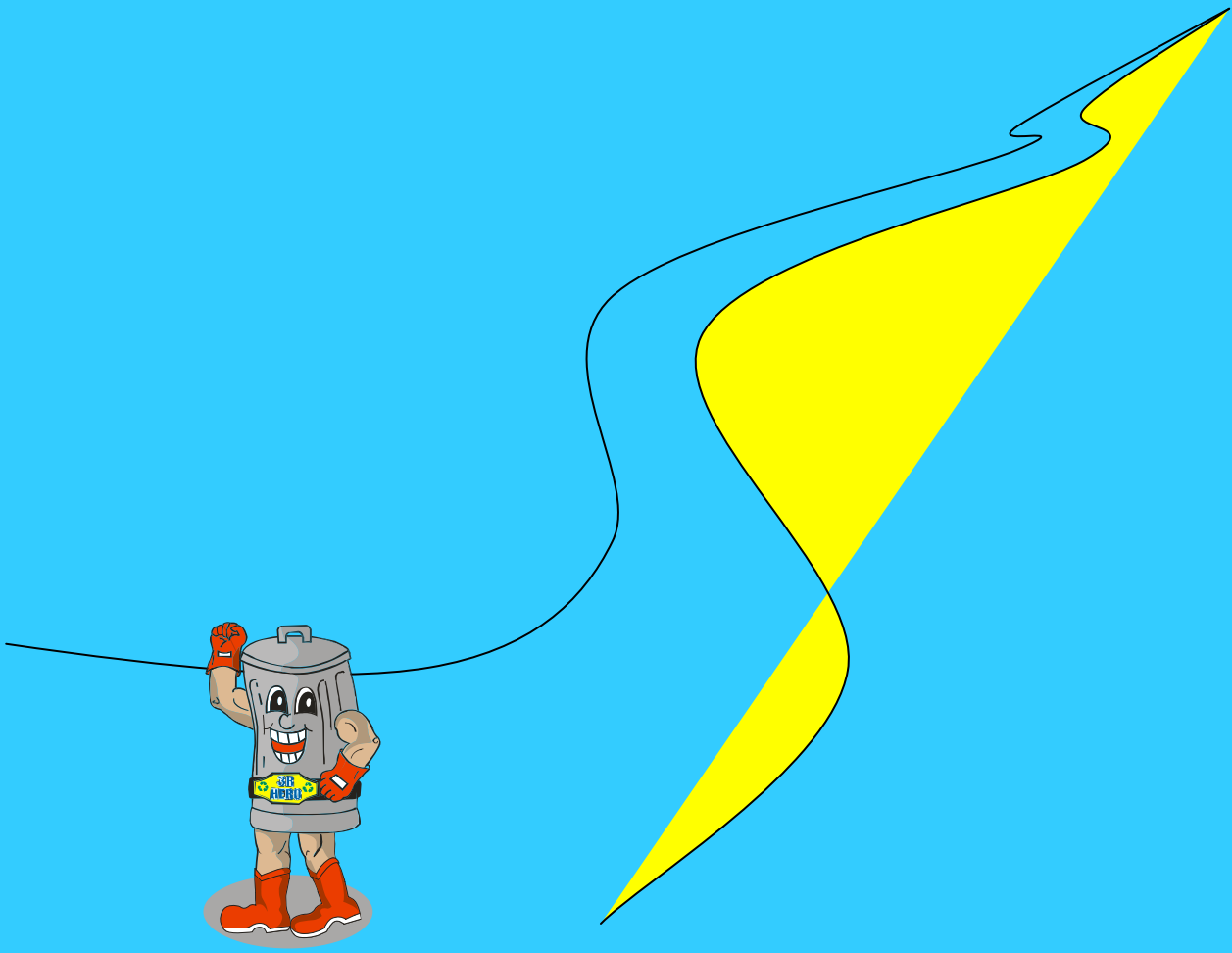


*APPENDIX*

JAPAN INTERNATIONAL COOPERATION AGENCY  
MINISTRY OF RESOURCES AND DEVELOPMENT  
THE REPUBLIC OF PALAU

# DRAFT OF NATIONAL SOLID WASTE MANAGEMENT PLAN

To Protect and Enhance Palau's Environment for Future Generation



February 2008

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## Abbreviations

CEM	Continuous Emission Monitoring
EIS	Environmental Impact Statement
GDP	Gross Domestic Products
ISWMP	Integrated Solid Waste Management Plan
NGO	Non Governmental Organization
NSWMP	National Solid Waste Management Plan
PEE	Public Education and Enhancement
PNC	Palau National Code
SSWMAP	State Solid Waste Management Action plan
SWM	Solid Waste Management

Organization	
BPH	Bureau of Public Health
BPW	Bureau of Public Works, MoRD
CNMI	Commonwealth of the Northern Mariana Islands
DEH	Department of Environment and Health, MoH
DMR	Division of Marine Resources
EQPB	Environmental Quality Protection Board
JICA	Japan International Cooperation Agency
KSG	Koror State Government
MoF	Ministry of Finance
MoH	Ministry of Health
MoRD	Ministry of Resources and Development
NEPC	National Environmental Protection Council
OEK	Oibill Era Kelulau
OERC	Office of Environmental Response and Coordination
PALARIS	Palau Automated Land And Resource Information System
PAN	Protected Area Network
PEEC	Public Education and Enhancement Committee
PIRRIC	Pacific Islands Regional Recycling Initiative Committee

*Draft of National Solid Waste Management Plan*

*Part1: Executive Summary*

PPUC	Palau Public Utilities Corporation
ROP	The Republic of the Palau
SPREP	Secretariat of the Pacific Regional Environment Programme

# Part 1

## Executive Summary



## **1. INTRODUCTION**

The Republic of Palau (Palau) is an island country in the southwestern Pacific Ocean with a tropical climate and average annual rainfall of approximately 4,000 mm.

Palau's population is approximately 20,000 (Census 2000). The majority of the population lives in Koror State, the capital of Palau; about 14,000 people, or 70% of the total.

Like many countries in the Pacific Region, Palau has been facing various kinds of solid waste problems caused by the characteristics of the country, such as lifestyle, high dependence on imports, concentration of population in the capital, limited capacity for solid waste management (SWM), and lack of proper waste management facilities and recycling industries.

Under these circumstances, JICA (Japan International Cooperation Agency) has been implementing a Technical Cooperation Project named "Project for Improvement of Solid Waste Management in the Republic of Palau" (the JICA Project) since October 2005.

As one of the outputs of the Project, this Draft National Solid Waste Management Plan (Draft NSWMP) has been formulated jointly by Japanese experts and their Palauan counterparts through numerous discussions and reviews of existing documents such as the "Report on Integrated Solid Waste Management Plan" prepared by an Australian consultant in 1999 and "Solid Waste Management Strategy for Pacific Region" under SPREP in 2006 (SPREP Strategy). Recent experiences related to SWM activities were also fed back into the Draft NSWMP. They included a recycling program by Koror State, establishment of a new Law related to the promotion of recycling, and pilot projects under the JICA Project.

The Draft NSWMP is composed of, following its Vision and Goal, an overall strategy, individual strategies and conceptual plans for each concerned SWM issue, and action plans. A summarized chart of the Draft NSWMP is shown in Figure 1.

## **2. VISION**

*"To Protect and Enhance Palau's Environment for Future Generations"*

## **3. GOAL**

*"Sustainable Solid Waste Management System with  
3R Policy, Suitable Technical Options and Stakeholders' Participation"*

## **4. Overall Strategies**

Considering the mechanisms of waste generation in Palau and waste management principles and hierarchy (see Figure 2 and 3), the following three major strategies, which were introduced as the key elements of the SPREP Strategy, are adopted as the overall strategies for this Draft NSWMP:

- Institutional activities by all key stakeholders, including policy development, capacity building, information exchange, public education and awareness
- Development and/or enhancement of waste minimization activities to reduce the amount of waste
- Improvement and upgrading of existing waste management and disposal system

## **5. Individual Strategies and Conceptual Plan**

Individual strategies and conceptual plans are categorized into the following SWM issues:

- 3R (Reduce, Reuse, Recycle)
- Final disposal
- Collection and transportation
- Overall Monitoring
- Intermediate treatment
- Hazardous waste management
- Institutional
- Financial
- Public education and enhancement

### **3R (Reduce, Reuse, Recycle)**

#### Individual Strategy

Considering the mechanism of waste generation in Palau that most waste is valueless or useless and derived from imported goods consumed and accumulated within the country, the activities to be promoted include: the reduction of the consumption of imported goods; the reuse of reusable waste/materials; and recycling activities such as material recovery and composting.



### Conceptual Plan

Imposition of excise taxes on certain materials such as plastic bags and “bulky” waste are planned for the purpose of waste avoidance in order to adjust the amount of goods imported into or consumed within Palau.

The reuse of the goods after consumption for alternative use is also promoted under the “mottai-nai” spirit in cooperation with public education and enhancement activities.

Recovery of non-organic recyclables, especially aluminum cans, iron scrap, PET bottles and paper items for recycling should be increased to reduce waste sent to landfill.

Source separation of such recyclables (Bun-betsu) will be promoted referring to the experiences of Koror State’s recycling program and a pilot project in Ngarchelong State under the JICA Project. Finding international markets for such recyclables and cooperation between the government and private companies is very important because recycling activities are a part of the market based business activities.

Composting of organic waste, which accounts for 30 to 40% of the waste stream, is also an option for recycling. For successful composting, quality control of the compost product and securing of a domestic market have to be considered. Lessons learned from a pilot scale trial currently being implemented by Koror State for material recycling and composting can be drawn upon to improve the recycling plan under the Draft NSWMP by making it more practical and feasible.

## **Final Disposal**

### Individual Strategy

An appropriate disposal system defined by the capacity, structure, location and users of the landfill should be introduced depending on the situation of each state. An appropriate structure is needed as a sanitary landfill with stability, impermeability, leachate control and gas venting with proper operation such as regular waste covering, recording, cell-method dumping, and use of suitable equipment. The post-closure management of the landfill site also needs to be taken into consideration.

### Conceptual Plan

A large scale landfill should be constructed and be ready to start operation as soon as the existing M-Dock landfill becomes full, around 2012. The new landfill can only be constructed on Babeldaob Island because no other suitable location can be found within Koror State. Other States in Babeldaob have several options: they can also use this large scale landfill, they can prepare their own small scale landfill within their state boundary, or they could prepare a medium scale multi-state landfill to be shared by several States. Until commencement of a new landfill operation, an existing small dumping site known “Gomi-Sute-Ba” will be renovated by the Palauan side referring to the experience of a

pilot project of the JICA Project in Ngarchelong State.

Details of the final disposal site such as location, capacity, and structure will be planned by BPW/MORD in cooperation with each state, utilizing the experiences from the rehabilitation works of M-Dock Landfill under the JICA Project.

Considering the time required to commence operation of the new landfill (time for land acquisition, planning, design, construction, and procurement of equipment) BPW/MORD has to start planning this future landfill as soon as possible.

In addition, typical measures for finishing or utilizing of post-closure sites including M-Dock landfill will be described.

## **Collection and Transportation**

### Individual Strategy

To maintain sanitary conditions in residential and commercial areas where waste is continually being generated, all the waste discharged should be collected in a cost-effective manner with an appropriate level of human resources and equipment under the limited circumstances.

Responsibility for waste collection should be taken by each State as is currently is the case, but a multi-state collection system under the management of the National Government will also be considered when a new large scale landfill is to be opened in Babeldaob Island in the future. Utilization of the private sector for self-collection should be also promoted as much as possible under the polluter pays principle.

### Conceptual Plan

In principle, each state has to provide waste collection and transportation services to the residents based on the state's final disposal plan. Different collection systems may be set up depending on the types of waste, such as domestic, commercial, bulky, or hazardous waste. For efficient recycling activities, source-separated collection will be considered for introduction if the experience of Koror State's recycling program can verify the effectiveness of source-separated collection.

When a new large scale landfill starts operation, expected in about 2012, a multi-State collection system will be considered in consultation between the national government and the state government of Babeldaob Island due to the limited capacity of each State for transportation of waste.

Involvement of the private sector in self-collection will be continued and promoted more in Koror State as currently it is, even if the new landfill site is constructed in Babeldaob Island in future.

## **Overall Monitoring**

### Individual Strategy

In addition to appropriate environmental monitoring for SWM activities, such as final disposal at the landfill, social monitoring to grasp the level of public awareness and technical monitoring to grasp the waste quantity and quality should be implemented.

### Conceptual Plan

Environmental monitoring of landfills and surrounding areas should be conducted by EQPB as well as for other SWM facilities and equipment. Especially for a large scale landfill such as M-Dock Landfill, the composition of leachate and water quality in surrounding areas should be recorded over time to understand whether any environmental pollution is caused by the landfill or not.

Since social acceptance is crucial for implementing sustainable SWM activities, social monitoring should be conducted through interviews and public hearings by responsible bodies such as EQPB, BPW/MORD or the State government.

Without understanding the actual condition of waste generation, it is very hard to review the Draft NSWMP and to prepare an appropriately detailed implementation plan. Therefore, technical monitoring in the form of regular waste quantity and quality surveys should be conducted as well as a survey on recycling activity, including a market survey.

## **Intermediate Treatment**

### Individual Strategy

Possible treatment options other than direct disposal at a landfill will be adopted in case such treatment is financially, technically and environmentally feasible.

### Conceptual Plan

Shredding, separating, compacting, baling and combustion will be described as possible alternative intermediate treatment options with consideration for the fundamental conditions to be adopted in Palau. In particular, an incinerator for the combustion of waste that is currently generated at some hospitals and States will be explained with numerous points for its introduction and operation.

## **Hazardous Waste Management**

### Individual Strategy

A definition of hazardous waste should be prepared. Then, the quantity of hazardous waste at generation source should be measured and appropriate treatment and disposal manner should be arranged.

### Conceptual Plan

First of all, the existing regulations and guidelines will be reviewed and revised with a clear definition of hazardous waste. Especially the major hazardous waste such as waste oil and hazardous hospital waste will be focused on for a more detailed plan. Hazardous household waste like batteries, paint, insecticides or pesticides will be collected by the national and state governments.

Appropriate treatment options such as isolated storage/landfill, incineration, or detoxification will be introduced.

## **Institutional Aspects**

### Individual Strategies

Following authorization of the Draft NSWMP as a national policy, related laws and regulations should be reviewed and newly established if required. An appropriate organizational structure for SWM activities should be set up at national and state levels, including the strengthening of the SWM section of BPW/MORD

### Conceptual Plan

The responsibilities of parties concerned, such as the national and state governments, people, and businesses will be clarified. The national government will mainly take care of SWM activities at the policy level and landfill management. The state government has responsibility to collect the waste and promote 3R activities with preparation of a state level SWM implementation plan.

The SWM section of BPW/MORD will be reinforced with suitable numbers of skilled workers. The relevant laws, regulations and standards will be reviewed and newly established if required.

## **Financial Aspect**

### Individual Strategies

The cost of appropriate SWM activities including 3R activities and expected benefits should be carefully estimated for budgeting so that self-sustainable monetary mechanism and incentives can be considered to maintain those activities under the financial responsibility of the organizations concerned.

### Conceptual Plan

As an economic measure to control the quantity of imported goods, an import tax will be imposed on certain consumer goods, plastic bags or bulky goods, such as vehicles or home appliances, which have a large potential to accumulate in Palau once they become waste.

According to the new Law for “Establishing a Recycling Program”, SB No. 7-94, a deposit refund system for beverage containers will be promoted.

A direct charge system for the use of landfill or indirect charge system through the existing tax system will be introduced so that self-sustainable operation of a large scale landfill can be conducted.

Funding requirements for development of new SWM facilities including a new landfill in Babeldaob Island will be studied and the Government of Palau should secure the financial resources.

## **Public Education and Enhancement**

### Individual Strategies

A key organization to lead public education and enhancement activities should be established and authorized. The target groups, messages, and methods for the public education and enhancement activities will be set and associated activities will be promoted continuously until they become thoroughly entrenched.

### Conceptual Plan

As an authorized key organization, PEEC has been established through the joint work of the JICA Project. The first priority target groups are women’s groups, schools, and Filipino community groups. The private sector will be positioned as the second priority. The target area is all states. The general matters to be common to all states and differences in the detailed methods depending on each state’s characteristics will be examined and experiences or lessons learned from the PEE activities in each state will be shared through PEEC.

## **6. Conclusion**

This Draft NSWMP is the national plan that generally describes the national level policies and strategies for SWM. Therefore, once this Draft NSWMP is authorized, the national and state governments should prepare implementation plans referring to the proposed Action Plans attached in the Draft NSWMP.

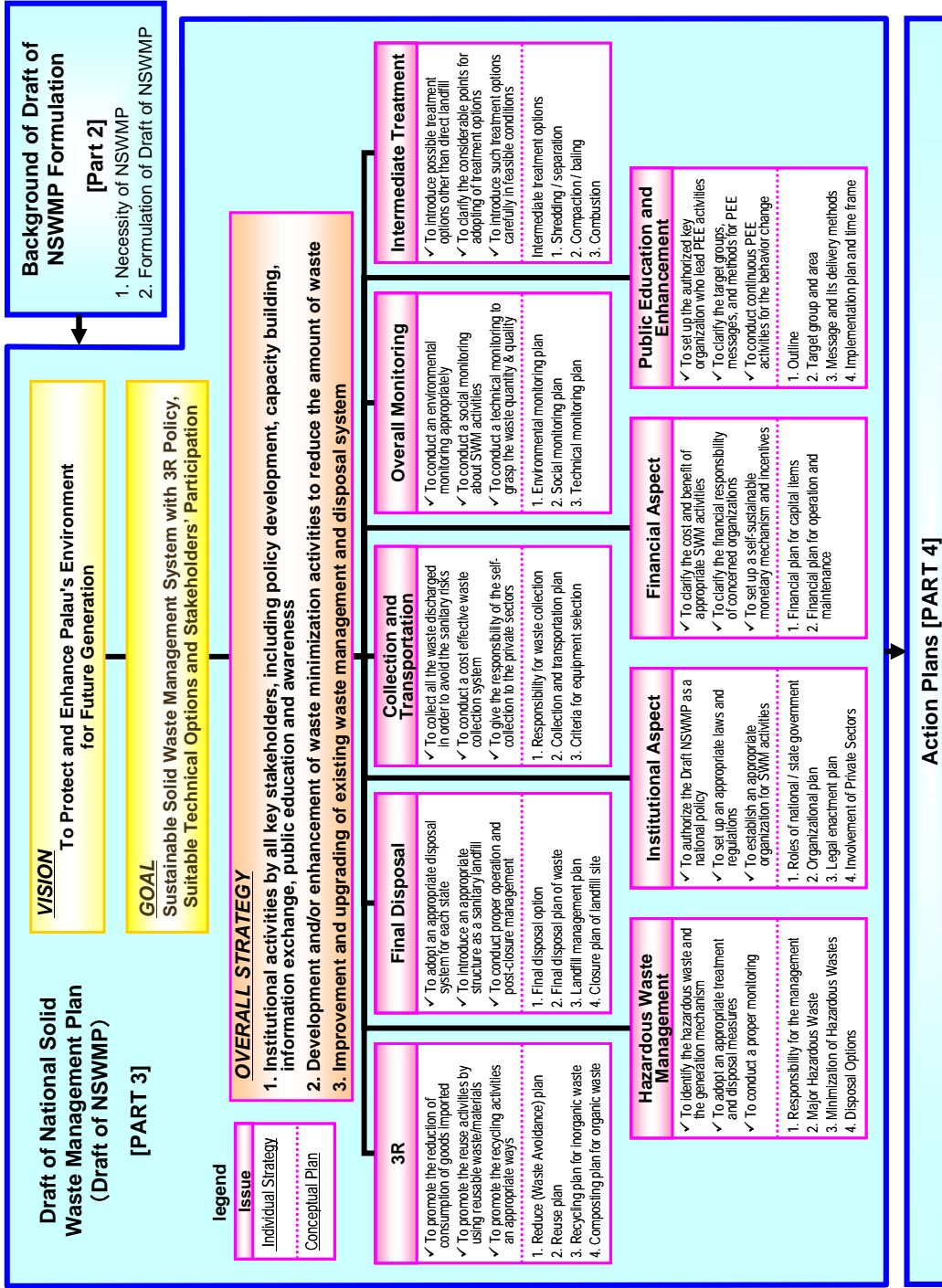


Figure 1 Summary Chart of Draft of NSWMP

## Material Flow Mechanism in Palau

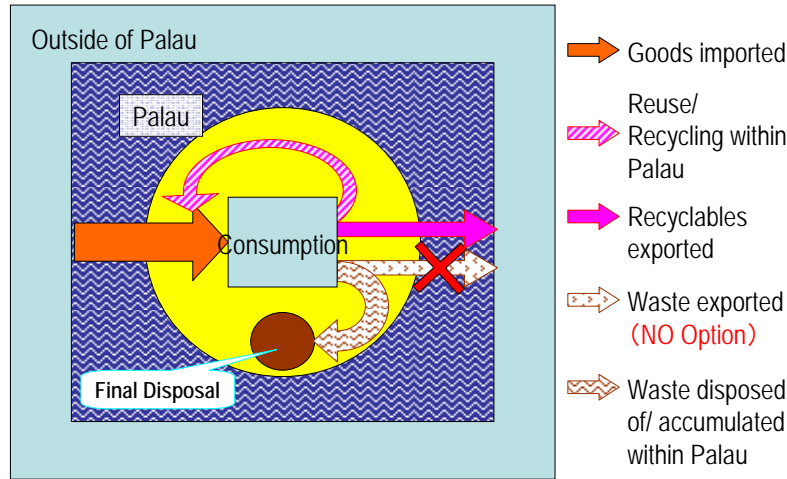


Figure 2 Material Flow Mechanisms in Palau

## SWM Principle and Hierarchy

- Principle**  
 People can not stop generating the waste, and there is the waste can not be recycled.  
 → Should need “Final Disposal” way of Waste
- Hierarchy**  
 But it is needed to reduce the waste to be disposed of by appropriate ways under affordable conditions

