10. PRE-FEASIBILITY STUDY ON THE SOLID WASTE MANAGEMENT PROGRAM FOR KOROR AND BABELDAOB

10.1 Project

10.1.1 Project Description

(1) Objective

The economic growth supported by the Compact funds as well as the growth of tourism has been accompanied by the rapid increase of solid waste in Koror. The relocation of the capital to Melekeok State will require the establishment of a new solid waste management system in Babeldaob. The Solid Waste Management Program for Koror and Babeldaob (K-B SWMP) includes the program for the collection and haulage system in Koror State and Babeldaob Island and the development of a new final disposal site in Aimeliik State. The GOP has selected one site in Aimeliik State for a future final disposal site among many candidates through the former study.

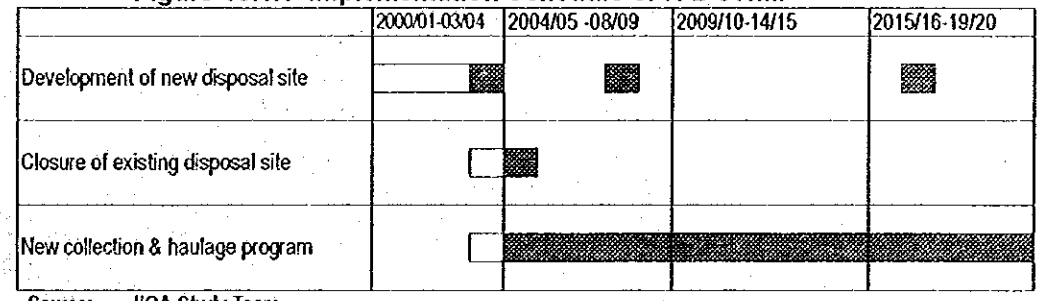
The study on the K-B SWMP is limited to the examination of the preliminary feasibility of the Solid Waste Management Program in Koror State and Babeldaob Island from the viewpoints of technical, environmental and economic aspects. It is noted that the topographic and soil survey has not been carried out at the designated disposal site in the study.

The objectives of the KB SWMP are as follows:

- To prepare a pre-feasibility study of a new final disposal site in the Aimeliik State including a closure plan of the existing disposal site near the M-Dock in Koror State; and
- To prepare a program for a new collection and haulage system in Koror State and Babeldaob Island after the utilization of a new disposal site from 2004/05 to 2019/20 and examine the pre-feasibility of the program

Figure 10.1.1 shows the implementation schedule of the K-B SWMP.

