	Polypropylene (PP)		Tyres
	Flexible/film		Other
	Other plastic		Glass bottles eligible for CDS
es	Lithium batteries	ass	Glass bottles wine and spirit
Batter	Used lead-acid batteries	<u>10</u>	Glass fines
	Other batteries		Glass jars
	Computer equipment		Glass other
aste	Mobile phones		
E-Wê	Electrical items and peripherals (including TVs)		
	Toner cartridges		

Table 4: Household sorting categories





The sorting area consisted of a raised table covered with a tarpaulin or plastic sheets. The bagged waste was opened, and the contents sorted into the categories in Table 5 above. Each bag was handled separately and material from only one bag was placed on the table at any one time.

Separated materials were placed in appropriate containers, weighed on a set of electronic scales (accurate to two decimal points) and the weight recorded. APWC brought its own pre-calibrated electronic scales from Australia to ensure accuracy. Volume was calculated by placing the material in a pre-calibrated bucket. All recorded volume was then checked during analysis against volume obtained using conversion factored published by the US EPA (United States Environment Protection Agency).

Beverage containers from all general waste samples were labelled to ensure no cross-contamination. They were then stored and counted separately.

Containers were sorted by size, material (e.g. plastic, aluminium) and product type (e.g. milk, juice).

Further, all plastic bags were sorted into different types of bags and all containers were further sorted by size, material type and product type. Cigarette butts, coffee cups and takeaway containers were also segregated. This further sort was undertaken to 294 categories. The sorting sheet is provided at Appendix C. All sorting sheets were scanned and emailed to the APWC headquarters at the end of each day.



Image 8: Waste sorting at Belmopan City Council

4.4 Ship waste collection

In Belize, no waste from ships is landed at any port except where special dispensation is provided to naval vessels.





APWC approached Caribbean shipping, International Merchant Marine Registry of Belize (IMMABRE) and the Port Authority to help support removal of some waste from several ships for the sorting purposes.

However, after repeated attempts we were not able to receive waste from the ships for auditing purposes.

4.5 Work, Health and Safety

APWC's parent company has an Integrated Management System covering quality, health, safety and environment (QHSE), which was used during these audits. The system has been developed to be consistent with the requirements of the international standards ISO9001 (Quality), ISO14001 (Environment) and AS4801 (Occupational Health and Safety).

We are proud of our excellent work, health and safety record, and our commitment to quality, environmental protection and sustainability. Therefore, the following steps were undertaken to ensure that APWC staff, along with those undertaking training, were always safe.

- Site-specific safe work method statements (SWMS) were developed;
- A pre- and post-work commencement risk assessment was undertaken;
- APWC collection and sorting supervisor undertook QHSE inductions for project staff;
- All staff were trained in the waste audit code of conduct developed by APWC, which includes a requirement to sign a confidentiality agreement prohibiting them from removing items from sorted material or from revealing any information they might obtain while sorting or auditing.

Adjustments were made to some standard operating procedures to suit the local conditions while continuing to ensure the safety of all staff, contractors and secondees. APWC's collection and sorting supervisor had full control over local safety requirements to ensure all work was being conducted in a manner protecting staff health and safety.



Image 9: Waste being disposed of at the tip face at Mile 24 sanitary landfill in Belize





5 Waste data – study limitations

The data for this study was collected and analysed using the best and most accurate methods available within the constraints of available time and budget. This study is a survey, which means that a relatively small amount of data has been collected and then treated as representative of the total. As in any survey, there are limitations to the accuracy of the data, as described below.

Time frame	 These audits were carried out to cover one week's waste from selected areas. The data was then extrapolated using mathematical models to obtain the generation rate for the whole of Belize. Seasonal trends (e.g. warmer weather leading to increased consumption of beverages; Easter, Christmas) and weather events (e.g. high rainfall leading to grass growth) may change waste generation over time. The results of this audit should be treated with caution when comparing the results with reports based on data taken at different times of year.
Representative sample	 The sample for this audit is necessarily small due to the high per-capita cost and resource-intensive nature of waste auditing. There is always a small probability of inadvertently collecting waste from atypical households, resulting in non-representative data. APWC audits are carried out using strict random sampling, stratified by geographic area, to minimise the chance of this situation occurring. We found substantial variation between disposal rates between rural and different urban areas even after accounting for factors like income and consumption. This adds additional uncertainty when using the data we collected to estimate disposal rates for regions we were unable to cover.
Sample size limitations	 All surveys carry an element of sampling error, which is the mathematical error associated with using a sample to represent a total population. Sampling error can be reduced by taking larger samples. The sampling error involved in waste audits is usually small and can be tabulated by producing estimates augmented by upper and lower confidence intervals.
Weight-based analysis	 The collection of data for this audit was recorded by weight. This type of collection may cause some materials to appear to be present in quite small proportions due to their comparatively low densities (e.g. plastic beverage containers). They can, however, consume large amounts of volume. Weight-based analysis has been used in this audit because it is a standard procedure and is the most accurate way to collect data on a number of different types of materials. All information has been converted to volume for further investigation.
Collection methodology	 For areas with collection services, a household's regular rubbish load was picked up. If households were disposing of any rubbish via other means, this was not picked up in the survey. The numbers collected may be a reasonable estimate of waste going to landfill, but are unlikely to be a reasonable estimate of waste generation rates. For areas without collection services, the households were given a bag into which to put rubbish and were collected after five days. Some households may have taken this opportunity have disposed of extra rubbish.
Model assumptions	 While we did not assume we knew the disposal rates for sites we did not sample, we assumed that they displayed a similar pattern of variation to sites we did sample. Relationships between variables were assumed to be linear. This reduces the chance that the model fits.

Figure 9: Waste data study limitations





6 Results

6.1 Waste generation rates

The waste audit data was used to determine per capita waste generation rates as well as per household waste generation rates. Data in Figure 10 shows a large difference between the rate of waste generation depending on the type of area sampled. Sources of data and all assumptions are listed in Appendix E.



Figure 10: Per

Per capita waste generation rates in Belize

The data clearly shows the following pattern:

- Belize City had the highest rate of waste generation at 0.86 kg per person per day.
- Belmopan, Corozal, Dangriga and Orange Walk all urban agglomerates outside Belize City generate very similar amounts of waste, around 0.5 kg per person per day.
- Bullet Tree Falls and Mahogany Heights communities outside of the town but not completely rural generate around 0.29 kg per person per day.
- Rural communities in Toledo generated the smallest amount of waste at around 0.15 kg per person per day.

The data above shows that the more urban an area, per capita generation rate was higher.

We undertook further analysis to examine the possible reasons behind the higher waste generation rates for urban communities. A model of household waste generation rates was constructed to





investigate what the data revealed about how generation rates vary with household- and town-level characteristics.

The following features were investigated as predictors of household waste generation:

- Household-level predictors:
 - Total monthly household income (from all employed members of the household)
 - Monthly household spending on groceries
 - Number of people in the house
 - Number of children in the house
 - Household rating of collection service
- Town-level predictors:
 - \circ $\;$ Whether or not there is a collection service in the household area
 - How often waste is collected, if there is a service
 - \circ $\;$ Average household income for the town where the house is located
 - \circ Average grocery spending for the town where the house is located
 - Population of the town where the house is located

The best results were obtained using only a single predictor: *the town population or size*. The log-linear model trained on the whole dataset is given by:

Generation rate
$$\left(\frac{kg}{hh \cdot day}\right) = 0.4 \times \ln(town \ population)$$









It is notable that even though the model is very simple, depending on a town's population alone, the predictions are within the 80% confidence interval for the true generation rate for all towns except Belmopan and Toledo (rural).

In Belize, populations are concentrated in discrete urban areas, so the population size serves as a proxy for the urban nature of a town and therefore 'access' to materials.

One possible interpretation of the data is that income level does not have a significant correlation to the total waste generation in Belize, whereas living in an urban area does.

Figure 10 shows that Belize City has the highest waste generation rates (per household, as well as per capita – see Figure 10), in addition it also features the widest range of generation rates. In fact, a general trend we found was that in urban centres where there were higher average generation rates, we also found a wider range of generation. A possible explanation is that in urban community's people have the opportunity to consume many more waste-generating products, but people also make different choices in their consumption, so some residents generate a lot of waste while others generate little. In rural areas, on the other hand, people do not have the opportunity to consume so many waste generating products, so people don't generate as much waste whatever consumption choices they make. This, once again, supports our hypothesis that the more urban the community, the larger and more diverse its waste, due to access to a wider variety of materials for consumption. We have identified a very close relationship between the degree of urbanisation of a settlement (which we can measure by population) and the average quantity of waste generated by a household (Figure 11). The variability in urban setting shown in Figure 12 might give us some clues as to why urban households produce so much more waste.








Population trends over the past five years show not only an increase in the population of Belize, but a steady increase in the urban population as well (see Figure 13)¹.



in Appendix F), we could estimate disposal rates in areas that were not directly sampled. Modelled disposal rates are more uncertain than measured disposal rates, but the model also provided an estimate of this uncertainty.

6.2 Total waste generated and landfill life

In 2009, the Inter-American Development Bank (IDB) approved the Solid Waste Management Project (SWMP I), a US\$14.9 million project with financing from the Bank, the OPEC Fund for International Development (OFID), and the Government of Belize (GOB).