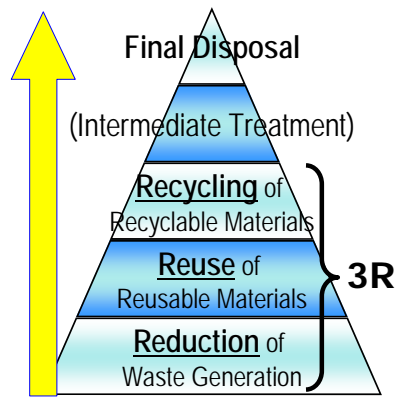


Figure 3 SWM Principles and Hierarchy

## Part 2

# BACKGROUND OF DRAFT OF NSWMP FORMULATION



# 1 Current Conditions of Solid Waste Management in Palau<sup>1</sup>

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## 1.1 General Information on the Country

The Republic of Palau (ROP) is the most western island group of the Caroline Islands, and is comprised of a 350-island archipelago located in the southwestern Pacific Ocean. The nearest neighboring island States are Guam, the Philippines and Papua New Guinea respectively. Palau has a tropical climate with an average annual rainfall of approximately 150 inches.

The largest island is Babeldaob with an area of 153 square miles (see figure 2), which contains 10 of the Republic's 16 States, and is connected to Koror via bridge. North of Babeldaob is the State of Kayangel, and south are the States of Koror (the current capitol), Peleliu and Angaur. Between Koror and Peleliu are hundreds of small, uninhabited coral "rock" islands. Palau's population is approximately 20,000 (Census 2000), the majority (69%) of whom live in Koror State, which serves as the commercial and business center of the nation. Koror is urbanized in character with modern infrastructure and services, while the remaining States and islands are characteristically rural in nature and still under development.

The sixteen States of the ROP have their own governors and State legislatures. The national government is modeled after that of the United States, and consists of the executive, legislative (bicameral) and judicial branches. Traditional leadership councils operate in coordination with the national and state governments and have jurisdiction over traditional cultural law not specifically regulated by state and national law. The largest sectors of the ROP economy are services, tourism, fisheries (tuna exports) and agriculture. The majority of the Palauan population is employed in the government sector. Palau's gross domestic product (GDP) is 3-6 times higher than that of other Pacific island countries.

## 1.2 Outline of Waste Management

### 1.2.1 Present Status of Waste Management

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<sup>1</sup> Source: Country Report at Workshop on Municipal Solid Waste Management for PIF Countries, Apia Samoa, February-March 2004

At present waste management is the responsibility of each state government with the exception of Koror, wherein the state handles collection and the national government Bureau of Public Works manages the dumpsite. Each of the 16 states of the Republic has at least one landfill site, and many have more than one.

**Table 1 Status of Dumping Site (2004)**

• State	• EQPB Compliance	• Collection	• Site Management
• Koror	• No	• State	• National Government
• Ngaraad	• Yes	• State	• State
• Ngatpang	• Yes	• State	• State
• Ngiwal	• Pending	• State	• State
• All others	• No	• State	• State

Table 1 indicates the status of the dumpsites in the various states. Note that “EQPB Compliance” refers to compliance with basic landfill management requirements as promulgated by the Environmental Quality Protection Board, the environmental regulatory agency (national government) for the Republic of Palau, which do not at this time ensure maintenance of a modern sanitary landfill.

As can be seen from table 1 only two states, Ngaraard and Ngatpang, can be said to have compliant landfill sites, with Ngiwal due to come on line within a year. With the exception of Koror, most of the state dumpsites handle relatively small quantities of waste (average state population of 388). However, many of the dumpsites are inappropriately located (e.g. in mangroves, adjacent to bodies of fresh or marine water, etc.) and unmanaged, leading to the potential for negative public health and environmental impacts.

In the past little emphasis has been placed on the issue of proper waste management, and it is likely that many of these “official” dumpsites were originally sited for convenience and simply grew to their present size without regard to sanitary landfill practices including cover requirements, fencing, segregation of hazardous waste and leachate collection and treatment.

There is evidence of a growing awareness on the part of the national and state governments regarding waste management issues:

- EQPB compliant landfills in Ngaraard and Ngatpang have come on line within the last 4 years
- The construction of the EQPB compliant landfill in Ngiwal was started in 2004

- Current construction efforts are underway to address some of the more serious issues regarding the Koror State dumpsite (M-dock)
- Koror State has recently created its new Office of Solid Waste Management
- The national government is following suit with its own waste management agency, due to be in operation this year
- The new national landfill is currently undergoing design and permitting, although funding for the landfill has not yet been obtained

Although the ISWMP, which was proposed by an Australian Consultant in 1999, has not received full endorsement by all parties, work has already begun on implementation of the various waste reduction/management mechanisms it envisions. At this time, pilot projects addressing composting, recycling and hazardous waste are under implementation.

The ISWMP addresses a number of program areas including waste minimization, collection systems, waste disposal, hazardous waste, administration and funding and community education. Additionally, the plan emphasizes the use of locally appropriate technologies and compliance with EQPB requirements.

The ISWMP can be thought of as a template for the creation of the legislative, administrative, educational and physical infrastructure necessary for the Republic to appropriately manage its waste such that negative impacts on Palau's public health, environment and economy are minimized. Implementation of the plan will be a rather large undertaking that will take a number of years to complete, primarily because it requires a paradigm shift in the attitudes that leaders and the public take towards waste management in order to be successful.

In addition to its own internal efforts to address waste management, Palau is a participant in certain initiatives of the Secretariat of the Pacific Regional Environment Programme (SPREP), including the persistent toxic substances project, the SPREP Waste Minimization, Management and Pollution Prevention Program, International Waters Program, and Capacity Building for Environment Management Program. These regional programs give the Republic access to resources that can assist Palau in implementing its national agenda. For example, an enabling grant from the SPREP waste minimization program allowed Palau to purchase a chipper for recycling green wastes. Furthermore, it is hoped that other regional efforts, such as the Regional Recycling Initiative currently under study by Palau, Yap, Guam and the CNMI, will enable these islands to explore waste management opportunities that would otherwise be inaccessible due to cost issues.

The Republic is also actively pursuing efforts to build capacity in the area of waste management by obtaining training through programs such as this workshop. Palau is developing a GIS in cooperation with the PALARIS project that will be used to track environmental indicators and compile information on landfills for reports on the environment.

Until the implementation of the national agency for waste management, efforts to

implement the ISWMP are being spearheaded by a group of government agencies, with input from NGO's, whose activities focus on development and the environment. These include the Office of the President, the Ministry of Resources and Development, the Environmental Quality Protection Board (EQPB), the Office of Environmental Response and Coordination (OERC), the National Environmental Protection Council (NEPC), Koror State Public Works, and the Koror State Office of Solid Waste Management.

## 1.2.2 Waste Generation Data

A waste characterization study was performed during the preparation of the effort to produce the ISWMP. Although a direct survey of waste production by residences, commercial enterprises, and other sources was not performed, figures were obtained based on data taken at the M-dock dump facility in Koror State and used in conjunction with waste generation rates for similar locales/populations. Based on this, the waste generation rate per day per capita for Palau is estimated to be 1 kg/day/person for residents of the urban center Koror, and 0.6 kg/day/person for the remaining rural states. The total mass of solid waste generated in Palau is estimated to be 17.9 tons per day, which equates to 6,500 tons annually. The breakdown of the waste stream based on percentage weight of waste components for the national landfill is provided in Table 2.

**Table 2 Waste Composition (2004)**

<b>• Waste Category</b>	<b>• % by weight</b>
• Paper	• 30
• Plastic	• 16
• Glass	• 5
• Metals (ferrous)	• 7
• Biodegradables (food/kitchen)	• 19
• Aluminum	• 4
• Garden (green waste)	• 17
• Other	• 2
• Textiles	• N/A
• Construction Debris	• N/A
• Hazardous	• N/A
• <b>Total</b>	• <b>100</b>

## 1.2.3 Waste Collection

The solid waste collection systems in Palau are described in table 3 for both the urban center of Koror and the remaining rural states.

**Table 3 Current Waste Collection System in Palau**

State	Locale	Collection Method	Schedule	Operated by	Cost	Collection Equipment	Rubbish Containers
Koror	Urban	Service	Weekly	State	None	5 collection trucks	Various*
Ngatpang	Rural/Main Island	Service	Bi-weekly	State	None	Pickup/flatbed	Various*
Ngchesar	Rural/Main Island	Service	Monthly	State	None	Pickup/flatbed	Various*
Aimeliik Ngaremlengui Ngardmau Ngarchelong Ngiwal Melekeok Airai	Rural/Main Island	Self haul	N/A	N/A	None	None	Various*
Kayangel	Rural/Outer Island	Self haul-transport to Koror	N/A	State	None	State boat	Various*
Peliliu Anguar	Rural/Outer Island	Self haul	N/A	N/A	None	None	Various*
Sonsorol Hatohobei	Rural/Outer Island not part of main chain	Self haul	N/A	N/A	None	None	Various*
* – Although numerous types of containers are utilized, the majority of them are 55 gallon metal drums							

## 1.2.4 Waste Disposal Method and Conditions

### (1) National Landfill at M-dock

Due to the lack of structured recycle/reuse and hazardous waste segregation mechanisms, a majority of the waste stream is deposited at the state dumpsites. By far the largest of the state dumpsites is the M-dock landfill, located in Ngerbeched hamlet, Koror State, which serves as the de facto national dumpsite. This facility has been in operation for about 50 years and is located in an area of former shallow reef and mangrove wetland. It is approximately 15 acres in size, and receiving amount of waste was averagely 20 tons per day (measured in 2007). It does not include the amount of scraps recovered by scrap

collectors to transport them overseas as recyclables.

Solid waste disposed of at the landfill is primarily from residences, commercial operations such as restaurants, hotels and retailers; and construction operations. Hazardous wastes known to have been received at the site include waste oil, batteries, and carbide sludge (from manufacture of acetylene), although the depositing of waste oil and used batteries has slowed due to recent efforts on the part of the national government to segregate these hazardous wastes and dispose of them appropriately.

Daily operations at the dumpsite consist of waste being brought into the facility by either Koror State Public Works vehicles or self-hauling by residents, and deposited at the north end of the site. A crew of two personnel from a private company then separates and collects aluminum cans from the deposited waste. Once enough waste has accumulated, a bulldozer is used to push the waste southward into the main body of the dump. Some compaction occurs due to the passage of the bulldozer over previously spread waste. This process occurs each working day, although the lack of entrance controls at the site results in the depositing (but not spreading or compacting) of waste over the weekends. In addition to household and commercial waste, car bodies and white goods are also deposited on the site although much less frequently. At present there is a substantial inventory of these items.

Coverage of the deposited waste occurs sporadically at best, with weeks or months between applications.

Unrestricted access to the site allows the public to enter for the purpose of scavenging items, mainly from the metallic solid waste inventory. Furthermore, numerous dogs live on the site, presumably feeding off of the deposited waste, and birds frequent the area for the same purpose. Ponds of standing water are common, providing fertile breeding grounds for mosquitoes.

Lack of proper grading and drainage controls results in contaminated runoff water leaving the site and impacting the surrounding marine environment with each heavy rain. The lack of an impermeable liner, combined with the porous nature of the underlying limestone allows leachate to do the same. A hazards assessment study performed in 1998 found that the levels of contaminants in the surrounding marine areas were detectable but low enough not to pose a significant hazard; however, the additional waste accumulated during the intervening six years may have rendered this conclusion invalid.

The dump constitutes a serious eyesore to persons, including tourists, using the adjacent road to access the Palau International Coral Reef Center, one of the Republic's main land based attractions. Finally, the stench from the dump is noticeable from up to a quarter mile away under certain conditions.

The national government Bureau of Public Works is currently charged with managing the dumpsite, with a total of six personnel dedicated to this task. Only one working bulldozer is available for operations, with this being the sole piece of equipment utilized on the site.

The operating budget is on the order of \$150,000 per year.

## (2) Dumpsites in the Rural States

Problems associated with these facilities are quite similar to those encountered at the M-dock facility, albeit on a much smaller scale. In most cases, these facilities completely lack any equipment (e.g. bulldozers), and hence compaction and daily cover of waste have never been implemented.

### 1.2.5 Waste Minimization/Recycling

There are no formal long-term programs for the minimization and recycling of waste in Palau. A local company performs aluminum collection and shipment off-island. A pilot program for composting, using a mobile chipping machine that was purchased through SPREP funding, is also underway.

### 1.2.6 Health-Care/ Hospital Waste

The Belau National Hospital and three other private medical clinics generate hospital/health-care waste. These facilities segregate out infectious wastes. Sharp wastes such as needles and syringes are placed in 1-gallon plastic containers and other infectious/contagious wastes are placed in specially designated bags. These segregated wastes are then incinerated at the Belau National Hospital using a single chamber unit that lacks temperature controls, is not connected to a smoke stack, and is in violation of the EQPB regulations. This, combined with the lack of an operable smokestack, subjects the operator and persons in the surrounding area to high levels of dioxins and furans.

### 1.2.7 Hazardous Chemicals/Waste

Currently, there is no comprehensive hazardous waste management program in Palau; however, waste oil is accepted by the Palau Public Utility Corporation where it is stored in a 750,000 gallon bulk storage tank for shipment off-island, and the EQPB collects and stores used batteries at a facility constructed outside of its office. Both of these efforts are less than optimal due to the high costs associated with final disposal of these wastes off-island. The principal types of hazardous wastes generated in the ROP include waste oils, lead/acid batteries, various cleaning agents, bleach, solvents, paints, pesticides and hospital waste. Most chemical wastes are associated with the service industries such as auto repair, boat repair, construction industry, heavy equipment repair, health-care system and the power sector, including a dry cleaning shop and two acetylene gas manufacturers in Palau that generate hazardous waste.

An overall program to address all types of hazardous waste, as envisioned by the ISWMP, is now being formulated and will be implemented in some form within the next two years. This program will be started through the implementation of small pilot projects, which will be scaled up once successfully established. This notwithstanding, previous limited efforts to address two types of hazardous waste in the Republic have been successful. In June of 2003 approximately 8,000 used automobile and marine batteries were shipped off-island in containers after they were drained and packed. This inventory represented approximately five years' worth of accumulation through battery drives managed by the EQPB. At present there is an inventory of approximately 281,060 gallons of waste oil stored at the Aimeliik power plant facility, and efforts are underway to seek an appropriate avenue of disposal for this material as has been done in past years.

To date chemical contamination of soil, water and air from solid and hazardous wastes has occurred only on a limited scale, due primarily to the low level of development currently manifested in the Republic. Notable exceptions include both the power plants in Aimeliik and in Malakal, where improper storage and disposal of fuel oil has resulted in contamination of both soil and marine resources. It is clear that this will continue to be the case only as long as levels of development remain low. Since it is the position of the government of Palau to increase the level of development in order to build the Republic's economy, it is imperative that the hazardous waste disposal program be put into place as quickly as possible.

Improper disposal of waste oils and lubricants, cleaning solvents and lead acid batteries probably pose the largest potential contamination threat to the environment. Abandoned stockpiles of hazardous wastes and chemicals in Palau were identified as described in table 4.

**Table 4 Current Hazardous Waste Collection System in Palau**

- Hazardous Materials Inventory, EQPB 2008
- Approximately 580 gallons of potentially PCB contaminated transformer oil at Malakal Power Plant
- A total of about 5,200 L of bitumen stored in 55 gallon drums
- A total of about 281,060 gallons of waste oil at Aimeliik Power Plant
- A stockpiles have been shipped off-island by HP Frontline Metals
- Approximately 2 tons of materials thought to be Japanese medical drugs from WWII
- Oil contaminated sites at various power stations
- 300 cubic meters of asbestos pipe

Source: Hazardous Material Section of EQPB, PPUC



### 1.2.8 Difficult/Bulky Waste

Junk vehicles, heavy equipment, appliances and scrap metal can be found in all state landfill facilities. Furthermore, these items can also be found scattered about the interiors of the various states, particularly the ten states on the island of Babeldaob. Finally, shipwrecks litter the near shore areas of the state of Koror.

There are currently a number of proposals by private contractors for the removal and sale of this solid metallic waste. Although the current inventory offers the potential for profit making if removed in bulk at one time, there is a great deal of concern that the long term disposal of these items on a regular basis may not be economically feasible due to the limited quantities produced each year. The Republic of Palau is investigating the feasibility of using a regional recycling approach to overcome this potential roadblock.

### 1.2.9 Management Practices

As stated above, the national government does not have a dedicated waste management office at this time, and out of the state governments only Koror has an agency of this type. The ISWMP has not been fully endorsed, and hence the Republic lacks a bona fide management system for waste disposal. This being the case, no user fee system is in place, and funds for the management of waste in Palau comes from the general funds of the national government (M-dock facility) or the state governments (all others). Overall, resources at all facilities are inadequate for their proper management.

### 1.2.10 Education and Awareness Building

To date, public education regarding waste management has focused on the collection and disposal of hazardous waste as well as cleanup efforts. These programs have been sponsored by the EQPB along with other national and state government bodies including the Palau Visitors Authority and the Division of Environmental Health under the Ministry of Health, and have met with a great deal of success owing to the participation of local businesses and civic action groups; However, the scope of the programs has been limited and they do not directly address important issues such as waste minimization. The EQPB is currently formulating educational programs that will complement the upgrades in the waste management infrastructure in order to ensure that the ISWMP is implemented fully and effectively.

### 1.2.11 Existing Laws and Regulations

The Palau National Code (PNC) mandates the creation of the Palau Environmental Quality Protection Board (PEQPB) through the Environmental Quality Protection Act (Title 24,

chapter 1). The EQPB is charged with regulating the disposal of all wastes including hazardous materials, and this is accomplished through the enforcement of the EQPB regulations, which carry the force of law. Beyond this there is little structure to the Republic's system of waste management. As previously stated, funding sources for waste management are very limited due to the lack of user fees. In other words, there is no system in place to cost burden for waste disposal on those persons or companies producing the waste.