Figure 10.1.1 Implementation Schedule of K-B SWMP

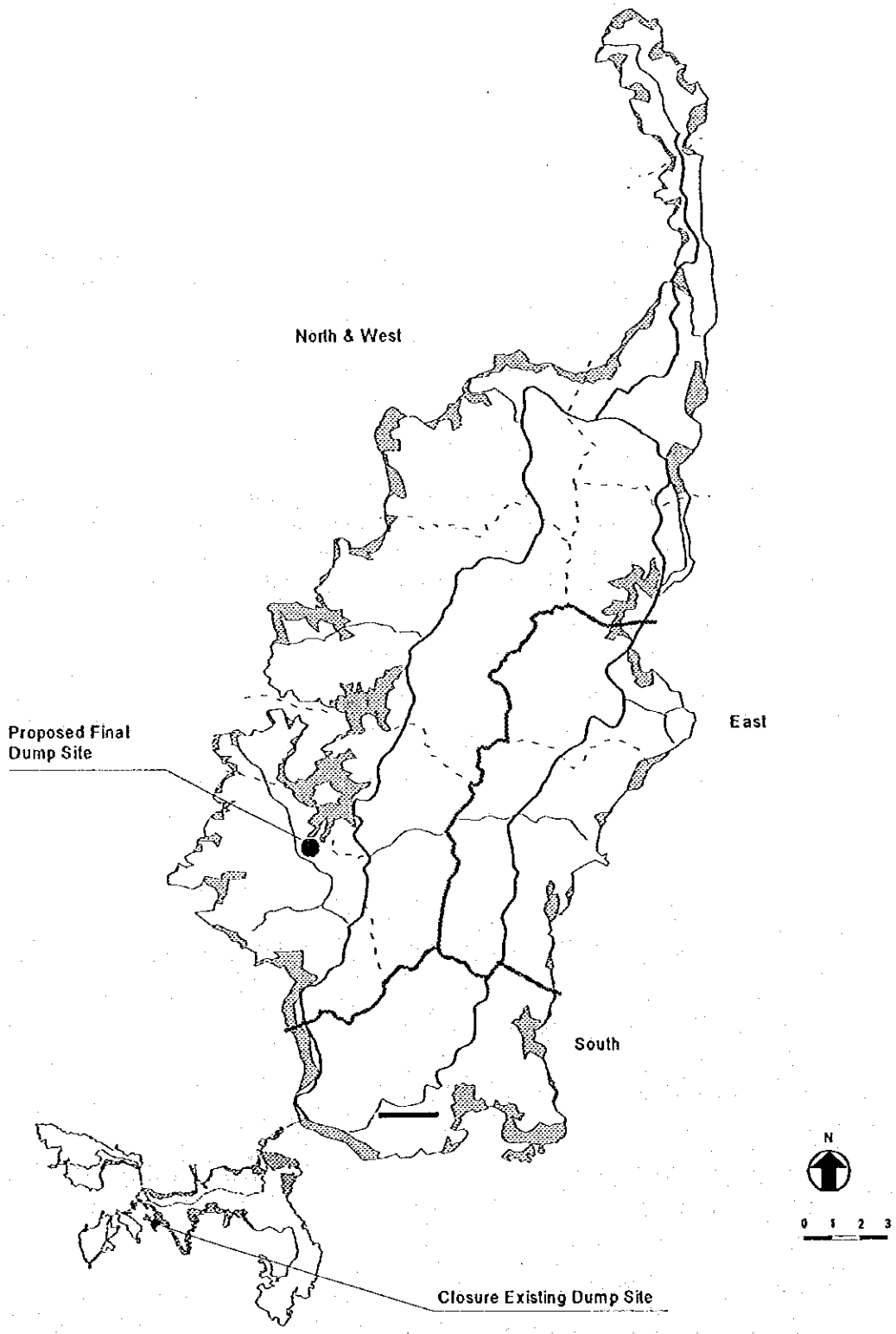


Source: JICA Study Team
Legend: Preparatory work Implementation

(2) Project area

The study area of the K-B SWMP is Koror State and Babeldaob Island including ten (10) States (Aimeliik, Airai, Melekeok, Ngaraard, Ngarchelong, Ngardmau, Ngaremlengui, Ngatpang, Ngchesar and Ngiwal) as shown in Figure 10.1.2.

Figure 10.1.2 Study Area



Source: JICA Study Team

10.1.2 Planning Issues and Framework

(1) Planning issues

Waste generation rate per person is estimated at 1.0 kg per day at present including business waste except the waste from hotels in Koror, which shows higher level of generation compared with the rate in the countries with the same income level. Furthermore, the current dumping site in Koror is almost full and needs to be closed in a few years. Under these conditions it is an urgent requirement for the GOP to formulate a new solid waste management system including collection and haulage systems and management of the new final disposal site. It is proposed that a new final disposal site be operated through sanitary landfill method in order to minimize the impact on the environment.

Institutional arrangements, such as coordination between central government and state government, and community participation are indispensable for the sound SWM. Above all, the most serious issue may be the recovery of the cost.

(2) Planning framework

The amount of future waste is estimated on the municipal waste and industrial waste based on the projections of population and number of hotel rooms in Koror State and Babeldaob Island until year 2020 as shown in Table 10.1.1.

Table 10.1.1 Population Projection of Koror State and Babeldaob Island

States		2000	2005	2010	2015	2020	Remarks
Koror	Population	14,734	15,799	14,183	13,687	13,956	Center of commercial
	Hotel Room	860	860	850	830	800	and business activities
Airai	Population	1,587	1,506	1,610	1,691	1,764	
Aimeliik	Population	365	354	361	413	426	
Ngatpang	Population	213	219	224	244	253	Tourism development
	Hotel room	0	0	20	25	30	
Ngeremlemgui	Population	240	230	235	271	279	
Ngchesar	Population	185	171	174	207	213	
Melekeok	Population	180	1,264	1,746	1,795	1,799	New capital
	Hotel room	0	0	30	30	30	
Ngardmau	Population	145	143	146	164	170	
Ngiwal	Population	141	129	132	157	162	
Ngaraard	Population	408	359	363	437	445	
Ngarchelong	Population	194	245	323	439	520	Tourism development
	Hotel room	0	30	60	90	120	
Total	Population	18,392	20,419	19,497	19,505	19,987	
	Hotel room	860	890	960	975	890	

Source: JICA Study Team

(3) Waste generation rate

Future waste generation rate of municipal waste is set based on the Integrated Solid Waste Management Plan conducted by the Bureau of Public Works, the Republic of Palau, in June 1999.

