Majuro Atoll Waste Company

Solid Waste Management Plan for Majuro

2019 – 2028

(Action Plan: 2019-2023)

Acknowledgements

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Foreword

Solid waste management is a major undertaking. Majuro Atoll is the capital of the Republic of the Marshall Islands with an estimated population of 27,797 (2011 Census) on land area of 3.75 square miles. Majuro Atoll Waste Company averages around 38.5 tons of waste collected at site per day.

Waste disposal remains a huge issue for RMI. The visible waste mountain in Majuro has not only become an eyesore but a major hazard. This document was gifted to the RMI National Government by Japan International Cooperation Agency (JICA); the Majuro Atoll Waste Company Solid Waste Management Plan for Majuro 2019 – 2028 (Action Plan: 2019-2023) will assist MAWC in establishing a technically sound and financially sustainable solid waste management (SWM) system.

Under the National Strategic Plan 2020-2030, Waste Management is included. The Goal is "Reliable infrastructure for effective management of waste, chemicals and pollutants." The objectives of this policy include: 1) Accessible community collection services 2) Sustainable landfill applications 3) Local Recycling 4) Appropriate incineration & 5) Effective export facilities.

Majuro Atoll Waste Company will continue to support the Cleaner Pacific Movement in accord with the Republic of the Marshall Island Government.

Honorable Minister Jiba Kabua
Chairman
Majuro Atoll Waste Company Board

7/28/20
Date

Table of Contents

TABLE OF CONTENTS III

EXECUTIVE SUMMARY VI

1 FORMULATION OF SOLID WASTE MANAGEMENT PLAN 2

1.1 OBJECTIVES 2
1.2 STRUCTURE OF SWMP 2

PART ONE: CURRENT SWM SITUATION 2

2 CURRENT SITUATION AND ISSUES 2

2.1 GENERAL INFORMATION 2
2.1.1 GEOGRAPHY 2
2.1.2 POPULATION 3
2.1.3 ADMINISTRATION 4
2.1.4 LAND OWNERSHIP 4
2.1.5 ECONOMIC SITUATION 4
2.2 CURRENT SITUATION ON SOLID WASTE MANAGEMENT 5
2.2.1 OVERVIEW OF SWM FROM THE POINT OF VIEW OF WASTE FLOW 5
2.2.2 TECHNICAL SITUATION OF SWM 6
2.2.3 INSTITUTIONAL SITUATION OF SWM 20
2.2.4 FINANCIAL SITUATION OF SWM 21
2.3 MAJOR CHARACTERISTICS OF SWM IN MAJURO 23
2.3.1 WASTE GENERATION 23
2.3.2 WASTE DISCHARGE 23
2.3.3 WASTE COLLECTION SYSTEM 24
2.3.4 CDL SYSTEM AND EXPORT OF RECYCLABLE ITEMS COLLECTED UNDER CDL 24
2.3.5 MANAGEMENT OF THE PUBLIC DISPOSAL SITE 24
2.3.6 INSTITUTIONAL SETTINGS 24

3 PART TWO: STRATEGIC PLANNING 25

3.1 THE SOLID WASTE MANAGEMENT PLAN FOR MAJURO (SWMP-M) 25
3.1.1 BACKGROUND 25
3.1.2 PURPOSE 25
3.1.3 VISION 25
3.1.4 SCOPE 25
3.1.5 GUIDING PRINCIPLES 25
3.1.6 SWM ISSUES TARGETED UNDER THE SWMP-M 26
ISSUE 1: PROPER FINAL DISPOSAL IS A CRITICAL COMPONENT OF SUSTAINABLE SWM 26
ISSUE 2: WASTE REDUCTION AND RECYCLING 27
ISSUE 3: IMPROVEMENT OF COLLECTION SERVICE 27
ISSUE 4: CAREFUL CONSIDERATION ON THE APPLICABILITY OF NEW TECHNOLOGIES 27
3.1.7 KEY STRATEGIC ACTIONS AND TIME FRAME 27
3.1.8 FUTURE WASTE FLOW 31

4. ACTION PLAN 36

4.1. ACTION 1 : PROPER OPERATION OF THE FINAL DISPOSAL SITE(S) 36
4.1.1. NECESSARY ACTIVITIES 36
4.1.2. IMPLEMENTATION SCHEDULE 37
4.1.3. IMPLEMENTATION BUDGET 37
4.2. ACTION 2: REDUCTION OF FINAL DISPOSAL AMOUNT BY COMPOSTING AND RECYCLING 38
4.2.1. NECESSARY ACTIVITIES 38
4.2.2. IMPLEMENTATION SCHEDULE 38
4.2.3. IMPLEMENTATION BUDGET 39
4.3. ACTION 3: MAINTENANCE OF WASTE COLLECTION SERVICE 39
4.3.1. NECESSARY ACTIVITIES 39
4.3.2. IMPLEMENTATION SCHEDULE 40
4.3.3. IMPLEMENTATION BUDGET 40
4.4. ACTION 4: CAREFUL EXAMINATION OF NEW SWM TECHNOLOGIES 40
4.4.1. NECESSARY ACTIVITIES 40
4.4.2. IMPLEMENTATION SCHEDULE 41
4.4.3. IMPLEMENTATION BUDGET 41
4.5. THE ACTION PLAN 42
4.5.1. SCHEDULE OF THE ACTION PLAN (2019-2023) 42
4.5.2. COST OF THE ACTION PLAN 44

ACRONYMS

AP	Action Plan
AWP	Annual Work Program
CDL	Container Deposit Legislation
EPA	Environmental Protection Authority
EIA	Environmental Impact Assessment
FY	Financial Year
HH	Household
JEMFAC	Joint Economic Management and Fiscal Accountability Committee
JICA	Japan International Cooperation Agency
MAWC	Majuro Atoll Waste Company
MALGOV	Majuro Atoll Local Government
MRF	Materials Recovery Facility
MWIU	Ministry of Works, Infrastructure and Utility
NGO	Non-governmental Organization
OCS	Office of Chief Secretary
PET	Polyethylene Terephthalate
POPs	Persistent Organic Pollutants
SPREP	Secretariat of the Pacific Regional Environment Program
SWM	Solid Waste Management
UNDP	United Nations Development Program
WACS	Waste Amount and Composition Survey

Executive Summary

Organizations in Majuro such as MWIU, MAWC, OEPPC and EPA have been making great efforts to keep the atoll clean and beautiful. Whilst substantial effort has been made by such organizations, and some of the waste problems have been ameliorated, several challenges remain. Strategic effort needs to be re-directed to focus on the remaining critical issues, as well as emerging ones currently faced by the waste sector on Majuro.

Considering the situation, this Solid Waste Management Plan for Majuro (SWMP-M) has been drawn up to enable Majuro to establish a technically sound and financially sustainable solid waste management (SWM) system. To do so, this new SWMP-M consists not only of strategic elements, but also a mid-term action plan for the first five years comprising technically, institutionally and financially appropriate options, which can provide guidance for the implementation of this SWMP-M.

SWM issues targeted under the plan

SWM issues targeted under this plan are summarized here based on the present SWM situation, which has been identified technically and quantitatively through a waste flow analysis.

Issue 1: Proper final disposal is a critical component of sustainable SWM

The current public disposal site which is located between Batkan and Jable has been operated by MAWC since 2007. It has been used as a landfill site for over10 years and the area is so limited, and the waste is piled up so high, that it is now said to be the highest point in the country. It is an urgent task to find and construct a new disposal site; however, related agencies have failed to convince policy makers to do so. Securing a new final disposal site is critical to developing a sustainable SWM system, as even if new technologies such as incineration and Waste to Energy (WTE) were to be adopted, there must always be a place to receive the end residues, which is must be a final disposal site.

Issue 2: Waste Reduction and Recycling

Managing, as well as finding, a final disposal site are critical but difficult and costly activities. When a new final disposal site is found and constructed, the site will fill up over time. The longer it takes to fill the final disposal site, the lower the overall cost of that site will be when that cost is spread over the lifetime of the landfill. Thus, through recycling and composting, it is essential to reduce waste coming to the final disposal site in order to prolong the life of the disposal site, and reduce long-term costs.

Issue 3: Improvement of Collection Service

MAWC provides collection services regularly. However the collection vehicles they use are quite old, frequently break down, and this damages collection efficiency. Also, challenges remain in carrying out appropriate and timely maintenance of such vehicles and equipment by MAWC workshops. In addition, even if MAWC purchases new vehicles and maintains them appropriately and timely, vehicles and equipment tend to have a short life in such a harsh operational environment as Majuro. Therefore it is important for MAWC to develop a plan to secure the funding for capital equipment replacement well in advance of need. Furthermore, it is quite difficult and time consuming to order spare parts in a remote island like Majuro, so it is more cost effective to order a stock of common spare parts at the time of the original purchase of equipment.

Issue 4: Careful consideration on the applicability of new technologies

Land reclamation using waste has been a traditional way of disposing of waste in Majuro.

Currently, some donors are proposing new intermediate technologies such as WTE. Usually donors will support the initial investment only, and the Operation & Maintenance (O&M) cost - which is usually very expensive in case of new technologies - is expected to be borne by the recipient countries. The amount of waste generated per day in Majuro is rather limited, and possibly insufficient to make this technology feasible in the long-run. Moreover, all these new technologies are *intermediate,* not a final solution, and therefore the problem of safe disposal of the residue remains. Along with the careful consideration on the applicability of new technologies, it is an appropriate time to shed new light to the traditionally-used disposal method.

Vision

A clean and healthy Marshall islands for today and future generation

Scope

The new SWMP-M covers the 10-year period from 2019 to 2028 with an action plan designed to be implemented for the first half of the period, 2019 to 2023. A general review of the plan will be undertaken in 2023 to update its relevance to current needs, and plan the next activities for the remaining period of the plan.

The new SWMP-M covers solid wastes generated by households, and institutional and commercial operations, which is termed Municipal Solid Waste (MSW) in this plan. This Plan does not cover medical waste or hazardous waste.

Key Strategic Actions

The SWMP-M consists of the following four strategic actions:

Action 1: Proper operation of the final disposal site(s);
Action 2: Reduction of final disposal amount by composting and recycling;
Action 3: Maintenance of Waste Collection Services;
Action 4: Careful examination of new SWM technologies.

Targets

Table 1 Targets under SWMP-M

Item	Unit	2017	2023	2028
3Rs rate (Recycling to generated waste amount)	%	9	16	22
Collection rate (to discharged waste amount)	%	63	65	65
Waste not collected (to generated waste amount)	%	10	0	0
Rate of waste transported directly to landfill site	%	37	35	35

Action Plan

By reflecting upon the vision, the guiding principles and the identified SWM issues, the specific activities required to pursue the realization of this plan are laid out below. This action plan, which defines the priorities for the next five years, consists of the following four actions:

Action 1: Proper operation of the final disposal site(s);
Action 2: Reduction of final disposal amount by composting and recycling;
Action 3: Maintenance of Waste Collection Services;
Action 4: Careful examination of new SWM technologies;

For each of these actions (i) the necessary activities, with personnel requirements; (ii) the implementation schedule; and (iii) implementation costs, are detailed below.

Implementation schedule for the Action Plan (the Project)

Table 2 Schedule of the Action Plan (2019-2023)

Activities	Mid-term plan					Long-term plan				
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Action 1: Proper operation of the final disposal site(s)										
1-1: Conduct periodical monitoring of the current disposal site										
1-2:Draw a plan for landfill mining (incl. sub-construct to the mining company, etc.)										
1-3:Conduct landfill mining operation to extract decomposed earth										
1-4:Utilized the decomposed earth to backfill inside sea walls.										
1-5:Draw a plan for an extension of the current disposal site;										
1-6:Preparation for construction (budget allocation and relocation of office buildings, scrap metals, wood waste, etc.)										
1-7: Conduct an extension work (construct see walls, boundary embankment etc.)										
1-8: Start landfill operation at the extended area;										
1-9: Start preparation for a new landfill site (site selection, design, budget allocation, etc.)										
Action 2: Reduction of final disposal amount by composting and recycling										
2-1:Construct a composting yard in Laura										
2-2:Procure wood chippers for green waste to accelerate composting process										
2-3: Operate and maintain the composting yard										
2-4: Maintain the CDL activities										
2-5: Monitor CDL activities and produce an annual report										
Action 3: Maintenance of Waste Collection Service										
3-1:Formulate investment plan for waste collection services										
3-2:Replacement of waste collection trucks										
3-3:Replacement of waste containers										
3-4:Proper operation and maintenance of waste collection equipment										
Action 4: Careful examination of new SWM technologies										
4-1:Conduct feasibility studies on new SWM technologies										
4-2:Careful examination of the results of these feasibility studies, and produce an assessment report.										
4-3:Submit an assessment report to the relevant authorities										

Cost of the Action Plan

The estimated cost to implement the Action Plan is shown in the table below. The entire cost of the Action Plan is estimated at US$9.2 million over five years.

Table 3 Estimated cost of the Action Plan by each component in 5 years.

	FY2019	FY2020	FY2021	FY2022	FY2023	Total
Action 1: Proper operation of the final disposal site(s)	344,000	500,000	1,890,000	1,044,000	636,000	4,414,000
Action 2: Reduction of final disposal amount by composting and recycling	204,000	382,800	232,800	232,800	232,800	1,285,200
Action 3: Maintenance of Waste Collection Service	642,000	1,010,000	600,000	600,000	600,000	3,452,000
Action 4: Careful examination of new SWM technologies	0	27,000	27,000	9,000	0	63,000
Total	1,190,000	1,919,800	2,749,800	1,885,800	1,468,800	9,214,200

1 Formulation of the Solid Waste Management Plan

1.1 Objectives

Organizations in Majuro such as MWIU, MAWC and EPA have been making great efforts to keep the atoll clean and beautiful. Whilst substantial efforts has been made by such organizations named above, and some waste problems has been ameliorated, several challenges remain. The strategic efforts have to be re-directed to focus on the remaining critical issues as well as emerging ones currently faced in the waste sector in Majuro.

By considering the above situation, this SWMP-M is formulated by aiming to enable Majuro to establish a technically sound and financially sustainable solid waste management (SWM) system. To do so, this new SWMP-M consists of not only strategic elements but also a mid-term action plan of the first five years with technically, institutionally and financially appropriate options, which will propel realization of the SWMP-M.

1.2 Structure of SWMP

This Solid Waste Management Plan for Majuro (SWMP-M) is presented in two parts:
Part One provides the current SWM situation faced in the waste sector in Majuro. In this part, the current issues are ascertained through a two-step process, first through an understanding of the current SWM situation, and then second, analysis of that situation. As a first step, the current waste flow is formulated based on a series of baseline surveys, and the situation is technically as well as quantitatively understood. Then, the issues and challenges are identified based on those waste flows.
Part Two presents the main body of the SWMP-M. It consists of (i) major SWM issues which will be targeted under the SWMP-M, (ii) an Action Plan with key strategic actions which tackle identified SWM issues, and (iii) annual implementation plans. Part Two will define the directions which Majuro should take to improve the solid waste management situation for the next generation.

PART ONE: CURRENT SWM SITUATION

2 Current Situation and Issues

2.1 General Information

2.1.1 Geography

The Republic of Marshall Islands (RMI) is situated in the Central Pacific Ocean between 4º and 14º North and 160º and 173º East in almost two parallel chains of 31 atolls and islands: the Eastern Ratak (Sunrise) chain with 15 atolls and islands and the Western Ralik (Sunset) chain having 16 atolls and islands. The total number of islands and islets is about 1,225.