The national government Bureau of Public Works and the Koror State Office of Solid Waste Management are the only two agencies dedicated to the management of waste in the Republic (EQPB's role is meant to be regulatory, not operational). This lends itself to the lack of overall structure with regard to this endeavor, making concerted efforts to implement appropriate mechanisms difficult. The soon to be created national government waste management agency will address this.

Part 3  
DRAFT OF NATIONAL SOLID WASTE  
MANAGEMENT PLAN

February 2008



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## 2 VISION and GOAL

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### 2.1 Vision

*“To Protect and Enhance Palau's Environment for Future Generation”*

### 2.2 Goal

*“Sustainable Solid Waste Management System with  
3R Policy, Suitable Technical Options and Stakeholders' Participation”*

## 3 POLICY AND STRATEGY

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### 3.1 National Government Policy

#### 3.1.1 Environmental Policy

The policy intentions of the government of Palau are clearly set out in its laws and constitution. The Environmental Quality Protection Act states:

The Olbiil Era Kelulau declares that it is the continuing policy of the national government, in cooperation with state governments to use all practicable means and measures to create and maintain conditions under which humankind and nature can co-exist in productive harmony, and fulfill the social, economic and other requirements of the present and future generations of the Republic.

In order to carry out the above policy, it is the continuing responsibility of the national government to improve and coordinate governmental plans, functions, programs, and resources to the end that the inhabitants of the Republic may:

- (1) Fulfill the responsibility of each generation as trustee of the environment for succeeding generations;
- (2) Assure for all Palauans safe, healthful, productive, and aesthetically and culturally pleasing surroundings;
- (3) Attain the widest range of beneficial uses of the environment without degradation, risk of health or safety or other undesirable and unintended consequences; and
- (4) Preserve important historical, cultural and natural aspects of our Palauan heritage, and maintain wherever possible an environment which supports diversity and variety of individual choice.

The Olbiil Era Kelulau recognizes that each person has a fundamental right to a healthy environment and that each person has a responsibility to contribute to the preservation and enhancement of the environment (Environmental Quality Protection Act RPPL 1-58, 102 PNC Title 24).

Article VI of the Palauan Constitution also states that "the national government shall take positive action to implement these national policies: Conservation of a beautiful, healthful and resourceful environment".

#### 3.1.2 SWM Policy

Adhering to the “Environmental Quality Protection Act RPPL 1–58 s. 102 PNC Title 24 and to which such legislation is administered by the EQPB, the Palau’s waste management policy is established to:

- Expand and improve the solid waste management capacity for the states of Palau to ensure the protection of the public health and the environment.
- Identify and correct as needed the deficiencies in the solid waste disposal and recycling system
- Provide opportunity for the closure of all of Palau’s open garbage dumps with the availability of a proper solid waste management facility.
- Establish the necessary mechanisms for the ongoing, correct operation and maintenance of Palau’s solid waste management.
- Initiate and establish programs to maximize recycling of Palau’s solid waste and eventually reduce the quantity of materials that ultimately must become part of Palau’s waste stream.

### 3.1.3 Definition of Solid Waste

As previously mentioned in detail in Part 2, the definition of the following types of solid waste is described in the EQPB Regulation (May 1996)

“Solid Waste”, “Residential Solid Waste”, “Commercial Solid Waste”, “Institutional Solid Waste”, “Rubbish”, “Food Waste”, “Bulky Waste”, “Hazardous Waste”, “Infectious Waste”, “Sludge”

## 3.2 SWM Strategy

### 3.2.1 Waste Management Hierarchy

#### (1) Over View

The waste management hierarchy is an integration of environmental and resource conservation principles with traditional waste management methods. The waste management hierarchy represents a series of options for dealing with various components of the waste stream. The option, ranked from most preferable to least preferable are broadly:

- Avoid/Reduce
  - Reuse
  - Recycle
  - Treatment
  - Disposal
- } 3R

Market conditions influence the economic viability of some of the higher options (particularly reusing and recycling). A significant cultural change is needed to achieve some of these options since they may cost the community more. It should be noted that disposal, ranked as least preferable option, should be absolutely indispensable option of the solid waste management.

These options are discussed in more detail below.

## (2) Avoid / Reduce

Waste avoidance or reduction refers to avoiding the generation of a particular type of waste. Some examples of waste avoidance and reduction include:

- Not or less packaging durable items such as hardware
- Not or less individually wrapping items that are contained within bulk packaging
- Not or less individually wrapping food items that are usually sold loose
- Not or less unnecessary over-wrapping
- Not or less using disposable plates, cups and utensils
- Double sided copying and printing
- Using a reusable cloth shopping bag, “my bag”
- Receiving goods in reusable plastic crates rather than cardboard boxes
- Repairing broken items rather than throwing them away and replacing them

From the viewpoint of global environment, if we can reduce the amount of materials that need to be manufactured through this waste avoidance/reduction, we can also reduce the impacts of the manufacturing industry that uses energy and other resources and produces pollution.

## (3) Reuse

Some waste items can be reused as it is or as other purposes. Some waste items can be reused only once, but some can be used over and over again depending on its characteristics. Examples of waste reuse include:

- Refilling large plastic mineral water barrels
- Refilling returnable glass bottles such as beer or soft drinks
- Taking plastic shopping bags back to the store to use again
- Using plastic shopping bags as trash bags
- Use of old tires for playground equipment
- Using the blank side of printed paper for another printing
- Using scrap paper for notes and phone messages

- Using glass jar or tin can as vase or pen-holder

Reusing waste more than once also reduces the impacts of manufacturing as well as waste avoidance/reduction activities.

#### (4) Recycling

Recycling is reprocessing recyclable materials that are discharged as waste into a usable product. In some cases, it is possible to remake the original item, as in aluminum can recycling, where the aluminum is melted down and made into new cans by blending with raw materials. In other cases, the end product is not the same as the starting product, for example when PET bottles are turned into PE fiber cloths.

Materials that are commonly recycled are:

- Aluminum
- Iron and steel
- Other metals
- PET bottle
- Other certain types of plastic
- Paper, cardboard and newspaper
- Glass

Composting can also be considered as a recycling method in case the compost product can be used as soil conditioner or fertilizer. Composting can also reduce the volume of organic material requiring disposal at landfill.

#### (5) Treatment

Waste can be processed prior to disposal to reduce its toxicity or make it easier to handle during disposal. Some examples of waste treatment include:

- Segregating recyclable waste by manual or by mechanical
- Shredding waste to reduce its volume
- Combusting burnable waste including infectious waste to reduce its volume and toxic risk, and to recover the energy
- Drying sewage sludge before landfill

## (6) Disposal

Disposal is the last option for management of waste that cannot be avoided, reused, recycled and so on.

However, it should be understood that this final disposal option, landfill, is most fundamental and indispensable measure for the solid waste management. It means the waste hierarchy shows the priority of programs of solid waste management only after the waste flow, means waste collection and disposal, is established.

Any of disposal options in Palau should have a concept of “sanitary landfill” that meets environmental protection standards.

### 3.2.2 Overall Strategy

Considering the mechanism of generation of waste in Palau where the islands countries entirely depend on imported the goods, and previously mentioned principle and hierarchy of SWM, the following three major strategies, which are introduced as key elements for SPREP Strategy, are adopted as overall strategies for this Draft NSWMP.

- Institutional activities by all key stakeholders, including policy development, capacity building, information exchange, public education and awareness
- Development and/or enhancement of waste minimization activities to reduce the amount of waste
- Improvement and upgrading of existing waste management and disposal system

### 3.2.3 Individual Strategy

Several individual strategies are set for each following solid waste management issue respectively.

- For 3R (Reduce, Reuse, Recycle)
- For Final Disposal
- For Collection and Transportation
- For Monitoring
- For Intermediate Treatment
- For Hazardous Waste Management
- For Institutional Aspect
- For Financial Aspect
- For Public Education and Enhancement

(1) Strategies for 3R

- Promote the reduction of consumption of goods imported which has a potential to be disposed of as waste within Palau
- Promote the reuse activities by using reusable waste/materials to avoid going to the disposal site
- Promote the recycling activities such as material recovering and composting with an appropriate institutional, financial, and technical ways

(2) Strategies for Final Disposal

- Adopt an appropriate disposal system depending on the situation of each state, individual small scale site or common large scale site
- Introduce an appropriate structure as a sanitary landfill with stability, impermeability, leachate control, gas vent, etc.
- Operate properly as sanitary landfill with regularly covering, recording, cell-method dumping and suitable equipment
- Conduct a post-closure management of the site (including monitoring of gas and leachate quality)

(3) Strategies for Collection and Transportation

- Collect all the waste discharged in order to avoid the sanitary risks at the generation source
- Conduct a cost effective waste collection system with an appropriate equipment under the limited circumstances
- Give the responsibility of the self-collection to the private sectors as much as possible under the polluter pay principle

(4) Strategies for Monitoring

- Conduct an environmental monitoring appropriately to check whether any environmental impact could be occurred by SWM activities
- Conduct a social monitoring to know how people feel about SWM activities
- Conduct a technical monitoring to grasp the waste generation / collection / dispose / recycled quantity, and its composition

(5) Strategies for Intermediate Treatment

- Introduce possible treatment options other than direct landfill
- Clarify the considerable points for adopting of treatment options
- Introduce such treatment options carefully in feasible conditions

(6) Strategies for Hazardous Waste Management

- Identify what hazardous waste are generated from what sources like hospital, industry, store, household or others, and how much those is
- Adopt an appropriate treatment and disposal manners to reduce such hazardous risk
- Monitor the hazardous waste management

(7) Strategies for Institutional Aspect

- Authorize this Draft NSWMP as a national policy
- Set up an appropriate laws and regulations related to implement SWM activities
- Establish an appropriate organization for SWM activities in national and state level, including strengthening of the SWM section under BPW/MoRD

(8) Strategies for Financial Aspect

- Clarify the cost and benefit of appropriate SWM activities including 3R activities
- Clarify the financial responsibility of concerned organizations for each SWM activities
- Set up a self-sustainable monetary mechanism and incentives to maintain the SWM activities including 3R activities

(9) Strategies for Public Education and Enhancement

- Set up the authorized key organization that will lead PEE activities
- Identify the target groups, messages, methods and resources for PEE
- Conduct PEE activities continuously so that PEE will be a part of people behavior



## 4 3R PLAN

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### 4.1 Reduce (Waste Avoidance) Plan

#### 4.1.1 Government Regulation through Import Controls

Most of the waste that requires disposal in Palau comes from goods that are imported into the country. Given this situation, an opportunity exists to place controls on imports to reduce the amount of waste that is produced. There are two options that this could be implemented, a ban or tax on certain imports.

Imports of certain materials can be banned on the basis that these materials contribute significantly to the waste stream and are not necessary to maintain the existing quality of life in Palau. House Bill No. 5-96-3 seeks to ban imports of single use disposable plastic objects such as cups, plates, flatware and other containers, although not on plastic packaging.

An outright ban on imports requires the government to decide that certain items are inappropriate for Palau. This may be considered undemocratic or unconstitutional as it assumes that the national government has the right to control consumer choices made by Palauan citizens and residents.

As an alternative to outright banning of imports of certain materials, an increased import tax can be placed on certain items that present particular problems for the waste stream. This tax will be passed on to the consumer through increased purchase price therefore forcing the consumer to pay more for these materials. Funds raised from this tax can be diverted for various waste management tasks. Care must be taken in the choice of goods that such a tax is applied to.

Such a tax is considered appropriate for single use disposable plastic objects on the following basis:

- Locally made, biodegradable alternatives exists for packaging and serving of locally made foods and these alternatives are also more culturally appropriate
- Durable alternatives exist for packaging and serving of locally made foods.
- Many of these items are not designed for reuse

The primary aim of this tax will be to reduce consumption of these items. Funds raised from the tax should be made available to BPW to assist activities of solid waste management in providing support for implementation of other waste minimization initiatives and not directed to general government revenue.

Taxation regulation will need to be amended to implement the tax and direct revenue to the

appropriate agency. The Palau Customs Classifications for Customs Declarations will need to be amended to provide a separate category for these items.

## 4.1.2 Consumer Choices

Consumers who are aware of the problems associated with disposal of packaging and other wastes may make a choice to purchase products that will contribute less to the waste stream.

For consumer choice to contribute to reductions in waste generation, two requirements must be met:

- Consumers must be aware of the impact of waste on the environment and be motivated to make purchasing choices that will reduce the amount of waste that is generated.
- Retailers must support consumers who wish to make waste reduction choices by providing low-waste alternatives, for example, goods that have less packaging. This requires retailers to also be aware of the impacts of waste.

To facilitate consumer choice as a means of waste reduction, consumers and retailers must participate in community education programs that:

- Describe the environmental impacts and economic costs of waste collection and disposal
- Explain the types of choices that can be made and give practical examples of how consumers and retailers can contribute to waste reduction.

A community awareness campaign targeting consumers and retailers should be also established to encourage consumer choice for waste reduction.

Consumer choices to reduce waste generation will be supported by implementation of waste collection and disposal fees that are based on the volume of waste that is being generated. A volume-based fee provides an incentive for all waste producers to reduce the volume of trash that they produce.

Consumer choices also have opportunities to develop waste reduction schemes with the following ways:

- Reduced packaging, or changes in the type of packaging for locally made foods and take away foods (or discounts for customers who provide their own containers or plates)
- Introduction of cloth shopping bags to replace plastic shopping bags

## 4.2 Reuse Plan

## 4.2.1 Government Regulation through Import Controls

Being different from the waste avoidance and reduction, any certain government regulation will not be necessary because these reuse activities will be achieved as business activity for the reuse of returnable bottles such as beer bottles, or as daily household activity for reuse of those to other alternatives by people's preference.

## 4.2.2 Consumer Choices

As with waste avoidance/reduction, consumers who are aware of the problems associated with disposal of waste may make a choice to purchase products that can be reused once or more prior to disposal.

A community awareness campaign introducing how to reuse the waste should be established to encourage consumer choice for the reuse of waste. For example, People can use an emptied glass bottle as a vase and tin can as vessels to store some household goods. Large used water bottles can be used to refill water or fill coconut oil.

**Comment [a1]:** Soeda;  
Added according to a floor  
comment at the WS.

## 4.3 Recycling Plan for Dry Recyclable Materials

### 4.3.1 New Government Law and Regulation

The passage of S.B No. 7-94, SD, PD1 "Establishing a Recycling Program" for the Palau came into law in October 2006, tailored specifically as a fee-based incentive system to encourage the redemption and recycling of beverage containers. This law is limited in its capacity to fully address and place environmental responsibilities on what should be expected of businesses, citizens, local governments, and other entities in undertaking the 3Rs.

Following this law, "Beverage Container Recycling Regulations" is prepared to put the recycling of beverage containers into effect. This regulations address recycling of deposit beverage containers, the national recycling program, collection of the deposit fees, administration of the recycling fund, redemption centers, record keeping requirements, and audit measures.

### 4.3.2 Recyclables for Material Recycling

Dry materials that are readily recycled include:

- Paper (all grades)

- Cardboard (all grades)
- Glass (clear, brown and green)
- Aluminum (cans, foil, containers)
- Other metals including iron, steel, copper, lead, zinc
- Plastics (PET, HDPE and others)
- Large and bulky waste such as car, tire, home appliance and so on

At present, most of these materials can be recycled in Palau as a same material purpose because of no reprocessing plant in the islands. Establishment of these recycling plants in Palau would be inappropriate given the very low level of industrial development in Palau, and would not be economically viable given the small quantity of recyclable materials generated. Therefore, these materials must be shipped off-island for recycling if those will be materially recycled.

However, paper, cardboard and glass can be recycled in Palau as for other purposes of utilization. Paper and cardboard can be a source of composting, and glass can be use for construction materials with an appropriate handling.

### 4.3.3 Material Flow of Recyclables

Recycling activities will begin by classifying targeted recyclable waste materials into the following three categories (Category 1 to 3) in the operation of Solid Waste Management (refer to Figure 1).

(1) Materials that are being traded in existing marketing routes: Category 1

Example: Aluminum, Steel, Copper, Scrap Vehicle, etc.

(2) Materials for which it is expected that a trading market can be established, or recovery of these materials can be enhanced by activities such as PIRRIC, even if the trading activity is not practical:

Category 2

Example: Pet-bottle, Cardboard (except source of compost), Plastic, Tire, Electrical appliance, etc.

(3) Materials that are not traded now and cannot be expected to be in the future: Category 3

Example: Textile, Garden waste (except source of compost), Branches, Biodegradable (Kitchen) waste (except source of compost), etc.

Category 1 recyclable materials collected will be transported to the recycling dealer directly or to the designated recycling facilities that will be established in future. Segregated aluminum and steel cans will be processed by compressing into blocks using the compaction machine and then will be sold to overseas recycling market.

In Koror State, large and bulky steel waste materials as well as scrap electrical appliances will be

**Comment [a2]: Soeda;**  
Understood the Palauan comment that paper items and glass can be recycled in Palau. What I wanted to say here was that there is very limited possibility of constructing processing facilities for plastic and paper recycling. Therefore, again original sentence was back to text with some modification and comments were feed back to the end of section.

**Comment [SMD3]: Before:**  
Cardboard

**Comment [SMD4]: Before:**  
Garden waste

transported to a designated site in the Mottainai Yard located in M-dock landfill site. Important action for recycling of some of white appliances such as refrigerator and air conditioner is to remove Freon gas from the equipment. Those stored recyclables will be regularly or occasionally shipped by contracted enterprises or individuals for the material recycling. For other States, those scraps will be stored at the designated area in each state respectively and then transported to Mottainai Yard by the government or recovered by the private contractor directly.

Category 2 recyclable materials collected from each designated area such as PET-bottles, cardboard, plastic materials will be transported to and stored at Mottainai yard in M-dock landfill as well as scrap metals but until the establishment of a market in the future. Once the recycling market for those recyclable materials will be formed, other states than Koror State can also start collecting those from the waste stream.

Other materials categorized as Category 3 will be disposed of at the M-dock landfill or new large scale landfill in future, or individual small scale landfill at each state, according to the instructions and operation plan prepared by MoRD/BPW.

Recyclable materials to be recovered and its target recovery rate shall be set based on the physical composition and generation amount of discharged waste at each state.

**Comment [SMD5]:** counter parts said that private companies should not be mentioned in this part. Category 1 is only for mottainai yard, issues about what to do to bulky waste and how bulky waste are being stored.  
 Soeda;  
 Concurred and revised according to the comment.

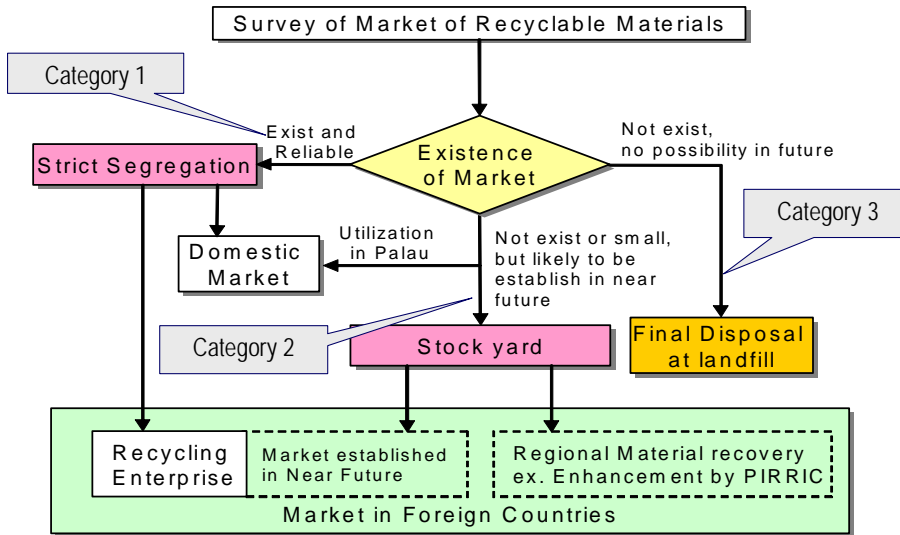


Figure 1 Flow of Waste

#### 4.3.4 Recycling Plan

## (1) Feasibility of Recycling in Palau

### 1) Economic Viability

While it is technically possible to recycle many components of waste stream, the cost of doing so often makes recycling uneconomic. If recycling is to be economically viable, the cost of collecting, cleaning and reprocessing the waste item must be less than the value of the material in the recycling market. The prices of recyclable materials on the recycling market depend on price and availability of raw materials and demand for recycled products.