In the states of Koror and Airai, the rate of municipal waste generation is estimated at 1.0 kg/person/day during the project period, including 40% of industrial waste, which is generated from restaurants, markets, factories, offices etc.

In Melekeok State, where a new capital construction project is now underway, the waste generation rate is currently as small as that in other states in Babeldaob Island (0.5 kg/person/day). However, after the relocation of the capital, waste generation rate will become twice (1.0 kg/person/day) showing the same level as that in Koror and Airai because of a rapid growth of population and industries.

In other eight states in Babeldaob Island, the waste generation rate per household is estimated to remain at the same level as present (0.5 kg/person/day).

Regarding the waste generation of hotel, it is estimated at 2.6 kg/room/day on average.

Table 10.1.2 Future Waste Generation Rate

	States	Rate	Remark
Municipal Waste	Koror & Airai	1.0kg/person/day	Including 40% of waste generated by other industries
	Melekeok	0.5-1.0kg/person/day	Including 40% of waste generated by other industries
	Aimeliik, Ngatpang, Ngaremlengui Ngchesar, Ngardmau, Ngiwal Ngaraard, Ngarchelong	0.5kg/person/day	-
Hotel	-	2.6kg/room/day	-

Source: JICA Study team

10.2 Project Component

The K-B SWMP consists of the following components:

- Collection and haulage program in Koror and Babeldaob; and
- Development of a new disposal site including the closure plan of existing disposal site.

10.2.1 Collection and Haulage

(1) Waste generation amount

The combined volume of waste generated daily in Koror State and the 10 states in Babeldaob Island in 2005 is estimated at 21.81ton/day (43.63 m^3/day), as shown in Table 10.2.1.

Koror will still generate a huge amount of waste at 18.04 tons/day (36.06 m^3/day) in 2005. Out of this amount, 15.80 tons/day (31.60 m^3/day) will be generated by households and industrial and commercial enterprises such as restaurants, markets, shops, offices and factories. On the other hand, hotels will generate 2.24 tons/day (4.48 m^3/day).

In Babeldaob Island, the 10states will generate an estimated 3.77 tons/day (7.54 m^3/day) of waste.

Table 10.2.1 Daily Generation Amount of Waste in 2005

State	Category	Amount		Remarks
		ton/day	Equivalent m³/day	
Koror	Municipal Waste	15.80	31.60	Including 40% of Business waste
	Industrial Waste (Hotel)	2.24	4.48	
	Koror Total	18.04	36.08	
Airai	Municipal Waste	1.51	3.02	Including 40% of Business waste
Aimeliik	Municipal Waste	0.18	0.36	
Ngatpan	Municipal Waste	0.11	0.22	
Ngeremlemgui	Municipal Waste	0.12	0.24	
Ngchesar	Municipal Waste	0.09	0.18	
Melekeok	Municipal Waste	1.26	2.52	Including 40% of Business waste
Ngiwal	Municipal Waste	0.06	0.12	
Ngardmau	Municipal Waste	0.07	0.14	
Ngaraad	Municipal Waste	0.18	0.36	
Ngarchelong	Municipal Waste	0.12	0.24	
	Industrial Waste (Hotel)	0.08	0.16	
Babeldaob Total		3.77	7.54	
Total		21.81	43.62	

Source: JICA Study Team
Note: * Volume of waste=weight of waste/0.5ton/m³

(2) Waste service area

The proposed service area after 2005 is divided into the following four areas:

- Koror State
- South Babeldaob: Airai
- North and West Babeldaob: Aimeliik, Ngatpang, Ngeremlemrui, Ngiwal, Ngardmau, Ngaraad and Ngarchlong
- East Babeldaob: Ngchesar and Melekeok

Koror State should be one service area. On the other hand, in order to collect effectively and to minimize the number of vehicles and employees, the service area in Babeldaob Island should be divided into three areas, taking into consideration the location of the ten states and the volume of their wastes.

(3) Volume of waste collected and hauled by the public sector

Waste is categorized into two types such as municipal waste and industrial waste, which are based on waste generators. The collection and haulage of municipal waste is a responsibility of state government as one of the municipal services. On the other hand, industrial waste is the responsibility (collection and haulage management) of the generator or polluter.