The SWMP I, which concluded in 2015 and was executed by SWaMA, has resulted in the construction of the first sanitary landfill in Belize, located at Mile 24 of the George Price Highway, which connects Belize City, Belmopan and San Ignacio, on the border with Guatemala. This landfill, which began operations in August 2013, is already delivering benefits for urban areas in the districts of Belize and Cayo, including Belize City, San Ignacio and Santa Elena, and Benque Viejo. By the last quarter of 2015, the landfill started benefiting San Pedro, Belize's main tourist destination; Caye Caulker, another important tourist destination; and areas north of Belize City through the completion of three new transfer stations. Dump sites in the Western Corridor (Belize City, San Ignacio, and Burrell Boom) have been closed and replaced with transfer stations, from where solid waste is being safely transported to the Mile 24 Regional Sanitary Landfill. Based on the progress made as part of SWMP I, SWMP II started in 2016; this will result in the closure of dump sites in Belmopan, Dangriga, Orange Walk, Corozal, Punta Gorda and the transport of waste to the Mile 24 Regional Sanitary Landfill.

This section outlines the lifespan of the landfill if all the material from the various transfer stations currently operating and those that are to start operations from 2020 onwards is taken into account.

¹ www.macrotrends.net/countries/BLZ/belize/urban-population'





Based on the waste audits conducted for the Northern and Central corridor by APWC and the waste already being brought to the landfill (SWaMA), APWC has estimated the total amount of waste being brought to the landfill from different transfer stations and the possible lifespan based on a predetermined compaction rate.



Figure 14: Landfill use as per APWC data + incoming waste tonnages to Mile 24 landfill

Based on the model above, the total amount of waste currently being generated (tonnes per day, May and June 2019) and landfilled is shown below:

Table 5:	Total	waste	generation
----------	-------	-------	------------

	Tonnes per day
Total currently moving to landfill (BSWaMA 2018), tons per day	118*
Extra waste moving to landfill with SWMP II	40 (32-49)**
Extra waste from tourist areas: Burrell Boom + San Pedro + Caye Caulker	20*
Overall Waste including tourist areas	180 (153-207)
Waste currently not being landfilled	62 (25-89)
Waste not landfilled including new transfer stations	22 (57)

The low and high numbers represent a 95% confidence interval determined by the model's observed performance at explaining 85% of the variance of off-sample data and a 95% confidence interval of the overall generation rate from our raw data. Though we say these are 95% confidence intervals, modelling assumptions contribute substantial additional uncertainty and the overall level of confidence is not anywhere near 95%. *BSWaMA 2018 ** APWC waste survey







Figure 15:

e 15:

Volumes of waste coming from different transfer stations

Data in Figure 15 shows that Belize City generates the largest amount of waste, with the remainder of the towns generating smaller quantities. Population, employment and household figures were combined with per-household and per-employee disposal rates to estimate incoming waste to transfer stations at the proposed sites. This waste was added to the projected data from existing transfer stations from 2020 onward. As per the APWC projections, the current cell for the landfill could fill in approximately 2029 and the entire landfill should be able to accept waste until 2073.

These projections for the total waste to be landfilled are based on the average waste incoming per transfer station collection zone. The collection zone for each transfer stations was defined in the IDB Feasibility study as the waste to be collected per city as well as that generated by the population within a 10km radius. Error margins are set at 80% (confidence intervals calculated per - transfer station collection zone from APWC data and BSWaMA data), and were chosen as the subjective level of confidence in other parameters (e.g. growth in waste generation) was substantially less than 80%, thus choosing a higher level of confidence (e.g. 95%) would give a wider range of estimates without substantially improving confidence in the overall projection. These error margins provide the range of





filling rates depending on the amount and type of material that comes in. This projection does not consider any additional bulky waste, commercial and industrial waste, waste from cruise liners or agricultural waste that will start coming in once the new transfer stations become operational. We note that bulky waste is currently an issue across Belize and will also add to the overall waste generation when it starts getting collected.



Figure 16: Proposed transfer stations as per SWMP II (Source: Consultancy Services to prepare a solid waste master plan for emerging tourism areas (Belize), TC No.: BL-T1067))





The following data assumptions were made in the construction of this model:

- Transfer station data from Belize SWaMA was used to estimate the tonnage present in the landfill from 2013 to the beginning of 2018; this corresponded to about 110,000 m³ at the end of the data period.
- Subsequently, the growth rate was applied to the previous year's data in order to project quantities of generated waste from existing transfer stations.
- APWC waste audit data was used to estimate per-household waste from the household stream and per-employee waste from the commercial stream.
- 2019 populations in Belmopan, Corozal Town, Dangriga, Orange Walk and Punta Gorda Town were estimated by projecting the 2010 census data forward with a 2.5% growth rate. For the planned transfer stations, these populations were augmented with estimated populations in the out-of-city catchment, as detailed in the SWMP II technical background document (2015); these figures were also assumed to have grown at a 2.5% rate since 2015.
- 2019 households were calculated from the 2010 census on the basis of a 3.5% growth rate. A proportional number of households were assumed to exist in the out-of-town catchment areas.
- The populated growth rate of 2.5% was calculated by considering the average population growth since 1960 was 2.58%. From 1991-2000 it was 2.55% and from 2000-2010 it was 2.65%. 2.5-2.6% growth appears to be a stable long-term average population growth rate for the entire country, and long term averages are of more interest for projection than the rates of growth at this particular point in time.
- 3.5% average growth rate in households was calculated based on the change in number of households from the 2000-2010 censuses.
- 42% of the residents of all locations were assumed to be employed, on the basis of the Labour Force Statistics, April 2018 from SIB.





6.2.1 Uncertainty

We considered two sources of uncertainty: in waste generation rates and in growth rates. For the former, 80% confidence intervals were calculated from APWC data. For the latter, a lower bound of 3% growth per year was used (slightly lower than the rate of GDP growth) and an upper bound of 6% growth per year was taken. These sources of uncertainty were combined to produce the error bars on the graph (Figure 17); the upper error bar assumes higher starting rates of generation and higher growth rates, and the lower bar assumes the lower end of both of these quantities.

6.2.2 Maximum per capita rate of generation

The current US rate of MSW generation is 2 kg/person/day. This rate has remained static since 2000, although it was previously growing before this date. APWC used



2 kg/person/day as a maximum rate of per capita disposal, and once per capita disposal hit this figure, subsequent growth in landfilling rates was limited to population growth (2.5% per year).

6.2.3 Mile 24 landfill audit projection

The Mile 24 landfill audit (IDB feasibility study) implicitly used a constant rate of waste generation, although this figure wasn't explicitly calculated. APWC took the stated lifespan of 66 years from 2015 and calculated that the report was using an implicit rate of incoming waste of around 132,000 m³ per year.

Observed figures demonstrate a much slower rate of incoming waste presently. However, with a growth rate of 4.8%, we estimate a shorter total site lifetime than the landfill audit report. We do note that the original lifespan is within the margin of error of the updated projections.

6.2.4 Potential for increased landfill lifespan and recycling

Currently more than 90% of the waste being collected and brought to the transfer stations is being transported to the Mile 24 landfill. APWC modelled landfill use under three additional scenarios:

- removing recyclable plastics (PET + HDPE) from waste at all transfer stations;
- removing organics from waste at all transfer stations; and
- removing both from waste at all transfer stations.

Further we made projections of landfill life based on whether waste generation will increase at a low or high rate:

• A 'low growth' scenario: Waste generation was assumed to grow in line with historical GDP growth of 3.5% per year





• A 'high growth' scenario: Waste was assumed to grow at the historical rate of waste generation growth of 4.8% per year based on incoming waste data through the transfer stations as published by BSWaMA.

Under both scenarios, removing plastics was found to increase the lifespan of the currently constructed cell by around one year, removing organics to increase it by around two years and removing both increased it by around three years.

	Additional lifespan if plastics	Additional lifespan if plastics +
	are removed	Organics are removed
High growth scenario	3	10
Low growth scenario	5	13

Table 6: Landfill lifespan if plastics and organics are removed for recycling

As shown in Table 6, under the high-growth scenario, removing plastics added around three years to the site life, removing organics added around seven years and removing both added around 10 years to the site life. Under the low-growth scenario, removing plastics added around four years to the site life, removing organics added around nine and removing both added around 13 years to the site life. All these projects are made on the assumption that although the total amount of waste will grow, the percentage of the recyclable and organic material within the total amount of waste will stay the same.

APWC understands that although removal of recyclables and organics will increase the lifespan of the landfill, it is important to be cautious about the removal potential of recyclables, given the challenging market conditions currently being experienced for recyclables worldwide.

The traditional and prevalent thinking— that is, volume drives price — is not always substantiated. Australia has small players receiving favourable pricing because of the quality and cleanliness of the product and the same should apply to Belize as the markets for the products are largely the same.

APWC believes the more challenging part of building a recycling market for Belize would be the logistics of transporting the material to the recycler. APWC also believes Belize has an advantage in terms of the potential to employ waste-pickers from closed landfills in handpicking recyclables and preparing cleaner materials.

A full feasibility study into the amount and type of material for recycling would result in a better understanding of the potential for recycling. If the container deposit legislation (CDL) currently in place was revamped and extended to several other containers (including all PET and HDPE containers), the total tonnage of materials available for recycling could increase (see Table 7).

Data shows that there is more than 18,000 tonnes of organics and 2,500 tonnes of plastics available for composting and recycling annually from the household and commercial sector, based only on the areas serviced by a collection system. These projections are highly conservative and do not include market, commercial, industrial or agricultural waste.