It is worth noting that the price of raw materials does not necessarily reflect the costs of environmental damage that occurs when these materials are mined, processed and so on. If these environmental costs could be incorporated into the price of raw materials, then the raw materials price would increase, making recycling more attractive. In any case, it must be remembered that there are other benefits to recycling than mere cost savings, as recycling can reduce the environmental impacts associated with obtaining the raw materials. This argument provides some motivation for subsidization of recycling costs.

### 2) Subsidization of Recycling

In many countries, recycling programs are subsidized by governments to ensure that they remain commercially viable. While this represents a cost outlay by the government, it also ensures that resource conservation objectives can be met. Recycling also reduces the environmental impacts of obtaining raw materials (the cost of which is not usually included in the price of raw materials).

General subsidizing of recycling programs in Palau is recommended at present. The need for subsidization for recycling of these materials should be reviewed if alternate uses are not realized. Funds for subsidization of recycling could come from an advanced disposal fee (import duty) on vehicles and electrical appliances.

Subsidization of recycling is warranted if a component of the waste stream creates a particular waste disposal problem and recycling offers a non-disposal alternative. Auto batteries fall into this category: There is no safe disposal option for auto batteries in Palau and therefore subsidization of shipping and handling costs to transport auto batteries to a recycling facility is warranted.

Car bodies and electric home appliances may also warrant subsidization to ensure that recycling is economically viable. Although car bodies are not toxic in the way that auto batteries are, their disposal also creates a problem because they are bulky and take up a lot of space in the landfill. If not disposed of, car bodies are unsightly.

Funds for subsidization should be raised through a specific tax on imports of these materials as a kind of environmental taxes.

**Comment [SMD6]:** Their should also be environmental tax  
Soeda;  
Concurred and revised according to the comment.

### (2) Other Barriers to Recycling

Recycling also requires that the recyclable components of the waste stream are carefully separated

so that there is no contamination with other wastes. Even a small amount of contamination can make the material difficult to reprocess and raise the recycling cost.

More difficult to overcome are the barriers that are outside local control: The fluctuating market price for recyclable materials and demand for large volume shipments only. In Palau, the volumes of most recyclable materials are quite small and materials would need to be stored for a long period of time before being shipped to recycling markets. It should be careful to store some of those not to degrade its quality.

### (3) Maximizing Recovery of Recyclables

Recycling requires that the materials to be recycled be separated from the waste stream.

Three different methods to recover recyclables exist:

- Voluntary recycling
- Manual sorting
- Container deposit schemes

It must be noted that none of these methods will result in 100% recovery of recyclable materials as some will be too closely intermingled with other components of the waste stream.

### (4) Voluntary Recycling

Voluntary recycling is currently occurring in Palau where individual may return cans to a scrap metal dealer, especially for aluminum cans, if they wish and receive a small payment per pound of cans returned.

Voluntary recycling can be assisted by making it easier for people to voluntarily return cans such as removing the need for people to transport the cans to a recycling dealer or a designated recycling center in future. One way of assisting voluntary recycling is to provide dedicated containers in public places and at convenient locations such as stores for certain recyclable materials so that people can deposit recyclables at their convenience. The bins can be emptied regularly and transported to the recycling center.

A more comprehensive recovery scheme is curbside recycling where householders place various recyclable materials in dedicated containers outside their houses and these are collected by government workers or contractors and transported to the recycling center.

While this assisted recycling increases the amount of recyclable materials that can be recovered, it is also more labor intensive since government or contract workers must collect the materials and transport them to the recycling center for processing.

Increased community awareness of the benefits of recycling is necessary to support voluntary recycling to avoid the contamination.

## (5) Manual Sorting

Manual sorting is to separate the recyclable materials that are collected as mixed waste at the certain places such as a recycling center.

This option is not recommended in Palau because of the operation cost of manual sorting will be usually more than that to introduce voluntary recycling with source segregated collection. Quality of recyclable materials sorted from mixed waste is also low because of clinging of inappropriate matters.

## (6) Container Deposit Schemes

The principle behind container deposit schemes is to provide an incentive to return recyclable containers for recycling.

According to the previously mentioned new law “Establishing a Recycling Program” and regulation “Beverage Container Recycling Regulations”, the deposit amount of 10 cents for each of beverage containers including empty containers would be paid to National Treasury by persons and businesses who imports said containers. Part of deposit amount can be redeemed by returning the containers to the designated redemption center. If containers are returned to a redemption center, then the half of deposit will be transferred from the central fund to consumers.

Those importers may pass on this cost for the deposit to consumers through an increased purchased price.

The benefits of container deposit schemes are obvious: They encourages people to collect and return containers which can then be recycled or reused, thus reducing the amount of waste requiring disposal and encouraging materials recovery.

On the other hand, manufacturers of beverages may argue against forced container deposit schemes on the following basis:

- Beverage containers are a small proportion of the total waste stream: Therefore removal of beverage containers from the waste stream will not have a significant effect on the volume of waste requiring disposal.
- Beverage containers are inert and do not contribute to toxic leachate or other releases in landfills: Therefore priority should be given to waste minimization methods that reduce organic and toxic components of the waste stream.
- Existing recycling businesses which currently rely on the revenue from sales of cans and bottles will have to change their business framework that has been developed for long years
- If containers are returned to redemption center, they must allocate space and resources for storage and removal of the containers.

Opponents to container deposit schemes also argue that the same results, in terms of recovery of cans and bottles, can be achieved through more promotion of voluntary recycling supported by

**Comment [SMD7]:** Fugi-s  
an opinion- Existing  
recycling businesses  
which rely on the revenue  
from sales of cans and  
bottles will be expand of  
sales.  
Soeda;  
Understood, but here shows  
how the existing bodies claim  
negatively in order to not  
lose their vested businesses.  
So, I changed the sentence as  
shown in the text

**Comment [SMD8]:** Fugi-s  
an opinion- Koror State  
Recycling Center has  
enough space for storage  
Soeda;  
As mentioned above, here  
should show predicted  
counterargument against the  
deposit refund system, so, I  
remain this.



better education and awareness programs.

## (7) Conclusions for Recycling

Given the current state of the recycling market, only aluminum cans, steel materials and PET bottles can be considered economically viable for recycling. However, the volume of other metals produced in Palau is negligible and will not contribute significantly to reduction in waste requiring disposal.

Plastic items other than PET bottle are widely used in Palau such as lunch box, small container, and wrapper. These plastics are indubitably convenient and popular in Palau as well as other countries. However, considering that the amount of plastics used in Palau has been rapidly increased and become one of biggest reason for the increase of waste generation, recovering of those should be considered in future as next step as well as import control.

Segregation is recommended to segregate aluminum and steel cans and PET bottle from the waste stream. At least initially, this may need to be supported with re-sorting after the collection while the community adjusts to sorting wastes prior to collection. Householders should use waste segregate stations placed on the edge of the road. As for recycling materials, collection frequency shall be set depending on the generation volume and availability of the collection trucks.

The Koror State Government began their recycling project in 2006. In this project, residents should segregate the waste into the following six categories and set out to the designated segregating station:

- 1) Aluminum can
- 2) Steel can / glass
- 3) Paper items
- 4) Biodegradable waste (kitchen waste)
- 5) PET bottle
- 6) Rest of plastics and other wastes

## 4.4 Composting Plan for Organic Waste

Collected biodegradable waste, mean organic kitchen wastes generated in markets and hotels, but excludes organic materials such as textiles and tree branches that are more difficult to decompose, can be treated using composting. Composting is recognized as an effective tool for implementing the 3R, which organic wastes are biologically decomposed under controlled conditions to convert them into a product that can be applied to the land beneficially. It greatly reduces waste volume and is also very effective in reducing or preventing the accumulation of hazardous leachate components in the landfill. Composting activities have been used in an organized fashion to deal with garbage at many places of the world since at least early 1900s.

**Comment [SMD9]:** Fugi-s  
an opinion- Existing  
recovery rate of Aluminum  
cans is still low level as  
less 20%.  
Soeda;  
As mentioned above, here  
should show predicted  
counterargument against the  
deposit refund system even  
the recycling rate is currently  
less than 20% and seems to be  
limited, so, I remain this.

**Comment [a10]:** Soeda ;  
This is added according to the  
floor comment at WS on Oct  
31.

There is a wide range of composting processes, depending on feed stocks, equipment uses, material preparation and handling methods and physical conditions (amount of water, air, temperature and other factors).

#### 4.4.1 Available Feed Stock

Available feed stock for composting in Palau is mostly kitchen waste and yard waste. Paper items are also categorized as organic matter and it can be used as moisture control during the composting process. Bulky yard waste such as tree or large branches is hard to be composted as it is; therefore crushing before composting is necessary or they should not be used for the composting.

The method used to separate organics from the waste stream will affect yield. If source separation is used, the yield of organic matter from the waste stream will depend on the extent to which waste producers (households and businesses) separate their own wastes. If some households and businesses continue to put all their waste in one container for collection, the yield of organics will be reduced.

The extent to which contamination of the compost feedstock with inorganic materials such as plastic, glass or metal affects the composting process depends on the process being used and also the proposed end use for the composted material. It is possible to separate out plastic and other inorganic components after composting using a sieve or screen. The final composted product may be less acceptable to users if it obviously contains pieces of plastic, metal, glass, and other inorganic components.

#### 4.4.2 Potential Use for Compost Products

##### (1) Beneficial Points of Compost Products

Typically, compost products are used as soil substitutes, or, if nutrient levels are high enough, as fertilizer. Potential uses for compost products in Palau include:

- Gardening
- Cover material or re-vegetation at landfills
- Rehabilitation of areas where erosion has removed topsoil
- Re-vegetation of batter slopes and other cleared areas for road works
- Soil conditioner or fertilizer in agricultural production

The composting process can destroy pathogens, weed seeds, insect eggs, and other unwanted organism under the certain fermentation conditions with high temperature around 60 degree

Celsius. Adding composting can also lighten heavy soils, improve the texture of light soils, and increase water retention capacity.

If there are no beneficial use markets initially for the composted product, composting still has advantages in waste management. Firstly, it reduces the volume of the organic waste by approximate a half, thus the landfill space can be saved even if the composted product is to be disposed of to landfill. Secondly, it reduces the organic matters in the waste so that, when the composted product is placed in a landfill, the quality of leachate generated at that landfill is expected to improve.

## (2) Issues to be Considered to Composting

Composting activity to produce the fertilizer or other common use products should be recognized as manufacturing activity, not as waste disposal activity. Careful quality control with proper management for the products including feed stock control should be needed. If the composting process is not managed property, there will be a risk of diseases by survived harmful organism.

A properly operated aerobic composting process has an acceptable odor level. However, if anaerobic conditions develop due to excessive moisture in the pile, or insufficient turning, then stronger odors can be generated. Composting operations should therefore be sited away from sensitive receptors or should be conducted at strict controlled closed facility.

### 4.4.3 Composting Options

Mulching involves chipping and/or shredding green wastes. The mulched material is then available for application on landscaped garden areas or agricultural areas. Mulching is not strictly composting since the mulched material is usually applied fresh, although in-situ decomposition will occur. Mulching requires a wood chipper to chip logs and branches and shredder to shred leaves and brush (one machine cannot necessarily do both) or a tub grinder which could handle most waste types. Mulching is used extensively by private and government organizations as a waste management method and is likely to be successful wherever there is a demand for mulch.

Home Composting is carried out at a household level. Typically, organic wastes are placed in a plastic or wooden container although an open heap method can be used if vermin are not an issue. Feedstock may be the entire organic waste stream from a household, or just garden waste. Poultry manure can be added to home composts to increase nutrient levels and encourage bacterial decomposition. Meat and other animal wastes are not suitable for home composting. The composting process will usually take 3–6 months, depending on what is put in and climatic conditions. Turning and aerating the compost can reduce composting time. Completed compost can then be used in gardening and as a potting mix.

Household compost units do not always attain the temperatures necessary for optimum decomposition or to kill seeds. Liquid seeping from the container is similar in composition and toxicity to landfill leachate, particularly if the compost is anaerobic. This liquid will contribute to

**Comment [SMD11]:** Sir

Fugi said that this section explain disadvantage of compost products, it was explained exaggeratedly. Compost technology does not use theory for explaining compost. Typical explanation of compost technology is:

Soeda;

According to Palauan comments, I modified the description of composting.

“Composting is a specialized part of recycling in which organic wastes are biologically decomposed under controlled conditions to convert them into a product that can be applied to the land beneficially and without adverse environmental impact. The composting process should destroy pathogens, weed seeds, insect eggs, and other unwanted organism. ... [1]

**Comment [SMD12]:** Sir

fugi said by 55% or more only.

Soeda:

Concurred. Text was modified.

local contamination of surface and ground waters, particularly if there is a high concentration of home compost units in an area. Compost heaps may attract flies and vermin and may become quite odorous if adequate air circulation is not provided. Surveys conducted in Australia show that many compost heaps are indeed not operating correctly and are experiencing some or all of these problems.

Public education on good composting techniques would support correct home composting and may reduce existing problems associated with dumping of organic wastes on private properties.

Open Windrow Composting is a large scale operation where organic materials are placed in elongated piles. Feedstock may vary from shredded/chipped vegetation to inclusion of shredded paper and cardboard. Sewage sludge can also be mixed in and will contribute nutrients to the mix. Some experimentation will be needed to determine the optimum ratio of feedstock. Cairns City Council in Northern Australia performed trials on total waste stream composting but found plastic film inhibited air and water flows and a suitable product could not be produced.

Windrow composting depends on providing a sufficient degree of aeration while still maintaining an internal temperature of around 50–60°C. Aeration can be provided by turning the pile or by forcing air through the pile. The pile can be turned using earthmoving equipment such as bobcats or front end loaders, or in larger commercial operations, by purpose built windrow turners that repeatedly turn and mix the pile. It is important that the outer layers are regularly exchanged with the inner layers to ensure uniform composting, although too frequent turning may lead to reduced temperatures within the pile.

Water composition is also important as a certain amount of water is needed for the biochemical composting reactions to take place but too much water will inhibit air flow through the pile and make the materials difficult to handle. Addition of a bulking agent such as large woodchips helps to keep the pile free draining and allow air flow. In a high rainfall climate like Palau, a covered area is essential for successful windrow composting.

In-vessel Composting Systems also known as bio-reactors are fully enclosed and controlled systems that facilitate the composting process. There are many different in-vessel composting systems available but all operate on the same basic principle. The feedstock is fed into the vessel and composted under closely controlled conditions (temperature, water level, oxygen content). Usually, some kind of conveyer or gravity feed system moves the waste through the vessel as it decomposes and fully composted waste is produced at the other end.

In-vessel composting systems have significant advantages in odor and vermin control as well as providing a high quality product. Some systems are designed to accept the entire waste stream (organic and inorganic) although the product then contains plastics and metals which may need to be removed. Other systems require pre-sorting of wastes. Size reduction is also usually needed, requiring a chipper, tub grinder or similar equipment to handle the range and quantity of materials in the feedstock.

The main disadvantage of in-vessel composting is the high capital and operating costs. Depending on system design, a higher level of process control may also be required, with an

**Comment [SMD13]:** Fugi-s  
an wants to add topic about  
in-vessel after this paragraph  
.....  
Soeda;  
According to Palauan  
comments, I again returned  
the original explanation about  
in-vessel composting from  
Golder Report.  
He recommended to add this:  
“In-Vessel composting  
methods are high  
technology methods in  
which composting are  
conducted within a fully  
enclosed system.  
All critical environmental  
conditions such as odorous,  
waste water, flies and  
vermin are mechanically  
controlled with this  
method, and, with most  
in-vessel system, they also  
are fully automated.  
System of in-vessel has  
significant advantage in  
odor and vermin control as  
well as providing a high  
quality product.  
So, in-vessel composting  
method is most effective  
system for our purpose  
such as “Waste Reduction  
in Koror State”, because  
... [2]

associated requirement for technically skilled operators. Smaller modular systems may be more convenient where selective composting of certain components of the waste stream is required.

**Table 1 Advantage and Disadvantage of Composting Operations**

• Option	• Advantages	• Disadvantages
<ul style="list-style-type: none"> <li>• 1. Home composting</li> </ul>	<ul style="list-style-type: none"> <li>• Very low cost</li> <li>• No sorting and handling of organic waste outside the home</li> <li>• Simple technology</li> <li>• Preferable to uncontrolled waste dumping on private land</li> <li>• Could be applicable to larger producers such as restaurants</li> <li>• Provides an alternative to landfilling once “user pays” fees for collection/disposal are introduced.</li> </ul>	<ul style="list-style-type: none"> <li>• Likely low participation level among householders without regulation</li> <li>• Does not involve larger commercial waste streams</li> <li>• Organic material may not be properly composted</li> <li>• Potential odor and vermin problems</li> <li>• Leachate may cause localized pollution</li> </ul>
<ul style="list-style-type: none"> <li>• 2. Open Windrow</li> </ul>	<ul style="list-style-type: none"> <li>• Proven technology but needs the expertised skills</li> <li>• Minimal sorting and handling required</li> <li>• Unlikely to attract vermin</li> <li>• Simple technology</li> </ul>	<ul style="list-style-type: none"> <li>• Have to operate and maintain a chipper/shredder – moderate mechanical expertise</li> <li>• Moderate labor intensity</li> <li>• Potential odor problems</li> <li>• Trials needed to optimize process</li> </ul>
<ul style="list-style-type: none"> <li>• 3. In-Vessel</li> </ul>	<ul style="list-style-type: none"> <li>• Available for all organics</li> <li>• Consistent, high quality product</li> <li>• No vermin or odor problem</li> </ul>	<ul style="list-style-type: none"> <li>• Have to operate and maintain a large shredder</li> <li>• High level of technical expertise to operate and maintain system</li> </ul>

#### 4.4.4 Composting Plan

Two options for composting in Palau have been developed for further consideration:

**Comment [SMD14]:** Fugi-san suggested to add another row for in-vessel...

In-Vessel Composting ... [3]

**Comment [SMD15]:** Fugi-san comment - (Comment)

1. Koror state has already started to construct the In-Vessel composting plant...

2. Reason for select of method!!

Our project team decided to use In-vessel composting method due to its low cost.

May also enquire condition for selected method with low capital cost by senior volunteer's idea

Another reason is that, this method is suitable for Koror state for waste reduction and the implementation of the 3R, Recycle, Reduce, Reuse.

Our engineer tried his best effort to design, train staff and to manage capital cost for such project and for solution of disadvantage of such method with high capital cost and technical sk<sup>III</sup> ... [4]

- Encourage home composting by providing subsidized compost bins and a public education program on the technique or home composting.
- Compost garden waste, sewage sludge and shredded paper and cardboard using an open windrow method or in-vessel composting in large scale at the centralized facility.

Trial programs are needed to determine the optimum ratio of feedstocks and the time taken for composting to be under local conditions. This will provide some valuable information on composting time and handling methods. Windrow composting requires a commitment to adapting the process to best suit local conditions and feedstocks. However it represents a high potential in Palau due to the extent to which soil conditioner and organic fertilizer products could be used. It is often said that open windrow composting has relatively low capital costs and operating costs are comparable or lower than for sanitary landfill disposal. Therefore, in the trial programs, operation cost should be also monitored.