However, waste generated by residents in the urban area, such as those in the states of Koror, Airai and Melekeok, consists of 60% of residential waste from households and 40% of business waste from industrial and commercial establishments. In the K-B SWMP, it is estimated that 50% of business waste is collected and hauled by the public sector and the remaining 50% of business waste is categorized as industrial waste and collected by the private sector in Koror State. On the other hand, business waste in Airai and Melekeok should be collected together with residential waste by the public sector considering the efficiency of collection. Figure 10.2.1 shows the collection and haulage system of waste in Koror and Babeldaob by sector.

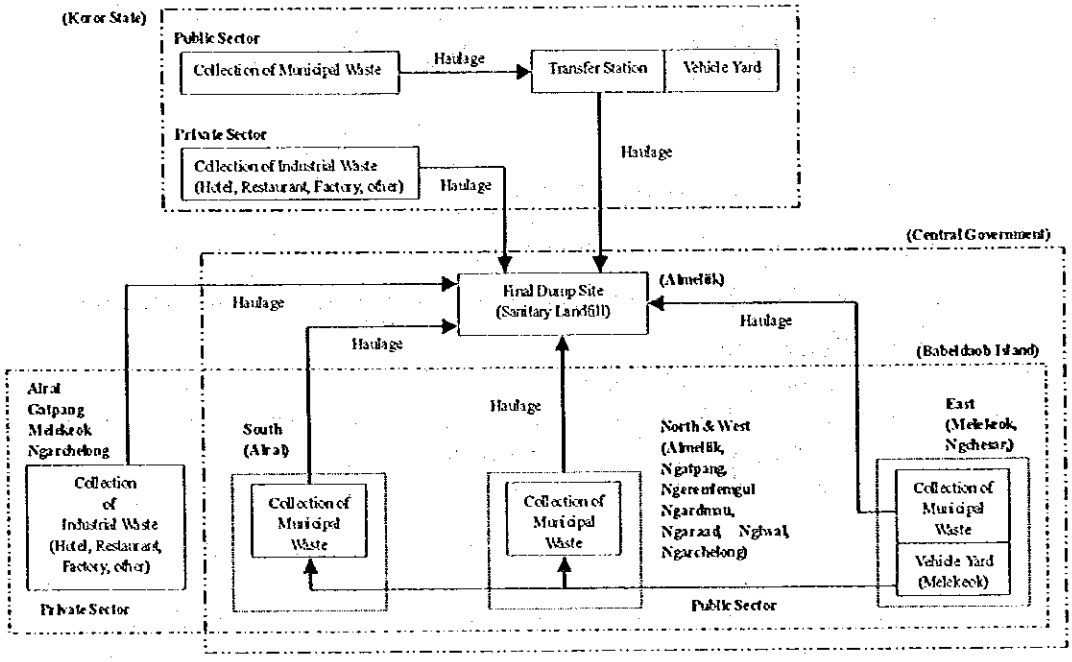
Residential waste generation will amount to 19.0 m^3/day in Koror State in 2005. However, 20% of this waste (3.8m^3/day) will remain uncollected because of the difficulties of access to the location of households due to the narrow width of road.

Therefore, total waste of 21.5 m^3/day will be managed by the public sector including 15.2 m^3 of residential waste and 6.3 m^3 of business waste. Figure 10.2.2 shows daily waste flow from generation to final dumping in the Koror State in 2005.

Total volume of waste managed by the public sector in Babeldaob will be 7.57 m^3/day in 2005. Out of that, 3.01m^3, 1.68m^3 and 2.88 m^3 per day will be managed in the three areas of South, North & west and East, respectively.