	Table 7:	Total tonnages	of material	available p	er year by	/ location	in Belize
--	----------	----------------	-------------	-------------	------------	------------	-----------

Material type		Belize	Belmopan	Corozal	Dangriga	Toledo	San	San Pedro	Caye	Burrell Boom	Total
		City		Town		Rural	Ignacio		Caulker		
Batteries	Total	31.7	4.9	3.8	3.0	0.5	13.9	11.6	3.1	3.2	75.8
E-waste	Total	152.3	23.3	18.4	14.5	2.4	66.7	55.7	15.0	15.3	363.7
Glass	Total	1177.3	180.2	142.2	112.4	18.7	516.1	431.0	116.1	118.6	2812.7
Hygiene	Total	3477.7	532.3	420.1	332.1	55.3	1524.6	1273.0	342.9	350.4	8308.4
Paper and cardboard	Total	1530.1	234.2	184.8	146.1	24.3	670.8	560.1	150.9	154.2	3655.5
Metal	Aluminium	72.0	11.0	8.7	6.9	1.1	31.6	26.4	7.1	7.3	172.1
	No Aluminium	59.1	9.0	7.1	5.6	0.9	25.9	21.6	5.8	6.0	141.2
Plastic	PET bottles	837.0	128.1	101.1	79.9	13.3	367.0	306.4	82.5	84.3	1999.7
	HDPE bottles	283.0	43.3	34.2	27.0	4.5	124.1	103.6	27.9	28.5	676.2
	Other plastics	1107.4	169.5	133.8	105.8	17.6	485.5	405.4	109.2	111.6	2645.7
Organics	Total	7593.0	1162.3	917.2	725.2	120.7	3328.7	2779.4	748.8	765.0	18140.2

Belize – Land-based Sources of Marine Litter





6.3 Household behaviours towards waste disposal

Figure 18 presents data from the household interviews undertaken for the same households from which waste was collected. Please note that the figure below represents the household's response to what they do with their waste, that is, what the household behaviour around disposal of waste is. This does not capture the actual fate of waste once the household has placed it out for collection or has dumped it on land or in water. We make this statement because anecdotal evidence suggests that in some instances, even after the waste is placed out for collection by the household, it may sometimes be grabbed and distributed in the environment by dogs or is not collected by the collection service.



Data shows that in towns where a collection service is provided, an overwhelming majority of the population uses the collection service that for general household waste. The lack of a collection service leads to waste being either dumped on the land or burnt. This is a consistent, worldwide phenomenon in areas without a collection service. This data also shows a marked improvement in the disposal practices among householders since the collection service has been expanded in 2010.

In the surveyed communities, a large amount of green waste is composted or used as feed for animals in the rural communities, and both urban and rural communities indicate a large prevalence of re-use for bulky waste.





6.4 Waste composition

Organics form the largest component of the waste stream by weight, at 40%, as well as by volume. Interestingly, recyclable materials (organics, plastic, metals, glass and paper) represent between 80 and 90% of the overall waste stream (see Figure 19).

Almost one-quarter (24%) of the commercial waste stream is cardboard and paper, which is to be expected. This presents an opportunity for a source-separated system for commercial premises targeting paper and cardboard. This system has been successfully trialled in the South Pacific (currently by the municipality of Luganville in Vanuatu).



Figure 19:

Overall composition of the waste stream by weight

Interestingly, the litter stream contains the largest proportion of recyclable plastic content as compared to the household and commercial waste streams. Therefore, public awareness campaigns around littering should focus on single-use plastics.







Household Waste by Weight

Figure 20: Household waste generation by city

Data (Figure 20) also shows a consistent trend in composition, with Corozal Town having the least amount of recyclable materials amongst the townships and Belize City a large amount of organic content (49%) in their respective waste streams. Amongst the rural communities, Punta Gorda had a much more proportional distribution of waste, with organic component forming only 23% of the overall waste stream. Anecdotally, the rural communities often tend to re-use organics more than urban centres.







Further investigation into the data (Figure 21) shows that 87% of the organic stream found in the cities is food waste. Therefore, any education materials targeting 'reduction' or 'rethinking' of waste should consider concentrating on reduction of food waste as a message.

6.4.1 Single-use plastics in Belize

APWC understands that legislation phasing out single-use plastics is currently being considered by GOB. Based on previous work undertaken by APWC in the Pacific nations of Vanuatu and Solomon Islands, Table 8 below shows the incidence of single-use plastics in the household and commercial waste stream by volume.

	Percentage of plastic waste by volume	Vanuatu - volume (ban in place)	Solomon – volume (no ban)
Straws	0.1%	0.3%	0.5%
Glossy bags (<300 gsm)	0.2%	3.6%	1.4%
Drink bags	1.0%	0.0%	0.0%
Supermarket bags (>300 gsm)	20.3%	5.0%	39.1%
Polystyrene (including takeaway containers)	23.3%	1.6%	11.9%

Table 8:	Single-use	soft	plastics	in	waste
10010 01	0	00.0	p.0.000.000		





Data shows that the major difference between the South Pacific and Belize is the consumption and use of polystyrene containers. Anecdotally, these styrofoam containers are predominantly used as takeaway food containers all around Belize.

Plastic drink bags, including those used for water and other drinks, are unique to Belize. They have not previously been encountered in any of the audits conducted by APWC in the South Pacific and Indonesia.

In Vanuatu, where the thin, supermarket-style plastic bag has been banned, there is a higher incidence of glossy bags (those used in clothes shops, etc.), indicating a change in consumer behaviour due to the unavailability of the thinner bag. Therefore, it is possible that if a differential ban on plastic bags in brought into place, the incidence of other types of bags might



Image 11: Single-use plastic items found in the waste stream in Belize

increase. APWC understands however, that all plastic bags are included in the phase out. We note however, a decision will have to be made on the "biodegradable plastic bags" and compostable bags as currently there are no disposal pathways available for these alternatives in Belize and the lifespan of these bags is still quite long.

Therefore, once the legislation is in place, education and the availability of alternatives will play a large role in community response to the phase out of the single-use plastic.

6.4.2 Returnable containers in Belize

The *Returnable Containers Act* came into play in 2009 in Belize and targets beverage containers for the prevention of waste. It provides for payment of a deposit on beverage containers and for a refund for the return of the containers. Data from around the world indicates that the introduction of legislation, such as a returnable containers act, leads to a reduction in littering of targeted containers by 40% at a minimum. However, no historical data is available for litter in Belize before the introduction of the Act.

Table 9:	Refunds	for	different	containers	
----------	---------	-----	-----------	------------	--

Material	Size	Refund
Plastic	Less than ½ litre	5 cents
Plastic	More than ½ litre	10 cents
Glass, metal, aluminium or steel	One gallon (3.79 litres) or less	15 cents
including beer		







Figure 22:



APWC data shows that even though there is a deposit on several PET containers, more than a quarter (26%) of the overall waste stream by weight is made up of PET bottles, followed by 20% plastic bags (not including no-brand drink bags and plastic drinking pouches) and 20% plastic films such as chip packets.





Detailed composition of glass and metals in the waste stream





One of the reasons for the large incidence of PET bottles in the waste stream could be that the *Returnable Containers Act* does not include water containers.

A detailed investigation of glass found in the waste stream shows that 34% of the glass found consists of containers that are eligible for a refund under the *Returnable Containers Act*, therefore greater awareness of what can be returned is required. A future review of the Act should consider inclusion of wine bottles and spirits as well as glass jars, as these form the remaining two-thirds of the glass component of the waste stream.

As seen in Figure 23, of all the metal containers found in the waste stream; steel cans account for nearly two-thirds or 65% of all metal containers and aluminium 20%. Metal, aluminium or steel cans are all eligible for a BZ15c refund under the *Returnable Containers Act*. However, data shows that a lot more aluminium containers are being recovered through the refund scheme as compared to steel. Therefore, significant amount of effort is required to be made in educating the community around the current containers that are eligible for a refund. It is also possible that the organisations offering the refund are only interested in the aluminium due to its value in the current market. Future CDL should consider differential levy or deposit amounts for different materials with different market values.

6.5 Waste service provision

APWC also undertook detailed interviews with mayors from each of the council areas visited to understand the current waste collection coverage, staffing levels and staff capacity, including infrastructure and financial support available to the councils to carry out their activities. A full breakdown is provided in Appendix G. Please note that all information provided in this table is based on the information provided to APWC during the interviews conducted with council staff and mayors in June 2019.

6.5.1 Waste Collection and street cleaning

All councils visited by APWC staff provide a waste collection and street-cleaning service to their community. A summary of the services provided are listed below in Table 10.

	Punta Gorda	Dangriga	Belmopan	San Ignacio	Orange Walk	Belize City
% Coverage (the percentage of households with a rubbish service)	100% within town boundary	More than 90% within town boundary	95% within town boundary	100% within town boundary	100% within town boundary	100% within town boundary
Staff	Driver + 2 runners 2 litter pickers (2 am to 6 am)	Driver + 2 runners 4 litter pickers, all women	50 staff 9 (3 truck crews) 15 parks and cleanliness	25 staff – 6 drivers and 19 garbage collectors	35 staff	More than 300 workers

Table 10: Waste collection service provision





	JICA volunteer	Litter pickers start at 6.30 am	3 litter pickers 11 at the market			
Collection start time	 First shift 4am to 10am Second shift 10am to 4am 	4am	6am everyday		 4am first trip 9am second trip 	Starts 6am Council puts out notice for bulky waste
Collection map	Yes, prepared by JICA volunteer	No, not formal but the town is divided into two zones with the river as the zone boundary	List of streets No collection map	Yes. San Ignacio has 4 zones and Santa Elena has 4 zones Collection map is available	Yes, very old.	No, but street list exists
How is waste placed out to be collected?	Residents are i homes.	requested to bag	g their waste a	nd place in waste	receptacles in front o	of their
Type of household service Frequency of service	Door to door Once a week	Door to door Once a week	Door to door Twice a week	Door to door once a week with	Door to door Once to twice per week depending on area Downtown 3 times per week	Door to door By contractor
Type of service Commercial	Door to door Everyday	Door to door Everyday	Door to door 2 times /week	Market area and downtown is twice or up to 3 times weekly	Door to door Everyday	Door to door Everyday

As indicated in the table above, most councils are providing a weekly door-to-door garbage collection service to households. The number of staff employed by each council is different and dependent on the funding available to the council for provision of garbage collection service.