Koror state has already started to construct the in-vessel composting plant at M-Dock landfill with some mechanical equipment. Though the in-vessel composting system usually requires high initial and operation cost as previously mentioned, the systems of Koror state are well contrived to reduce those cost including utilization of state workers to design and construct the facility. Such experiences of Koror state can be referred when other states will plan their own in-vessel composting facility.

However, in the satellite state, home composting is more practical to reduce the waste to be disposed of at the landfill.

## 5 FINAL DISPOSAL PLAN

**Comment [SMD16]:** Mr. Ngiraked suggested to add more issues about improper waste disposal practices and climate change.. Do not limit the topic to landfill itself.

### 5.1 Necessity of Designated Proper Final Disposal Site

From the point of view of public sanitation, the first priority of solid waste management is to remove the waste which contains sanitation risks from the generation sources. Therefore, the local government usually has a responsibility of waste collection as a part of public services. If there is no sufficient collection services, some people may have to take those waste to their backyard or far away to other places and dump them inappropriately. Once such waste dumped somewhere, waste are accumulated on after the other and become a huge pile of unlawful dumping yard. There is no way such open dumping yards can be managed in environmental sound manner. In case the waste collected by public or private collection services is appropriate, it should be disposed appropriately.

Final disposal site for the waste, generally recognized as a landfill, can be considered the accumulated place of environmental risks caused by collected waste. If there is improper management of the landfill, the site itself and surrounding area should be exposed to nasty odor, littering of the waste, smoke and toxic gases from open burning, contamination of leachate into ground and surface water. Methane gas generated from the decomposition process of accumulated waste is not something that can be ignored because of its effectiveness as a green house gases. Therefore, careful plan for proper landfill system with proper construction and management should be needed, especially in the island country like Palau that has limited area for the landfill.

### 5.2 Sanitary Landfill

The bulk of waste generated in Palau is disposed of to un-engineered and poorly managed dumps. Some waste is burned, either within the dumps or on private property. While these waste disposal methods are low cost, they are detrimental to the environment, public health and visual appearance of the islands. They are inappropriate for Palau which has indicated a desire to modernize, raise its standard of living and develop its tourism industry while maintaining a high level of environmental quality.

Sanitary landfills are the most common waste disposal method used around the world. Landfill is basically controlled dumping of waste at a designated site. Landfills are characterized by engineering controls which are built into design and operation of the sites.

Sanitary landfills receiving general domestic and commercial waste can have significant environmental, public health and amenity impacts, even if no “toxic wastes” are being received at the sanitary landfill. Proper design and operation is essential if these impacts are to be minimized.

Sanitary landfills should not be located near residential or other sensitive land uses, near environmentally sensitive areas, in watersheds that have sensitive areas downstream and near water supply areas (groundwater or surface water). Sanitary landfills also should not be located in areas of landscape value or tourist and recreational areas. Sanitary landfills tend to attract birds which can be a hazard to flying jet aircraft. Sanitary landfills should not be located within several miles of an airport (It is usually required for sanitary landfills to be at least 2 km from an airport). At the same time, sanitary landfills need to be located within a reasonable distance of the main waste generating areas to minimize the distance that waste must be transported.

Leachate generated by the waste can cause significant pollution of surface waters or groundwater if it is allowed to seep from the site. Design of the sanitary landfill must allow for leachate to be contained on the site and collected for treatment or recirculation within the site. Covering of waste with a low permeability layer and provision of surface drainage over covered areas minimizes the amount of rainwater that can infiltrate the waste mass, thus reducing the volume of leachate that must be handled. Site selection for the sanitary landfill is very important in this respect. Where sanitary landfills are to be located within sensitive watersheds, strict design and operating controls over leachate releases from the site are needed to protect sensitive downstream environments.

Covering waste in sanitary landfills also minimizes odor, vermin attraction and mobilization of litter from the waste mass. Good sanitary landfill practice requires wastes to be covered at least daily although this may be reduced some circumstances, for example if the site is located away from residential or other sensitive areas.

As organic waste decomposes in landfills, methane, carbon dioxide and other gases are produced. Methane is flammable and may contribute to fires within the waste mass. These gases can contribute to air pollution and in particular, methane and carbon dioxide which is a greenhouse gas. If it is possible to collect gases and either flare methane, converting it to carbon dioxide which is a less potent greenhouse gas, or recover energy in the form of heat from the methane.

## 5.3 Function of Landfill and Structure of Facilities

Overall, sanitary landfill is considered a preferred option for waste disposal in Palau on the basis of lower cost and lower technical requirements. This preference is provisional on selection of a suitable site for sanitary landfill development and implementation of a minimum set of design and operating measures to minimize environmental impacts, including:

- Construction of a leachate barrier layer (natural or synthetic)
- Leachate collection and treatment system
- Surface water drainage system to divert surface water around the site and prevent runoff of rain water from the site.



- Systematic placement of waste in properly constructed sanitary landfill cells
- Daily soil covering of waste
- Progressive closure of completed waste disposal cells to minimize rainwater infiltration
- Progressive rehabilitation and re-vegetation of completed areas of the site
- Landfill gas controls (depending on selected end use)
- Control over types of waste entering the site and prohibition of disposal of hazardous waste such as auto/marine batteries and waste oil at the site.
- Diversion of as much organic waste as possible for composting and other purposes.

Open dumping, that is simply dump the waste at the site in an uncontrolled manner, has been happened in Palau for long time. This type of waste disposal has adverse environmental, public health and aesthetic impacts and is not considered appropriate for Palau given its development aspirations and the economic value of its natural environment. Therefore, such open dumping should be strictly banned and existing sites will be closed or renovated in environmental sound way.

### 5.3.1 Structure of Landfill

The rehabilitation works of the existing Landfill and new construction of landfill shall be designed by semi-aerobic landfill system. The rehabilitation works shall be improved the site from anaerobic to semi-aerobic condition by placement of leachate collection pipes, a leachate pond, vertical shaft for gas ventilation etc.

In the semi-aerobic disposal structure, air circulation occurs naturally inside the site by opening the edge of leachate collection pipes. The air circulation promotes the waste stability and the gas occurred by waste decomposition is released out from vertical shaft or gas vent.

The structure of semi-aerobic landfill shall be complied with following functions and structures.

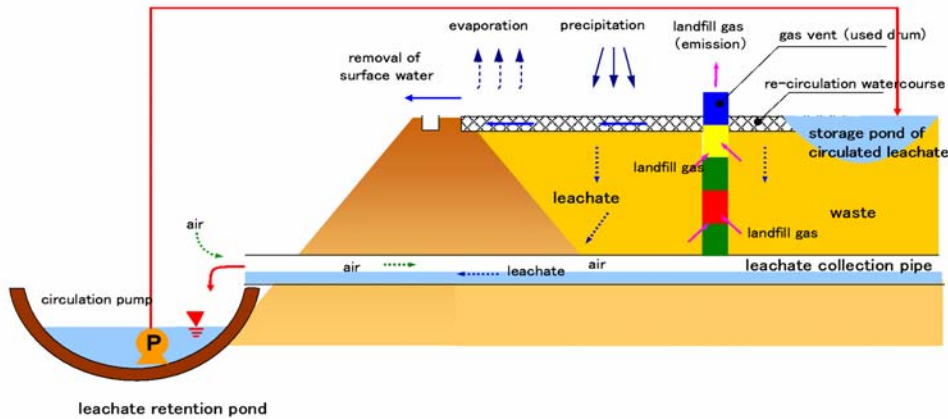


Figure 2 Structure of Semi-aerobic Landfill

### 5.3.2 Required Facilities for Semi-Aerobic Landfill

#### (1) Dike and Bottom Structure

Dike and bottom structure are made of impermeable material that prevents the flow of leachate out to the neighboring sea or mangrove bushes (liner sheet is recommended).

#### (2) Slope Formation

Slope formation is covered by 30cm thickness of clay soil and its surface is finished by hydroseeding. Slope formation prevents landslide, bad odor, and flying of waste.

#### (3) Drainage

Rain water at the site is collected in the drainage. The generated amount of leachate can be restrained by collecting rainwater smoothly on covering soil and slope formation.

#### (4) Leachate Collection Pipes

The leachate collection pipes will collect the leachate inside the site and drain out to the leachate pond. There are two types of leachate pipes: Main pipes and branch pipes.

#### (5) Leachate Pond

Leachate pond stores the leachate collected by leachate collection pipes. Collected leachate in the pond is return to the landfill site by a pump.

#### (6) Vertical Shaft

The vertical shafts release the gas which occurs in the process of waste decomposition. The shafts are placed vertically on the top of leachate collection pipes and release the gas inside of landfill site.

Utilization of landfall gas contains large portion of methane can be studied whether it is feasible or not.

**Comment [a17]:** Soeda;  
Added according to a floor  
comment at the WS.

#### (7) Receiving Facility

This facility is use for inspection and measurement of waste which is hauled to landfill. The facility is consisted of management office at the entrance and a truck scale.

#### (8) Access Road

There are two types of road: The road for trash truck and the road for maintenance of facilities.

#### (9) Car Wash Facility

The facility is to wash truck which run into landfill and dump waste. The facility is consisted of a washing basin and a washer.

#### (10) Gate and External Fence

For safety purpose, provide gate and external fence to prevent outsider's cars from going inside landfill at closing time.

#### (11) Mottainai Yard (Recyclables Stock Yard)

Mottainai Yard is use for stocking and separating recyclable waste, scrap vehicles, electrical appliances and bulky waste.

## 5.4 Final Disposal Plan of Waste

### 5.4.1 Future Estimation of Waste Disposal Quantity

#### (1) Basic Planning of Landfill

Planning for future landfill disposal of waste requires that an estimate of the volume of waste requiring disposal be made. The existing M-Dock landfill will be reached full capacity within 5–6 years. Planning of proposed landfill shall be considered following conditions.

- Estimation of population growth (including growth in the numbers of tourists visiting Palau) over the next 20–25 years
- Assumption of the unit generation rate of household waste, per day per capita.
- Assumption of the generation volume of commercial waste based on the waste acceptance record at M–Dock landfill
- Confirmation of user states for the new landfill
- Estimation of waste to be accumulated in the new landfill considering the volume of cover soil and waste reduction activities under 3R policy
- Introduction of the semi–aerobic system
- The amount of compaction of waste that can be achieved in the landfill, or the in–situ density of the waste

## (2) Estimate Amount of Waste Generation

The previous study report by Golder Associates in 1999 estimated the future population growth rates in Palau based on an annual growth rate provided by the Office of Planning and Statistics and a growth in tourism numbers provided by Palau Visitors Authority. Waste generation quantity for residents and tourists was calculated as shown in Table 2 according to following assumptions:

- Unit generation rate per resident and visitor: 1.0 kg/day–capita
- Average staying days of visitors: 12 days
- Assumption of waste reduction rate: 21.8%

**Table 2 Predicted Waste Generation (Example)**

	• 2000	• 2005	• 2010	• 2015	• 2020	• 2025
Mid–year Population (resident) (1)	• 17,776	• 19,376	• 21,120	• 23,021	• 25,093	• 27,352
Annual Visitors	• 63,000	• 86,000	• 105,000	• 128,000	• 155,000	• 189,000
Annual Waste Generation (tones)	• 7,244	• 8,104	• 8,969	• 9,939	• 11,019	• 12,251
Daily Waste Generation* (tones)	• 20	• 22	• 25	• 27	• 30	• 34
Waste Requiring	• 5,665	• 6,337	• 7,014	• 7,772	• 8,617	• 9,581

Disposal (2)

Daily Waste Disposal* (tones)	• 16	• 17	• 19	• 21	• 24	• 26
----------------------------------	------	------	------	------	------	------

Source: Report on Integrated Solid Waste Management Plan, October 1999, Golder Associates  
Daily waste generation and disposal value are calculated by JICA Project Team

When JICA Project Team conducted a 7-days survey on the quantity of waste transported and disposed of at M-Dock in February 2007, about 20 to 25 tons of waste was accepted. It means the projection in the above table can show the actual situation but with the condition of low waste reduction rate.

When the basic plan for the new landfill in Palau, above estimation should be reviewed and recalculated carefully.

Diversion of waste from the sanitary landfill through waste minimization practices will maximize the life of the sanitary landfill and delay the need for a new sanitary landfill to be established. Obviously, by extending the life of a landfill, capital costs are spread over a longer period of time and therefore, it is preferable to seek sites with sufficient area for landfill operation in the future. More than twenty years is recommended for landfill design.

## 5.4.2 Necessity of EIS under EQPB Regulation

A new National Waste Disposal Site would require preparation of an Environmental Impact Statement (EIS) according to the requirements of the EQPB Regulations. The regulations allow the BPW (as applicant) to first prepare an Environmental Assessment and request determination from the EQPB regarding whether an EIS is required or not. However in the interests of saving time, it is recommended that the Bureau of Public Works move straight to preparation of an EIS.

## 5.4.3 Final Disposal Plan for Koror State

M-Dock Landfill where fully improved through the JICA Project has a remaining capacity for 5 to 6 years, means till around 2012. Immediately after closing M-Dock Landfill, Koror State will have to shift their final disposal site to the new landfill.

Due to the limitation land in Koror Island, it is impossible for Koror State to find their landfill within the island. Therefore, Koror State will have to depend on the provision of land by other state in Babaldaob Island.

Based on such circumstances, there are some studies including environmental study for the construction of new landfill have been prepared but no practical plan is prepared yet.

BPW under MoRD has a responsibility to prepare the necessary implementation plan of the new

landfill with consultation among Koror State, the state where new landfill will be constructed, and EQPB.

The followings are typical schedule for implementation of the landfill construction.

- 1) Site selection: 1 – 3 years
- 2) Basic plan including capacity, type and structure of new landfill: 0.5 year
- 3) Basic design and Feasibility study: 0.5 year
- 4) EIS: 1 – 2 years
- 5) Public consensus: 1 – 3 years
- 6) Fund arrangement: 1 – 2 years
- 7) Detail design and tender document: 1 – 1.5 years
- 8) Tendering: 0.5 year
- 9) Construction and its supervision: 2 years

Considering the expected remaining life of M-Dock landfill and above mentioned necessary time for landfill construction, It is most urgent task for BPW to start planning the new site, otherwise M-Dock will become open dumping yard as it was before for longtime.

#### 5.4.4 Final Disposal Plan for States in Babeldaob Island

Two options exist for disposal of waste from the rural states in Babeldaob Island:

- Continued operation of existing individual state dumps with improvements to provide adequate environmental protection measures and permitting to EQPB standards
- Closure of state dumps to coincide with development of new national sanitary landfill and transfer of waste from states to new national sanitary landfill.

Each state in Babeldaob Island should prepare its own landfill plan by the following schedule:

- (1) Survey of the conditions of the present dumping site on location, area, access road, dumping method, types and amount of accumulated waste, frequency of waste acceptance, dumped waste volume per day, environmental damage at surrounding area, landscape, informal waste picking activity and so on.
- (2) Rehabilitation of existing dumping site by verifying the result of JICA Pilot Project in Ngarchelong State: ASAP
- (3) Decision to have state's own landfill site or to join the national landfill: 1 – 2 years
- (4) In case for state's own landfill, construction plan will be needed: 2 year
- (5) In case for participating the national landfill, transportation plan will be needed

### 5.4.5 Final Disposal Plan for Other State

Angaur dump is considered to be appropriately located. Some works are recommended to improve management standards at the site:

- Site limits should be delineated within the borrow pit so that waste does not spread sideways. This can be done with bunds made from inert material if sufficient quantities are available. Old car bodies and other bulky metal wastes may be appropriate. Otherwise precast concrete walls should be constructed. Waste should then be pushed right back into the borrow pit area rather than allowed to accumulate on the upper edge.
- Inert material should be stockpiled and used as cover material whenever sufficient quantities are available.
- Recyclable materials should be separated from waste and placed aside for composting. Car bodies and other bulky wastes should also be set aside.

Peleliu dump site is considered to be poorly located and a new waste disposal site is needed. A survey should be undertaken to identify available sites and then sites should be evaluated against environmental and technical criteria to select the most appropriate site. An Environmental Assessment describing the site selection process and assessing the preferred site in detail should be prepared and submitted to EQPB for approval.

The new landfill site should be developed using a trench and fill method where waste is buried in pre-excavated trenches. Spoil from trenches should be stored in a pile adjacent to the trench and used to cover waste on a weekly basis. Drainage from within the site should be directed to a sediment trap before discharge from the site. The trench should be slightly sloped to one end and a sump should be excavated to collect leachate.

Since neither Angaur nor Peleliu has the option of utilizing the new national sanitary landfill, the National government should make a nominal financial contribution to capital works required to establish a landfill at Peleliu and improve landfill operations at Angaur. This contribution should be negotiated with each state after consideration of the costs involved in meeting recommendations of this NSWMP. The contribution to each state should not necessarily be equal but should reflect the capital costs facing each state.

## 5.5 Landfill Management Plan

### 5.5.1 Responsibility for Waste Disposal Site

Construction and operation of a sanitary landfill to adequate environmental protection standards requires a relatively high level of expertise.

Discussion with State and National government agencies in Palau indicated that there is a preference for the National government to retain control of landfill operations. This preference is supported on the basis that:

- The site will serve most of the nation
- The size of state administrations is too small to justify development of appropriate expertise to manage the sanitary landfill site.
- Land acquisition is already started for the construction of new national landfill by MoRD

The National government then has the choice of developing adequate sanitary landfill management expertise within one of its Bureaus of Divisions or of contracting out operation of the sanitary landfill. Development of adequate sanitary landfill management expertise within the National Government would require a combination of recruitment of key personnel and advance training of existing personnel.

Use of a contractor would place responsibility for developing and maintaining adequate expertise on the contractor. Worldwide, there is a general trend towards using contractors for activities such as landfill management. Contractors can gain access to higher levels of expertise and specialist advice than may be available to the National Government. Performance standards also tend to be higher with a contractor as these standards can be specified in the contract with penalties if they are not met. Finally, use of a contractor reduces the amount of up-front expenses for capital works and equipment as contractors are willing to make investments with a view of recouping funds over an extended period. By contrast, the National government must appropriate funds from the nation's annual budget in advance of expenditure. It is recommended that long-term operation of the Sanitary landfill be performed by a contractor under contract with the National government.

The National Government would need to retain expertise within BPW to oversee contract performance.

Use of contractor for operation of the new National landfill can be built into development of the landfill. Initially, a contract will need to be formed for construction of the sanitary landfill to design specifications. This contract could be linked to an initial short-term "commissioning" contract where the construction contractor would be required to bring the site to full operating level. Once the site was commissioned, a longer terms operating contract could be established.

- Requirement to develop and implement an Environmental Management System/Plan
- Operational goals for compacting, covering frequency, waste diversion and other requirements for implementation of the NSWMP



## 5.5.2 Operation and Management of Landfill

Operation and maintenance of the sanitary Landfill shall be conducted according to the operation and maintenance manual prepared by JICA Solid Waste Project (2007).

In order to meet EQPB permit requirements and minimize site closure costs, the following recommendations are made with respect to the sanitary landfill:

An interim operations plan should be developed which includes:

- Authorization and registration of individual and business to enter the site
- Dumping of waste in conformance with final contours
- Management of site drainage including erosion and sediment control measures
- Stockpiling of inert material that can be used as covering material to achieve closure contours
- Stabilization and rehabilitation of mangrove frontage batter slope
- Prohibition on dumping of hazardous wastes
- Environmental Monitoring
- Compaction of waste and other waste handling methods.
- A revised closure plan should be developed which minimizes cost but provides adequate environmental protection based on understanding of the risks associated with the dump. The revised closure plan should also provide a more detailed timetable for closure of the dump.