The total sea and land area of the country is approximately 1.94 million square kilometers and 181 square kilometers respectively; the land area is less than 0.01% of the total surface area. The climate is tropical - ocean. The temperature averages 27ºC, with little variation throughout the year. The

northern atolls receive about 2m of rainfall a year while the annual rainfall in southern atolls is normally higher, about 4m per annum.

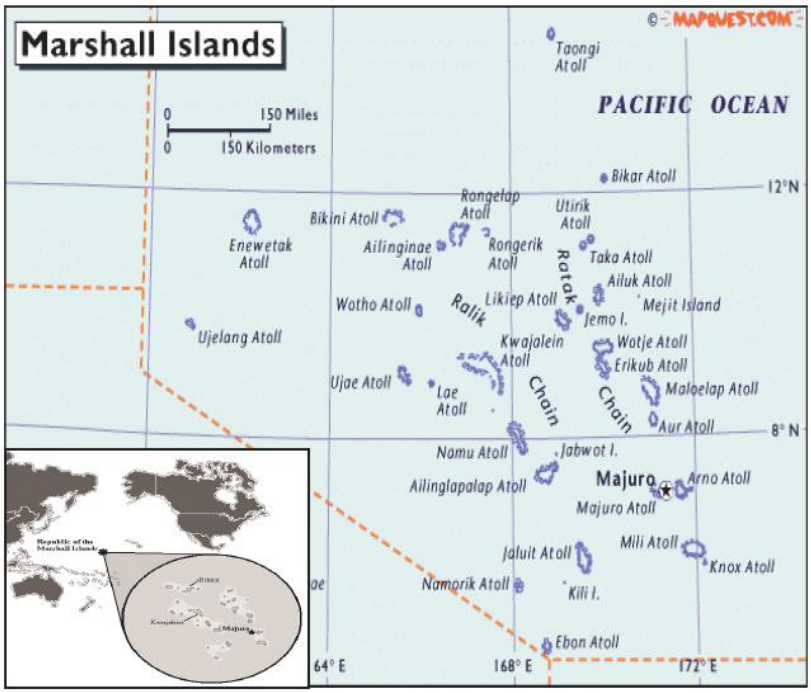


Figure 2-1: Map of the Marshall Islands and Location in the Pacific Ocean

2.1.2 Population

Table below provides a comprehensive summary account of population size and population density for Majuro and Ebeye for the last 30 years. A key feature of RMI population distribution has been the dominance of Majuro and Kwajalein (largely Ebeye), currently accounting for 74% of the country's population. Expressed differently, 3 out of every 4 Marshall Islanders live on these two atolls. This predominance has steadily increased over the years, from 60% in 1980, to 67% and 68 % in 1988 and 1999. This uneven population distribution has been exacerbated over the years by a growing exodus of people from the outer islands to these two population centers, and in recent years, overseas migration.

Table 2-1 Population size and density by island in 1980, 1988, 1999 and 2011 census years

	Population				Population Density		
	1980	1988	1999	2011	1988	1999	2011
Marshall	**30,873**	**43,380**	**50,840**	**53,158**	**619**	**726**	**759**
Majuro	11,791	19,664	23,676	27,797	5,244	6,314	7,413
Kwajalein	6,624	9,311	10,902	11,408	1,471	1,722	1,802

Source: *The RMI 2011 Census of Population and Housing Summary and Highlights Only,* Economic Policy, Planning, and Statistics Office Office of the President

These different growth rates also impact on varying population densities across the Marshall Islands.

Majuro, with a total land area of 3.75 square miles (or 9.71 square kilometers) is home to 27,797 residents, which translates into a population density of 7,413/sq. mile, or 2,860/km2. The highest density in the Marshall is on Ebeye island in Kwajalein Atoll where 9,614 people live on 0.12 square miles (0.31 km2), resulting in population densities 80,117/sq. mile or 31,013/km2). Population densities of this magnitude, when associated with overcrowding, often entails health and other social challenges of varying severity.

2.1.3 Administration

The government of Marshall Islands operates under a mixed parliamentary presidential system, which includes a head of state, the President, and a bicameral parliament the Council of Iroiji (an unelected upper house) and Nitijela (the elected lower house). Executive power lies with the President, who is elected by the Nitijela, and the Presidential Cabinet. The President appoints cabinet ministers to lead in government departments with the approval of the Nitijela.

Legislative power resides in the Nitijela, which consists of 33 senators elected by 24 electoral districts by universal suffrage of all citizens above 18 years of age. The electoral districts correspond roughly to each atoll of the RMI. Although no legal restrictions exist against the formation of political parties, no formal parties exist. Two ad hoc parties have existed since the mid-1990s. The Council of Iroij is comprised of 12 traditional chiefs who advise the Presidential Cabinet and review legislation regarding customary law and traditional practice.

2.1.4 Land Ownership

The land tenure in the Marshall Islands is based on a matrilineal society. All children inherit lands from their mothers. There are no landless people and their land tenure pattern is the most important single factor of their lives. All children become members of their mother's clan. However, the clan is not a factor in the land ownership pattern. A paramount chief in the Marshalls is not a clan chief. His powers are associated with specific land parcels and the people that live on them. A land parcel is controlled by a paramount chief, a family head and an undetermined number of commoners, or workers as they are sometimes called. Each land parcel bas a name and a history. The relative interests of various owners are seldom determined exactly.

2.1.5 Economic Situation

Latest (2015) economic indicators as supplied by the Asian Development Bank are a GNI of US$209 million, a GNP per capita of US$4,630, and economic growth in 2017 of 4%. This makes the RMI a lower middle income nation, although differences in wealth across urban areas and remote outer islands can be dramatic. The 2011 census revealed that the median annual household income in the Marshall Islands is US$6,476, down from the US$6,840 reported in the 1999 census. The median annual household income varies widely by atoll/island. In Ebon, Jabat, Lae and Mili it is almost nil, whilst Aur, Likiep, Mejit and Namdrik reported a median annual household income of less than 1,000 US dollars. Kwajalein Atoll (where Ebeye is located and has workers at the US Army base) reported the highest median annual household income US$11,640.

Table 2-2 Economic Situation

	2013	2014	2015	2016	2017	2018	2019
GDP Growth Rate, % per year	2.9	-0.8	-0.4	1.9	4.0	2.5	2.5

Growth Rate of Per Capita GDP, % per year	2.5	-1.1	-0.7	1.5	1.7	2.1	-1.4
Per capita GNI, $, 2016				4,630			
Inflation, % per year	1.9	1.1	-2.3	-1.5	0.5	1.0	1.0

Note: 2018 and 2019 are forecasts.
Source: ADB (https://www.adb.org/countries/marshall-islands/economy#tabs-0-0)

The RMI has a Compact of Free Association (CoFA) with the United States of America which provides for a regular – but gradually decreasing – financial assistance package; the CoFA allows for funding in various sectors such as educations and health, but also has funding for SWM. The current Compact is the second, and runs from 2003 to 2023.

2.2 Current Situation on Solid Waste Management

2.2.1 Overview of SWM from the point of view of Waste Flow

Study of the waste flow is the very first step to understand the current solid waste management (SWM) situation on Majuro. A series of baseline surveys, such as the waste generation survey at the household level, and a survey on incoming waste to the public landfill site, were carried out in July 2017, and based on these results and data, the waste flow situation for Majuro Atoll can be seen. In this section, the current SWM situation of Majuro is presented.

- **Waste generation by source:** Sixty-one percent (61%) of the total waste generated is from households, while the remaining 39% is from non-household sources such as shops, restaurants, businesses, and public institutions. Managing household waste is thus of great importance.

- **3Rs:** Eight point four percent (8.4%) of generated waste is re-used as feed or firewood on site. This practice contributes to ***reduce*** waste amounts. Also, recyclable materials, mostly aluminum cans which are equivalent to 0.4% of the generated waste (173.2 kg -381.8 lbs per day) are recycled through the efforts of MAWC.

- **Waste collection:** The collection of waste by collection services is 50.8% of the generated waste (approximately 63.2% of the discharged waste). On Majuro, collection services are provided by MAWC. MAWC collects waste from most of the residents of Majuro.

- **Final disposal:** As much as 89.0% of the discharged waste, which is equivalent to 80.4% of generated waste, is properly discharged to the public landfill site.

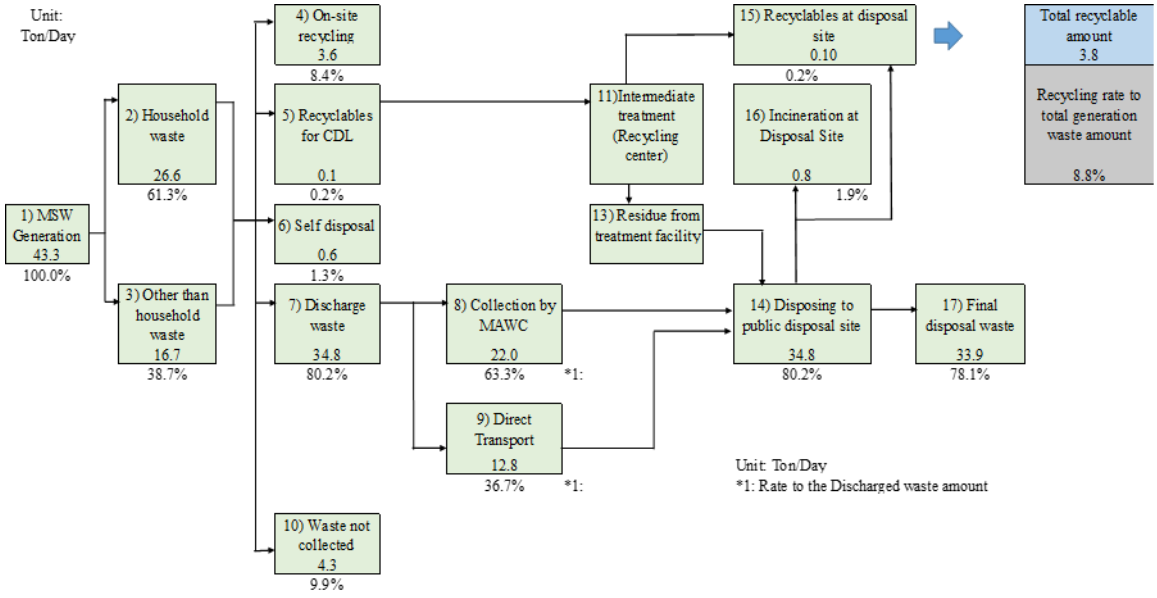


Figure 2-1 Waste flow in Majuro in 2017

2.2.2 Technical situation of SWM

a. Waste Generation and Composition

As a very first step to understanding the current SWM situation, waste generation rates must be calculated: firstly, the unit generation rate of household waste (UGRHW)[1], and secondly, the unit generation rate of municipal solid waste (UGRMSW)[2], which includes all other solid wastes, not only from households but from commercial entities and public organizations.

a.1 Unit Generation Rate of Household Waste

As seen in the table below, URGHW is 868g/person/day, which consists of (i) the unit rate of reuse on site, 118g/person/day, (ii) the unit rate of recycling beverage containers, 3g/ person/ day, (iii) the unit rate of self-disposal, 18g/ person/ day and (iv) the unit rate of discharged waste, 728g/ person/ day. In total, approximately 14% of generated waste is recycled at source, and some of the generated wastes are disposed on the premises. The remaining 84% of the generated waste is discharged.

Table 2-3 Unit Generation Rate of Household Waste (g/person/day)

Recyclable		Non-recyclable		Waste Generation
Reuse on-site	Recyclable of beverage containers	Self-disposal	Discharged waste	

[1] UGRHW = waste generated from household per person per day (g/ person/day)

[2] UGRMW = (household waste generated per day + waste generated from non-households per day) / person

118	3	18	728	868
13.4%	0.3%	2.1%	84.2%	100%

a.2 Unit Generation Rate of Municipal Solid Waste

Municipal Solid Waste (MSW) includes not only household waste but also waste from the tourism industry, waste from commercial entities and public institutions, etc. Waste generated from non-household sources has been calculated as 546g/person/day by dividing the daily amount of waste from non-household sources, which is estimated from the waste flow, by the population. By adding UGRHW to this amount of 546g/p/d, the UGRMWS rate has become 1,413g/person/day.

Table 2-4 Unit Generation Rate of Municipal Solid Waste (g/person/day)

Household waste	non-household waste	Municipal solid waste
868	546	1,413
61.4%	38.6%	100%

【Outlines of Waste Amount Survey】

- Survey period : Five (5) days in August 2017、
- Number of sample households : 40
- Survey items : Unit generation rates, apparent specific gravity
- Survey Method : Weigh the wheelie bin with waste divided by number of people and days stored.

Checking weight of wastes inside wheelie bin

Questionnaire survey to the residents

a.3 Waste Composition

The waste composition[3] was analyzed for the wastes which were collected and transported to the current final disposal site as shown below. This survey was carried out at the landfill site and not at the generation source, such as the household. Therefore these results represent the composition of wastes which is not only household, but also includes wastes from other sources such as business, hotels and so on, and is thus Municipal Solid Waste

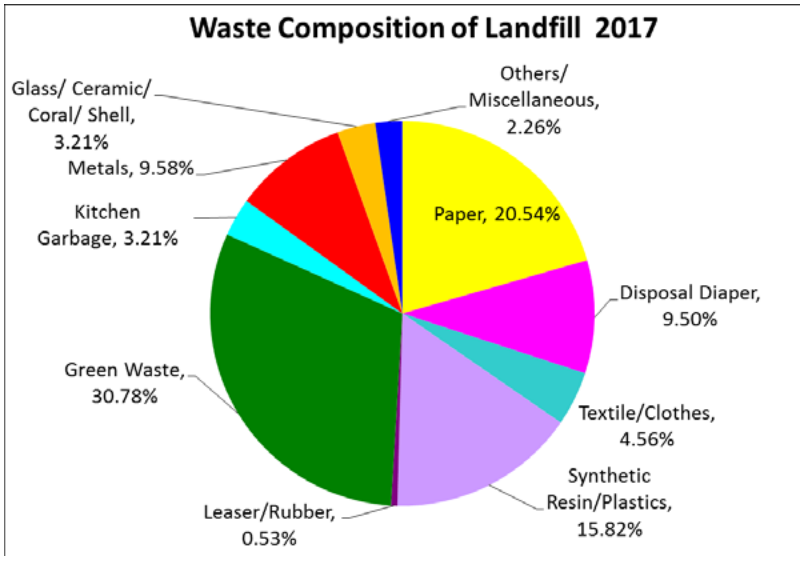


Figure 2-3: Waste Composition at Landfill Site

The biggest component is green waste, which is 31% of the waste. Second biggest is paper which is 21%, then plastic which is 16%. Forth is - surprisingly - disposal diapers which are 9.5%. Reducing the green wastes disposed at the landfill site will be the biggest issue to be solved to use the current landfill site longer.

b. Waste Discharge

Households who discharge waste using the Majuro collection services usually use the 96 gallon wheelie bins. These wheelie bins were donated by the Japanese Government in 2010 and normally several households share one wheelie bin.