Most notably, all councils require their residents to place their waste in metal or plastic drums in front of their houses, and residents are encouraged to do so in most councils. However, based on our collection data, the compliance with the use of the drums is low with Belmopan being the notable exception and more than 90% of residents placing their rubbish in drums. APWC notes that picking up large drums of waste or removing waste from receptacles with hands can lead to council collector injuries. For all urban areas assessed, 180 to 240-litre mobile garbage bins (MGBs) should be considered by councils. These can be easily wheeled over and hooked onto the rear-loader compactor trucks most councils currently use for collection. A raised platform type collection point system or a trailer that can be later towed, should be considered for rural communities.







Image 12:Large plastic drums filled with garbage have the potential to cause injury
to council collection staff

The APWC interview questionnaire asked the households where waste was collected to rate their level of satisfaction with the council's collection service. The results are shown in Figure 24 and indicate a direct relationship between the days between consecutive collection and the rating given by residents, that is, the more frequent the collection service, the more satisfied people were with the service. Overall, Belizeans are quite satisfied with the collection service provided by their councils.

Please note that the data below is based on residents' perception of the frequency of the service and not that provided by the council.







6.5.2 Fees, charges and council budgets

An ongoing source of income is one of the most important requirements for the provision and maintenance of high-quality service. Around the globe, councils collect a household waste collection charge that is used for the provision of collection services, purchase and maintenance of waste trucks and waste education. APWC therefore asked all interviewed councils about their source of income and expenditure on the waste services. The responses are provided in Table 11.

	Punta Gorda	Dangriga	Belmopan	San	Orange Walk	Belize City
				Ignacio		
Service charge per household	BZD 1 per household per week urban BZD 4 per household per week remote	No fee	BZD60/hhld/ year	No fee	Currently no fees Proposal to charge 5bzd/household/month	No fee
Service charge commercial	BZD10–15 per week based on size of business	Based on generation Covers 20% of total cost	BZD 3-60 per year	BZD 5.00– 100.00 per month	BZD 13–BZD 26 per month	Direct contract with Belize waste control
Total expense for waste management	BZD 30,000 per month	BZD132,000 per year or BZD 11,000 per month	2 million BZD per year or 170,000BZD per month	Not provided	40,000 BZD per month	BZD 58,000 per week 0r ~700,000 per month
Total income from fees collected	BZD2000 per year	BZD32,040 per year	Not provided	Not provided	Not provided	Part of property tax
Who is responsible for collecting fees?	Collection officer for council that accompanies the truck	Council issues an invoice, customers come and pay at counter	Council issues an invoice, customers come and pay at counter	Council issues an invoice, customers come and pay at counter	Council issues an invoice, customers come and pay at counter	Council issues an invoice, customers come and pay at counter
What percentage of fees is collected? Or do all people pay their fees?	80%	No fees	\$60/year with a Only 20% of the households pay their fees			 18 million in arrears in 5 years 58–70% Engaged a commission system for collections
Are there fines for littering	Yes, but not enforced	Yes, but not enforced	Yes, but not enforced	Yes, but not enforced	Yes, but not enforced	Littering falls under DOE and Litter Act giving ability to any authority to issue fines

Table 11: Fees and charges by council





* All mayors mentioned that the Mayors' Association is considering looking into the authority to issue littering tickets

Most councils do not have a waste charge, while others have minimal charges. For councils that do have waste charges, only about 20 to 80% cost recovery was reported by the mayors. The Town Councils (Control of Refuse) By-Laws has provision of fines for littering. Most mayors are aware and were unanimous in their opinion that the Mayors' Association is considering the best way to bring the community along in the process of issuing of littering tickets.

All mayors also acknowledged that once the transfer stations (TS) are functional, they will be charged a tipping fee. There was, however, less clarity about the amount that will be charged. Once the TSs become functional, this will be an additional cost for councils unless a specific waste charge is introduced to supplement the income base.

6.5.3 Equipment and disposal infrastructure and equipment

A comprehensive waste management service for a city includes personnel to collect waste, clean the streets and manage the overall waste collection and disposal services. Infrastructure and equipment to collect and manage this waste is also essential.

At the time of APWC visits, all councils visited (except Belize City) were dumping their waste in open, partially managed dump sites. None of the councils owned equipment for compaction or movement of waste at the dump sites. Burning was being practiced at each of the landfills.

The dump sites visited included Belmopan, Dangriga, Orange Walk and Punta Gorda. All dump sites are currently co-located on a future transfer station site and partially built transfer stations were evident at each site. APWC is aware that as part of the SWMP II, the dump sites will be completely remediated as the transfer stations become operational. We have therefore not provided an issues analysis of these dump sites in this report.



Image 13:

Waste burning at the Belmopan dumpsite and burnt-out waste at the Punta Gorda dumpsite

The Solid Waste Management Project II beneficiary municipalities or the contractors to the municipalities are responsible for the collection of solid waste and the subsequent transportation to the transfer stations. At the time of the APWC visit, each council was asked to provide the number of operational and available trucks used for collection of waste. Data in Table 12 shows that most of the councils do not have the trucks necessary to undertake collections sustainably. Punta Gorda, Orange Walk and Dangriga reported having only one truck undertaking multiple





trips daily. If the truck is out for maintenance, the collection is not undertaken and must be made up over the weekend. Belize Waste Control, by contrast, has a fleet of 10 compactors and San Ignacio had four compactor trucks (at the time of APWC visit).

	Punta Gorda	Dangriga	Belmopan	San Ignacio	Orange Walk	Belize City
No. of trucks	o. of trucks 1 + 1 requested 1 truck		3 trucks + 1	2 tractors	3 trucks in	2 flatbeds for
Trucks for	from JICA	(matched	requested	with trailers	total	bulky waste
collection of		50% from	from JICA	and	2 flat beds +	Rest of the
household		prime	2 tractor	4 compact	1 compactor	vehicles are
waste,		minister) +	trailers	trucks	1 currently	owned by
commercial		1 requested	3 flatbeds		requested	contractor –
waste, trees		from JICA	1 septic		from JICA	Belize waste
and branches			truck			control
and bulky						
waste?						
No. of pickers	4	8	25		20	All waste
at the landfill						going to
						Transfer
						Station
Equipment at	Currently none,	Hire a	2 staff and	Backhoe and	Currently none	All waste
landfill	hired as required	bulldozer	hire a	2 trucks	 hired as 	going to
		every three	dozer as	which take	required	transfer
		months	required.	waste to		station
			Practice	Belize City		
			burning			

Table 12: Equipment available to councils

We also note that all councils except San Ignacio and Belize City currently have requests pending with JICA for additional compactor trucks and they are confident they will receive the trucks within the next year.



Image 14: Broken down truck at Orange walk and the truck fleet at Belize Waste control

6.5.4 Community education

All mayors and staff interviewed consider community education as being under the purview of the Department of Education. This was corroborated by DOE themselves. APWC's experience in





other countries and communities shows that education needs to be tailored to the community setting to be effective. We recommend that although the DOE needs to ensure consistency of message and provide approval of content, it is also important for messaging to be community specific. Therefore, it is imperative that council staff, with support from community groups and NGOs, are engaged in the process of designing education material that is appropriate for each community.

Recycling in Belize 7

The Returnable Containers Act is currently in force in Belize. However, the only company currently refunding customers for return of their containers is Bowen & Bowen Pty Ltd. Customers are refunded 25 cents for each returned empty glass beverage container of beer and carbonated soft drinks. Plastic bottles containing carbonated soft drinks have a deposit and refund value of 5 cents and 10 cents, and the 5-gallon (19.93 litres) water bottles each have a \$15 deposit value. There is currently no refund offered for the return of empty water and juice containers.

APWC understands that the glass bottles returned are refilled and the PET bottles are taken for recycling to Resource Recovery Recycling Ltd where they are cleaned, shredded and baled for shipping overseas.



Refunds offered by Bowen and Bowen in Belize

7.1.1 **Resource Recovery Belize**

Resource Recovery Belize is located at 1061 Durgeon Drive, Belize City. It accepts paper and cardboard, PET and metals for recycling. It also previously accepted e-waste for recycling. A number of other materials are also collected on an adhoc basis depending on the market demand of recycled materials (like PVC water drums). Currently, it receives all PET bottles collected by Bowen & Bowen, which are washed and baled and then sent to overseas markets for recycling through brokers.





7.1.2 The Belize Recycling Company

The Belize Recycling Company is located at Mile 8 on the Western Highway, Belize District. The company purchases metal, plastic and paper, which are then processed into new goods. Paper is converted into 100% recycled toilet paper, napkins and tissue paper, which are then sold as an environmentally friendly product. Metals and plastics are cleaned and sold to larger recycling companies in Mexico and the USA to be processed and reused.