**Comment [a18]:** Soeda;  
Added according to a floor  
comment at the WS.

## 5.5.3 Interim Management of Airai Dump and Rural Dumps

Current waste management practices at all these sites involve open dumping of waste with little or no attempt to compact or cover waste. In some cases, waste is pushed back into mangrove/wetland areas. New management practices must be implemented immediately to minimize problems such as litter, contaminated surface water runoff and vermin as well as to reduce the visual impact of the sites based on the experiences expected to be taken from JICA Projects at M-Dock landfill and Ngarchelong State.

Interim sanitary landfill practices should involve burial of waste in pre-excavated trenches. Spoil from trenches should be stored in a pile adjacent to the trench and used to cover waste on a weekly basis. Drainage and a silt fence should be installed around the spoil stockpile to prevent sediment runoff. An intercept drain should be installed around the site to divert runoff from entering the site. Drainage from within the site should be directed to a sediment trap before discharge from the site. The trench should be slightly sloped to one end and a sump should be excavated to collect leachate.

Bulky items such as cars, old tires and white materials should be separated from the waste stream and stockpiled on the site. A small covered and bunded area should be provided for storage of

auto batteries, waste oil and other hazardous materials.

## 5.6 Management of Landfill Site after Closure

### 5.6.1 Concerning Matters at Closure of Landfill Site

For the completion of landfill operation, a final closure plan for the site shall be prepared by the BPW according to the operation and maintenance manual.

In the landfill site, the waste decomposition will be continued even after disposal work is completed. It means that still, leachate and gas will be discharged from waste decomposition after the site closure. The waste become more stable, and the leachate and gas become safer. So it is important to continue the management of leachate and check the progress of waste stability after disposal completion in order to avoid environmental damages to neighboring area and future's site utilization.

Post-closure land use plan will be also prepared at each existing dumping site. Large area such as M-Dock Landfill or Landfill in Airai can be used as a green park for leisure and environmental education. However, in case no land use will be planed at the existing site, it is recommended to set the boundary fence and put the sign board which shows that area used to be a waste dumping site.

The site can be utilized before the site is not completely stabilized. In this case, however, the way of site utilization should be limited because there is a risk of land subsidence and occurrence of leachate and gas discharged from waste decomposition.

### 5.6.2 Management of Leachate after Closure of Landfill

The Measurement of water quality of leachate and the checking of its gradual change should be well controlled after disposal completion in order to study the date when the waste stabilization is finally completed.

#### (1) Method to Reduce the Amount of Leachate

There were some constructions for leachate control in The Rehabilitation Works for M-dock Landfill: Leachate pipes, leachate pond, and a pump for leachate circulation. There will be circulation system for leachate in M-dock Landfill. However, there is no other place where leachate can flow out except inside the site, so the total amount of leachate should be tried to reduce as much as possible.

To reduce the leachate coming from rainfall, impermeable materials such as clay can be used as the final covering so the rainwater can flow smoothly toward outside of the site. Also some drainage

can be installed after the final covering to prevent water ponding at the surface of the final covering.

On the other hand, there is a risk of differential settlement caused by waste decomposition or compression and it makes difficult to secure enough slope of the drainage and to promote rainwater running smoothly. To avoid this kind of situation, the regular inspection should be conducted and the drainage should be under proper management after disposal completion.

The 5 types of method to reduce the amount of leachate are shown below:

- Use clay for final covering
- Sloping of the final covering to remove rainwater from the surface of the site
- Make channels by manpower on the final covering
- Do hydro-seeding or planting on the final covering to proceed evaporation of rainwater and increase the capacity of the soil for containing water
- Proceed evaporation of rainwater by circulating leachate

## (2) Survey on Water Quality

After disposal completion, the survey on water quality for leachate should be followed to the leachate inspection. At that time, there will be no disposal work at the site, so the risk of environmental damages to neighboring area will be reduced. As for leachate inspection, the following frequency will be appropriate according to the site condition: Water inspection with a portable water measure is more than once a month and 7 types of survey on water quality by EQPB is more than once in 6 months.

### 5.6.3 Management for Land Subsidence at the Site

After disposal completion, there will be possibility of land subsidence because waste decomposition and compression are still going on inside the site. To avoid land subsidence damages to the future's site utilization, the level of subsidence should be measured and managed. Especially if there is a future plan to construct specific types of buildings which need large bearing capacity, subsidence condition at the site must be evaluated carefully for building security.

### 5.6.4 Evaluation of the Site Stability

The level of site stability can be judged based on quality of leachate and level of land subsidence. As for leachate, the conditions of water quality can be an important index to judge the site stability. In order to determine that the site gets permanently stable, the water quality of leachate and the degree of land subsidence should keep the same level for 2 years.

In addition, the amount of gas created from inside the site can also be an important index for evaluation of site stability. If the amount of the gas discharged from vertical pipes is in high level, it is preferable to purchase some equipment to measure gas level, and continue to manage the site.

## 5.7 Waste Disposal Cost

### 5.7.1 Capital Cost

The following major capital items will require funding:

- Closure and rehabilitation of M-Dock landfill and other small dumping site in each state
- Detailed design and preparation of Environmental Impact Statement for proposed new national landfill
- Construction and commissioning of proposed new national landfill

In addition, several expensive pieces of equipment will be needed and at least two new staff positions will need to be created at BPW.

There is currently no budget allocation made for these items and given that these items must be funded within the first few years of implementation of the NSWMP, time available to raise funds is limited. Funds for these items will need to be appropriated from the national budget.

In the future, forward planning for waste management will allow large expenses to be anticipated well in advance and funds can be set aside for these over a period of time. Hence, the situation where large amount of appropriations are required for these items will not need to occur again.

**Comment [SMD19]:** What does it mean Soeda; "one-off" means that something happens only once as you can guess, construction of large public landfill is not conducted so often, maybe every 15 to 30 years depends on the availability of land and therefore it should cost too much. So, I remain this as it is.

### 5.7.2 Operation and Maintenance Cost

It is recommended that a "User Pays System" be implemented to fund operation of the new national landfill.

This will basically take the form of a tipping fee, where all persons disposing of waste at the site will be required to pay a fee per volume of waste that is disposed.

In practice, this will be implemented as follows:

- In the case of domestic waste, each state will be required to reimburse the National Government for the waste collected from that state (whether a state operated or contract collection system is used). State government will be able to charge residents through the Waste Management Service Fee (which will collect fees for collection and disposal costs).

- In the case of commercial waste, the waste contractors will include disposal charges in their overall fee and will pay a gate fee as waste is delivered to the landfill.
- Individuals bringing waste to the landfill will also pay a gate fee.
- There is a concern about increase of illegal dumping by some people who do not want to pay a gate fee. Therefore, patrol and penalty system should be reinforced when the user pays system will be introduced.

**Comment [a20]:** Soeda;  
Added according to a floor  
comment at the WS.

## 6 COLLECTION AND TRANSPORT Plan

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### 6.1 Responsibility for Waste Collection

#### 6.1.1 National and State Government Responsibilities

Currently, waste collection is the responsibility of the individual state governments. In developing a new collection system, consideration must be given to whether the collection system should remain the responsibility of the State governments or should be a National government responsibility. In the short term, however, it is recommended that State governments retain responsibility for waste collection as it is till the new national landfill will start its operation.

In other countries, waste collection (and waste management in general) is not typically a national government responsibility. This is because the level of detail required for waste collection is more appropriately managed at a regional level. This also allows waste collection to be tailored to the individual region's needs. However, in a country as small as Palau, there is no strong rationale for allocating waste collection responsibilities to the states and in fact, many of the states may be too small to have adequate resources to manage a collection system.

It must be recognized that the collection needs of Koror and Airai are different to those of other states in terms of population density and also the level of commercial development. Those two states certainly have the resources to manage a collection system and there is no compelling reason to change the existing responsibility.

Other Babeldaob states have low population levels and few resources for waste collection, especially if a more extensive service is to be offered, and waste is to be transported to a central national disposal site. On this basis, it is recommended that the nine rural Babeldaob states collaborate on providing a waste collection system as soon as transportation of collection vehicles between the states is possible (that is, once the Compact Road is complete). This will provide an economy of scale for equipment and allow a higher level of service to be achieved.

In the island states (Kayangel, Peliliu and Angaur), it is appropriate for individual states to retain responsibility for waste collection.

This position should be reviewed every year subsequently to determine whether changes need to be made to reflect changes in population distribution and level of commercial development in Babeldaob. In reviewing the collection system, consideration should be given:

- Whether the collection system is meeting needs of the commercial and domestic sectors in each state

- Whether waste collection should remain a state government responsibility, or should be handed over to the National government (with adjustments for the island states)
- Whether improvements in the system can be made through inclusion of Airai and Koror with the Babeldaob states in a centralized collection system.

## 6.1.2 Public and Private Operation

Private contractors are used extensively for waste collection services in many other countries. Under the public private partnership policy, such private collection services can contribute to implement more cost efficient collection and to give more local employment opportunity under the limited resources of the local government. However, from the point of view of public sanitation, the local government should control such private collection activities.

Contractors can provide a range of services within an overall waste collection system, either as one large contract or a number of small contracts. Services which are appropriately provided by contractors include:

- Household waste collection services, usually by contract with local authorities for a particular urban area
- Commercial waste collection services, usually by contract arrangement between individual commercial waste generators and waste contractors
- Special collections for bulky waste, hazardous wastes and so on, usually by arrangement with local authorities
- Long-distance haulage of waste (for example, from individual states in Babeldaob Island to a new national landfill).

Use of contractors for waste collection has several advantages. Competition between contractors encourages contractors to keep costs as low as possible and provide the most efficient service possible. If a contractor does not perform as required by contract specifications, then the contract can be taken away and awarded to another contractor. Contractors that specialize in waste management have access to waste management expertise which may not be readily available to government agencies in a small country like Palau.

Several hurdles exist to the use of subcontractors in Palau. Firstly, there are no existing waste management contractors available in Palau. Although some of the larger waste producers in Palau have contracts with individuals who haul their waste using conventional trucks, these contractors would not have the capacity or expertise to provide waste collection services on a larger scale. However, these individuals may be able to provide haulage services to a larger waste management contractor within the framework of the principal contract.

Secondly, the volume of waste generated in Palau may not be attractive to waste management

**Comment [SMD21]:** Use local company in Palau as an example  
[Soeda](#);  
I deleted an example in [Micronesia](#). Current private collection in Palau are already mentioned in later part here.

contractors, as the revenue from this volume of waste is unlikely to justify the expenses of establishing operations in Palau. There may be insufficient waste quantities generated to allow two contractors to work in competition. If only one contractor was chosen to establish operations in Palau, this contractor would have a monopoly and it would be difficult to penalize the company for poor performance under contract specifications as there would not be other contractors available if the contract was cancelled.

These hurdles can be overcome to some extent if the National or State government retains ownership of expensive waste collection equipment such as collection vehicles. This would reduce the amount of capital outlay required for private companies to establish waste collection contracting services in Palau. It would also mean that if the chosen contractor did not perform, the equipment could be repossessed and allocated to a different contractor. The contractor would be responsible for maintenance of equipment to a certain standard. The government would be responsible for replacement of capital items on a pre-agreed schedule.

In future, this situation may be changed, for example, if the availability of waste management contractors increases.

If waste collection services are passed to a contractor, the government will need to retain at least one waste collection expert to provide contract management and supervision. Other government workers who are currently involved in waste collection would become obsolete. However, these workers could be employed by the chosen contractor, and in fact, employment of these workers at pre-determined rates and conditions can be a condition of the contract.

## 6.2 Collection and Transportation Plan

### 6.2.1 Collection Needs

For the purpose of developing a collection system, waste in Palau will be considered in seven streams:

- Stream 1 – Koror and Airai – Domestic Waste. These two states are the most populated in Palau. Koror has a population density typical of an urban area and most of the population of Airai also lives in similar conditions. The total population of the two states is around 15,000 people and the number of households is approximately 2,250. The two states are connected by an all-weather road and road access within each state is generally good, although the some of less populated areas of Airai may be difficult to reach in wet weather. According to the previous study report on ISWMP by Golder Associates, the mass of waste generated each week (domestic only) is 82 tons. Based on a compaction density of 300kg/m<sup>3</sup> (within garbage collection trucks), the volume of waste requiring collection is 275m<sup>3</sup>. Domestic waste coverage must also include collection of waste from several public parks in Koror and Airai.



- Stream 2 – Koror and Airai – Commercial Waste. Most commercial/business operations in Palau are located in Koror and Airai. Government offices are included in this category. Although many commercial premises are located on major roads with good access, there are some premises where access by large vehicles may be a problem. Many commercial enterprises require a more frequent collection service than domestic premises. This is partly due to the need to maintain amenity through prompt removal of waste (particularly for hotels and restaurants) and also due to the small area available for storage of waste at many premises. As a result many commercial enterprises are already hauling their own waste to the dump, or hiring a contractor with a suitable truck to haul waste. There is a wide range of types and quantities of waste produced in the commercial sector and so collection and handling needs may differ between (for example) hotels, restaurants and retail stores. The amount of waste generated is estimated to be 41 tons/week or 135m<sup>3</sup> according to the ISWMP by Golder Associates but it is recommended to make a survey on measuring the collection amount of the commercial waste.
- Stream 3 – Babeldaob States (Except Airai). The nine remaining states have a total population of approximately 2,700 people in 550 households, generating approximately 11.15 tons of waste per week. It was estimated in the ISWMP that the amount of waste generated per state varies from 2 tons/week (Ngaraard and Aimeliik) to 0.75 tons/week (Ngardmau). The amount of commercial waste generated in the Babeldaob states is negligible compared to domestic waste quantities.
- Stream 4 – Island States (Kayangel, Peleliu and Angaur). These states have populations of about 1,200 according to 2005 census and most of the solid waste produced in the island is from household and small scale hotels. Road access within each state is good but access to each state from Koror or Babeldaob is by boat only. There are very few vehicles in each island.
- Stream 5 – Bulky Wastes: Bulky waste is car bodies and white goods that those cannot be collected through a normal domestic or commercial waste collection system. Annual generation of bulky wastes is not known but it can be assumed by counting the import numbers of those items. There is a significant stockpile of bulky waste that has developed due to lack of any appropriate disposal options for these wastes. Bulky wastes are generated throughout Palau, in correlation with population distribution. Recently in 2006, as for scrap vehicles and electrical appliances were started to be treated and shipped out under the contract with a private company.
- Stream 6 – Construction Wastes: The volume of construction waste varies greatly depending on construction activities taking place. These wastes are generally inert. At present, most construction projects are taking place in Koror and Airai. The Palau Compact Road construction project generated significant quantities of construction waste, however, it was the responsibility of the construction contractor to provide for its own waste disposal needs.
- Stream 7 – Hazardous Wastes: Generation of hazardous wastes in Palau is variable and, with the exception of waste oil, tends to involve small quantities of a range of materials. Collection and management of hazardous wastes is discussed in more detail in Chapter 8.

In addition to collection of each of these streams, consideration must also be given to the transfer of collected waste to the designated disposal site.

Finally, if certain materials are to be segregated from the waste stream as part of a waste reduction strategy, an appropriate method to sort and transport these materials must be developed.

Segregated collection is one of such methods. Waste are segregated in several categories at the generation source and discharged into each designated waste containers respectively. Each container will be emptied by the waste collection service body depending on the designated collection frequency. For example, wet organic waste containing many of kitchen waste should be picked up quite often because of its perishability and dry recyclables such as cans and bottles could be less than that.

Advantages of segregated collection are to recover the recyclables in good quality and also to motivate people how to handle the waste appropriately. Disadvantages are often argued about an additional cost for the equipment and collection. If the waste collection body mixes such segregated waste and recyclable at the source when they are picked up, people may loose their intention to cooperate the waste reduction activity.

**Comment [a22]:** Soeda;  
Added according to a floor  
comment at the WS.

In assessing collection system options, the following factors are considered significant:

- Cost (capital and operating)
- Aesthetic and amenity factors
- Public Health
- Flexibility to accommodate changes in population and redistribution of population and businesses
- Public acceptance and ease of use
- Compatibility with recycling options

## 6.2.2 Standard of Service for Future Waste Collection

After discussions with government officials, consideration of waste disposal practices in other countries and consideration of needs of commercial and household waste generators, the following standards of service have been developed for future waste collection services in Palau:

- A reliable collection service should be provided to households in urban areas of Koror and Airai. Collection points should be at each household or small group of households (waste segregate station) such that waste does not need to be transported in private vehicles.
- The minimum standard of service for rural areas is that a transfer point will be established in each state and waste will be removed from that transfer point with a certain frequency in case that state will adopt to transport the waste to the new national landfill. State governments may choose to provide household waste collection services from households to the transfer point.

- Collection should be available to commercial and business enterprises at request. Frequency of collection should variable depending on needs, with daily collection available to restaurants and major hotels.
- Waste must be collected from public parks and recreation areas at least weekly, more often if special events are taking place that may generate more waste.
- The waste loaded on the body of truck should be covered when it is being transported in order to avoid the littering the waste and the odor.

**Comment [a23]:** Soeda;  
Added according to the T/C  
comment.

The rationale for adopting these standards of service is based on the following factors:

- Household and commercial waste becomes a hazard to public health if left uncollected.
- Transport of waste in private vehicles creates a health hazard to passengers in these vehicles and requires vehicle owners to clean vehicles after transporting waste.
- Uncollected waste affects amenity of residential areas and areas frequented by tourists through ugly appearance and odor.
- A waste collection service supports business and commercial enterprises by allowing them to maintain their premises in good condition.
- Collection of waste using large purpose built waste collection vehicles is more efficient in terms of vehicle trips and fuel consumption than having large number of small vehicles transporting waste to the sanitary landfill.

Options for domestic waste collection in Koror and Airai are:

- Individual state operated and funded collection systems
- Collaborative state operated and funded collection system
- Individual state government managed contracts with waste collection contractor
- Combined Babeldaob state managed contract with waste collection contractor
- Individual businesses make arrangements with contractors for collection service

The following factors are usually important to public officials when evaluating collection system.

- Cost of required new equipment and ability of community to obtain financing for it
- Cost to operate collection system and transfer facilities
- Compatibility of total costs with budget available for solid waste services
- Differences in levels of service provided by alternative systems
- Ability of system to meet public's demand or expectations for service

- Proposed methods for financing system costs and public acceptability of those methods as well as the tipping fee at the landfill.
- The system's effects on efforts to meet the community's waste reduction and management goals

**Comment [a24]:** Soeda;  
Added according to T/C's  
comment

## 6.3 Criteria for Equipment Selection

To determine specific equipment design information, hauling conditions, should contact vendors and review the existing equipment record. Following Factors shall be used to determine the most appropriate collection system.

- Loading location
- Truck body or container capacity
- Chassis selection
- Loading height
- Loading and unloading mechanisms
- Truck turning radius
- Water tightness
- Safety and Comfort
- Adaptability to other use

# 7 OVERALL MONITORING PLAN

## 7.1 Environmental Monitoring Plan

### 7.1.1 Objectives of Environmental Monitoring

Objectives of environmental monitoring are as follows:

- Periodical observation of the environmental condition and impact from the landfill sites and other SWM facilities to the surroundings
- Prevention of the surrounding from pollution
- To secure the environment including nature as well as human health
- To apply a suitable method of landfill operation based on the changes of water and air quality in the landfill site

As previously described in Chapter 4, landfill should be recognized as the accumulated place of environmental risks caused by collected waste. Leachate is created from water already containing in the waste, or entering from outside, moving through the deposited waste. Rainwater is the major source of leachate in Palau because of its climate characteristics.

Leachate contains extracted contaminants from the decomposing waste. Landfill produces wide varieties of combination of pollutant concentrations which also vary over time. The pollutants in the largest volumes in leachate are carboxylic acids which come from microbial decomposition of waste. The followings are often observed in Leachate.

- Major elements and ions such as calcium, magnesium, iron, sodium, ammonia, carbonate, sulphate and chloride
- Trace metals such as manganese, chromium, nickel, lead, and cadmium
- Organic compounds including carboxylic acids, which are usually measured as Chemical Oxygen Demand (COD) together with some individual organic species and phenols
- Microbiological compounds

As well as leachate, aerobic or anaerobic decomposition of waste at the landfill ultimately leads to production of landfill gas which is a mixture of carbon dioxide and methane gas together with small portion of other gas. Such gasses should be recognized as a green house gasses cause global warming and there is also a potential risk of accumulations of flammable concentrations in the site.