Commercial and office wastes that are collected by MAWC are discharged to dumpsters, and there are several types of dumpster. There are 109 active customers who use dumpsters on Majuro and most are using 2 cubic yard. dumpsters. These are placed where they can be accessed by the collection truck, and collection is made upon a request to MAWC to pick up the dumpster when it is full.

Below are photos that show these waste collection methods, from both household and commercial sites.

[3] Waste composition survey was carried out by the JICA senior volunteer in July 2017.

	
96 gallon wheelie bin donated by Japanese Government	Containers used for discharging commercial wastes

c. Waste Collection

The collection system used in Majuro is as follows:

- Most of the household wastes are collected and transported to the final disposal site by MAWC free of charge;
- Some of the household wastes are transported by households' own vehicles to the final disposal site, but a tipping fee is not collected;
- Wastes generated from public institutions, such as government offices, are collected by the individual institutions or by MAWC;
- Some commercial wastes are collected by MAWC with fees based on the size of the containers;
- Some commercial wastes, for example from supermarkets, are collected and transported by their own trucks to the final disposal site, in which case they are charged a tipping fee.

Below is a map of Majuro Atoll, showing the population and waste generation amounts for each area.

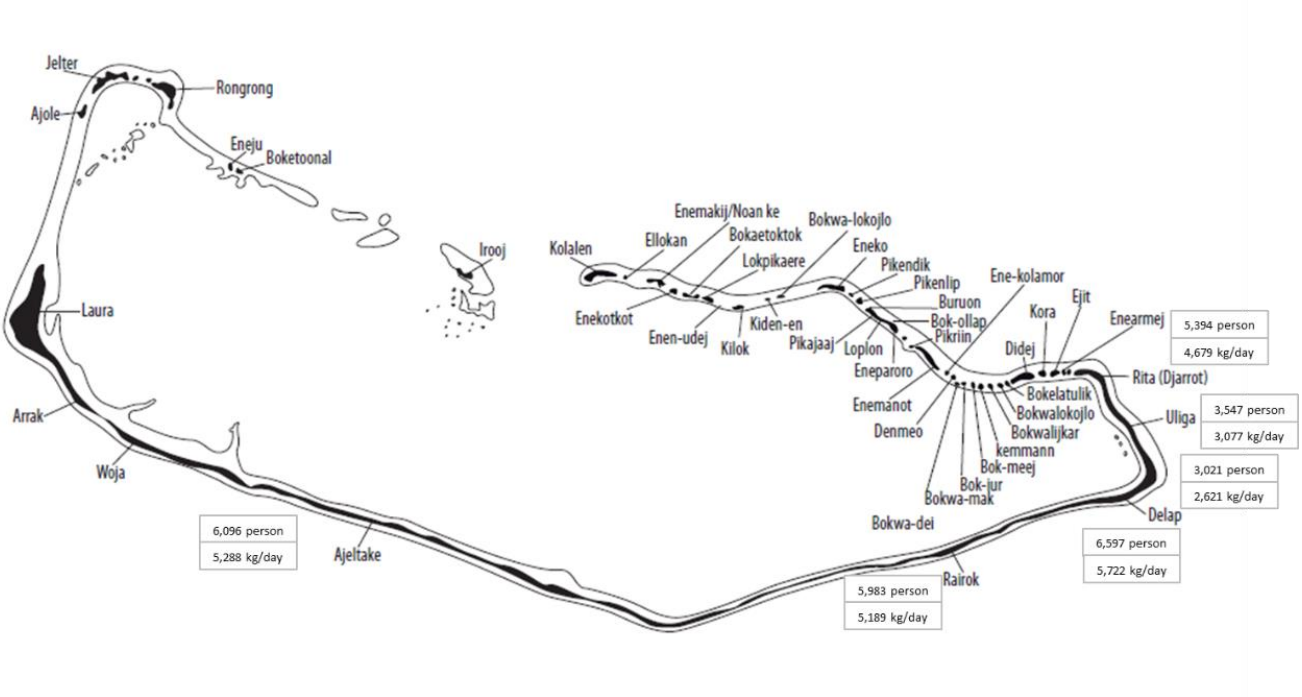


Figure 2-4 Population and Waste Generation Amount by area, in Majuro

c.1 Collection Services provided by MAWC

Waste collection services provided by MAWC for household wastes are as follows:

- Frequency of collection is once a week: Wheelie bins with wastes are placed at the roadside and collected by one of two compactor trucks owned by MAWC;
- MAWC collects 6 days a week from Monday to Saturday, and green wastes and bulky wastes are collected on Saturdays only;
- The Collection area is from Rita to Laura, along the road system:
- A prepaid bag system has been introduced for areas past the airport up to Laura.

	
Yellow US-made compactor truck delivered in 2011 through a donation from Taiwan. Capacity is more than 8 tons (out of order as of May	Small US made compactor truck delivered in 2009. Capacity is 4 to 6 tons(out of order as of May 2019).

2019).	
	
Loading of wastes from wheelie bins with loading device.	Discharging wastes from wheelie bins into compactor truck

Waste collection services provided by MAWC for non-household wastes, such as those from commercial operations, institutions, schools, offices and parks are as follows:

- 109 commercial customers[4] have a contract with MAWC for waste collection;
- The Collection Fee is set according to the size of containers: there are four types of containers which are 96-gallon wheelie bins, and 2, 4 and 6 cubic yard dumpsters;
- Some commercial operators transport their own wastes and paying tipping fees at the disposal site;
- Majuro Atoll Local Government (MALGOV) also collect wastes, generally green waste and litter from public urban and park areas.

	
Front loading compactor truck used for transporting commercial wastes (out-of-order as of May 2019)	Small truck used for transporting 96 gallon wheelie bins

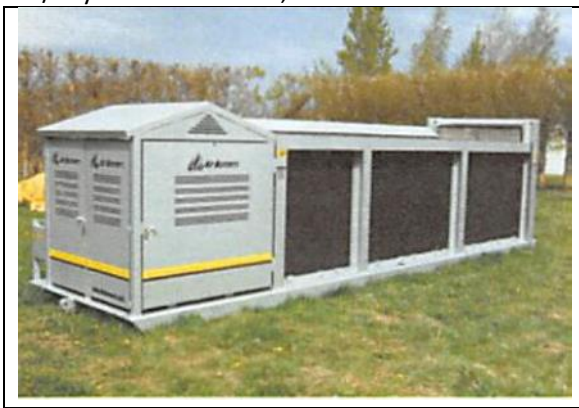
[4] As of July 2017

	
MAWC received a Chinese-made 6 ton flat bed truck with a crane in January 2019 from Taiwan, and this is used for transporting commercial wastes in case of breakdown of the front loading compactor truck.	MAWC received 6 ton Chinese-made Dump Truck in January 2019 from Taiwan and this is used for transporting green waste to the compost yard at Laura.

d. Intermediate Treatment

A simple incinerator was imported and installed at the landfill site in early 2017. This incinerator is a shipping container-sized open steel box, with a forced air supply and requiring added liquid fuel, and is used to burn woody wastes. This device does not have any exhaust gas treatment system or a roof, thus it is not suitable to operate in a residential area such as that which surrounds the landfill site. Furthermore, as there is no roof, it is impossible to operate during rainy periods. Continuous operation has proved to be difficult and the incinerator is now rarely, if ever, used.

The operation record, as taken in mid 2017 by the JICA senior volunteer, shows that around 0.8 ton/day was incinerated, which contributed to a reduction of just 1.9 % of the waste generated.

	
Incinerator of the type installed in Majuro, which is a container with an air curtain designed to burn forestry cuttings and green waste.	The incinerator was installed at the final disposal site to reduce incoming waste for land-filling. (Operation has ceased as of May 2019.)

e. Waste Disposal

e.1 Public Disposal Site

In Majuro, there is a single public disposal site at the border between Batkan and Jable villages, being a filled area between what was originally two separate islands. Outline of the site is as follows:

<table>
<tr><th>Item</th><th>Details</th></tr>
<tr><td>Name</td><td>Batkan – Jable Dump Site</td></tr>
<tr><td>Address</td><td>Between Batkan and Jable</td></tr>
<tr><td>Land Owner</td><td>Private</td></tr>
<tr><td>Area</td><td>1.62 ha (4 acres)</td></tr>
<tr><td>Commencement of operation and renovation work history</td><td>・2007: MAWC was established under an ADB programme recommendation,
MAWC took over landfill operations on the existing dumpsite
・2013: Training on semi aerobic landfill operation at current landfill site.(Fukuoka Method)
Interim landfill site operation at Rairok for reducing Batkan-Jable waste pile (in operation from 2013 to 2014)
・2017: Continued operation at the landfill site increases the height of the waste pile as no more area to spread to.</td></tr>
<tr><td>Operation</td><td>MAWC</td></tr>
<tr><td>Landfill Procedure</td><td>• Waste is discharged on a concrete floor at ground level, then discharged wastes are loaded by excavator and piled up to the top of waste mountain.
• Discharged place of wastes are controlled by the super-visor. Green waste, scrap iron and other fractions are separated out to separate piles.
• No compaction work is carried out by heavy equipment.
• As of Aug 2017, the height of the waste mountain reached 17 meters above ground level.
• Aerial photos were taken in May 2018 and February 2019 as shown below.</td></tr>
<tr><td>Equipment at Disposal Site</td><td>
<table>
<tr><th>Type of Equipment</th><th>Capacity</th></tr>
<tr><td>Excavator 1</td><td>Hitachi, 1.2 m3 manufactured in 2014</td></tr>
<tr><td>Excavator 2</td><td>Hyundai, 1.2 m3, manufactured in 2011</td></tr>
<tr><td>Wheel Shovel 1</td><td>Xiajin Machinery 3.8m3 bucket, manufactured in 2011</td></tr>
<tr><td>Wheel Shovel 2</td><td>2.2 m3 bucket, manufactured in 2011</td></tr>
</table>
</td></tr>
</table>

e.2 Public Disposal Site as of May 2018 and February 2019

Aerial photos of the Batkan-Jable disposal site were taken in 2018 and 2019:

Figure 2-5 Aerial photos taken by the drone

e.3 Incoming Waste to Final Disposal Site

The number of vehicles and the amount of incoming waste arriving at the public disposal site were surveyed, and the results are shown in the next figure. The average incoming waste amount was 34.8 tons/ day, while the average number of incoming vehicles was 50 per day. The average amount of incoming waste was 696 kg per vehicle. While 63% of the incoming waste is collected waste by MAWC, the remaining 37% of the incoming wastes are brought directly by households, business entities and so on. Household waste comprises approximately 52% of disposed waste at the final disposal site, which is equivalent to 22 tons per day, while the remaining 48%, which is equivalent to 12.8 tons per day, are from non-household sources. Incoming general waste, scrap metals, wood and green wastes

are disposed of in each of the designated areas.

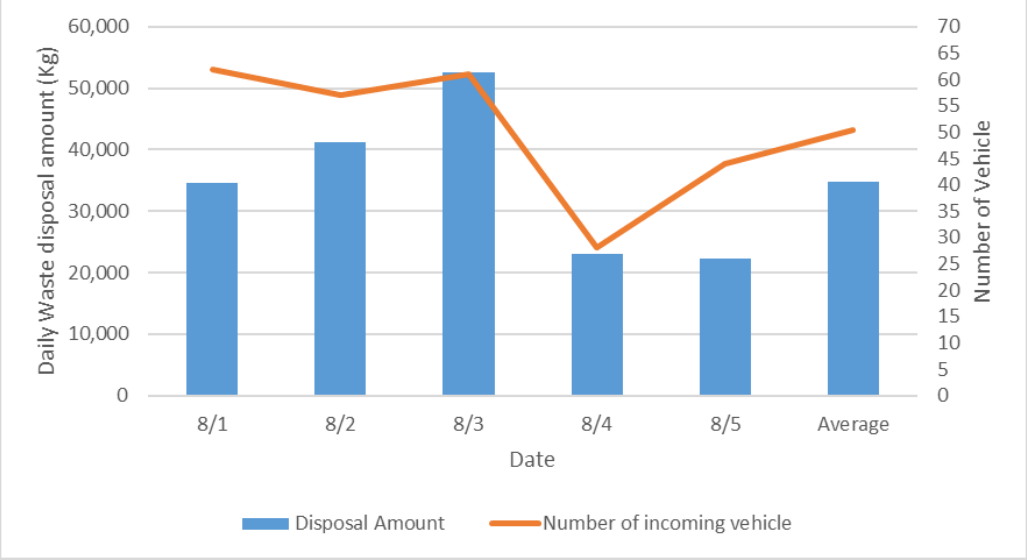
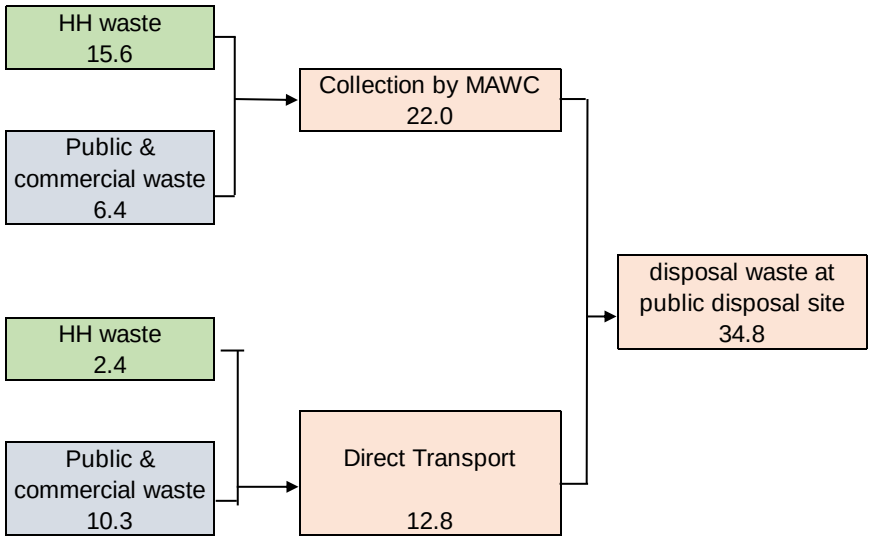


Figure 2-6 Number of vehicles and amount of incoming waste to the final disposal site



Unit: ton/day

Figure 2-7 Flow of incoming waste to the final disposal site

f. Reduce, Reuse and Recycling

f.1 Waste Reduction

The results of the household waste generation survey showed that 8.6% of household waste is reused and recycled at source. Of this amount 8.4% is reused within the household, i.e. kitchen waste used

as feed to livestock or dried coconut fiber/husks as firewood, whilst 0.2% is aluminum cans set aside at each household to sell for recycling.

	
Kitchen waste is separated out to be fed to livestock. Even among households in urban areas, kitchen waste is separated and given to relatives who own pigs and dogs.	As of August 2018, the CDL commenced operations in Majuro, and valuable recyclables such as aluminum cans have been collected and sold to MAWC by the public.

f.2 Compost

As is clear from the pie chart in Figure 2−3, green wastes account for 30.8% of the wastes coming in to the final disposal site. Diverting these green wastes from the waste stream and composting them would be one good option for waste reduction on Majuro. As of May 2019, MAWC has signed a 30-year lease for some land in Laura, and has constructed a composting facility. MAWC plans to bring most of the green wastes coming in to the final disposal site to the compost yard at Laura.