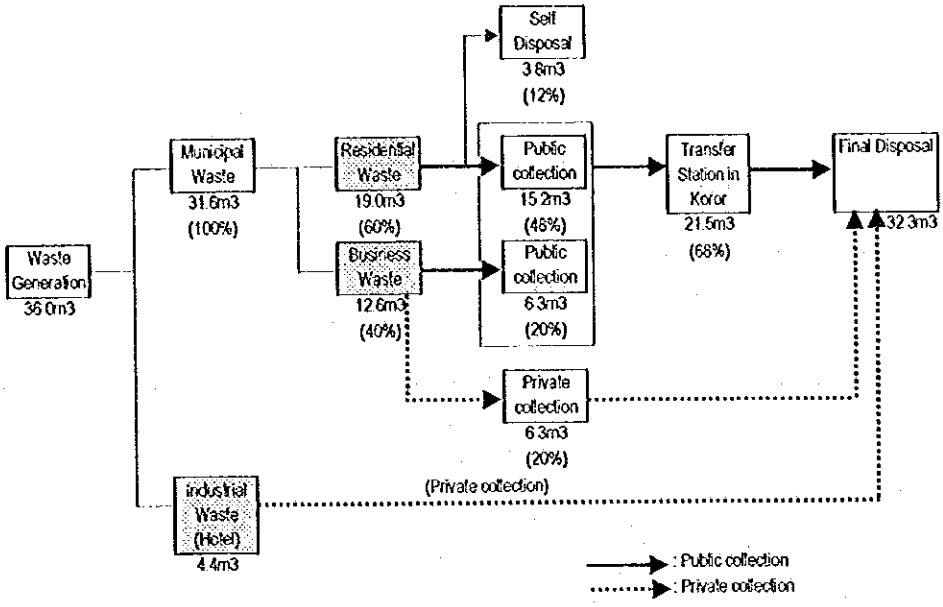
Table 10.2.2 shows daily collection and haulage volume by both public and private sectors for the four service areas.

Figure 10.2.1 Collection and Haulage System of Waste in Koror and Babeldaob



Source: JICA Study Team

Figure 10.2.2 Daily Waste Flow in Koror State in 2000



Source: JICA Study Team

Table 10.2.2 Daily Collection and Haulage Volume by Public and Private Sector

(Unit: m³/day)

Area	Kind of waste		Generation	Collection & haulage		Remarks
				Public	Private	
Koror State	Municipal waste	Residential	18.96	15.17		Collection coverage: 80%
		Business	12.64	6.32	6.32	
		Sub-total	31.60	21.49	6.32	
	Industrial (Hotel)		4.48		4.48	
	Total		36.08	21.49	10.80	
Babeldaob						
South			3.01	3.01		Airai
North & West	Municipal waste		1.68	1.68		Airnelilk 0.36 m³ Ngatpang 0.22 m³ Ngeremlemgui 0.24 m³ Ngiwa 0.12 m³ Ngardmau 0.14 m³ Ngaraad 0.36 m³ Ngarchlong 0.24 m³
East			2.88	2.88		Ngchesar 0.18 m³ Melekeok 2.70 m³
		Sub-total	7.57	7.57		
	Industrial (Hotel)		0.16		0.16	
	Total		7.73	7.57	0.16	

Source: JICA Study Team
Note: The apparent specific gravity of the incoming waste is 0.5 ton/m³.

(4) Number of customers served by public SWM service

In 2005, there are going to be 3,160 households in Koror State, of which 2,530 or 80% of total households will be provided public SWM service. On the other hand, a half number of industrial and commercial establishments, roughly about 300 establishments, will receive public SWM service and private collectors will serve others. In Koror, therefore, the public sector will render collection services to 2,830 households and business establishments in 2005.

Table 10.2.3 Coverage of Solid Waste Collection by the Public Sector in 2005 (Koror State)

Area	Category	Population	No. of Households	No. of Business Establishments	Collection Coverage (%)	No. of Customers Served
Koror	Residents	15,799	3,160*		80	2,530
	Business			600**	50***	300
Total						2,830

Source: JICA Study Team
Note: * Five persons per household
** Number of establishments is assumed from the number of businesses registered with the Tax and Revenue Office and information by the Public Works Office of Koror State.
*** 50% will be collected by private collectors.

Public sector will collect waste generated by households and business establishments in three areas in Babeldaob. Number of customers at the South, North & West, and East area is estimated at 332, 346, and 317, respectively.

Table 10.2.4 Coverage of Solid Waste Collection by the Public Sector in 2005 (Babeldaob)

Area	Category	Population	No. of households*	No. of business establishments	Collection coverage (%)	No. of customers served
South	Residents	1,506	302		100	302
	Business			30	100	30
North & West	Residents	1,679	336		100	336
	Business			10		10
East	Residents	1,435	287		100	287
	Business			30	100	30

Source: JICA Study Team
Note: * five persons in one household

(5) Number of collection vehicles needed

Number of collection vehicles needed is calculated under the following assumptions:

- Service day: 6 days in one week;
- Working hours: 8 hours per day (7:30am to 11:30am, and 12:30pm to 16:30pm);
- Number of households covered by collection service in one day: 120 households per vehicle;
- Collection frequency is twice a week;
- Collection area in Koror: Koror service area is divided into three (3) collection areas; and
- Capacity of collection vehicle: 4 m^3 (2ton) per vehicle.