**Comment [SMD25]:** Enhance the content by tackling terrestrials-what will happen to endangered species.

Whatever an environmentally appropriate construction and operation of landfill can be conducted, these leachate and gas should be monitored to understand the operating conditions of the site.

**Comment [SMD26]:** Enhance the content by tackling terrestrials-what will happen to endangered species.

### 7.1.2 Monitoring Plan at Landfills and Surrounding Area

Environmental Monitoring around M-Dock, new national landfill site and or any other landfill is classified to two kind of monitoring. One is Basic monitoring, which is conducted periodically in short term by means of handy equipments, and the other is regular monitoring designated to be carried out by a specialized laboratory in Palau on a contract basis according to EQPB regulation.

Monitoring items are considered as follows:

1) Water Environment

- Surface water
- Underground water
- Wastewater (Leachate)

2) Air Environment

- Emission gas from landfill
- Ambient air quality

3) Human Health

- Health condition of landfill employee and resident

Detailed monitoring substances are shown in the following tables. These substances should be reviewed considering the result of monitoring.

**Table 3 Monitoring Substances of Water Environment**

No.	Parameter and Substance	Basic monitoring			Regular monitoring		
		Surface	Under ground	Leachate	Surface	Under ground	Leachate
1	Temperature	○	○	○	○	○	○
2	pH value	○	○	○	○	○	○
3	Electric Conductivity (EC)	○	○	○	○	○	○
4	Hardness (as CaCO <sub>3</sub> )					○	
5	BOD <sub>5</sub>				○		○
6	COD				○		○
7	Dissolved oxygen (DO)	○			○		
8	Turbidity	○					
9	Suspended solids (SS)				○		○
10	Arsenic				○	○	○
11	Barium				○		

12	Cadmium				○	○	○
13	Lead				○	○	○
14	Chloride					○	○
15	Chromium (VI)				○	○	○
16	Chromium (III)				○		○
17	Mineral oil and fat						○
18	Animal-vegetable fat and oil				○		○
19	Copper				○	○	○
20	Zinc				○	○	○
21	Manganese				○	○	○
22	Nickel				○		○
23	Organic phosphorous						○
24	Total phosphorous (T-P)						○
25	Iron				○	○	○
26	Tin				○		○
27	Mercury				○	○	○
28	Total nitrogen (T-N)						○
29	Trichlorethylene						○
30	Tetrachlorethylene						○
31	Ammonia (as N)				○		○
32	Fluoride				○	○	○
33	Nitrate (as N)				○	○	
34	Nitrite (as N)				○		
35	Sulfide						○
36	Sulfate					○	
37	Cyanide				○	○	○
38	Phenol compounds				○	○	○
39	Coliform				○	○	○

**Table 4 Monitoring Substances of Air Environment**

No.	Parameter and Substance	Basic monitoring	Regular monitoring
1	Temperature	○	○
2	Wind direction		○
3	Wind velocity		○
4	Humidity	○	○
5	Methane	○	○
6	CO	○	○
7	NH <sub>3</sub>	○	○
8	H <sub>2</sub> S	○	○
9	NO <sub>2</sub>		○
10	SO <sub>2</sub>		○
11	Lead (Pb)		○
12	SPM		○

Dry season and rainy season have to be chosen for the time for investigation of items to be monitored at two times per year.

**Table 5 Operation Period**

Monitoring Items	Monitoring frequency	
	Basic monitoring	Regular monitoring
<u>Water environment</u>		
Surface water	2 time / week	Temp, pH, EC, hardness, BOD5, COD, DO, SS, coliform: 4time/year Others: 2time/year
Underground water		
Wastewater (Leachate)		
<u>Ambient Air environment</u>		
Emission gas from landfill	2 time / week	-
	1 time / week	2 time / year
	-	
<u>Human Health</u>		
Health condition of landfill employee and residents	-	1 time / year

**Table 6 Closing Period**

Monitoring Items	Monitoring frequency	
	Basic monitoring	Regular monitoring
<u>Water environment</u>		
Surface water	First and second years: 1 time / months Subsequent years: 1 time / 3 months	First and second years: Temp, pH, EC, hardness, BOD5, COD, DO, SS, coliform: 4time/year Others: 2time/year Subsequent years 2 time /year
Underground water		
Wastewater (Leachate)		
<u>Ambient Air environment</u>		
Emission gas from landfill	First year: 1 time / 2 weeks	First year: 2 time / year
	Subsequent years: 1 time / 3 month	Subsequent years: 1 time / year

### 7.1.3 Monitoring Plan at Other SWM Facilities and Equipment

There is several SWM facilities such as small scale incinerator, recycling and composting plant in Palau.

Those facilities should be also monitored environmentally according to EQPB regulations.

Especially it is recommended to analyze the gas and ash from incinerator even if those are small unit used at hospitals or some states. Operation record of incinerator should be kept in terms of the items such as input (waste) / output (ash) amount, operation time, burning temperature and weather condition by the operating body.

For other mechanical equipment including waste collection trucks shall be inspected according to the manufacturer's inspection manual.

**Comment [SMD27]:** Incinerator is not an option in waste management Soeda;  
Yes, incinerating municipal waste is not recommended in NSWMP in Palau. However, in reality, there are several incinerators used in the country including those at hospitals. EQPB should have an responsibility to control if those facilities are used appropriately or not.



## 7.2 Monitoring Plan of Waste Generation and Recycling

Other important monitoring items are the quantity of managed waste and recovered recyclables.

It is recommended the site inspector at M-Dock landfill and other landfills shall keep the record of number of trucks. Regularly the loading weight of each collection trucks should be measured.

Amount of recovered recyclable materials should be also monitored to understand the recycling rate.

## 8 INTERMEDIATE TREATMENT OPTIONS

Waste treatment is carried out to reduce environmental impacts of waste disposal. Options for waste treatment applicable to Palau are discussed below.

### 8.1 Shredding

Shredding of waste reduces particle size and therefore allows waste to be packed more efficiently, reducing volume. This increased compaction reduces the need for landfill space, making landfills last longer. It also reduces vermin and litter problems and reduces the need for cover material. The increased surface area of particles enhances the biological stabilization of the organic waste present, which reduces long term leachate toxicity.

In order to shred all components of the waste stream, a heavy duty shredder or tub grinder is needed.

Operators would require special training to ensure safety and regular maintenance by a mechanic with diesel experience would also be required.

Tub grinders can be used to chip wood and logs but are not effective for shredding/chipping brush, leaves, paper and cardboard, all of which may require shredding for implementation of composting recommendations. Therefore, a shredder/chipper will also be needed to support the composting recommendations.

Plastic waste can be also shredded by the shredder. If the purpose of shredding the plastic is to downsize the mass volume of plastic for efficient handling and transportation, the plastic waste should be cleaned before putting into the machine. The Machine should be also cleaned after the operation in order to avoid the contamination of different types of plastic in the next shredding.

**Comment [a28]:** Soeda;  
Added according to the floor  
comment at the WS.

### 8.2 Combustion

#### 8.2.1 Introduction

Incineration of waste has become common in places where availability of land suitable for landfilling is limited and financial and technical capability is enough to operate the incinerator appropriately. Incineration is strictly controlled with a high temperature combustion of waste as compared to open burning of waste. Incinerator for waste combustion is purpose built and must be well maintained and operated to work effectively. Most incinerators require waste to be mixed, shredded or ground before it is placed in the incinerator in order to burn the waste in stable condition.

Small modular incinerators may be used by national hospital and quarantine office for particular components of the waste stream such as medical waste and quarantine waste where complete destruction of the waste is needed.

High temperatures are necessary to ensure that all components of the waste stream are burnt, and to minimize formation of certain toxic organic chemicals that are released in low temperature combustion gases, especially as a result of combustion of plastics. Even at high temperatures there is still considerable concern about the level of organic chemicals emitted from waste incinerators, as well as air pollution in general.

Incinerators can be designed to allow energy recovery from waste as it is burnt. In Palau, there do not appear to be any suitable applications for energy recovered from incineration of waste (typically, this energy may be used for heating large buildings, swimming pools or in some cases driving steam turbines for production of electricity).

In addition to gaseous compounds, incineration of waste produces ash which must be disposed of to a secure landfill cell. The ash is relatively inert and therefore ash landfills do not require the level of environmental protection controls that normal sanitary landfills do.

Incinerators do not provide flexibility as the quantity of waste generation changes. If an incinerator is designed to handle a certain quantity of waste, the cost savings of incinerating a smaller amount of waste are minimal, providing little incentive for waste minimization. Also, once capacity is reached, the incinerator cannot be easily expanded to handle the additional waste, and an additional incinerator is usually required to handle the increased waste volume.

In Palau the moisture content of waste also presents a difficulty for incineration as a significant amount of energy must be used to evaporate the water before combustion can occur.

It is possible to combine incineration with energy supply if a suitable use for waste heat from the incineration process can be found. When the waste heat is used to generate electricity, this process is known as co-generation, and is frequently used in hospitals where heat from medical waste incinerators can be used to generate electricity for the hospital.

Capital costs for incinerators are high and are not directly in proportion to the size of the incinerator. Thus small capacity incinerators are less cost effective (per ton of waste incinerated) than large capacity incinerators.

Burning of waste provides a means to reduce waste volume. However, burning of waste can contribute significantly to air pollution. Smoke from burning reduces visibility and can cause respiratory problems in people exposed. Also, low temperature burning of plastics produces toxic dioxins and other chemicals.

As expected, a small capacity incinerator is significantly more expensive in terms of capital and operating costs than a sanitary landfill handling similar quantities of waste. In addition, operating an incinerator requires a higher level of technical expertise than a sanitary landfill, and this level of expertise may not be available on a permanent basis in Palau.

Burning of waste is not considered an appropriate waste treatment option for Palau except for the

medical waste treatment. Solid waste management regulations should be recommended to ban burning of any solid waste without a permit.

## 8.2.2 Site Evaluation of Incinerator

In the case of installing Incinerator, the selection of final site should be based on a more detailed and comprehensive environmental and technical evaluation the selection criteria should be based on specific design requirements for the facilities including the following:

- Adequate land area
- Subsoil characteristics to structurally support the facility
- Access to required utilities

In addition, each site should be evaluated in details for its social and environmental compatibility for this type of facility, including the following:

- Compatibility with other land use types in the neighborhood
- Evaluation of the area's flora and fauna

## 8.2.3 Monitoring

To assist the operator in the proper operation of the combustion process and the emission control equipment, continuous emission monitoring (CEM) equipment has become a requirement for any new or existing waste combustor. CEM system typically monitor stack emissions of NO<sub>x</sub>, carbon monoxide, oxygen particulate via opacity meters and acid gases via monitoring sulfur dioxide. Gas temperature are also monitored to control the scrubber process and to ensure baghouse safety.

# 9 HAZARDOUS WASTE MANAGEMENT PLAN

## 9.1 Responsibility for Management of Hazardous Wastes

It is recommended that existing regulations for hazardous waste management prepared by EQPB should be reviewed and modified. Recommendations made in this section and elsewhere in this report can be incorporated into the revision of the regulations to formalize management requirements for hazardous waste. In particular, these regulations should:

- Have a list of hazardous waste
- Make it an offence (with suitable penalty) to dispose of hazardous wastes in any way other than specified or permitted by EQPB
- Require that guidelines for management and disposal of certain types of hazardous wastes, such as auto and marine batteries and waste oil etc. shall be developed.
- Introduce some kind of permitting system (similar to that used for management of pesticides) to cover generators of waste oil and large quantities of other hazardous wastes.
- Clarify the demarcation of responsibility of hazardous waste management among EQPB, MoRD, MoH and other concerned organizations. For example, BPW of MoRD should have the responsibility of collection and disposal of those hazardous waste and MoH has the responsibility of handling the medical hazardous waste at the hospitals including the preparation of handling manual and operation of small scale incinerator.
- Include the safety handling guideline of hazardous waste including avoiding the accidents caused by hazardous waste collection and disposal. Based on the guideline, training and educating procedure including the segregation of hazardous waste should be established.

**Comment [a29]:** Soeda;  
It was modified because Mr. ellis mentioned there are already regulation for hazardous waste at T/C.

**Comment [a30]:** Soeda;  
Added according to the floor comment at the WS. This NSWMP is not focusing only hazardous waste, mostly focus on domestic waste. So, it is recommended the list of hazardous wastes should be prepared as another form (see action plan 7c).

## 9.2 Household Hazardous Waste

### 9.2.1 Waste Oil

Some waste oil cannot be used in energy recovery as it is contaminated or otherwise unsuitable. Management of waste oil falls within the responsibility of BPW. BPW has accepted this

responsibility and has been developing various programs for waste oil management, working with oil importers, waste oil generators, and Palau Public Utilities Corporation (PPUC: Operator of Aimeliik Power Station).

BPW should continue this role and discussions should focus on:

- Identifying as many opportunities as possible for reuse of waste oil
- Developing codes of practice for handling of waste oil to maximize reuse opportunities and minimize risk of environmental contamination
- Identifying options for disposal of waste oil that cannot be reused, for example through removal by importers.

BPW should also establish a formal register to allow oil imports to be tracked and ensure that incorrect disposal of waste oil is not occurring. This could include a system for permitting all bulk oil users in a similar manner to the existing permitting system for pesticide users.

## 9.2.2 Hazardous Hospital Waste

The Belau National Hospital has an incinerator for disposal of infections and biomedical wastes. This practice should continue.

The Belau National Hospital should undertake a waste audit to identify:

- Whether all infectious, pathological, biomedical or otherwise medically hazardous wastes are being separated from the general waste stream for disposal to the incinerator.
- Whether storage and handling of these waste is adequate to protect hospital workers and patients from exposure and infection.

The waste audit could also identify opportunities for general waste minimization at the hospital.

## 9.2.3 Hazardous Household Waste

If disposal of hazardous wastes in the landfill or by other environmentally damaging means is to be avoided, generators of hazardous wastes must have an alternative means to get rid of their hazardous wastes. This is particularly true for small generators, for example at the household level where the minimum-effort option is to place small amounts of hazardous substances with general waste.

It is recommended that a once-off hazardous waste collection program be implemented to collect all these small quantities of hazardous wastes from households and other locations. This program should be coordinated and publicized by BPW with labor, transportation and other assistance

provided by each of the states. It should be noted that BPW successfully coordinated a battery collection program.

In Koror, a door to door collection could take place on designated days. Householders would need to be notified of the collection and the types of waste that they could put out for collection. Safety precautions during collection should include:

- Personal safety equipment including overalls, rubber gloves, safety boots and safety glasses.
- Training of all personnel in the risks involved and proper use of safety equipment and techniques
- Install eyewash and body wash facilities in case of contact with hazardous wastes
- First aid kit on collection truck
- Spill proof containers (for example plastic drums or tubs) to place wastes in after collection
- Instructions on types of hazardous substances that are incompatible with each other, and correct segregation of these substances.

Outside Koror, householders and others should be encouraged to drop hazardous wastes at temporary local drop off centers which would be established specifically for the collection program on a designated day or days. Drop off centers should be located in each hamlet to make it easy for householders to deliver hazardous wastes. These drop off centers would need to provide secure spill-proof containers to place wastes in and would need to be staffed at all times to ensure that accidental spills did not occur. Staff would need to undertake safety precautions as outlined above.

All hazardous wastes collected would need to be transported to a central secure storage area which would be established by BPW. During transport, hazardous wastes would need to be fully contained within spill proof containers and incompatible materials would need to be transported separately.

The secure storage area should provide:

- Complete spill containment
- Separate storage areas for different categories of materials with design features to ensure that incompatible materials cannot come into contact with each other, even if spilt.
- Proper labeling of all materials
- External security to prevent unauthorized access
- Protection from weather
- Ventilation to ensure that fumes do not build up or can be vented.

In the longer term, provision should be made for delivery of hazardous wastes to transfer points. Small secure storage areas should be established for small quantities of waste oil, auto and marine batteries and other hazardous wastes. These storage areas should be regularly cleared.

Batteries can be transferred to a battery storage area awaiting recycling and waste oil can be used in energy recovery programs if uncontaminated. Other hazardous wastes should be placed in the central secure storage area.

## 9.3 Minimization of Hazardous Wastes

The amount of hazardous waste generated in Palau is relatively low. The following initiatives recommended elsewhere in this report will contribute to the minimization and better management of hazardous wastes:

- Implementation of an advanced disposal fee on vehicles and electrical appliances including auto and marine batteries
- Continued monitoring of oil and waste oil generation and training of waste oil producers
- Certification program for pesticide application

Generation of hazardous waste in Palau should continue to be monitored and further actions taken if the nature or quantities of hazardous waste increases. In particular, EQPB should ensure that all new developments undergoing environmental assessment/impact assessment under its regulations are assessed for the potential for hazardous wastes to be generated. If hazardous waste is to be generated, the applicant must propose suitable methods for management and disposal of the waste that comply with EQPB regulations.

## 9.4 Disposal Options

### 9.4.1 Landfill

Disposal of hazardous wastes to landfill creates a risk that toxic compounds will be released from the landfill, either in leachate, which may enter surface or ground waters, or possibly to the air environment.

Special design/management features can be incorporated into the landfill to increase containment of toxic substances, such as very low permeability liners and advanced leachate collection and treatment systems. However, these are costly and require on-going maintenance even after the landfill has been closed. These measures do also not guarantee that no toxic substances will be released from the landfill.

Keeping hazardous wastes out of the landfill avoids these problems and reduces the level of landfill design and management that is needed to provide adequate environmental protection. Given the low level of hazardous wastes in Palau, this approach is considered more appropriate.



Accordingly, it is recommended that the following types of waste be excluded from the landfill:

- Auto and marine batteries
- Waste oil, oily rags and oil contaminated machinery
- Pesticides, paints and other chemicals
- Explosives and ordinance
- Any other wastes that might result in release of toxic substances from the landfill.

The BPW Solid Waste Regulations should be established to make it an offence to place any of these materials for collection with general or commercial waste or to allow them to be disposed of at the landfill or by any other unauthorized means.

## 9.4.2 Energy Recovery

Energy recovery from waste almost always involves combustion of waste to produce heat. Most types of waste produce relatively low grade heat when burnt and applications for this heat are usually limited.

In Palau, the only existing application for energy recovery is combustion of waste oil for power generation at the Aimeliik Power Station. PPUC currently accepts waste oil from a number of larger producers. Oil is only suitable for use at the power station if it has no contaminants such as hydraulic oil. PPUC filters all waste oil before using it.

The contribution of PPUC to waste oil management in Palau should be acknowledged and PPUC should be asked to continue this role and accept all waste oil that meets its standards.

Producers of waste oil should be educated in waste oil management so that their oil can be kept at a standard that is acceptable to PPUC. EQPB has begun an initiative in this area and should be asked to continue its work in waste oil management.

# 10 INSTITUTIONAL PLAN

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## 10.1 National Environmental Institution

The Environmental Quality Protection Board (EQPB) has the main charter (under PNC Title 24) for environmental protection. The responsibility for environmental protection aspects of natural resource management rests with the Ministry of Resources and Development (MoRD) (under PNC Title 24 and other legislation) through its Bureau of Natural Resources and Development, with its Division of Marine Resources (DMR) (and the Forestry Department within that Division), Protected Area Network (PAN), Palau Automated Land and Resources Information System (PALARIS), Bureau of Public Works (BPW), and the Bureau of Land and Survey. Within the Ministry of Health is found a fourth body with chartered environmental responsibilities, Division of Environmental Health (DEH) in the Bureau of Public Health.