	
There was a huge pile of green waste (middle heap in the picture) in the final disposal site. (May 2018)	The compost plant in Laura under construction (May 2019)

f.3 CDL

The beverage container recycling which the RMI administration had hoped to introduce for long time, finally started in August 2018. The brief history of its development and system is described below:

- P.L. 2016-17 Styrofoam Cups and Plates and Plastic Products Prohibition and Container Deposit Act was introduced. (September 2016);
- The above act was amended (January 2018);
- The recycling program regulations, which specify details such as deposit and refund amounts, were promulgated by EPA (approved by the Cabinet in June 2018);
- Deposit collection at the customs started in July 2018;
- Buying CDL-targeted containers from consumers started at MAWC in August 2018.

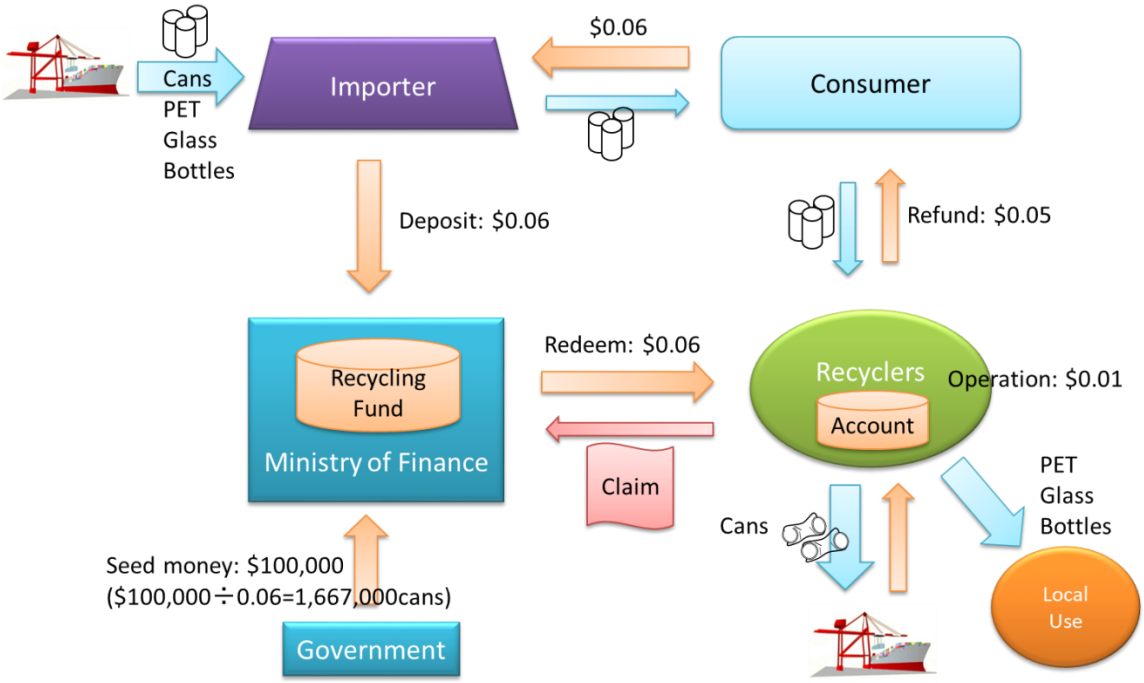


Figure 2-2 CDL system in RMI

A. Target Items

Target items for the CDL system are;

- Aluminum beverage containers (drink cans);
- Glass beverage bottles;
- PET beverage containers;

B. Deposit amount

The deposit fee is currently six (6) cents per container; of this deposit, five (5) cents per container is returned to the consumer as a refund, and one (1) cent per container is claimed from the Recycling Fund by the Recycling Program System Operator (MAWC) as a “Handling Fee” to provide income support for ongoing operational costs.

C. Roles of related organizations

THe roles and responsibilities of the organizations participating in the CDL system are as follows:

Table 2-6 Outline of roles for CDL entities and offices

Organizations	Roles and Responsibilities
EPA	Regulatory agency responsible for managing and overseeing the recycling program through enforcement of the Styrofoam Cups and Plates, and Plastic Products Prohibition and Container Deposit (Amendment) Act 2018 and the related regulation.
Ministry of Finance	Through its Custom Division, collects deposits on recyclable materials from importers; keeps records and manages the Recycling Fund; and through its Division of Finance issues reimbursement of refunds to Recycling Program Operator (MAWC in case of Majuro) upon receipt of a weekly claim; provides EPA with monthly copies of all records.
MAWC	MAWC is the Recycling Program System Operator in Majuro through a contract executed with EPA. Responsible to operate CDL program as per Regulations and their contract with EPA.
Importers	Responsible to pay required deposits to the Ministry of Finance through RMI Customs.
Consumer	Participation in the CDL Recycling Program is by turning in recyclable beverage containers to MAWC, following the rules and conditions about number and cleanliness.

D. Operation of CDL by MAWC

The current CDL Recycling Program System Operator, MAWC signed a 2-years contract with EPA in November 2018. MAWC has carried out the recycling activities on Majuro since then.

Each full basket is equal to 500 cans

Cans are Compressed by a baling machine

E. CDL Financial Status

Deposits paid by importers and the refund paid to consumers are shown in the table below.

Table 2-7 Deposits paid by importers, and refunds paid to consumers

FY	Deposit(US$)	Refund(US$)

	Yearly	Total	Yearly	Total
FY 2018	127,196	127,196	76,323	76,323
FY 2019	861,257	988,453	785,724	862,047

(Note) FY2018 covers July, August and September 2018, while FY2019 covers from October to September, 2019.

F. Amounts of collected containers

The number of containers on which deposits were paid by importers, and the number of containers that were collected by MAWC in exchange for refunds, as well as the number of containers refunded sorted by material type, are shown in the tables below.

Table 2-8 Number of containers imported and refunded

FY	IMPORTS(piece)		REFUND(piece)	
	Yearly	Total	Yearly	Total
FY 2018	2,119,935	2,119,935	1,526,428	1,526,428
FY 2019	14,354,283	16,474,218	15,714,480	17,240,908

(Note) FY2018 covers July, August and September 2018, while FY2019 covers from October to September, 2019.

Table 2-9 Number of containers refunded by categories

FY	REFUND(piece) by categories			
	Can	PET	Bottle	Total
FY 2018	916,082 (60%)	650,111 (40%)	5,235 (0%)	1,526,428 (100%)
FY 2019	9,205,723 (58.5%)	6,366,856 (40.5%)	141,916 (1%)	10,228,636 (100%)

(Note) FY2018 covers July, August and September 2018, while FY2019 covers from October to September, 2019.

Public Hearing on the CDL Regulations (April 2018)

Presentation at the monthly meeting of the Marshall Islands Chamber of Commerce (May 2018)

2.2.3 Institutional Situation of SWM

a. Organization for SWM

The following are the main roles and responsibilities of the relevant SWM organizations.

a.1 Majuro Atoll Waste Company (MAWC)

MAWC was established in March 2007 under the Ministry of Public Works with the support of the Asian Development Bank. MAWC is responsible for waste collections, and operation and maintenance of the final disposal site on Majuro Atoll. MAWC has the following organizational goals:

1. Efficient operation and maintenance of final disposal site in Majuro Atoll;
2. Improvement of waste collections;
3. Establishment of a comprehensive recycling system;
4. Strengthen organizational and financial systems.

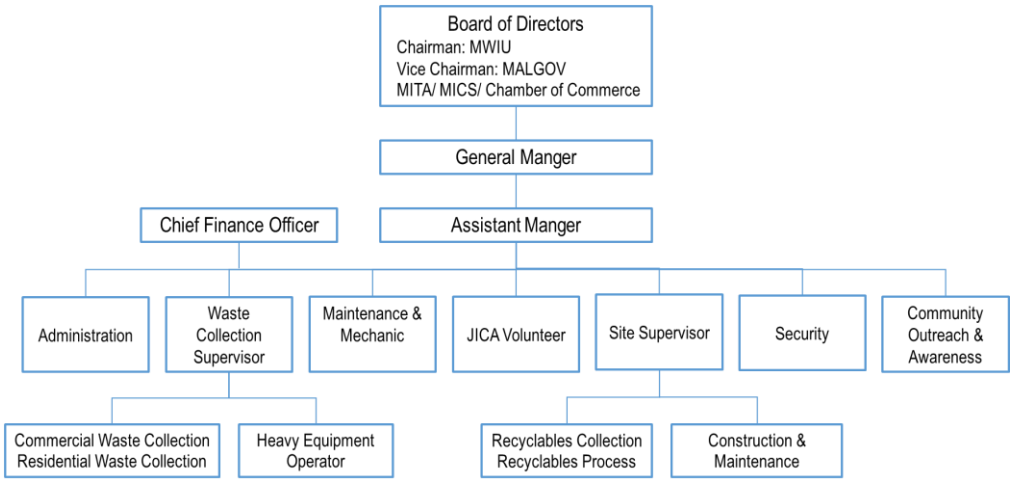


Figure 2-9 Organization chart of MAWC (Source: MAWC)

a.2 Environmental Protection Authority (EPA)

The EPA in the RMI is responsible for the development of environmental policies and programs, and the implementation and supervision of those programs and policies. EPA is not a service provider but rather a policy maker and regulator. With regard to the CDL, the entire system is under the purview of the EPA, although the actual operation has been contracted out to MAWC. In addition, EPA actively organizes environmental & awareness raising campaigns in collaboration with other relevant organizations and local communities.

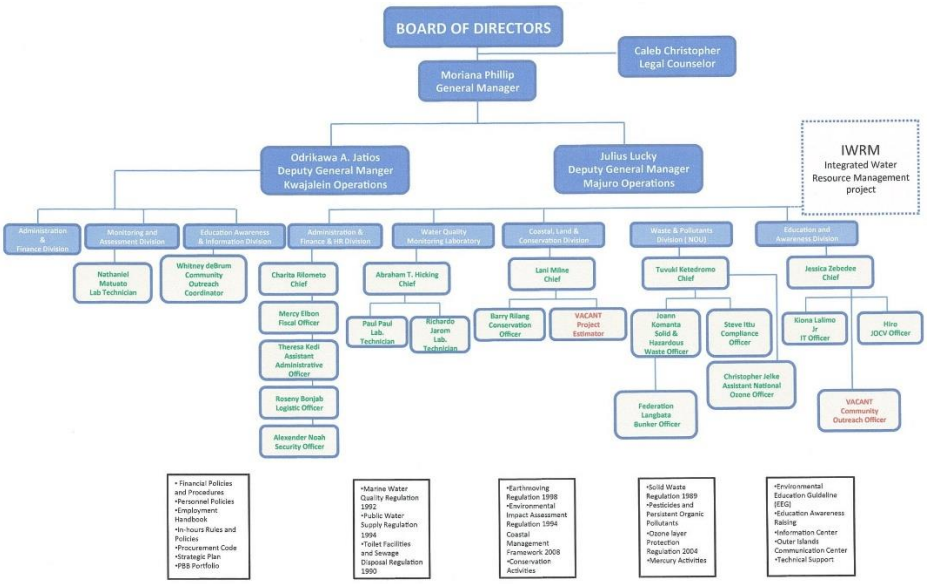


Figure 2-10 Organizational chart of the EPA

b. Policies and Laws on SWM

There is no comprehensive policy and regulatory framework for solid waste management in the Marshall Islands. The following are the laws and regulations that are related to SWM:

a. National Environmental Act 1984;
b. Solid Waste Regulation 1989;
c. Marine Water Quality Regulation 1992;
d. Ozone Layer Depleting Substances Regulation 2004;
e. Marshall Islands Public Health, Safety and Welfare Act 1966 (a Ministry Of Health responsibility);
f. Marshall Islands Littering Act 1982 (empowers National Police and Local Government to enforce this act);
g. MAWC Charter/Bi-laws;
h. Majuro Atoll Local Government Ordinances (Nos.: 1986-16, 1986-17, 1986-20, and 1988-3);
i. Styrofoam Cups and Plates, and Plastic Products Prohibition and Container Deposit Act 2016;
j. Styrofoam Cups and Plates, and Plastic Products Prohibition and Container Deposit (Amendment) Act 2018;

2.2.4 Financial Situation of SWM

a. Waste collection fee and gate fee at the disposal site

Fees are collected only from business entities, being either waste collection fees, or fees for disposal at the final disposal site which is called the “gate fee”. Regarding the waste collection fees, there are 109 active customers as of July 2017, and collection fees are set as follows:

- Container (96 gallon): $24 per month

- Container (2 cubic yard): $12 per pick-up
- Container (4 cubic yard): $24 per pick-up
- Container (6 cubic yard): $36 per pick-up

Gate fees are as follows:

Table 2-9 List of gate fees

Type of wastes	Conditions	Gate fee (USD)
General Waste (mixed)	Pickup truck, Small vehicle 8:30am-5:00pm	5.00
General Waste (mixed)	Pickup truck, Small vehicle 5:00pm-10:00pm	8.00
Oversized garbage	Flat body truck, Large truck	10.00
Green waste	Flat body truck (less than 3 ton) 8:30am-5:00pm	3.00
Others	After 10:00pm	10.00

b. Expenditure for SWM and total state expenditure

Based on the financial data submitted by MAWC, expenditure for SWM is summarized as follows below. The average of expenditure for the last four years was US$ 886,584.

Table 2-10 Revenue for MAWC 2012 - 2018

	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017	FY2018
1. Operational revenues							
1.1 Waste collection	76,331	79,626	103,968	124,508	136,425	130,943	112,203
1.2 Recycling income	63,139	55,449	29,879	39,190	41,284	36,950	153,499
1.3 Miscellaneous	14,641	2,324	3,039	3,754	4,420	3,515	262
Sub total	154,111	137,399	136,886	167,452	182,129	171,408	265,964
2. Nonoperation revenues and expenses							
2.1 Contribution from RepMar	468,411	352,769	325,000	455,678	635,950	472,018	518,214
2.2 Contribution from Government of Japan	116,531	0	0	0			
2.4 Other Grants and Contributions	0	0	0	53,920	151,426		
Sub total	584,942	352,769	325,000	509,598	787,376	472,018	518,214
5. Capital contribution							
5.1 RepMar	65,000	557,894	104,965	201,842	74,438	650,270	456,995
5.2 Government of Japan	0	114,733	0	0	130,363	265,061	0
Sub total	**65,000**	**672,627**	**104,965**	**201,842**	**204,801**	**915,331**	**456,995**
Grand total	**804,053**	**1,162,795**	**566,851**	**878,892**	**1,174,306**	**1,558,757**	**1,241,173**

Source: MAWC

Table 2-11 Expenditures by MAWC 2012 - 2018

	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017	FY2018	Average
1. Operational expenses								
1.1 Payroll	418,241	419,873	413,981	436,881	403,669	365,399	501,558	422,800
1.2 Depreciation	186,647	204,982	303,952	250,172	223,382	223,135	226,744	231,288
1.3 Fuel	83,265	83,862	82,315	83,577	75,037	70,214	92,705	81,568
1.4 Utilities and communication	14,492	16,780	14,207	12,839	14,429	10,784	11,594	13,589
1.5 Repairs and maintenance	45,269	36,179	13,026	9,933	96,087	10,454	56,081	38,147
1.6 Office supplies	7,965	8,756	8,147	11,488	8,512	11,276	12,499	9,806
1.7 Recycling	41,988	27,875	7,332	21,350	50,852	31,296	101,596	40,327
1.8 Insurance	6,397	5,169	4,746	2,152	4,010	3,378	2,460	4,045
1.9 Taxes and licenses	14,389	8,514	4,659	3,164	3,688	4,205	5,895	6,359
1.10 Professional and consultation services	5,699	8,665	3,892	7,602	4,493	8,364	17,507	8,032
1.11 Travel	2,162	4,222	0	1,618	3,800	1,070	10,390	3,323
1.12 Advertising	845	678	1,584	2,591	1,382	1,144	1,046	1,324
1.13 Rental and other waste collection	0	300	0	0	0	39,416	5,579	6,471
1.14 Meetings and entertainment	0	0	0	0	7,590	6,764	11,722	3,725
1.15 Trash bins	113,032	0	0	0	0	0	0	16,147
1.16 Miscellaneous	10,296	19,967	14,312	19,082	3,562	5,758	4,897	11,125
Sub-total	**950,687**	**845,822**	**872,153**	**862,449**	**900,493**	**792,657**	**1,062,273**	**898,076**
2. Non-operational expenses								
2.1 Interest expense	0	0	8,781	6,445	4,069	10,458	0	4,250
Grand Total	**950,687**	**845,822**	**880,934**	**868,894**	**904,562**	**803,115**	**1,062,273**	**902,327**

Source: MAWC

2.3 Major Characteristics of SWM in Majuro

2.3.1 Waste generation

The generation rate of household waste is calculated as 868g (1.91lb)/person/day, and the generation rate of non-household waste is 546g (1.20lb)/person/day. By summing these figures, a generation rate of Municipal Solid Waste, 1,413g (3.11lb)/person/day, is obtained. While 61.3% of the generated waste is from households, the remaining 38.7% is from non-household sources, namely from business entities, public institutions, etc. The ratio indicates that the management of household waste is very important in the case of Majuro.