As shown in Table 10.2.5, number of vehicles needed for waste collection in Koror and Babeldaob is 8 and 3 respectively.

Table 10.2.5 Number of Collection Vehicles

Service area	No. of Customers Served		Collection Frequency	Unit****	No. of Vehicles	Remarks
Koror	2,680	943	Twice a week*	120	8 (7.86)	8x4 m^3=32 m^3>21.49 m^3
		943	Twice a week**	120	8 (7.86)	8x4 m^3=32 m^3>21.49 m^3
		944	Twice a week***	120	8 (7.87)	8x4 m^3=32 m^3>21.49 m^3
Babeldaob						
South		332	Twice a week*	120	3 (2.77)	3x4 m^3=12 m^3>9.03 m^3
North & West		346	Twice a week**	120	3 (2.88)	3x4 m^3=12 m^3>5.04 m^3
East		317	Twice a week***	120	3 (2.64)	3x4 m^3=12 m^3>8.10 m^3

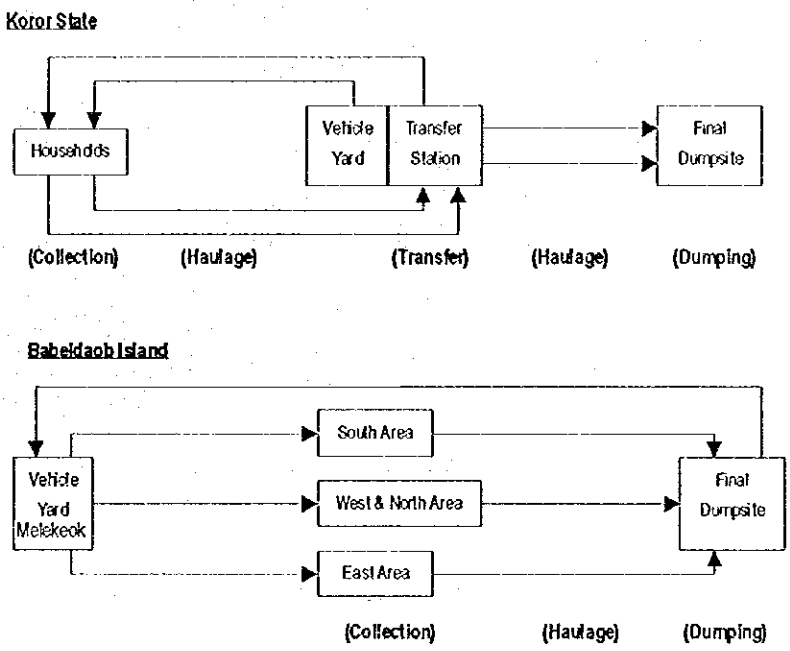
Source: JICA Study Team
Note: * Monday and Thursday
** Tuesday and Friday
***Wednesday and Saturday
**** Number of households/vehicle/day

(6) Transfer station

Transfer station is a place where solid wastes are brought by smaller refuse collection vehicles and transferred to larger trucks to be hauled to a final disposal site. A new disposal site is located 20km away from the center of Koror State. It is effective and economically efficient to develop a transfer station at a logistically appropriate place in Koror State in order to transfer waste from collection vehicles to container trucks.

As shown in Table 10.2.2, a volume of 21.49m^3 of waste will be collected and brought daily to a transfer station in 2005. It is assumed that collection vehicles will bring and transfer the waste to a container truck twice a day. Therefore, a container with a capacity of 15m^3 will be required.