7.1.3 Transfer station recycling

Recyclable material is removed from municipal solid waste, sorted and stored by recyclers at the new transfer stations established under SWMP I. According to IDB documentation, since the closure of dumpsites at Belize City and San Ignacio, thirty-eight informal recyclers have been employed at the transfer stations. Enclosed buildings now provide shelter from the elements and dedicated space to store recovered recyclable materials is provided, the remaining waste is transported to Mile 24 Sanitary Landfill. SWMP II aims to establish a source separation pilot, separating by hand commingled recyclables then compacting using a baler in preparation for shipping to end users and buyers.

7.1.4 Upcycling in Belize

During the APWC visit in June 2019, several upcycling initiatives and alternatives were observed. The APWC team visited the Made in Belize Expo and discovered entrepreneurs using waste materials to make products for sale at the expo. Upcycling is an effective tool to engage varied community sectors involved in the reuse and recycling economy, as well as being a cottage industry if provided with adequate support.

The total amount of material recycled by the recycling companies, as well as through the upcycling initiatives, varies greatly, with little consistency in the amount of material available to these organisations for recycling or reuse. Most organisations reported scavenging at the dump sites to gather materials.

7.1.5 Proposed phase-out of single-use plastics

On 20 March 2018, the GOB Cabinet approved the proposal for a planned phase-out of single-use disposable bags and single-use, disposable 'styrofoam' and plastic food utensils by 22 April 2019. This phase-out was considered a measure to reduce the waste generated by these single-use disposable plastics at the source by restricting their entry into the system. The phase-out also acknowledges that in order to be successful, Belize will need to transition to affordable and readily available biodegradable and reusable alternatives. The DOE has already promoted the use of alternatives such as biodegradable plastics and plant-based plastics. This is controversial because they are not bio-degradable in the environment but might need industrial composting, that is lacking right now. The draft regulations to this effect are currently in circulation at the time of writing of this report.

No large-scale composting operations were observed, although the community interviews revealed that composting is practised extensively at the household level. Representatives from





the poultry industry noted at the national workshop for the development of the Marine Litter Action Plan that the agriculture sector is currently making some compost but there is a higher demand for compost if it was available.

The following overall observations were made by APWC:

- a) Composting of organic materials is one of the most effective means to reduce the total amount of material going into landfill, reduce emissions, as well as reducing overall transport costs. The separation of organics cannot be undertaken at the transfer stations and will have to be done through a wet and dry collection system at the household level or through organics collection stations at a group of commercial premises.
- b) With the transfer stations coming online, the supply of recyclable feedstock materials for recyclers should become more consistent. This will help provide certainty in the market regarding Belize's commitment to resource recovery and recycling. The availability of recyclables, combined with supporting legislation, would help promote increased resource recovery in the future.
- c) Upcycling of problem materials such as tyres currently should be encouraged, and all future strategies and plans should include an upcycling component as part of the community engagement process.

8 Solid waste management gap analysis

A gap analysis of the waste management sector has been provided in Table 13 below. Please note that this list is based on stakeholder consultation and initial observation only. We also note that some of these gaps overlap with those identified in the National Solid Waste Management Policy 2015, however considerable time has passed since the development of the policy. This list is presented to re-focus attention on matters requiring attention.

Theme	Gaps
Policy & legislative framework	 The existing legislative framework is mostly outdated and requires a review. A detailed National Solid Waste Management Policy (SWMP) exists but needs to be supported through legislative reform at the national level. The policy framework at the municipal level does not exist to support the implementation of the SWMP. Currently litter by-laws exist however, very little or no enforcement takes place.
Data collection and decision making	 No waste data is collected for collection, transport and disposal of waste at the municipal level. There is no internal capacity within local council to use data for decision-making processes.

Table 13: Gaps in waste management in Belize





Theme	Gaps
	 No litter data or illegal dumping data collection is undertaken in a systematic process to understand, what, why and where. It is mostly anecdotal and dealt with when resources are available. Most municipalities don't have managed dumping spaces. When transfer stations come online, there is no understanding of the cost burden associated with tipping at the transfer stations. Most rural areas don't have a consistent/ongoing waste collection service and there is no long-term data to determine what happens with the waste that is generated in rural areas.
Economic instruments	 The cost of construction of infrastructure is being met by GOB and supported by IDB and other multilateral funding agencies. There is little or no income from waste management activities being generated currently other than small amounts being collected in approximately 33% of the municipalities. The commercial premises are charged a small fee in each municipality assessed. The budget for solid waste management is limited and is being replenished through other revenue sources such as traffic and housing rates. Although municipalities are thinking about having financial mechanisms in place, it is not currently the case. None of the unmanaged dump sites charge a fee for disposal, so the expectation for having to pay for disposal does not currently exist. There are no financial incentives in place in the form of tax breaks for recycling activities and shipping of recyclable materials overseas.
Collection services	 Domestic collection services are provided by local governments through their own staff except for Belize City where it is contracted out. The collection services are limited to the urban areas only but an expanding population and expansion to the peri-urban areas will require services and substantial support. The services in rural settlements are ad hoc and basic. During the CLiP national policy workshop small companies were reported to be charging households to remove waste and bring it to the dumpsite (for example in Hopkins). These activities should be mapped and charges analysed to have an idea of how much people would be likely to spend for the service
Equipment and maintenance	 None of the municipalities visited, except Belize City and St Ignacio, have an adequate number of trucks for collection. None of these municipalities had adequate equipment at their dump sites to deal with the waste currently being disposed of. Belize Waste Control privately owns and operates an incinerator that is currently being used to incinerate medical waste and some shipping waste from naval vessels. Belize needs to undertake a review of its current incineration capacity in parallel to designing a national ship waste strategy focussing on domestic shipping waste. There is





Theme	Gaps
Contracts and tenders	 potential for the incinerator to be confounded and used for both medical and quarantine waste. However, the current size and quality of the incinerator at Belize waste control will need to be assessed before any such arrangement is made. Private contractors are being used by Belize City. However, the contract currently presents various challenges and needs to be assessed. Anecdotally, there are small emerging contractors that are directly being contracted by villages to collect and dispose of their waste at the landfill. However, there are no clear guidelines around licencing for these contractors and a greater level of clarity should be provided to improve competition for the smaller remote villages. Lack of experience managing large mufti year contracts associated with waste management
Landfill design and management	 Current landfill capacity seems to be smaller than originally anticipated. None of the dump sites in the municipalities visited are controlled, sanitary or safe. No landfill cover was seen on any of the dump sites visited except at the Mile 24 landfill. Heavy equipment for compaction is not available and is hired periodically. Municipalities are dependent on hired heavy plant and equipment to manage landfill, which also has a propensity to break down. All dump sites visited have waste-pickers of all ages and genders working in very unsanitary conditions.
Education and engagement	 At dump sites, waste-picker activity is not regulated or formalised. There are a number of NGOs undertaking education activities but the messaging is fragmented and inconsistent. Waste education/awareness is missing/limited in rural areas and settlements There are no staff currently undertaking or responsible for waste education or awareness activities at the municipal level.
Recycling	 There is limited recycling of pre-sorted and easily available material currently taking place. Organics are not being composted or even source separated at household or commercial level. Market waste is currently going to the landfill at every municipality. Recycling capacity in Belize is limited by the lack of consistent availability of feedstock, prohibitive shipping costs and lack of availability of simple, bespoke recycling infrastructure that allows for the collection and consolidation of material. There is currently no coordination amongst the collection, recycling and disposal organisations to ensure resource recovery takes place





Theme	Gaps
Monitoring	 There is no monitoring and evaluation being undertaken for the impact or implementation of the policies and plans that exist at the national and municipal level. There is a lack of staff available to undertake this monitoring as all organisations with responsibility in the SWM sector are severely understaffed. Waste coming into landfill is weighed and the data uploaded periodically on the BSWaMA website. However, this data is currently underutilised. The weighbridge data could possibly be used for ongoing monitoring of the landfill disposal rates and possible impacts on landfill life as demonstrated by the APWC analysis.
Training	 None of the staff currently managing waste at the municipal level have had direct waste management training. Due to the current focus of national and international organisations on waste, especially on plastics, the waste sector is moving at a pace that most organisations can't keep pace with. The staff responsible for policies and plans being developed or requiring implementation feel ill-equipped to undertake this work.





9 Recommendations

APWC makes the following recommendations based on collected data, stakeholder interviews and observation over the course of this project.

Theme	Recommendations
Policy & legislative framework and institutional arrangements	 Undertake a full review of the current policies, plans and strategies at the national level that deal with all aspects of solid waste management and how they help fulfil the goals of the National Solid Waste Management Plan 2015 (NSWMP). Develop a National Action Plan with goals, and achievable and measurable targets that can be monitored over time encompassing the entire waste hierarchy including avoidance. The action plan must help fulfil the vision and goals outlined in the NSWMP 2015. Help the municipalities develop targeted action plans that work towards setting practical targets for their communities. The targets within these action plans should contribute towards the goals of the NSWMP. The municipalities should be also be supported to develop data-collection mechanisms that assist in reporting against the targets. Review the implementation of the environmental levy and the disbursement of funds. The development of action plans should help provide clarity around the roles of each organisation (both nationally and at the municipal level) and how they contribute towards achieving the national waste management goals. Clarity of roles would also help in achieving greater enforcement of the existing legislation by apportioning responsibility.
Waste management financing	 Introduce applicable waste-financing mechanisms to generate sustainable funding support for the provision of waste services. This includes introducing household waste management fees and tipping fees. This might have to happen slowly or can piggyback on other bills, such as electricity and water. Ensure all funds collected through the financial arrangement are ring-fenced for waste management-related activities only, including the development of the recycling sector. Review the current <i>Returnable Containers Act</i> and overhaul it to include a wider range of items (with a differential return price) with an attached financial feasibility study to ensure the Act does not favour one sector over the other. Introduce extended producer responsibility schemes (EPR) that support the recovery and safe disposal of materials considered hazardous or harmful.