2.3.2 Waste discharge

While only 8.4% of the household generated waste is reused as feed for livestock or firewood on site (which is a much lower rate than that of the four states of the FSM) the majority of household generated waste, 80.2%, is discharged. As much as 50.8% of that waste, which is equivalent to 63.2% of the discharged waste, is collected by MAWC, while some people do bring their wastes to the final disposal site by themselves. As a result, 89.0% of the discharged waste, which is equivalent to 80.4% of the generated waste, is properly disposed at the public disposal site.

2.3.3 Waste collection system

In Majuro, residential wastes are collected for free, while commercial waste collections are charged. As mentioned, as much as 50.8% of the generated waste, which is equivalent to 63.2% of the discharged waste, is collected by MAWC.

2.3.4 CDL system and export of recyclable items collected under CDL

As mentioned in the previous section, CDL had been successfully introduced in August 2018. If the system continues to run in a sustainable manner, it is projected that approximately 2% of the generated waste will be recycled under the CDL system by 2023. However, whilst these recyclables are only 2% by weight, the volume ratio quantity is far larger as cans & bottles are not dense but take up a lot of space in landfill, and also the system contributes tremendously to the reduction of littering and beautification of the islands. So far, only aluminum cans collected under the CDL system have been exported, as the shipping costs for PET plastic bottles and crushed glass greatly exceed the value of these materials, and no overseas buyers can be found, especially as there is currently an excess of recyclable PET on the world market.

2.3.5 Management of the public disposal site

The only public disposal site on Majuro, which is located between Batkan and Jable, has been operated by MAWC since 2007. Before use as a landfill site, it was a mining pit for coral sand. It has been used as a landfill site for more than 10 years; the area is constrained by houses on either side and the waste is piled up so high, that it is become the highest point in the country. The slope of the dumpsite is also very steep, and great care must be taken to avoid slope failure and a resulting avalanche of waste. It is reaching the end of its life as a landfill site using the current approach of no significant compaction or cell formation, and preparation of a new landfill site must be made, unless a very significant reduction in the amount of waste disposed to landfill can be achieved.

2.3.6 Institutional Settings

MAWC, which was established under the Ministry of Public Works with the support of Asia Development Bank in March 2007, is responsible for waste collection, operation and maintenance of the final disposal site on Majuro Atoll. MAWC plays a key role for CDL, too, as the Recycling System Operator.

3 PART TWO: STRATEGIC PLANNING

3.1 The Solid Waste Management Plan for Majuro (SWMP-M)

3.1.1 Background

The SWMP-M is being formulated to establish a roadmap to improve waste management practices in Majuro for a timeframe of ten years, from 2019 to 2028, based on an understanding of the current state of SWM in Majuro.

With support extended through the JPRISM II, MWIU and MAWC are developing their plan for the next ten years. This plan supports the long-term goals developed within the Cleaner Pacific 2025 Plan developed by SPREP and JICA.

3.1.2 Purpose

The SWMP-M is developed as a means to understand the current state - and different facets of - waste management in Majuro; and more importantly, to lay a practical road map to improve the key components of waste management, and address the challenges faced, with the aim of reaching a sustainable and truly integrated means of solid waste management in Majuro. It is also envisioned that this SWMP-M be endorsed, adopted, and used as the guiding document for waste management activities, and as such should be developed in collaboration with, and the agreement of, a wide range of stakeholders; and as a formal means of adoption, be approved by the board members of MAWC and endorsed by the Minister of MWIU.

3.1.3 Vision

A clean and healthy Marshall Islands for today and future generations

3.1.4 Scope

The new SWMP-M covers the 10-year period from 2019 to 2028 with an action plan designed to be implemented for the first half of the period, 2019 to 2023. A general review of the plan will be undertaken in 2023 to update its relevance to current needs, and plan the next activities for the remaining period of the plan.

The new SWMP-M covers Municipal Solid Waste, being wastes generated by households and institutional and commercial operations. The Plan does not cover medical waste nor hazardous waste.

3.1.5 Guiding Principles

Principle 1: Establish a Financially Sustainable SWM System with due Consideration of "Post 2023".

With regard to finance, the current SWM system in Majuro partially depends on Compact Funds from the U.S. Government. It must be presumed that such financial support will end in 2023 when the current Compact ends, and so it is very important to start considering the establishment of a self-financing SWM system to be in place for "Post-2023". The potential options for self-financing will

require some type of ***User-pays system,*** involving the introduction of collection fees and landfill tipping fees, or imposing some sort of environmental levy for waste.

Principle 2: Transition to an Environmentally Friendly Lifestyle

In the RMI, with the strong leadership of the government, progress in preparing a self-financing waste system has been made through the introduction of the Container Deposit Legislation (CDL) system. The introduction of this new recycling system is a first step in the transition to a more environmentally friendly lifestyle. It also contributes significantly to waste and litter reduction, and the beautification of Majuro.

Principle 3: Emphasis on Capacity Development

New challenges continuously arise along with social-economic changes, and such challenges need to be tackled on a case-by-case basis; in the field of waste management, capacity development of SWM personnel is particularly important. SWM personnel need to enhance their capacities through implementing key strategic actions, and so enable them to solve the evolving challenges and problems they face, and eventually establish a sustainable SWM system on Majuro.

Principal 4: Commitment to the Clean and Beautiful Pacific Region

Wastes are a grave threat to sustainable development in the Pacific Islands. Inadequate management of wastes can affect the health of Pacific Communities, degrade natural ecosystems and reduce their resilience to climate change impacts, and ultimately retard the social and economic development of Pacific Island Countries and territories. Many countries and territories of the Pacific face heightened risks from the impacts of poor waste and pollution management, since their economic bases (tourism, fishing and agriculture) are heavily reliant on an environment relatively free of waste. Furthermore, many waste issues are transboundary in nature, which means that poor control and management in one country (or region) can negatively affect neighboring countries. By considering all these issues, this SWMP-M is aligned with the aspirations elucidated in the Pacific Regional Waste and Pollution Management Strategy (Cleaner Pacific 2025[5]), which aims to support the Pacific Island Countries to develop practical and sustainable SWM systems.

3.1.6 SWM Issues Targeted Under the SWMP-M

Issue 1: Proper final disposal is a critical component of sustainable SWM

The current public disposal site which is located between Batkan and Jable has been operated by MAWC since 2007. It has been used as a landfill site for more than 10 years and the area is limited, waste is piled up so high it is now said to be a highest point in the country. It is urgent to find and construct a new disposal site, however related agencies have failed to convince policy makers to do so. Securing a final disposal site is critical to developing a sustainable SWM system, as even if the new technologies such as incineration and WTE were found to be feasible and were adopted, a final disposal site is required to receive the residues of these other operations.

[5] Cleaner Pacific 2025 is the regional SWM strategy which is formulated by SPREP and JICA. Refer to http://www.sprep.org

Issue 2: Waste Reduction and Recycling

Both finding and managing a final disposal site are critical tasks, but difficult and costly. Even though a new final disposal site must be successfully identified, and constructed, the site will fill up over time. Thus, it is essential to reduce waste coming in to the final disposal site in order to prolong the life of the disposal site, and the primary ways that this can be done are through recycling and diversion of green-waste from landfill, for example by composting.

Issue 3: Improvement of Collection Service

MAWC provides collection services regularly. However the collection vehicles they use are quite old, and frequently break down, and this impacts collection efficiency. Challenges remain in carrying out appropriate and timely maintenance of such vehicles and equipment by MAWC workshops. Even where MAWC purchases new vehicles and maintains them appropriately, vehicles and equipment tend to have a shorter working life than other places in such a harsh operational environment as Majuro. Therefore it is important for MAWC to formulate a plan to secure the funding for capital equipment replacement well in advance of actual need. Furthermore, it is quite difficult and time consuming to order spare parts from a remote island like Majuro, so it is more cost-effective to order a stock of common spare parts at the time of original the purchase of equipment.

Issue 4: Careful consideration on the applicability of new technologies

Land reclamation by using waste for landfill has been a traditional way of disposing of waste in atolls like Majuro. Currently, some donors are proposing the consideration of new intermediate technologies such as waste to energy (WTE). Donors will usually only support the initial investment, and the O&M cost, which can be very expensive in the case of new technologies, must be borne by the recipient country. The amount of waste generated per day in Majuro is rather limited when considering the amounts usually required to make this technology feasible in the long-run. Moreover, all these new technologies are *intermediate,* not a final solution, and therefore the safe disposal of the residue of this intermediate processing is required. Along with the careful consideration on the applicability of new technologies, it is an appropriate time to shed new light to the traditionally-used, tried and tested landfill as land reclamation disposal method.

3.1.7 Key Strategic Actions and Time Frame

a. Key Strategic Actions

This plan consists of three strategic actions. These actions are as follows:

Action 1: Proper operation of the final disposal site(s)

As reiterated, proper final disposal is a critical component of a sustainable SWM system. As key strategic actions, the following steps are required:

Monitoring

1-1: Conduct periodic monitoring of the current disposal site;

Reduction of the current landfill amount

1-2: Draw up a plan for landfill mining (incl. sub-construct to the mining company, etc.)

1-3: Conduct landfill mining operations to extract decomposed earth

1-4: Utilized the decomposed earth to backfill inside sea walls.

Extension of the current landfill site

1-5: Draw up a plan for an extension of the current disposal site;

1-6: Preparation for construction (budget allocation and relocation of office buildings, scrap metals, wood waste, etc.) ;

1-7: Undertake landfill extension works (construct sea walls, boundary embankments, etc.);

1-8: Commence landfill operations at the extended site;

Preparation for a new site

1-9: Start preparation for a new landfill site (site selection, design, budget allocation, etc.).

Action 2: Reduction of final disposal amount by composting and recycling

Reduction of the waste amount going to landfill is important from the view point of the limited capacity of the final disposal site. In order to reduce the waste quantity, diversion of green-waste for composting, and recycling of beverage containers through CDL system are highly recommended actions.

Composting

2-1: Construct a composting yard at Laura;

2-2: Procure a wood chipper for green waste to accelerate the composting process;

2-3: Operate and maintain the composting yard;

Recycling (CDL)

2-4: Maintain the CDL activities;

2-5: Monitor CDL activities and produce an annual report.

Action 3: Maintenance of Waste Collection Services

MAWC provides a waste collection service to most of the atoll using their collection vehicles. These vehicles are very old and will soon reach the end of their useful working lives. An investment plan that includes replacing waste collection vehicles and equipment, as well as waste containers - wheelie bins and dumpsters - needs to be prepared. At the same time, it is necessary for MAWC to identify and order a stock of commonly used spare parts alongside the purchasing of new equipment so as to save time and money for future operations, and ensure regular continuity of the collection services. This requires the following steps:

3-1: Prepare an investment plan for the waste collection services;

3-2: Replacement of waste collection trucks;

3-3: Replacement of waste containers such as dumpsters and wheelie bins;

3-4: Ensure proper operation and maintenance of waste collection equipment.

Action 4: Careful examination of new SWM technologies

Careful examination of any new SWM technologies, in terms of their applicability, their feasibility, as well as cost-efficiency, is required before introduction of such new technologies can be approved by the government. Examples of where these technologies have been successfully used in a similar small island state should be investigated for lessons learned. For that, the following steps are required:

4-1: Conduct feasibility studies on these new SWM technologies;
4-2: Careful examination of the results of these feasibility studies, and produce an assessment report;
4-3: Submit an assessment report to the relevant authorities.

b. Time Frame

Whilst some parts of this Plan - such as the overall vision and guiding principles - cover the 10-year period from 2019 to 2028, the section on strategic planning, the main body of this SWMP-M, targets the current five-year period, from 2019 to 2023. The time frame for key strategic actions is shown in the table below.

Table 3-1: Time frame to conduct strategic actions

Activities	Mid-term plan					Long-term plan				
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Action 1: Proper operation of the final disposal site(s)										
1-1: Conduct periodical monitoring of the current disposal site										
1-2:Draw a plan for landfill mining (incl. sub-construct to the mining company, etc.)										
1-3:Conduct landfill mining operation to extract decomposed earth										
1-4:Utilized the decomposed earth to backfill inside sea walls.										
1-5:Draw a plan for an extension of the current disposal site;										
1-6:Preparation for construction (budget allocation and relocation of office buildings, scrap metals, wood waste, etc.)										
1-7: Conduct an extension work (construct see walls, boundary embankment etc.)										
1-8: Start landfill operation at the extended area;										
1-9: Start preparation for a new landfill site (site selection, design, budget allocation, etc.)										
Action 2: Reduction of final disposal amount by composting and recycling										
2-1:Construct a composting yard in Laura										
2-2:Procure wood chippers for green waste to accelerate composting process										
2-3: Operate and maintain the composting yard										
2-4: Maintain the CDL activities										
2-5: Monitor CDL activities and produce an annual report										
Action 3: Maintenance of Waste Collection Service										
3-1:Formulate investment plan for waste collection services										
3-2:Replacement of waste collection trucks										
3-3:Replacement of waste containers										
3-4:Proper operation and maintenance of waste collection equipment										
Action 4: Careful examination of new SWM technologies										
4-1:Conduct feasibility studies on new SWM technologies										
4-2:Careful examination of the results of these feasibility studies, and produce an assessment report.										
4-3:Submit an assessment report to the relevant authorities										

c. Setting Future Targets

Future targets are based on the projected future population, waste amounts and strategic values.