Environmental Quality Protection Board (EQPB) was established as an authorized policy-setting and decision-making regulatory agency under PNC Title 24, RPPL 1-58. The mandate of the EQPB is to ensure that the quality of the human environment, air, soil, and water, of the Palau is protected. Major responsibilities include:

- Promulgation and enforcement of primary and secondary drinking water regulations and other such regulations as are necessary to carry out the purposes the Safe Drinking Water Act;
- Establishment and provision for the continuing administration of a permit and monitoring system for the discharge of any pollutants in the air, land, or water;
- The adoption and implementation of plans for the certification of applicators of pesticides and issuance of experimental use of permits for pesticides;
- Promulgation and enforcement of nuclear and other hazardous waste regulations;
- Promulgation and enforcement of other regulations for the purposes of monitoring, inspection, and record-keeping for environmental quality protection.

The main resource management issues affecting the EQPB include:

- Road construction, tourist resorts and other developmental projects directly impacting on soil, air, and water quality, such as dredging, earth moving, filling of mangroves swamps, and other wetlands;
- Water, solid, and liquid waste problems relating to population growth in the Palau;
- Pollution of freshwater and marine water through dumping of wastes and use of pesticides;

- Lack of knowledge by the general public, business people and government employees and politicians on the potential impacts of everyday activities as well as development activities on environmental quality.

#### Other Government and Non-Government Agencies with Environmental Responsibilities

These include:

- The Division of Conservation and Entomology which has a mandate to develop and implement national policies to conserve the natural resources of Palau;
- The Division of Marine Resources which is mandated to develop and manage the inshore marine resources of Palau;
- Governors Association
- Solid Waste Management Office, BPW, MoRD
- The Division of Agriculture and Mineral Resources, including the Forestry Department
- The Division of Cultural Affairs in the Ministry of Community and Cultural Affairs
- The Ministry of Commerce and Trade responsible for enforcing, marketing, and promotion of economically sustainable development for the benefit of local economy and the quality of life
- Non-government organizations such as the Palau Conservation Society, Traditional Leaders, and any other ethnic groups.

For over 10 years various environmental agencies particularly EQPB have addressed the existing environmental problems posed by the present disposal system initiated at the M-Dock landfill, a national disposal site that has been receiving Municipal Solid Waste (MSW) for over 50 years. The recent development infrastructures in Babeldaob and other outlying states had created additional landfill sites without proper disposal systems.

It is becoming a realistic issue that the Palau is currently under development and such economic growth has transpired resource constraints, which can become a threat to future depletion on the environment and such constraining factors can provide opportunities for economic growth. It is vital to create new sustainable economic systems based on the 3R that enable both the environment protection and economic growth.

Concerns about landfill capacity and the environmental impacts of solid waste disposal, in combination with increasing interest in recycling has brought forth attention to solid waste management in the Palau and will serve as an impetus for implementation of several states initiatives to more effectively manage this waste.

### 10.1.1 Current Situations

- (1) In recent years, financial and environmental costs to dispose of municipal solid waste are beginning to overwhelm the Palau's local and national government. Public attitudes about garbage are also changing in response to new information about costs and practices of solid waste disposal. As our disposal sites will be filled to capacity in the future major issues will arise and new sites become hard to locate, disposal becomes more complex, controversial, and expensive as new standards for landfill design require highly engineered facilities.
- (2) Environmental concerns deal not only in locating new waste management facilities, but also in posing the question of who is at risk of being exposed to the waste.
- (3) Although EQPB environmental regulations distinguish non-hazardous and hazardous waste: the lines between the two categories are sometimes distorted. Household waste may contain hazardous waste that pose environmental and health impacts if not properly disposed of.
- (4) Medical wastes need to be dealt with in a responsible manner that does not jeopardize human or ecosystem health.

## 10.2 National Operational Institution

Currently the National Government Bureau of Public Works operates the main dump in Koror and each state government operates a small dump in its own state through their public works divisions (except for Koror State). Once the Palau Compact Road will be fully completed, road transport of wastes around Babeldaob will be possible. This presents an opportunity to develop a centralized National Waste Disposal facility serving Koror, Airai and the Babeldaob states.

Many of the Babeldaob state dumps are considered to be causing negative environmental impacts and public health impacts. If the individual states were to continue operate these dumps, the level of management would have to be increased so that these sites at least met the minimum standards set out in the EQPB Solid Waste Regulations. Some dumps would need to be relocated away from mangrove/wetland areas and residential areas.

Maintaining adequate environmental protection controls at one central waste disposal site is likely to be more cost effective than maintaining these controls at many different, smaller sites. Balancing this saving is the cost of transporting waste from the states to a central site.

Peleliu and Angaur would have to maintain waste disposal sites for solid waste since transport of waste by boat is impractical and expensive. Kayangel must continue to remove inorganic wastes by boat since it does not have any appropriate sites for a solid waste disposal site. Burial of organic wastes should continue at Kayangel.

The EQPB Solid Waste Regulations make the States responsible for providing facilities for the disposal of hazardous waste materials (2401-31-21). Given that most states have small budgets and low levels of resources and expertise available, it would seem inappropriate and inefficient for

each state to provide adequate disposal facilities for hazardous waste. Responsibility for management of hazardous waste should be allocated to the National Government. The National Government may seek to engage contractors to carry out certain activities in relation to a sustainable management of hazardous wastes.

Collection of waste is currently a State government responsibility. It is appropriate for the states to retain this responsibility since states will have a better understanding of the individual collection needs of their populations. States may choose to engage contractors to carry out collection activities.

At State and National government level, it is appropriate for the management of waste management services to lie with the Public Works sections. These sections manage a range of government services relating to infrastructure and have the experience with contract management and other aspects of engineering works.

## 10.3 Personal Resources of Solid Waste Management

### 10.3.1 National Level

The skills and experience of existing waste management staffs within the Bureau of Public Works are certainly important. However, implementation of this NSWMP will also require expertise that is currently not available within any National Government Agencies.

It is recommended that minimum of three full time person be appointed within the Bureau of Public Works to administer and supervise waste management services. This should be the case even if contractors are being used to provide all waste management services as contract supervision will still be required.

The appointed staff should have waste management experiences, with an emphasis on not only landfill plan and management but also overall solid waste management. Especially, the Manager should have engineering qualifications or equivalent training as well as skills and experience in strategic planning aspects of waste management. Experience in waste management in Pacific Island and/or developing countries should also be a requirement and the successful applicant should preferably have also lived for extensive periods in a Pacific Island or developing country.

If the National Government continues to provide waste management services such as disposal or bulk haulage, existing personnel should be retained and should be placed under the direction of the Manager, Waste Management Services.

If these services are contracted out, a condition of the contract should be that existing National Government employees are hired by the contractor at an equivalent salary.

## 10.3.2 State Level

State Government Department of Public Works will retain responsibility for household collection of waste or supervision of household waste collection contract(s).

The State Government in each state should retain responsibility for supervision of household waste collection and may appoint an employee to assist with this. This should not represent an increase in existing duties. The State Government will also be responsible for budget matters, including determination of an appropriate level for User Pays Fees and distribution of a proportion of fees collected to the National Government.

Where two or more states are collaborating on waste collection contracts, responsibility for contract administration can be allocated to one state with suitable recompense from other states involved.

State governments will also have responsibility for collecting User Pays fees from state residents. State governments have existing mechanisms for collecting revenue, for example for vehicle registration and should be able to absorb this responsibility without requiring additional resources.

## 10.4 Involvement of Private Sectors

There will be a number of tasks arising from implementation of the NSWMP that will require expert input, often on a short term basis. As is currently the practice, the National and State governments should hire consultants to provide this specialist advice. Some examples of consultancies that will be required early in implementation of the NS WMP are:

- Preparation of contract documents and terms of reference for contracts
- All aspects of design, construction, commissioning and operation of a new National Landfill site
- Preparation of an Environmental Impact Statement for the new National Landfill

Preparation of terms of reference/requests for Proposal for these consultancies, and supervision of the consultancies themselves should be the responsibility of the Manager, Waste Management Services.

In terms of operation of waste management services such as waste collection and landfill operation, involvement of private sectors should also be considered more optimizing the solid waste management cost and quality. Then, at that time, role of National and State Governments, with limited human resources, will be shifted for supervision, contract management, monitoring, enforcement and complaint procedure.

## 10.5 Institutional Cross Coordination

In order to have common understanding about the solid waste management situation in Palau

**Comment [a31]:** Soeda;  
Added according to a floor  
comment at the WS

among the all concerned, the following opportunities should be established.

- Governmental Solid Waste Management Committee: MoRD, EQPB, DMR, PALARIS, Division of Sanitation, DEH, BPH and State Governments should form a committee that associates with representatives from each of the mentioned above organizations and create a monitoring process or system that relates to each representatives field expertise.
- Business association for solid waste management: Representatives from the all kinds of businesses that generate the waste or are engaged in waste management businesses should form an association to share the information of the solid waste.
- Open dialogue meeting for better solid waste management: Above mentioned governmental committee and business association should have open dialogue meetings regularly to discuss about any kind of issued in the field of solid waste management and recycling.

# 11 Financial Plan

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## 11.1 Capital Items

Waste management services in Palau are currently paid for entirely by National and State Governments. Operating costs for collection systems and disposal sites are allocated within annual operating budgets.

Capital projects, equipment purchase and specialist waste management studies are usually funded through appropriations from the annual budget for the Republic of Palau. Leasing of equipment is not usually considered.

In the future, it is anticipated that government revenue in Palau will be affected by the gradual reduction in Compact funds. AS revenue falls, the amount of funding available for waste management services can also be expected to be reduced, and it will become more difficult to maintain adequate waste management services. It is therefore not appropriate to continue to rely on 100% government funding for waste management services.

Provision of free waste management services to the public and business communities also contributes to a lack of appreciation of the environmental impacts and other costs associated with waste management. If there are no taxes and charges for management of wastes, there is no incentive to reduce the quantity of wastes, or avoid production of potentially environmentally damaging waste.

Residents of Palau have always had 100% government funded waste management services and may have an expectation that this service will continue at no charge to them. However, given the need for improved waste management in a climate of reduced government funding, it is no longer considered appropriate to rely on 100% government funding for waste management.

Many businesses are currently providing their own waste collection services and are therefore accustomed to having to pay for waste management services. It should be noted that there is no disposal fee for commercial waste.

Although funding of waste management services from general government revenue should be phased out, there are a number of major expenditures that will be required in the next few years in order to implement the programs under the NSWMP. These includes

- Maintenance and closure of M-Dock Landfill
- Rehabilitation of existing dumping site in each state
- Design and preparation of EIS for the new national landfill
- Construction of the new national landfill



- Purchase of several large capital items such as bulldozer and woodchipper

The government will have to make appropriations for these items and several smaller items from its annual budget.

## 11.2 Operations

### 11.2.1 Introduction of Fee Charge System

It is proposed to use a User Pays system to fund operation of waste collection and treatment systems. Private businesses that wish to take advantage of the state operated collection system will pay a Waste Management Service Fee to the State Government. Each State government will design waste management collection fee and services.

Generators of bulky wastes will need to make their own arrangements for haulage of these wastes to a disposal site and will incur a disposal fee when the waste is dumped.

State governments will be responsible for collection of the Waste Management Service Fee from private business. In the transition period, before the National Landfill and transfer stations are operational, State governments may retain a proportion of fees for improvement and eventual closure of individual state dumps.

The amount of the Waste Management Services Fee will be set by each State government. The National Government will submit costs of waste transfer (haulage) and disposal services to each state government annually so that State Governments can incorporate these costs into the fee.

When the fee charge system will be introduced, there is a concern about increase of illegal dumping. Therefore, strict enforcement of anti-litter and dumping regulations will be required to ensure that waste generators do not dispose of waste improperly. This should be accompanied by a community awareness program so that waste generators understand the negative impacts of improper waste disposal and are motivated to dispose of wastes legally.

**Comment [SMD32]:** Misplayed, delete and put it on chapter 11 in the last paragraph of 11.1

### 11.2.2 Collection of Disposal Fee

Presently, all of operation cost for M-dock landfill was covered by national government budget (BPW). However, it is observed that 65% of the hauled waste to M-dock is generated by private company according to waste quantity survey. Therefore, it is recommended to collect tipping fee from private company. Collected tipping fee will be utilized for operation of M-dock or proposed new national landfill.

### 11.2.3 Advance Treatment Fee

For implementation of recycling and treatment of vehicles and electrical appliances, it is recommended to collect advance disposal fee (import tax) on each vehicles and electrical appliances imported to Palau. Advance treatment fee to be paid by importer and can be passed on to consumers through purchase price.

## 11.2.4 Container Deposit Program

Recycling program of deposit system (SBNo.7-94, SDI, PDI) was issued by president office in October 2006. As details will be mentioned in "Beverage Container Recycling regulations", the deposit amount of 10 cent/each container, is paid to National Treasury by importer or local manufacturer and can be redeemed by returning the containers to redemption center. Koror State is constructing the State's recycling center under the Koror Recycling Program. In case the redemption center under the new national program will be difficult to set up when the program will be come into force, national government and Koror State should discuss the utilization of State's recycling center as a redemption center.

**Comment [SMD33]:** Suggestion: Add this sentence---Koror State will be the initial implementation of recycling redemption center.  
**Soeda;**  
**Modified.**

# 12 PUBLIC EDUCATION AND ENHANCEMENT PLAN

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## 12.1 Outline

Encouraging public education and enhancement on solid waste management is critical, because most of the solid waste is generated by public. Public effort in addition to government effort to reduce waste is necessary for successful implementation of NSWMP. Practicing 3R (Reduce, Reuse, and Recycling) by public contributes waste reduction, so this practice should be encouraged through public education and enhancement

To effectively practice 3R by public in Palau, public education and enhancement program should be strategic. Strategy for public education and enhancement including target groups, target area, message to be delivered, and methods to deliver the message is formulated to attain practicing 3R activity in Palau. Establishing a coordinating body to promote public education and enhancement, and operating the body are important in Palau.

The cost of the public education and enhancement will be set by both National Government for national level activity and State Governments for state level activity. The National Government will also support State Governments according to the request.

**Comment [SMD34]:** This paragraph is from chapter 10, last paragraph of 10.2.3-container deposit program  
Soeda;  
I don't think this comment is understandable. But I agree there should be something about cost in this chapter, too, so modified as you see.

## 12.2 Target Group

### 12.2.1 Target Groups

The following nine groups are target groups in public education and enhancement. The features of each target group in public education and enhancement are also shown below.

- Woman's Group: Powerful influence not only to family level but also society level in Palau
- Schools: Importance of environmental education to elementary school students, principals of school have intention to take waste segregation in their education program
- Traditional Chiefs: Easy access and support to each state
- Filipino Community: Largest population of foreigners in Palau
- Japanese Community: A strong support to public education and enhancement can be expected
- Grocery Stores: One of the groups generating a great deal of waste, cooperation to reduce and recycle waste is expected

- Construction Companies: One of the groups generating a great deal of waste, cooperation to reduce and recycle waste is expected
- Hotels: One of the groups generating a great deal of waste, cooperation to reduce and recycle waste is expected
- Dive Shops/Tours: Enlightening waste reduction and recycling to international tourists can be expected

## 12.2.2 Prioritized Target Groups

The priority is given to Woman's Group, Schools, and Filipino Community. These groups are more important than other groups in terms of opportunity to generate waste, necessity of education, cooperation to 3R, impact to other groups, and sustainability of activity. Residents, kids, and community are to be educated first, and they are expected to push other target groups in the long run. The activities for the prioritized target groups will be implemented in the first three years. The activities for other target groups will start after the next three years step by step.

## 12.3 Target Area

Public education and enhancement is to be implemented in all 16 states of Palau in the long run. Since Koror State has the largest population and more advantages including the availability of resources and the location of business and administrative functions than other states have, the activities for public education and enhancement start from Koror State.

## 12.4 Message

Message should be associated with reduce, reuse, and recycle. In addition, message is to be tailored to each target group based on the assessment regarding how each target group can take actions to reduce waste.

Reduce including refusing plastic bags and disposable plate is the most preferable options to reduce waste, so inclusion of reduce in messages is to be encouraged more than reuse and recycle. In addition, Koror State Government is implementing the Waste Segregation Project, so a message addressing recycle is also effective to enhance the waste segregation project.

## 12.5 Methods to Deliver Message

A message is delivered with combining plural media such as news paper, radio program, TV program, news letter, billboard, posters, book marks, stickers, brochures, and T-shirt. Media to deliver the message should be selected by finding the way of retrieving information in daily life of

each target group. The following media are combined to effectively deliver the message within the budget and project period. Presentations to each target group are beneficial way to enable two-way communication between servers and receivers of the message.

## 12.6 Time Frame

In the first three years, public education and enhancement to prioritized target groups is to be conducted mainly in Koror. In the next three years, other target groups are to be covered and the target area is to be extended to other states. While monitoring the effect of the segregation project by Koror State Government, message to each group is also to be reviewed and revised if need arises.

## 12.7 Organization

Since the following governmental organizations that were mentioned in 11.2.1 have been involved in Solid Waste Management and experienced public enhancement and education, coordination committee of these organizations is to be established to effectively implement public education and enhancement to proper target groups at proper time with proper ways as well as information sharing. Any state governments are to be eligible to participate the coordination committee if need arises.

Sir Fugi said that this section explain disadvantage of compost products, it was explained exaggeratedly. Compost technology does not use theory for explaining compost. Typical explanation of compost technology is:

Soeda;

According to Palauan comments, I modified the description of composting.

“Composting is a specialized part of recycling in which organic wastes are biologically decomposed under controlled conditions to convert them into a product that

can be applied to the land beneficially and without adverse environmental impact. The composting process should destroy pathogens, weed seeds, insect eggs, and other unwanted organism.

Adding composting can lighten heavy soils, improve the texture of light soils, and increase water retention capacity.

Composting is a natural process that has been used in an organized fashion to deal with garbage since at least early 1900s”

( Pathogen, bacterial and weed seeds can not survive more than 1 hour with high temperature such as around 60°C. In-Vessel Compost technology has keep high temperature with around 60°C during composting process-15days ).

Fugi-san wants to add topic about in-vessel after this paragraph ....

Soeda;

According to Palauan comments, I again returned the original explanation about in-vessel composting from Golder Report.

He recommended to add this:

“In-Vessel composting methods are high technology methods in which composting are conducted within a fully enclosed system.

All critical environmental conditions such as odorous, waste water, flies and vermin are mechanically controlled with this method, and, with most in-vessel system, they also are fully automated.

System of in-vessel has significant advantage in odor and vermin control as well as providing a high quality product.

So, in-vessel composting method is most effective system for our purpose such as “Waste Reduction in Koror State”, because system may treatment of all kind of organic materials for composting such as kitchen waste, yard waste, paper, cardboard and sewage sludge even animals manure, and may not enquire large space for building of facility.

→ Soeda;

KSG can adopt in-vessel composting system as most effective system according to this NSWMP as a State’s Solid Waste Management Plan. Therefore, here should not mention which options are most effective,

Disadvantage of In-vessel composting method is the high capital cost, approximately 2 time higher cost than open windrow composting method, and a higher level of process control may also be required, with an associated requirement for technically skilled operators.

Fugi-san suggested to add another row for in-vessel...

In-Vessel Composting	Yard waste	1 •Product of high quality compost	1 •Necessity technical skilled for operate, maintenance
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Fugi-san comment - (Comment)

1. Koror state has already started to construct the In-Vessel composting plant...
2. Reason for select of method!!

Our project team decided to use In-vessel composting method due to its low cost. May also enquire condition for selected method with low capital cost by senior volunteer's idea

Another reason is that, this method is suitable for Koror state for waste reduction and the implementation of the 3R, Recycle, Reduce, Reuse.

Our engineer tried his best effort to design, train staff and to manage capital cost for such project and for solution of disadvantage of such method with high capital cost and technical skill.

For example

- (1) Building of facility may be done by public work's labor without sub contractor.
- (2) Installation works of machines will be installed by public work's labor.
- (3) Automatic control panel, system and electric works which costs around \$100,000 may designed, site works and manufacture by senior volunteer, can