Table 14: Draft key recommendations for Belize waste management





Capacity building	 Support training for existing staff supporting waste management activities at national and council levels. Priority must be given to staff and workers that have not yet attended any training
	Explore a regional collaboration model whereby staff can establish long-term connections with other staff in Central
	America and the Caribbean who are involved in developing and implementing similar policies and programs.
	Promote the transfer of skills from current trained and experienced staff to new staff and workers. Use the current staff
	and workers within BSWaMA, DOE and various municipalities to provide technical assistance and training to others who
	might need more technical support, therefore creating a national pool of trainers.
	Use donor-funding opportunities like with Cefas and JICA to help promote a cross-regional network. For example, various
	experiences and projects in the Pacific can be applied in the Caribbean and the same is true for projects in the Caribbean. A
	cross-regional network whereby staff from the Caribbean can benefit from training with their Pacific colleagues and vice versa should be explored through various aid agencies and donor organisations.
Co-ordination	 Strengthen the national co-ordination capacity of the responsible agencies for the co-ordination of waste management activities throughout Belize including medical waste, ship-generated waste and waste from agricultural and industrial sectors.
Collection service	Consider a stand environment to increase the area environment for the provision of collection convice hyperprision litics or village
	 Consider a staged approach to increase the area covered for the provision of collection service by municipalities of village councils. Different collection models like pre-paid bag systems (much like the Pacific) could be trialled to determine their feasibility in the Belizean context
	 Provision of trucks to support the pilot project at the above areas outside of urban agglomerates.
	 Trial and slowly introduce source separation. Wet and dry materials could be separated in stage 1 with all dry materials
	pre-sorted at the transfer stations and wet materials going to windrow composting.
	• Change the mode of collection currently used from metal or plastic drums to MGBs with wheels or collection points with
	provision of skip bins. However, collection points often remove responsibility of waste segregation and amenity away from
	a household. Experience shows that it can cause issues.
	• Establish a comprehensive system to collect and manage all hazardous waste. The availability of transfer stations in most municipalities lends itself to an opportunity for separation and storage of hazardous wastes for appropriate disposal.
Recycling	Develop a feasibility study that determines the best possible options for separation, storage, compaction and transport of
	recyclable materials including composting to help increase the lifespan of the regional landfill.





	 Provide support of upcycling and community reuse initiatives.
	 Support the establishment of a National Waste and Recycling Association that acts as an advocacy agency for the recycling sector. Such an association must include representatives from current recyclers, manufacturers and have government support. However, the association must be convened and run by the private sector to ensure that the views of the industry are communicated through a collective forum.
Education	 Support the development of educational materials in both English and local languages for public awareness programmes and activities to promote awareness on the impacts of poor waste management and how to address it. Ensure council and NGO participation for the implementation of such programs and DOE to retain control over the content. Ensure a fully funded school education programme and integration of education materials into the curriculum.
Waste Pickers	 Actively promote the training and development of all waste-pickers currently active at the uncontrolled dump sites to transition to material segregation staff at the transfer stations. Provision of training for waste-pickers to help improve resource-recovery outcomes and value-add to the recyclable products being generated at each transfer station. An example is the initial dissemination of e-waste prior to making it available to the market.



10 References

Cia.gov. (2019). *Central America: Belize — The World Factbook - Central Intelligence Agency*. [online] Available at: https://www.cia.gov/library/publications/the-world-factbook/geos/bh.html [Accessed 11 July. 2019].

Hydea Spa (2015). Solid Waste Master Plan for Emerging Tourism Areas: Mile 24 Landfill Audit Report.

Insights, G. (2019). *Belize: Statistics*. [online] Globaledge.msu.edu. Available at: https://globaledge.msu.edu/countries/belize/statistics [Accessed 11 Aug. 2019].

Inter-American Development Bank (2013). Water and Sanitation in Belize.

Inter-American Development Bank (n.d.). *Belize Solid Waste Management Project II (BL-L1021)* sTechnical Annex.

Integrated Skills (2013). Government of Belize Consultancy to Prepare a National Solid Waste Management Policy and Strategy and Update the National Solid Waste Management Plan: Inception Report.

IDB 2013 water and sanitation in Belize technical note

Statistical Institute of Belize. (2019). *Statistics*. [online] Available at: http://sib.org.bz/statistics/ [Accessed 07 Jun. 2019].



Appendix A Household collection sheet

	Date	Auditor		Weather			
	Sample number	GPS location recorded?	Pho to?	Interview sheet provided?	Interview sheet returned?	Bags provided ?	Comm ents
1							
2							
3							
4							
5							
6							
7							
8							
9							

Household collection sheet





Appendix B: Household interview sheet

Area or Island Name: Date:..... Date:..... Sample number (H1 to H200)_____

Weather(Sunny/Windy/Rainning)

1. CONTACT INFORMATION

Household name/number	
Total number of people in the	
No. of adults in the household	
No. of children in the household	
Location	
House type	
House ownership	

2. NATURE OF THE WASTE GENERATED

Daily Diet:

Preference 1	P or Buy		
Preference 2	P or Buy		
Preference 3	P or Buy		
Weekly number of soft drink cans cons	umed		
Weekly number of water bottle consur	ned		
Weekly expense on groceries: VUV	Per	OR	
(Total)			
Weekly expense on transportation: VL	JVPer	OR	
(Total)			
Weekly expense on electricity: VUV	Per	OR	
(Total)			

3. MEASURE OF INCOME

Source of Income	
No. of people employed in the family	
Estimated monthly income	

4. WASTE MANAGEMENT

No. of bins in the house	
What is the waste level in your house	
when the collection comes	
Do you burn any waste	
 Take your bin out to a 	
collection point	
 Throw it along the 	
road/creek/ocean	





 Bin gets collecte house 	d from your	
 Other (describe dispose of your where) 	how you waste and	
Green waste		
General waste		
Bulky waste		
 Nappies 		

5 AWARENESS LEVEL

Are you aware of the waste	
collection/recycling services	
available? (Y/N) if yes, how many?	
Did you get any information about	
the collection services	
How did you get this information	
or where did you hear about it	
from?	
Do you have a radio?	

6. APPRECIATION OF THE COLLECTION SERVICE

Rate your collection service from 1	
to 10. 1 is really bad.	
What's the reason for the score?	
Do you have any suggestions for	
improvement?	

7. WILLINGNESS TO PAY FOR THE SERVICE

How much you are willing to pay if	
the waste collection is charged	
(monthly)?	
Do you support an idea of	
introducing a rubbish bag for	
people to put in their waste like in	
NZ, Australia, Kiribati and Vanuatu	
These rubbish bags cost between	
20 cent to 1 dollar. How much you	
can afford if we sell the rubbish	
bag?	

8. CDL & RECYCLING

In order for cans, plastic bottles, and bulky waste to be recycled and sent overseas, we need to support the cost by introducing a waste levy like other countries, e.g. 10 cent for soft drinks, \$100 for import cars, \$50 for washing machines and refrigerators. Do you support this plan?





Appendix C: Further sort sheet

Beverage containers	Cigarette Butts	Cigarette Packets	Straws	Coffee Cups		
Bags - heavy glossy typically branded	Bags - supermarket type	Takeaway containers (plastic and paper)	Takeaway container lids		+	
	ingine weight curry sugs	(plustic and paper)	container nus			
	BEV	ERAGE CONTAINER ONLY FU	RTHER SORT			
Aluminium	<150	>151 - 500	>501-1000	1001-3000	>3001	
Alcoholic sodas & spirit-based mixers						
Beer						
cider/fruit based etc						
flav water/soft drink (carbonated)						
flav water/soft drink (non-carb)						
Other Steel						
Alcoholic sodas & spirit-based mixers						
Beer						
cider/fruit based etc						
flav water/soft drink (carbonated)						
flav water/soft drink (non-carb)						
IPR						
milk						
flavoured milk						
fruit juice (>90% fruit &/or Veg juice)						
fruit drink						
flav water/sports drink, non-carb						
DET						
milk						
drink pouches						
flav. Milk						
flav water/ sports drink etc (non-carb)						
flav water/soft drink (carbonated)						
fruit juice (>90% fruit &/or Veg juice)						
fruit drink						
Other						
HDPE						
milk drink noveboo						
flav Milk						
flav water/ sports drink etc (non-carb)						
flav water/soft drink (carbonated)						
plain water (carbonated or non-carb)						
fruit juice (>90% fruit &/or Veg juice)						
fruit drink Other						
Other Plastic						
milk						
drink pouches						
flav. Milk						
flav water/ sports drink etc (non-carb)						
plain water (carbonated or non-carb)						
fruit juice (>90% fruit &/or Veg juice)						
fruit drink						
wine bladders						
Other						
Alcoholic sodas/spirit-based mixers						
Beer						
Cider/fruit based etc						
Flav water/soft drink (carbonated)						
Plain water (carbonated or non-carb)						
fruit juice (>90% fruit &/or Veg juice)						
Wine (glass only)						
Wine cooler						
Spirit						
Other						