Table 3-2: Targets under SWMP-M

Item	Unit	2017	2023	2028
3Rs rate (to generation waste amount)	%	9	16	22
Collection rate (to discharge waste amount)	%	63	65	65
Waste not collected (to generation waste amount)	%	10	0	0
Rate of waste transported directly to landfill site	%	37	35	35

Table 3-3: Planning indices

Item	Unit	2017	2023	2028
Population	person	30,638	33,304	35,701
GDP Growth Rate	%	3.6	3.0	3.8
Waste generation rate - Household waste	g/person/day	868	921	968
	lb/person/day	1.9	2.0	2.1
Waste generation rate - MSW	g/person/day	1,414	1,500	1,577
	lb/person/day	2.7	3.3	3.5

3.1.8 Future Waste Flow

Waste flows expected are based on the numerical targets for the mid-term target year in 2023, and for the final target year in 2028, are shown below[6].

Table 3-4: Future waste amount

	Unit	2017	2023	2028
Generation amount	ton/day	43	50	56
Discharge amount	ton/day	35	44	50
Collection amount	ton/day	22	29	32

[6] As of May 2019, green waste reduction through home composting and introduction of collection fees, which may substantially affect the future waste flow, are just starting.

3Rs amount	ton/day	4	8	12
Final disposal amount	ton/day	34	41	43

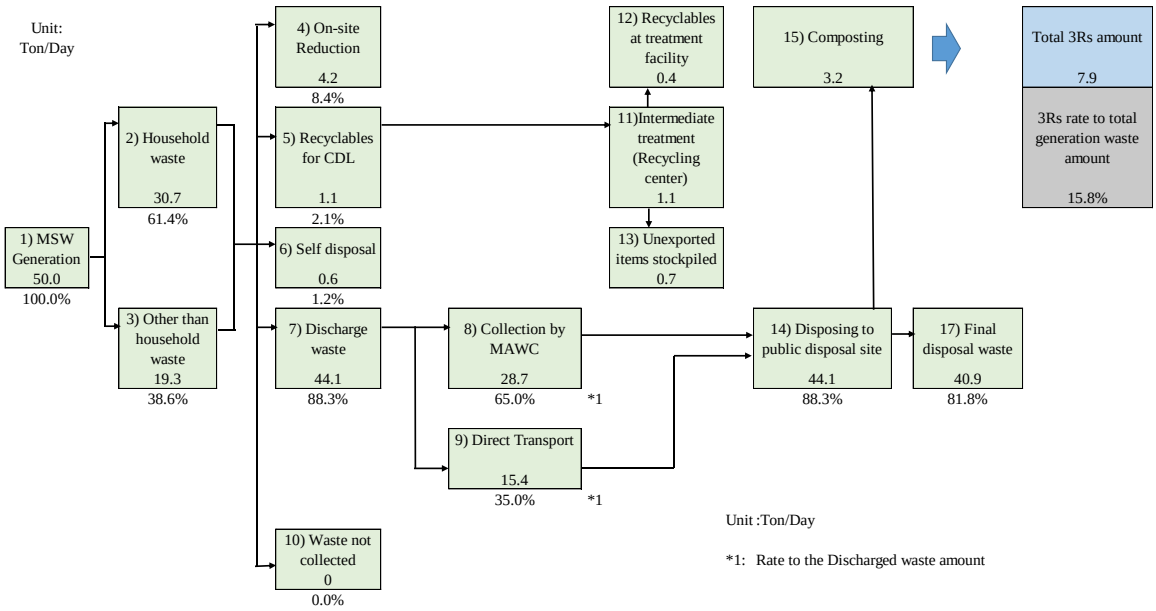


Figure 3-1: Future waste flow in 2023

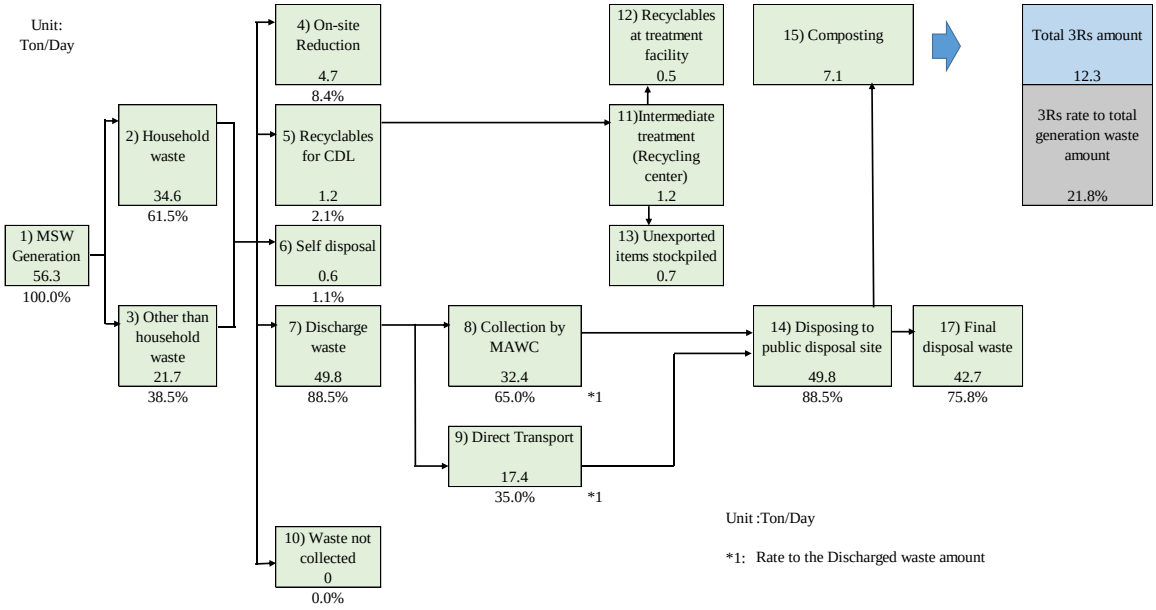


Figure 3-2: Future waste flow in 2028

a. Setting the Planning Indices

a.1 Future Population

The population in Majuro had increased by 4,121 people between 1999 to 2011 based on the census data. The future population is predicted based on the growth rates between 1999 and 2011, as shown below.

Table 3-5: Future population

	Census		Growth rates (%) 1999-2011	Present	Future estimation	
	1999	2011		2017	2023	2028
Majuro	23,676	27,797	1.4	30,638	33,304	35,701

a.2 Future Waste Generation Amount

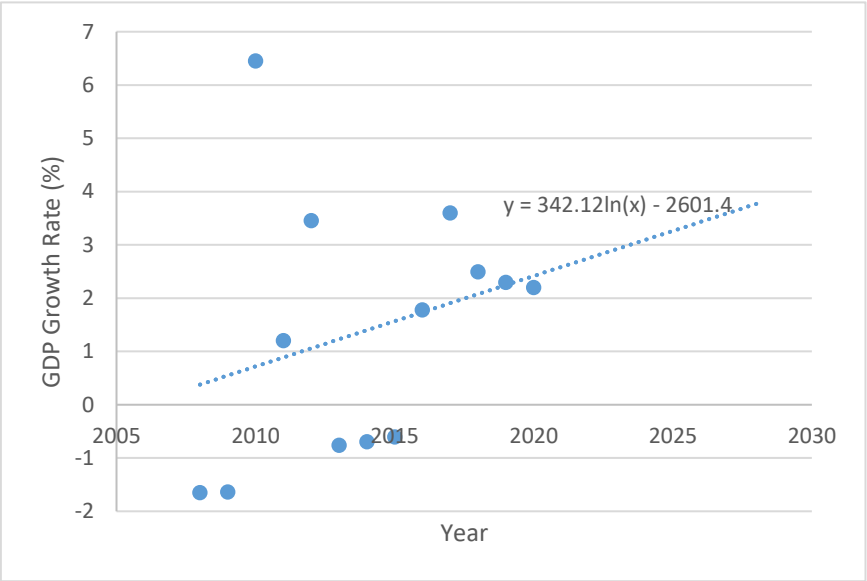
The future waste generation amount in Majuro is estimated using the following formula:

(Future waste generation rate per person per day) x (Future population) = Future waste generation amount in Majuro.

Future waste generation rate per person per day is heavily influenced by economic conditions. The actual GDP growth rate of the RMI from 2008 to 2018, as published by the Asian Development Bank, has been used as the economic indicator to estimate the future GDP growth rate. The future waste generation rate per person per day was estimated based on the future GDP growth rate estimate.

A. GDP Growth Rate

The actual GDP growth rate of the RMI from 2008 to 2018 as published by the Asian Development Bank was used to estimate the future GDP growth rate. The past actual, and the estimated future GDP growth rates up to 2028 are shown in the next table. The GDP growth rate is estimated to be 2.9% in the mid-term target year in 2023 and 3.8% in the long-term target year in 2028.



	unit	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Actual (%)	%	-1.6	-1.6	6.5	1.2	3.5	-0.8	-0.7	-0.6	1.8	3.6	2.5	2.3	2.2								
Projection (%)	%												2.3	2.2	2.6	2.8	2.9	3.1	3.3	3.4	3.6	3.8

Figure 3-3: Future GDP Growth Rate Estimates

B. Waste Generation Rate

Current waste generation rates for household and non-household are shown in the table below.

Table 3-6: Waste generation rate

Year	Unit	Household waste	Non-household waste	Municipal Solid Waste
2017	g / person / day	868	546	1413
	lbs /person / day	1.9	1.2	3.1

C. Future Waste Generation Rate

The future waste generation rate is deemed to increase in proportion with economic growth. It is necessary to examine the relationship between GDP and the increase in waste generation rates. The waste generation rate of each generation source may increase in proportion to the growth of GDP. In Japanese statistics which were recorded from 1963 to 1988, the only available data of its kind in the world, it is seen that the trend of the waste generation rate due to the development of the economy is as follows:

- At the time of developing economy (1963 to 1970)
  Increase of Generation Rate = 0.55 of GDP growth rate.
- At the time of developed economy (1975 to 1988)
  Increase of Generation Rate = 0.29 of GDP growth rate.

These metrics have been adopted to make estimates of the future waste generation rate in the plan, based on the above Japanese statistics.

- The generation rate of household and non-household wastes may be expected to increase at 29% of the GDP growth rate in each year.

Table 3-7: Future waste generation rate

Year	unit	Household wastes	Non-household wastes	Total
2023	g/person/day	921	579	1,500
	lbs/person/day	2.0	1.3	3.3
2028	g/person/day	968	609	1,577
	lbs/person/day	2.1	13	3.5

4 Action Plan

As a result of reflecting upon the vision, the guiding principles and the identified SWM issues, the specific activities required to pursue the realization of this plan are articulated and presented in this chapter. This action plan, which defines the priorities for the next five years, is provided below.

The action plan consists of the following four actions:

Action 1: Proper operation of the final disposal site(s);

Action 2: Reduction of final disposal amount by composting and recycling;

Action 3: Maintenance of Waste Collection Services;

Action 4: Careful examination of new SWM technologies;

For each action (i) the necessary activities and personnel requirements; (ii) implementation schedule; and (iii) implementation costs, are detailed.

4.1 Action 1 : Proper operation of the final disposal site(s)

4.1.1 Necessary activities

Activities required for proper operation of the final disposal site(s) are as follows.

1-1: Conduct periodic monitoring of the current disposal site;
1-2: Draw up a plan for landfill mining (incl. sub-construct to the mining company, etc.);
1-3: Conduct landfill mining operations to extract decomposed earth;
1-4: Utilized the decomposed earth to backfill inside sea walls;
1-5: Draw up a plan for an extension of the current disposal site;
1-6: Preparation for construction (budget allocation and relocation of office buildings, scrap metals, wood waste, etc.);
1-7: Undertake landfill extension works (construct sea walls, boundary embankment etc.);
1-8: Commence landfill operations at the extended site;
1-9: Start preparation for a new landfill site (site selection, design, budget allocation, etc.).

Table 4-1: Activities required and organizations responsible for Action1

Activity	Contents of activity	Organization	
		MAWC/ MWIU	EPA
1-1: Conduct periodical monitoring of the current disposal site	Periodical monitoring of landfill operation shall be conducted by MAWC in order to decide timing for extension work and investment for new landfill site.	◎	○
1-2:Draw a plan for landfill mining (incl. sub-construct to the mining company, etc.)	Draw a plan for landfill mining in order to reduce current landfill amount and corroboration with sea wall projects.	◎	○
1-3:Conduct landfill mining operation to extract decomposed earth	Conduct according to the plan for landfill mining.	◎	–
1-4:Utilized the decomposed earth to backfill inside sea walls.	After conducting landfill mining and take out debruises, decomposed earth will be utilized for backfilling material inside sea wall.	◎	–
1-5:Draw a plan for an extension of the current disposal site;	Plan for extension of current disposal site will be formulated in order to utilize until completion of new landfill site.	◎	○
1-6:Preparation for construction (budget allocation and relocation of office buildings, scrap metals, wood waste, etc.)	Preparation for construction of extension works such as budget allocation, relocation of scrap metals and so on.	◎	○
1-7: Conduct an extension work (construct see walls, boundary embankment etc.)	Actual extension work shall be carried out according to the plan and budget allocated.	◎	–
1-8: Start landfill operation at the extended area;	Start landfill operation using extended area.	◎	–
1-9: Start preparation for a new landfill site (site selection, design, budget allocation, etc.)	Start preparation for new landfill site including site selection, design, and necessary budget allocation.	◎	○

4.1.2 Implementation schedule

The implementation schedule for the proper operation of the final disposal site(s) is shown below.

Table 4-2: Schedule for Action 1

	FY2019				FY2020				FY2021				FY2022				FY2023			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1-1: Conduct periodical monitoring of the current disposal site																				
1-2:Draw a plan for landfill mining (incl. sub-construct to the mining company, etc.)																				
1-3:Conduct landfill mining operation to extract decomposed earth																				
1-4:Utilized the decomposed earth to backfill inside sea walls.																				
1-5:Draw a plan for an extension of the current disposal site;																				
1-6:Preparation for construction (budget allocation and relocation of office buildings, scrap metals, wood waste, etc.)																				
1-7: Conduct an extension work (construct see walls, boundary embankment etc.)																				
1-8: Start landfill operation at the extended area;																				
1-9: Start preparation for a new landfill site (site selection, design, budget allocation, etc.)																				

4.1.3 Implementation Budget

The budget required to implement this component is shown in the table below.

Table 4-3: Budget for Action 1 in 5 years

	FY2019	FY2020	FY2021	FY2022	FY2023	Total
a. Personnel cost	204,000	252,000	108,000	204,000	72,000	840,000
b. Transportation expenses	0	0	0	0	0	0
c. Construction and treatment cost	0	0	630,000	468,000	312,000	1,410,000
d. Purchase of equipment/machinery	0	0	300,000	0	0	300,000
e. Operation cost	120,000	120,000	600,000	180,000	120,000	1,140,000
f. Planning and Design cost	20,000	128,000	252,000	192,000	132,000	724,000
Total	344,000	500,000	1,890,000	1,044,000	636,000	4,414,000

4.2 Action 2: Reduction of final disposal amount by composting and recycling

4.2.1 Necessary activities

Activities required for the reduction of the final disposal amount through composting and recycling are as follows:

i. Develop a base map for planning purposes;
ii. Draw up an improvement plan;
iii. Implement an improvement plan;
iv. Manage the incoming wastes.