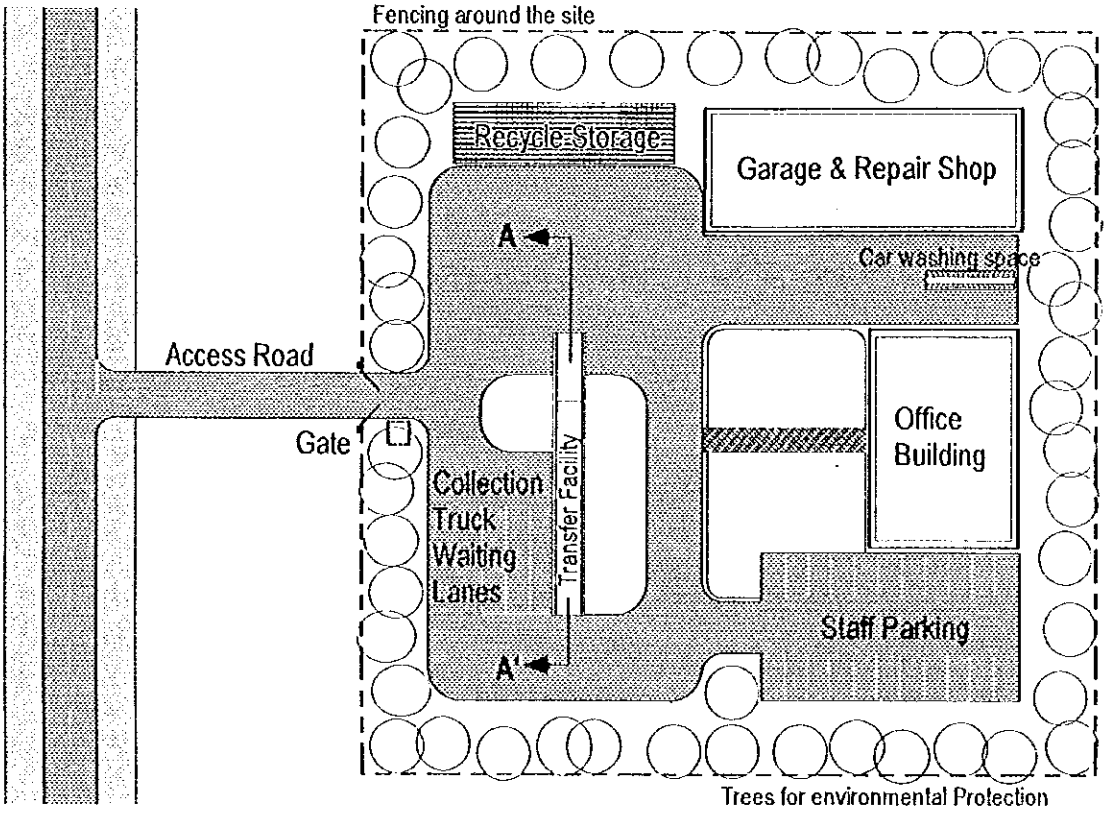
Figure 10.2.3 Transfer System in Koror and Babeldaob



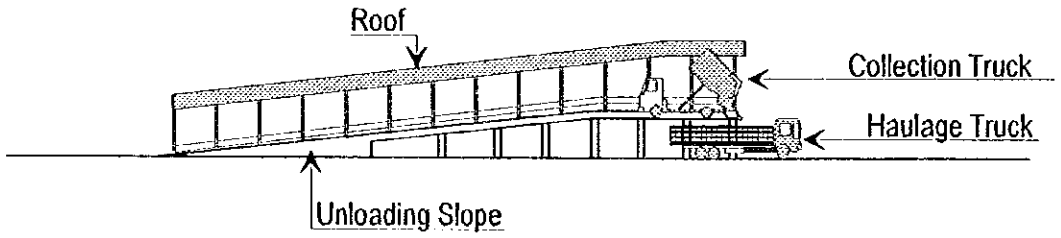
Source: JICA Study Team

In addition, part of the Public Works Office of Koror State in Malakal should be moved to the transfer station. Figure 10.2.4 shows a facility layout plan of transfer station and transfer system proposed in Koror State.

Figure 10.2.4 Layout Plan of Transfer Station In Koror



Facility Layout Plan of Transfer Station



Cross Section of Transfer Facility (Section A - A')

(7) Types and number of vehicles needed for collection/haulage

Types and number of vehicles needed by the public sector for collection and haulage by area are shown in Table 10.2.6.

Table 10.2.6 Types and Number of Vehicles Needed for Collection/Haulage

	Vehicle Type	Number	Use method
Babeldaob Island	Compactor (4 m³)	4	Collection and Haulage (Include 1 standby)
	Truck (4 m³)	1	Street Sweeping & other
Koror State	Compactor (4 m³)	9	Collection (Include 1 standby)
	Truck (8 m³)	2	Street Sweeping & other
	Container (15 m³)	2	Haulage (Include 1 standby)

Source: JICA Study Team

10.2.2 Final Disposal site

(1) Main facilities

The new final disposal site should have enough capacity to handle incoming waste from Koror and Babeldaob for a long period. Furthermore, it should be properly maintained in order to keep the surrounding area environmentally sound.