Appendix D: Inclusions and exclusions in CDL

		>150 -	>500ml -					
MATERIAL CATEGORY	0 - 150ml	500ml	1lt	>1L - 1.5lt	>1.5lt - 2lt	>2 - 2.5lt	>2.5lt - 3lt	>3L
Aluminium	EXCL							EXCL
Alcoholic sodas & spirit-based mixers	EXCL							EXCL
Beer	EXCL							EXCL
cider/fruit based etc	EXCL							EXCL
flav water/soft drink (carbonated)	EXCL							EXCL
flav water/soft drink (non-carb)	EXCL							EXCL
Other	EXCL							EXCL
Steel	EXCL							EXCL
Alcoholic sodas & spirit-based mixers	EXCL							EXCL
Beer	EXCL							EXCL
cider/fruit based etc	EXCL							EXCL
flav water/soft drink (carbonated)	EXCL							EXCL
flav water/soft drink (non-carb)	EXCL							EXCL
Other	EXCL							EXCL
LPB	EXCL							EXCL
milk	EXCL	EXCL	EXCL	EXCL	EXCL	EXCL	EXCL	EXCL
flavoured milk	EXCL			EXCL	EXCL	EXCL	EXCL	EXCL
fruit juice (>90% fruit &/or Veg juice)	EXCL			EXCL	EXCL	EXCL	EXCL	EXCL
fruit drink	EXCL							EXCL
flav water/sports drink, non-carb	EXCL							EXCL
Other	EXCL							EXCL
HDPE	EXCL							EXCL
milk	EXCL	EXCL	EXCL	EXCL	EXCL	EXCL	EXCL	EXCL
drink pouches	EXCL							EXCL
flav. Milk	EXCL			EXCL	EXCL	EXCL	EXCL	EXCL
flav water/ sports drink etc (non-carb)	EXCL							EXCL
flav water/soft drink (carbonated)	EXCL							EXCL
plain water (carbonated or non-carb)	EXCL							EXCL
fruit juice (>90% fruit &/or Veg juice)	EXCL			EXCL	EXCL	EXCL	EXCL	EXCL
fruit drink	EXCL							EXCL
Other	EXCL							EXCL
PET	EXCL							EXCL
milk	EXCL	EXCL	EXCL	EXCL	EXCL	EXCL	EXCL	EXCL
drink pouches	EXCL							EXCL
flav. Milk	EXCL			EXCL	EXCL	EXCL	EXCL	EXCL
flav water/ sports drink etc (non-carb)	EXCL							EXCL
flav water/soft drink (carbonated)	EXCL							EXCL
plain water (carbonated or non-carb)	EXCL							EXCL
fruit juice (>90% fruit &/or Veg juice)	EXCL			EXCL	EXCL	EXCL	EXCL	EXCL
fruit drink	EXCL							EXCL
Other	EXCL							EXCL
plastic other	EXCL							EXCL
milk	EXCL	EXCL	EXCL	EXCL	EXCL	EXCL	EXCL	EXCL
drink pouches	EXCL							EXCL
flav. Milk	EXCL			EXCL	EXCL	EXCL	EXCL	EXCL
flav water/ sports drink etc (non-carb)	EXCL							EXCL
flav water/soft drink (carbonated)	EXCL							EXCL
plain water (carbonated or non-carb)	EXCL						-	EXCL
truit juice (>90% truit &/or Veg juice)	EXCL			EXCL	EXCL	EXCL	EXCL	EXCL
Truit drink	EXCL						-	EXCL
wine bladders	EXCL			EXCL	EXCL	EXCL	EXCL	EXCL
Other	EXCL							EXCL
Glass	EXCL							EXCL
Accorolic sodas/spirit-based mixers	EXCL							EXCL
Beer Cideo (fruit based at a	EXCL							EXCL
Cluer/Truit based etc	EXCL							EXCL
Flav water/soft drink (carbonated)	EXCL							EXCL
fruit water (carbonated or non-carb)	EXCL			EV/CI	EVCI	EV.CI	EVC:	EXCL
fruit drink	EXCL			EXCL	EXCL	EXCL	EXCL	EXCL
II UIL UIIIIK	EXCL	EV.CI	EV.CI	EV/CI	EVCI	EV.CI	EVC:	EXCL
Wine coolor	EXCL	EXCL	EXCL	EXCL	EXCL	EXCL	EXCL	EXCL
while cooler	EXCL	EVO	EVO	EVCI	EVCI	EVO	EVCI	EXCL
Othor	EXCL	EXCL	EXCL	EXCL	EXCL	EXCL	EXCL	EXCL
Utilei	EXCL							EXCL





Appendix E: All data sources and assumptions

Data used	Assumption/source of data
Town Population 2010	Census 2010
	Assuming a 2.5% growth rate (national rate, 2010 census).
Town Population 2019 (est.)	Belmopan in particular may be growing faster than this
Estimated population out of	SWMP II Technical background; Cayo similarly populated to Orange
city TS catchment (2015)	Walk and Corozal
Estimated population out of	
city TS catchment (2019)	Assuming 2.5% growth rate (based on 2010 census data)
Population Served by transfer	
station 2019	Sum of Town pop 2019 and Estimated out of town population 2019
Households 2010	Census 2010
	Assuming 2.5% growth rate for Belize City and 3.5% (national rate,
Households 2019 (est. –	2010 census) for other areas. Belmopan in particular may be
census data)	growing faster than this
Estimated per capita	
household disposal rate	APWC waste generation data
Estimated per employee	
commercial disposal rate	APWC waste generation data
Workforce participation	Statistical Institute of Belize, Labour Force Statistics April 2018
Estimated monthly tonnage to	Per capita disposal rate * population * 30 days + per employee
transfer station (by	disposal rate * workforce participation * population * number of
population)	days
Estimated monthly tonnage to	Per household disposal rate * households * 30 days + per employee
transfer station (by	disposal rate * workforce participation * population * number of
households)	days
Recorded monthly tonnage to	Belize Solid Waste Management Authority Statistics 2013–2018
transfer station	assuming 5% growth rate to 2019
	WA Waste Authority Converting volumes to tonnes, US EPA volume-
Densities	to-weight conversion factors 2016




Appendix F: Overall waste quantity based on population model

APWC modelled the national waste disposal based on populations and household numbers of major administrative areas from the 2010 census, which we projected forward to 2018 figures by applying a blanket growth rate of 2.5% to the population and 3.5% to the number of households. For towns and villages not listed in the major administrative areas (table 2 of the 2010 census), we assumed an average population of 700.

The model used is <u>described here</u>. We focused on predicting the household generation rate as we found that our model achieved a much better fit for predicting household generation rates than it did for predicting per capita rates. In addition, we found that an estimate of overall waste generation for Belize city based on the household rate agreed better with the BSWaMA figure than the estimate based on per capita rates. Census data recorded household numbers as well as population numbers, so a per household rate could be used to predict total waste generation.

Generation Rate
$$\left(\frac{kg}{hh \cdot day}\right) = 0.4 \times \ln(Town \ population)$$

To this, we assumed commercial waste increased the overall generation rate by an additional 35%, the average across all towns in our data.

The low and high numbers represent a 95% confidence interval determined by the model's observed performance at explaining 85% of the variance of off-sample data and a 95% confidence interval of the overall generation rate from our raw data. Though we say these are 95% confidence intervals, modelling assumptions contribute substantial additional uncertainty and the overall level of confidence is not anywhere near 95%.

First, we checked the model's output against existing data from BSWaMA. For the San Ignacio area, the model predicted somewhat less waste than was seen at the San Ignacio transfer station; in fact the actual figure did not fall within our confidence interval. Note that we took the San Ignacio area to include San Ignacio, Santa Elena, Benque Viejo and San Jose Succotz. There may have been additional villages served by collection services that we did not consider here – these would still have contributed to our total estimated, but we did not identify them as connected to the San Ignacio transfer station.

For the tourist destination of San Pedro, the model predicts only 50% of the waste. For Caye Caulker and Burrell Boom, it predicts only 15% of the waste. Including contributions from tourists, these towns are likely to have much higher per-household waste generation rate than the towns we studied. Therefore, we added the "missing waste" to the total waste estimate to account for this likely shortcoming of the model.





	Total Waste Generation (Tons per day) – model prediction	Existing data
Overall Waste for Belize	160 (133-187)	
Belize City	63 (57-68)	60*
San Ignacio Area	19 (17-22)	25*
San Pedro	10 (9-11)	21*
Burrell Boom	1 (0.8-1.2)	6*
Caye Caulker	0.8 (0.7-0.9)	6*

*BSWaMA 2018

** APWC waste survey

We generated rough estimates of the total quantities of generated waste that are not presently provided any service transporting waste to the Mile 24 landfill, as well as the amounts of generated waste that will not be transported after SWMP part II is complete.

These figures are very inexact, and as we have seen true values may fall outside the confidence intervals. The overall trend, however, is that waste generation is much less intensive in less populated areas where there tends to be more people in each house *and* less waste per household generated, so even though we estimate up to 40% of the country's population will not be reached by waste collection services after SWMP II is complete, our estimate was that this only represents 15-35% of the generated waste.