Table 4-4: Activities required and organizations responsible for Action 2

Activity	Contents of activity	Organization	
		MAWC	EPA
2-1:Construct a composting yard in Laura	Off site composting yard is under construction as of May 2019. Composting material will be green wastes, coconuts husk, and fish bone and so on.	◎	-
2-2:Procure wood chippers for green waste to accelerate composting process	Wood chipper will be introduced to reduce the volume decompose wood wastes faster.	◎	-
2-3: Operate and maintain the composting yard	Composting yard will be operated and maintained by the MAWC. Yard will be used for temporary stockpile area for Compressed PET.	◎	○
2-4: Maintain the CDL activities	CDL redemption center at MAWC FDS starts operation in Aug 2018. Maintenance of the CDL activities will be essential.	◎	○
2-5: Monitor CDL activities and produce an annual report	Monitoring CDL activities quantitatively and financially is important to sustain the system. Annual report shall be produced and submit to relevant authorities.	○	◎

4.2.2 Implementation Schedule

The implementation schedule for the reduction of the final disposal amount by composting and recycling is shown below.

Table 4-5: Schedule for Action 2

	FY2019				FY2020				FY2021				FY2022				FY2023			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
2-1:Construct a composting yard in Laura																				
2-2:Procure wood chippers for green waste to accelerate composting process																				
2-3: Operate and maintain the composting yard																				
2-4: Maintain the CDL activities																				
2-5: Monitor CDL activities and produce an annual report																				

4.2.3 Implementation Budget

The estimated budget for reduction of the final disposal amount by composting and recycling is shown in the table below.

Table 4-6: Budget for Action 2

	FY2019	FY2020	FY2021	FY2022	FY2023	Total
a. Personnel cost	168,000	168,000	168,000	168,000	168,000	840,000
b. Transportation expenses	0	0	0	0	0	0
c. Construction and treatment cost	0	0	0	0	0	0
d. Purchase of equipment/machinery	0	150,000	0	0	0	150,000
e. Operation cost	36,000	64,800	64,800	64,800	64,800	295,200
f. Planning and Design cost	0	0	0	0	0	0
Total	204,000	382,800	232,800	232,800	232,800	1,285,200

4.3 Action 3: Maintenance of Waste Collection Services

4.3.1 Necessary activities

Activities required to maintain the waste collection services are as follows:

3-1: Draw up an investment plan for waste collection services;
3-2: Replacement of waste collection trucks;
3-3: Replacement of waste containers, such as dumpsters and wheelie bins;
3-4: Proper operation and maintenance of waste collection equipment.

Table 4-7: Activities required and organizations responsible for Action 3

Activity	Contents of activity	Organization	
		MAWC	EPA
3-1:Formulate investment plan for waste collection services	Investigate current condition of collection truck including operation and maintenance cost for each collection truck and formulate investment plan for waste collection services	◎	-
3-2:Replacement of waste collection trucks	Replacement of waste collection trucks based on the investment plan including necessary spare parts.	◎	-
3-3:Replacement of waste containers	Replacement of waste containers based on the investment plan.	◎	○
3-4:Proper operation and maintenance of waste collection equipment	Keep proper records for maintenance of equipment including order of spare parts to avoid future problems.	◎	-

◎: Responsible organization, ○: Supporting organization

4.3.2 Implementation Schedule

The implementation schedule for the maintenance of waste collection services is shown below.

Table 4-8: Schedule for Action 3

	FY2019				FY2020				FY2021				FY2022				FY2023			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
3-1:Formulate investment plan for waste collection services																				
3-2:Replacement of waste collection trucks																				
3-3:Replacement of waste containers																				
3-4:Proper operation and maintenance of waste collection equipment																				

4.3.3 Implementation Budget

The estimated budget required to maintain waste collection services is shown in the table below.

Table 4-9: Budget for Action 3

	FY2019	FY2020	FY2021	FY2022	FY2023	Total
a. Personnel cost	312,000	240,000	240,000	240,000	240,000	1,272,000
b. Transportation expenses	0	0	0	0	0	0
c. Construction and treatment cost	0	0	0	0	0	0
d. Purchase of equipment/machinery	0	410,000	0	0	0	410,000
e. Operation cost	330,000	360,000	360,000	360,000	360,000	1,770,000
f. Planning and Design cost	0	0	0	0	0	0
Total	642,000	1,010,000	600,000	600,000	600,000	3,452,000

4.4 Action 4: Careful examination of new SWM technologies

4.4.1 Necessary activities

Activities required to carefully examine new SWM technologies are as follows:

4-1: Conduct feasibility studies on each of the new SWM technology proposals for Majuro;

4-2: Examination of the results of those feasibility studies, and production of an assessment report;

4-3: Submit the assessment report to the relevant authorities.

Table 4-10: Activities required and organizations responsible for Action 4.

Activity	Contents of activity	Organization	
		MAWC/ MWIU	EPA
4-1:Conduct feasibility studies on new SWM technologies	Consultant for ADB project is conducting feasibility study on WTE technology. Final report will be submitted by the end of 2019..	◎	○
4-2:Careful examination of the results of these feasibility studies, and produce an assessment report.	Careful examination on the results of FS report shall be conducted through input from SWM expert and produce assessment report.	◎	○
4-3:Submit an assessment report to the relevant authorities	Assessment report shall be submitted to the decision makers.	◎	○

◎: Responsible organization, ○: Supporting organization

4.4.2 Implementation Schedule

The implementation schedule for the careful examination of new SWM technologies is shown below.

Table 4-11 Schedule for Action 4

	FY2019				FY2020				FY2021				FY2022				FY2023			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
4-1:Conduct feasibility studies on new SWM technologies																				
4-2:Careful examination of the results of these feasibility studies, and produce an assessment report.																				
4-3:Submit an assessment report to the relevant authorities																				

*FY: From 1st of October to next year 30th of September

**Q1: Oct.-Dec., Q2: Jan.- Mar., Q3: Apr.-Jun., Q4: Jul.-Sep.

4.4.3 Implementation Budget

The estimated budget required for the careful examination of new SWM technologies is shown in the table below.

Table 4-12: Budget for Action 4

	FY2019	FY2020	FY2021	FY2022	FY2023	Total
a. Personnel cost	0	27,000	27,000	9,000	0	63,000
b. Transportation expenses	0	0	0	0	0	0
c. Construction and treatment cost	0	0	0	0	0	0
d. Purchase of equipment/machinery	0	0	0	0	0	0
e. Operation cost	0	0	0	0	0	0
f. Planning and Design cost	0	0	0	0	0	0
Total	0	27,000	27,000	9,000	0	63,000

4.5 The Action Plan

4.5.1 Schedule of the Action Plan (2019-2023)

The schedule for the complete Action Plan is shown in the table below.

Table 4-13: Schedule of the Action Plan (2019-2023)

Action 1: Proper operation of the final disposal site(s)

	FY2019				FY2020				FY2021				FY2022				FY2023			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1-1: Conduct periodical monitoring of the current disposal site																				
1-2:Draw a plan for landfill mining (incl. sub-construct to the mining company, etc.)																				
1-3:Conduct landfill mining operation to extract decomposed earth																				
1-4:Utilized the decomposed earth to backfill inside sea walls.																				
1-5:Draw a plan for an extension of the current disposal site;																				
1-6:Preparation for construction (budget allocation and relocation of office buildings, scrap metals, wood waste, etc.)																				
1-7: Conduct an extension work (construct see walls, boundary embankment etc.)																				
1-8: Start landfill operation at the extended area;																				
1-9: Start preparation for a new landfill site (site selection, design, budget allocation, etc.)																				

Action 2: Reduction of final disposal amount by composting and recycling

	FY2019				FY2020				FY2021				FY2022				FY2023			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
2-1:Construct a composting yard in Laura																				
2-2:Procure wood chippers for green waste to accelerate composting process																				
2-3: Operate and maintain the composting yard																				
2-4: Maintain the CDL activities																				
2-5: Monitor CDL activities and produce an annual report																				

Action 3: Maintenance of Waste Collection Service

	FY2019				FY2020				FY2021				FY2022				FY2023			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
3-1:Formulate investment plan for waste collection services																				
3-2:Replacement of waste collection trucks																				
3-3:Replacement of waste containers																				
3-4:Proper operation and maintenance of waste collection equipment																				

Action 4: Careful examination of new SWM technologies

	FY2019				FY2020				FY2021				FY2022				FY2023			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
4-1:Conduct feasibility studies on new SWM technologies																				
4-2:Careful examination of the results of these feasibility studies, and produce an assessment report.																				
4-3:Submit an assessment report to the relevant authorities																				

*FY: From 1st of October to next year 30th of September

**Q1: Oct.-Dec., Q2: Jan.- Mar., Q3: Apr.-Jun., Q4: Jul.-Sep.

4.5.2 Cost of the Action Plan

A description of main budgeted items for the Action Plan are shown in the table below.

Table 4-14: List of budgeted main items by each component

Components	Personnel cost	OM cost	Construction and treatment cost	Purchase cost for Machinery and equipment	Planning and Design cost
Action 1: Proper operation of the final disposal site(s)	• Operators and workers for machinery	• Fuel and lubricant for machinery • Maintenance of machinery	• Construction of sea walls	• Landfill mining equipment	• Design for sea wall and extension work • Design for new landfill site
Action 2: Reduction of final disposal amount by composting and recycling	• Operators and workers for Compost yard and CDL	• Operation and maintenance cost	-	• Wood chippers	-
Action 3: Maintenance of waste collection services	• Operators and workers for waste collection • Analyze record for spare parts.	• Fuel and lubricant for machinery • Maintenance cost	-	• Replace two compactor trucks	-
Action 4: Careful examination of new SWM Technology	• Assessment of FS for new SWM technologies	-	-	-	-

Estimated costs to implement the Action Plan are shown in the table below. The entire cost of the Action Plan is estimated at US$9.2 million for five years.

Table 4-15: Estimated cost of the Action Plan by each component over 5 years.

	FY2019	FY2020	FY2021	FY2022	FY2023	Total
Action 1: Proper operation of the final disposal site(s)	344,000	500,000	1,890,000	1,044,000	636,000	4,414,000
Action 2: Reduction of final disposal amount by composting and recycling	204,000	382,800	232,800	232,800	232,800	1,285,200
Action 3: Maintenance of Waste Collection Service	642,000	1,010,000	600,000	600,000	600,000	3,452,000
Action 4: Careful examination of new SWM technologies	0	27,000	27,000	9,000	0	63,000
Total	1,190,000	1,919,800	2,749,800	1,885,800	1,468,800	9,214,200

Annex 1: Proposed Extension of Sea Wall at the Batkan Dump Site.

Phased Extension of Sea Wall (blue line)

Phase 1:

Length of Sea Wall: 900 Feet

Area for Filling: 48,750 sq.ft.

Volume of Filling: 17,805 cy (13,612 m3) where filled to a height of 10 feet)

Phase 2:

Length of Sea Wall: 670 Feet

Area for Filling: 67,000 sq.ft.

Volume of Filling: 24,814 cy (18,970 m3) where filled to a height of 10 feet)

Phase 3:

Length of Sea Wall: 450 Feet

Area for Filling: 35,000 sq.ft.

Volume of Filling: 12,963 cy (=9,910 m3) where filled to a height of 10 feet)

Annex 2 : Current Waste flow in Majuro（As of 2017）

1 Current Waste flow in Majuro

Purpose

Waste flow is mainly formulated for the following purpose;

- To figure out current situation of waste management and recycling quantitatively in Majuro
- To set target figures for future waste management in Majuro
- To formulate practicable strategy and action plan on waste management in Majuro

Outline of Waste Flow

Outline of waste flow is shown as follows.

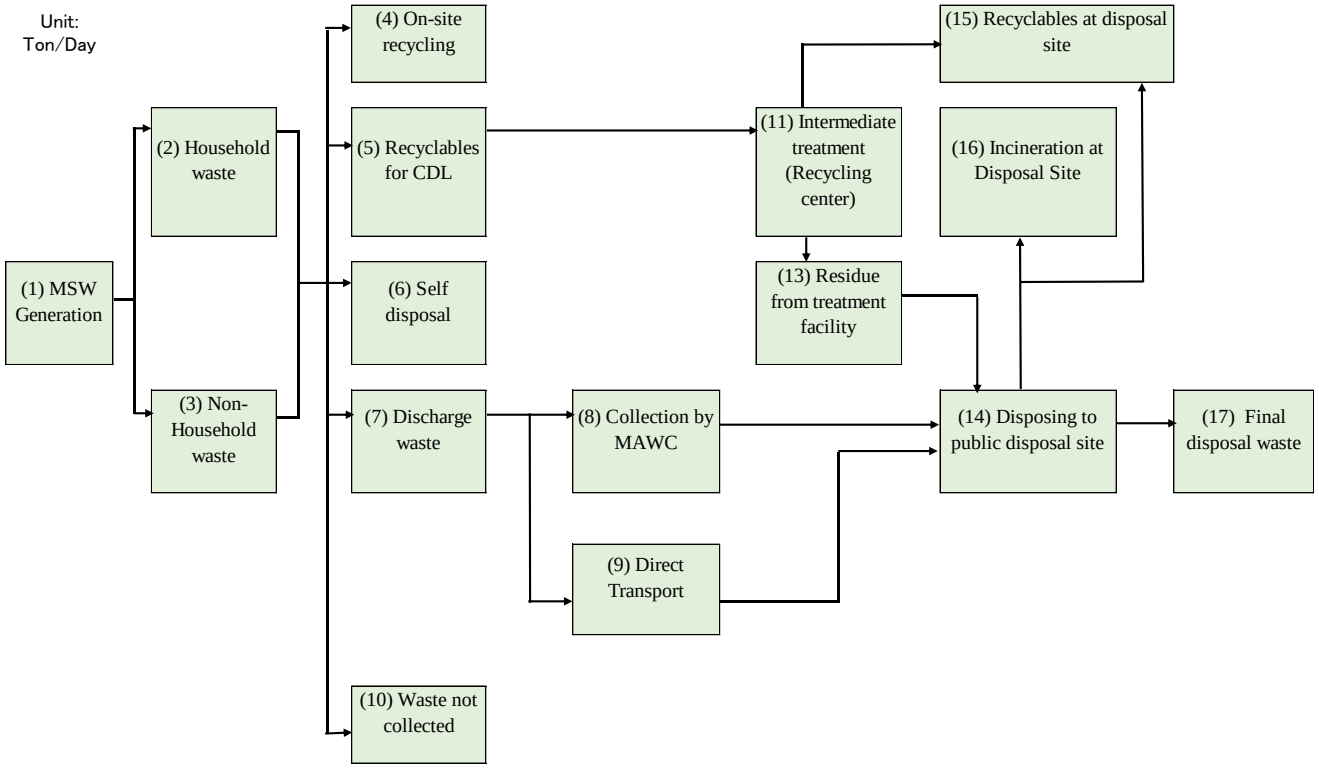


Figure 4-1 Outline of Waste Flow

Definition of each component in waste flow is as follows.

- ☐ [MSM Generation (1)] is consisted of [Household waste (2)] and [Non-household waste (3)].
- ☐ [On-site Recycling (4)] is recycling at generation sources such as composting of green waste and kitchen waste, using kitchen waste as feed for livestock and pets and using green waste as fire-wood.

- ☐ [Recyclables for CDL (5)] refers to beverage containers returned to and refunded at the recycling center.
- ☐ [Self-disposal (6)] refers to burying or open burning of waste in their own property.
- ☐ [Discharged waste (7)] refers to waste excluding [On-site Recycling (4)], [Recyclables for CDL (5)] and [Self-disposal (6)] from [MSM Generation (1)]
- ☐ [8) Collection waste] refers to waste collected by collection service.
- ☐ [9) Waste transported directly to public disposal site] refers to waste transported by households, shops, super markets, restaurants, hotels and public office, etc. to disposal site directly.
- ☐ [Intermediate Treatment (Recycling center) (11)] refers to the redemption center of recyclables for CDL.
- ☐ [Recyclables at a treatment facility (12)] refers to the recyclables separated and counted at the above-mentioned facility.
- ☐ [Residue from Intermediate facility (13)] refers to residue generated at [intermediate treatment facility (11)].
- ☐ [Disposing to public disposal site (14)] refers to collection waste and the transportation waste directly to public disposal site.
- ☐ [Recyclables at disposal site (15)] refers to the recyclables picked up at the public disposal site.
- ☐ [Incineration at Disposal site (16)] refers to the waste transported to the public disposal site and incinerated with a simple incineration device
- ☐ [Final disposal waste (17)] refers to [Disposing waste to public disposal site (14)] and [Disposing waste to community dump sites (16)] excluding [(Recyclables at disposal site (15))

Methodology

Baseline Survey

The waste flow in Majuro was formulated based on the result of baseline survey as follows.

1. Waste amount and composition survey
2. Questionnaire survey on waste generation from household
3. Incoming waste survey at public disposal site (hereinafter; disposal site)

Waste amount of household waste

Waste amount generated from household was calculated using the following formula; unit waste amount (g/person/day) multiplied by population.

The Generated waste is composed of the following;

- Recyclable at generation source
  - ✓ On-site recyclables: compost, feed for livestock, fire-wood, etc.
  - ✓ Recyclables for CDL: PET bottle, Aluminum can, steel can, glass bottle
- Non-recyclables
  - ✓ Self-disposal waste: Burning of garden waste, etc.
  - ✓ Discharge waste: discharging to collection service, transporting to disposal site individually, etc.

Questionnaire survey was conducted to each household as a part of baseline survey. The amount of on-site recyclables, recyclables for CDL and self-disposal waste was estimated based on the result of the household survey. Unit amount of discharged waste was referred to the result of waste amount and composition survey conducted in 2017.

Questionnaire survey on waste generation from household

Unit waste amount (g/person/day)

Unit waste amount calculated based on the survey is 868g (1.89lb)/person/day. Of this amount, 14% is recycled at generation source such as on-site recyclables, recyclables for CDL and so on. A break down of the unit waste amount is presented in Table 1-1.

- Table 4-1 Unit waste amount generated from household

Generation waste	Unit waste amount		%	Source
	(g/person/day)	(lb/person/day)		
1. Recyclable waste (a+b)	121	0.27	13.9	
a. On-site recycling waste	118	0.26	13.6	2017 JPRISM II & JICA Senior Volunteer
b. Recyclable waste for CDL	3	0.01	0.3	Ditto
2. No-recyclable waste	746	1.64	85.9	
c. Self- disposal waste	18	0.04	2.0	Ditto
d. Discharge waste(2-c)	728	1.60	83.9	Ditto
Total(1+2)	868	1.91	100	

Population

Population of Majuro excluding outer islands in 2017 was estimated at 30,638 based on the increase-decrease rate of population from 1999 to 2011.

- Table 4-2 Estimated population of Majuro in 2017

	Population in census		Annual Growth rates	Population in 2017 (estimate)
	1999	2011		
Majuro	23,676	27,797	1.3 %	30,638
Kwajalein	9,572	9,935	0.3 %	10,186

Generation amount of household waste

Generation amount of household waste was calculated as 26.6t/day on the formula below. Unit generation amount and population in the formula was referred to the data mentioned above.

(Generation amount of household waste) ＝(Unit waste amount) × (Population)

Breakdown of the generation amount is shown as Table 1-3.

- Table 4-3 Unit generation amount and waste amount generated from household

Item	Unit waste amount (g/capita/day)	Population	Waste amount (ton/day)
4) On-site recycling waste	118	30,638	3.6
5) Recycling waste for CDL	3	30,638	0.1
6) Self- disposal waste	18	30,638	0.6
7)+8) Discharge waste	728	30,638	22.3
2) Generation waste	868	30,638	26.6

*The number attached beside each type of waste corresponds to the number in the chart of waste flow.

Disposal waste amount

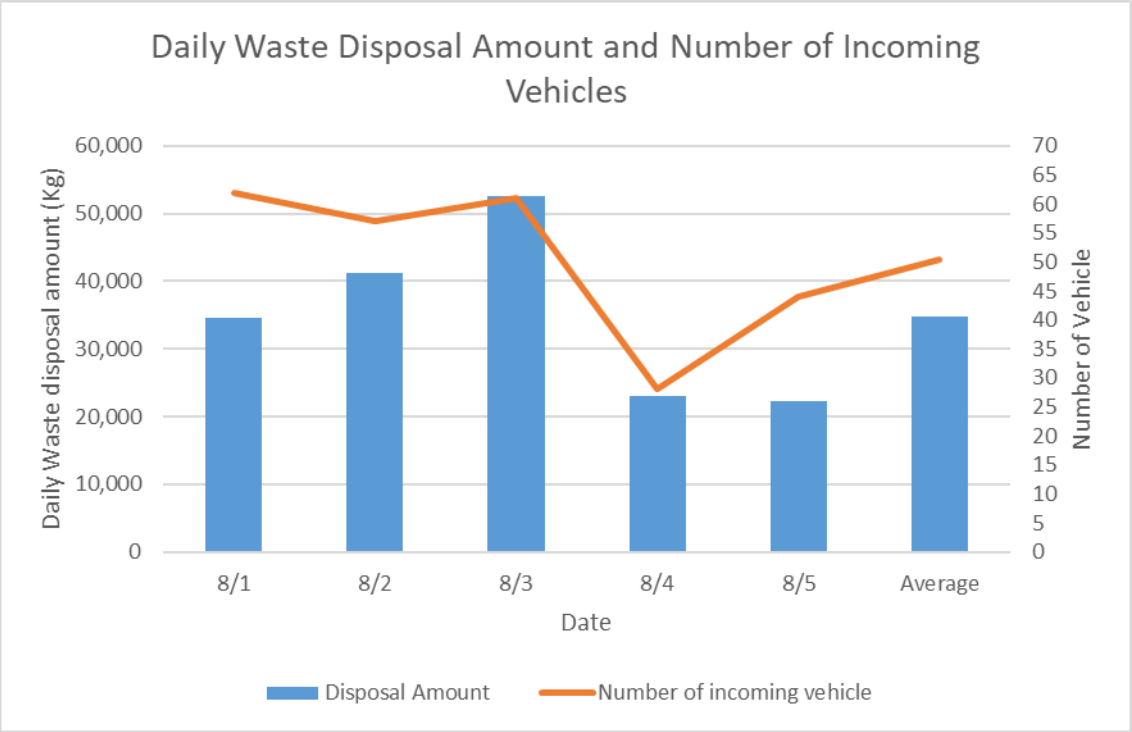
Disposal waste amount in Majuro was calculated based on the amount of incoming waste and net specific weight of each type of waste.

Daily average amount of incoming waste is 34.8t/day, breakdown of which is 22.0t/day of the collected waste and 12.8t/day of the waste transported directly by each household, small business, hotel and restaurant.

Incoming waste survey at disposal site

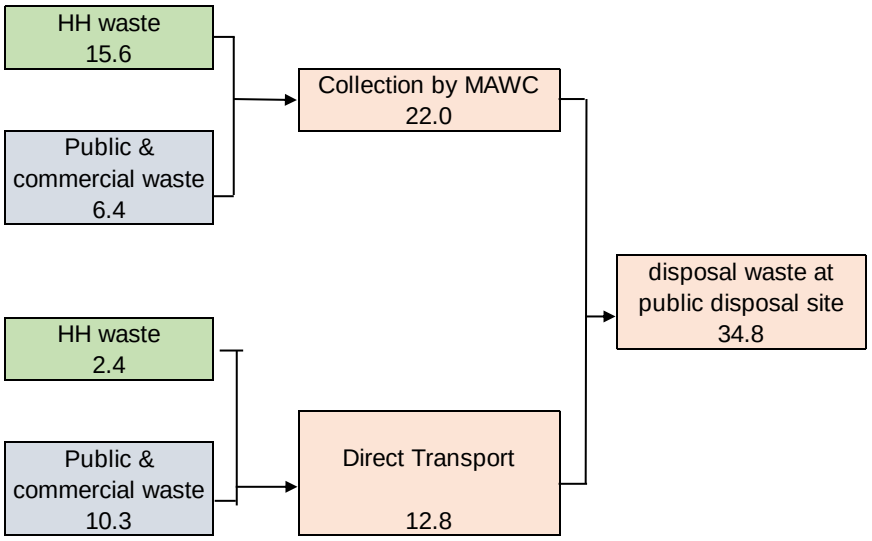
- Table 4-4 Number of incoming vehicles and disposal waste amount (ton/day)

	Aug.1	Aug.2	Aug.3	Aug.4	Aug.5	Average
Number of incoming vehicle	62	51	61	28	44	50
Incoming waste amount	34.6	41.1	52.6	23.1	22.4	34.8
8)Collected waste amount	20.9	26.4	27.4	20.8	14.4	22.0
9)Waste amount transported directly	13.7	14.7	25.1	2.2	8.0	12.8



- Figure 4-2 Number of Incoming vehicles and disposal waste amount

Breakdown of disposal waste at disposal site is shown as Figure 1-3. Disposal amount of household waste accounts for 52 % (28.0 ton/day) of total disposal waste. The other 48% accounts for public waste and commercial waste such as from small businesses and restaurants.



- Figure 4-3 Breakdown of disposal waste at disposal site

Recycling amount at disposal site

Scrap metal and green wastes are segregated and stored. Aluminum can was segregated and even purchased for export. These minor recycling amount were reflecting on waste flow in 2017.

(15) Recycling at disposal site = 0.1 ton/day

Intermediate Treatment

A simple incineration device was introduced in early 2017. This is a shipping container sized open steel box, with a forced air supply and added liquid fuel, used to burn woody wastes. The operation record, as taken in mod 2017 by the JICA senior volunteer, shows that around 0.8 ton/day was incinerated, which contributed to a reduction of just 1.9 % of the waste generated.

(16) Incineration at Disposal site = 0.8 ton/day

Final disposal waste amount

Final disposal waste amount was calculated as the following formula;

(17) Final disposal waste amount =(14) Disposal waste amount - (15) Recycling amount at disposal site – (16) Incineration at Disposal Site＝34.8 - 0.1 - 0.8 =33.9 ton/day

Recycling amount of beverage container for CDL

CDL system is not commenced as of mid of 2017 when base line survey was conducted.

Waste amount from collection service

MAWC (Majuro Atal Waste Company) is contracted with the government to provide waste collection services to households free of charge. In addition MAWC made the individual contracts with commercial facilities and business entities and provide waste collection service with charges. The total amount of waste collected by MAWC is 22.0 ton /day. Hence direct transportation amount by individual waste discharger is 12.8 ton /day

(8) Collection by MAWC is 22.0 ton /day

(9) Director transport is as.12.8 ton /day

Discharged waste amount

The total amount of discharged waste was calculated as 34.8 t/day from the result mentioned above.

(7) Amount of discharged waste ＝(8) Amount of collected waste + (9) Amount of disposal waste transported directly to disposal site = 22.0 + 12.8 = 34.8 t/day

Waste generation from non-household

Waste amount generated from non-household was calculated as 18.7 t/day (38.7 % of generated waste) based on the following formula.

(3) Amount of the waste generated from non-household ＝ (4) Amount of On-site recycling + (5) Amount of recyclables for CDL + (6) Amount of self-disposal waste + (7) Amount of discharged waste + (10) Amount of waste not collected – (2) Amount of household waste = (3.6 + 0.1 + 0.6 + 34.8 + 4.3 - 26.6)＝ 18.7 t/day

Amount of Generated Waste in Majuro

The total amount of generated waste in Majuro was calculated as 43.3 t/day, which is the sum of generated amount of household waste and non-household waste.

(1) Amount of Generated Waste ＝ (2) generated amount of household waste＋(3) generated amount of non-household waste ＝ 26.6 + 16.7 = 43.3 t/day

Waste flow in Majuro

Waste flow in Majuro was formulated as follows, based on the result mentioned above.

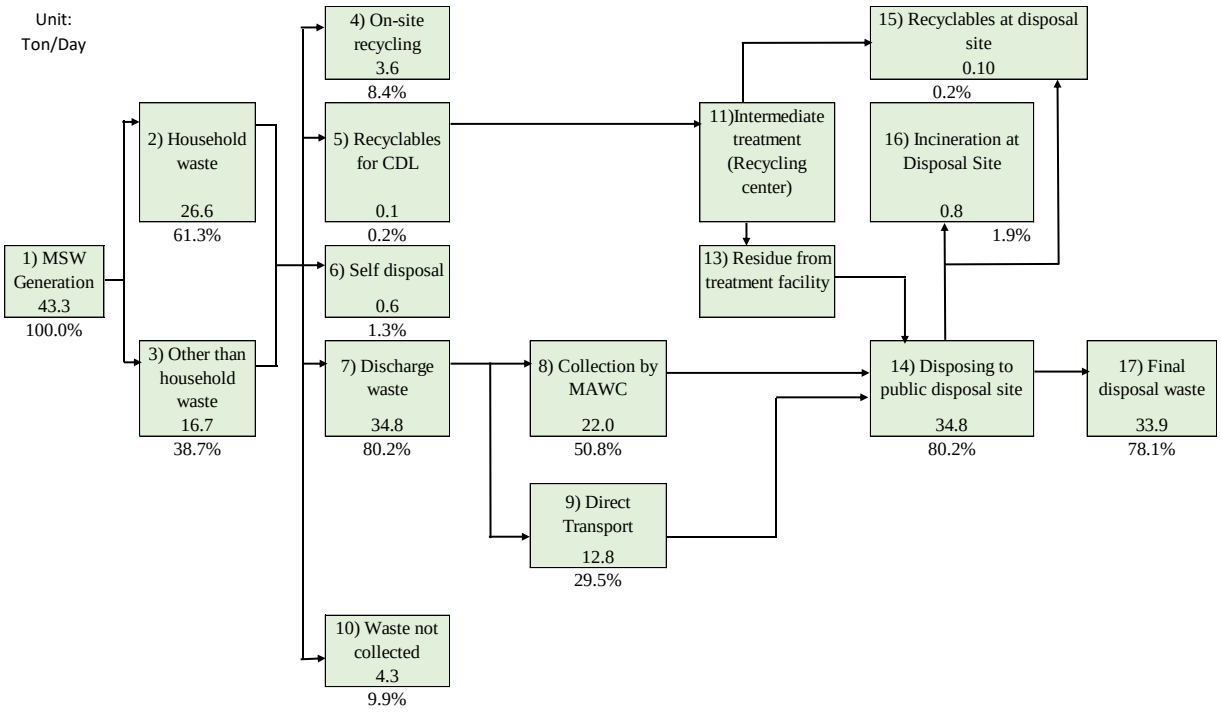


Figure 4-4 Waste flow in Majuro (2017)