Total currently moving to landfill (BSWaMA 2018), tons per day	118*
Extra waste moving to landfill with SWMP II	40 (32-49)**
Extra waste from tourist areas: Burrell Boom +	20
San Pedro + Caye Caulker	
Overall Waste including tourist areas	180 (153-207)
Waste currently not being landfilled	62 (25-89)
Waste not landfilled including new transfer stations	22 (57)







Appendix G: Council service provision

	Punta Gorda	Dangriga	Belmopan	San Ignacio	Orange Walk	Belize City
Mayor	Mayor Mr Ashton Mckenzie <u>mckenzieashton@gmail.com</u> 610-8906	Mayor Francis Humphreys <u>Dangrigatowncouncil@gmail.com</u> 6210068	Mayor Khalid Belisle bntcitco@gmail.com	Mayor Earl Trapp	Kevin Bernard 6701412	Mayor Bernard Wagner
Counsellor in- charge of sanitation	Counsellor Winston Chun 6140374				Josue Carballo 6701098 Jcarballo.tec@gmail.com	Councillor Michael Norales
Director of sanitation (if exists)					Mr Omar Mendez Operationsmanager2@hotmail.com 6703949	Mr. Kevaun Jenkins sanitation@belizecitycouncil.org
Do they currently have a JICA volunteer?	Yes	No, have requested one. Application currently in place.	No	No	Yes, have for the past 10 yrs every two year/mostly education	Yes
Total population of town in 2019 as estimated by council		10,000		35,000	19,000	80,000 ppl
Total households in town as estimated by council		2000			700+126	16,000+ properties
% coverage (Percentage of households with a rubbish service)	All houses within town boundary	More than 90%	95%	100% within town boundary	100% within town boundary	100% within town boundary







	Punta Gorda	Dangriga	Belmopan	San Ignacio	Orange Walk	Belize City
No. Of trucks Trucks for collection of household waste, commercial waste, trees and branches and bulky waste?	1 + 1 requested from JICA	1 truck (matched 50% from prime minister)+ 1 requested from JICA	3 trucks + 1 requested from JICA 2 tractor trailers 3 flatbeds 1 septic truck	2 tractors with trailers and 4 compact trucks	3 trucks in total 2 flat beds+ 1compactor 1 currently requested from JICA (8 tonnes per truck collected/ 2routes per day)	2 flatbeds for bulky waste Rest of the vehicles are owned by contractor- Belize waste control
Staff	Driver + 2ppl 2 litter pickers (2am to 6am) JICA volunteer	Driver + 2ppl 4 litter pickers, all ladies Litter pickers start at 6.30am	50 staff 9 (3 truck crews) 15 parks and cleanliness 3 litter pickers 11 at the market	25 staff – 6 are drivers and 19 are garbage collectors	35	More than 300 workers including litter pickers.
Collection start time	First shift 4am to 10amSecond shift 10am to 4am	4am	6am everyday		 4am first trip 9am second trip	Starts 6am, put out notices.
Collection map	Yes, prepared by JICA volunteer	No, not formal but the town is divided into two zones with the river as the zone boundary. North of river=Monday - Thursday South of river=Tuesday - Friday	Does not exist.	San Ignacio and Santa Elena are one administrative municipality, but for collection of garbage it counts as two. San Ignacio has 4 zones and Santa Elena has 4 zones Collection map is available	Provided ACTION- Create collection map	Contractor requires residents to bag their waste







	Punta Gorda	Dangriga	Belmopan	San Ignacio	Orange Walk	Belize City
How is waste placed out to be collected?	Residents are requested to bag their waste and place in waste receptacles in front of their homes.	Residents are requested to bag their waste and place in waste receptacles in front of their homes.	Residents are requested to bag their waste and place in waste receptacles in front of their homes.	Households are expected to have their garbage bagged off and in a bin. The bin has to be outside of the household property.	Residents are requested to bag their waste and place in waste receptacles in front of their homes.	Residents are requested to bag their waste and place in waste receptacles in front of their homes.
Type of household service Frequency of service	Door to door Once a week	Door to door Once a week	Door to door Twice a week	Door to door once a week with market area and downtown is twice or up to 3 times weekly	Door to door Once to twice per week depending on area Downtown 3 times per week	Door to door By contractor see schedule
Service charge hhld	BZD 1/hhld/week urban BZD 4/hhld/week remote	None	BZD60/yr	None	Currently no fees Proposal to charge 5 BZD/hhld/month	No fee
Type of service Commercial	Door to door Everyday	Door to door Everyday	Door to door 2 times /week		Door to door Everyday	Door to door
Service charge commercial	BZD10-15 per week based on size of business	Based on generation Covers 20% of total cost	BZD 3-60 per yr	\$5.00 - \$100.00 per month	\$13-\$26 BZD per month	Direct contract with Belize waste control
Total expense for waste management	BZD 30,000 per month	BZD132,000 per yr	2 mil BZD per yr		40,000 BZD per month	BZD 58,000 per week
Total income from fees collected	BZD2000	32,040				Part of property tax
Who is responsible for collecting fees?	Collection officer for council that accompanies the truck	Hhlds come in and pay the fees.	Council issues a bill, customers come and pay at counter	The revenue collectors for SISE do the collection. But mostly business		Invoice issued yearly come in any pay







	Punta Gorda	Dangriga	Belmopan	San Ignacio	Orange Walk	Belize City
				owners need to go pay at SISE.		
What percentage of fees is collected? Or do all people pay their fees?	80%	No fees	\$60/yr with a 20% collection rate		Collectors go out and collect fees	18 mil in arrears in 5years 58-70% Engaged a commission system for collections
Are their fines for littering	Yes, but not enforced. Council provided a copy of their littering Act	Yes, but not enforced. Council provided a copy of their littering Act	Yes, but not enforced. Council provided a copy of their Littering Act	No fines as of yet	Yes, but not enforced. Council provided a copy of their Littering Act	Littering falls under DOE Mayor association is considering looking into the authority to issue littering tickets.
Needs of council to improve waste service?	Trucks Safety equipment like gloves, boots, suits and raincoats. Education for residents	Trucks Safety equipment like gloves, boots, suits and raincoats. Education for residents	Trucks Safety equipment like gloves, boots, suits and raincoats. Education for residents	Education, implemented bin systems, school outreach, implement separation system, differentiation of garbage trucks for different wastes, health guidelines, installing garbage nets in problematic areas to make collection from public spaces more efficient.	4 compactor trucks Safety equipment Truck for collecting illegal dumps and C&D material Prefer to have more authority to act. Currently limited authority and limited staff	







	Punta Gorda	Dangriga	Belmopan	San Ignacio	Orange Walk	Belize City
Organisations active in the space?	JICA- 1yr OCEANA – 3yrs TIDE – 17yrs	JICA- 1yr OCEANA – 3yrs TIDE – 17yrs	JICA- 1yr OCEANA – 3yrs TIDE – 17yrs	None	JICA mostly	OCEANA – 3yrs TIDE – 17yrs
Market waste	 Market- waste water located next to the sea- waste water pumped \$120/month per stall- water, electricity, cleaning 				 Collected everyday even on public holidays. Approximately 2 tonnes per day 	Picked up by waste control Current charges include market waste Exclusive control over all services Currently trying to negotiate the dumping waste fees
Biosolids pumping	• \$200/truck 6 truckloads per 3 months.		40% of town on sewer managed by Belize water services 60% septic tanks which is pumped by a contractor \$135/visit End treatment at BWS		• 75% septic tanks pumped by private contractor	BWS- Belize Water services By law each household if not collected by sewage, each house should have a soak-away and Currently drain connects directly to the drain. The new homes that are being built in the squatter areas People are moving out to the outskirts Only two building inspectors
No. of pickers at the landfill	4	8	25	Landfill closed	20	Landfill closed waste goes to regional landfill
Equipment at landfill	Currently none, hired as required	Hire a bulldozer every three months	2 staff and hire a dozer as required. Practice burning	Backhoe and 2 trucks which take waste from Belize City	Currently none, hired as required	All waste going to Transfer Station



Centre for Environment Fisheries & Aquaculture Science

About us

The Centre for Environment, Fisheries and Aquaculture Science is the UK's leading and most diverse centre for applied marine and freshwater science.

We advise UK government and private sector customers on the environmental impact of their policies, programmes and activities through our scientific evidence and impartial expert advice.

Our environmental monitoring and assessment programmes are fundamental to the sustainable development of marine and freshwater industries.

Through the application of our science and technology, we play a major role in growing the marine and freshwater economy, creating jobs, and safeguarding public health and the health of our seas and aquatic resources

Head office

Centre for Environment, Fisheries & Aquaculture Science Pakefield Road Lowestoft Suffolk NR33 0HT Tel: +44 (0) 1502 56 2244 Fax: +44 (0) 1502 51 3865 ASIA PACIFIC WASTE CONSULTANTS

growing our business in overseas markets, with a particular emphasis on Kuwait and the Middle East.

Our customer base and partnerships are broad, spanning Government, public and private sectors, academia, non-governmental organisations (NGOs), at home and internationally.

We work with:

- a wide range of UK Government departments and agencies, including Department for the Environment Food and Rural Affairs (Defra) and Department for Energy and Climate and Change (DECC), Natural Resources Wales, Scotland, Northern Ireland and governments overseas.
- industries across a range of sectors including offshore renewable energy, oil and gas emergency response, marine surveying, fishing and aquaculture.
- other scientists from research councils, universities and EU research programmes.
- NGOs interested in marine and freshwater.
- local communities and voluntary groups, active in protecting the coastal, marine and freshwater environments.

www.cefas.co.uk

Weymouth office Barrack Road The Nothe Weymouth DT4 8UB

Tel: +44 (0) 1305 206600 Fax: +44 (0) 1305 206601



Customer focus

We offer a range of multidisciplinary bespoke scientific programmes covering a range of sectors, both public and private. Our broad capability covers shelf sea dynamics, climate effects on the aquatic environment, ecosystems and food security. We are

© Crown copyright 2016 minimum 75% de-inked post-consumer waste