The final disposal site should be constructed with the following main facilities:

- Access road from existing road the site;
- Main dike;
- Surface water drainage system;
- Groundwater discharge system;
- Leachate collection system and leachate treatment facility;
- Weighbridge;
- Management and maintenance building; and
- Fence (Perimeter of a site).

A weighbridge is provided for the following reasons:

- To record the amount of waste, to estimate the future waste demand based on the records and to prepare a proper plan for the operation and maintenance of the disposal site; and
- To impose tipping fees based on the weight of waste measured.

(2) Operation and maintenance of the new final disposal site

Basic volume

Daily incoming and disposal waste volume to the final site is 39.82m³/day and 24.89 m³/day in 2005, respectively. Necessary volume of daily covering soil is 3.73 m³/day.

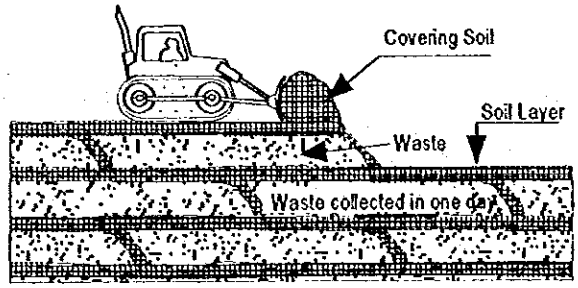
Basic volume of operation and maintenance works for sanitary landfill in 2005 is shown in Table 10.2.7 and daily operation and maintenance work is illustrated in Figure 10.2.5.

Table 10.2.7 Basic Daily Volume of Operation and Maintenance Works in 2005

Item	Unit	Volume	Remark
Daily Incoming Solid Waste amount *	Ton	19.91	
Daily Incoming Solid Waste Volume	m³	39.82	0.5ton/ m³ of *
Daily Disposal Solid Waste Volume**	m³	24.89	0.8ton/ m³ of *
Daily Covering Soil	m³	3.73	15% of **
Soil excavated per day	m³	3.73	

Source: JICA Study Team

Figure 10.2.5 Daily Operation and Maintenance Work for Sanitary Landfill



Source: JICA Study Team

Number and type of vehicles needed

To spread, crush and compact waste discharged is very important to operate a disposal site for a long period. Daily soil covering is necessary to prevent breeding of vermin, and the scattering of waste and odor.

Number and type of vehicles needed for daily work at the final disposal site are shown in Table 10.2.8.

Table 10.2.8 Number and Type of Vehicles Needed for Daily Work at Final Disposal Site

Work Item	Type of Vehicle	Number
1. Management Work		
- Management	4 x 4 Service Pick-Up	1
2. Landfill Work		
- Spread	Crawler Tractor with dozer blade (15 t class)	1
- Crush/Compaction	Steel Wheel Compactor (15 t class)	1
- Water Spread	Water Tank Truck (3m³ class)	1
3. Soil Cover Work		
- Excavation	Power Shovel (0.2 m³ bucket)	1
- Haulage	Dump Truck (4t, 2 m³)	1
- Spread/Compaction	Crawler Tractor with dozer blade (15 t class)	1
4. Maintenance Work		
- Haulage	Truck (1ton class)	1
- Maintenance	Power Shovel (0.2m³ bucket)	1

Source: JICA Study Team

(3) Construction of new final disposal site

Estimated total amount of waste disposed and capacity of disposal site required

Total amount of waste that will be disposed to the final disposal site for 16 years (from 2005 to 2020), is estimated at 147,000 m^3. The required capacity of the final disposal site is 169,000 m^3, including disposed waste and covering soil as shown in Table 10.2.9.

Table 10.2.9 Estimated Total Volume of Waste (2005-2020)

Item	Unit	Volume	Remark
Total Waste generated *1	ton	117,600	Total of 16 years
Total Waste incoming	m^3	235,200	Waste $1m^3$=0.5ton (*/0.5)
Total Waste disposed *2	m^3	147,000	Disposed or compacted waste $1m^3$=0.8ton (*/0.8)
Total covering soil required *3	m^3	22,000	15% of **
Total Capacity of Disposal site	m^3	169,000	**+***

Source: JICA Study Team

Capacity of final disposal site

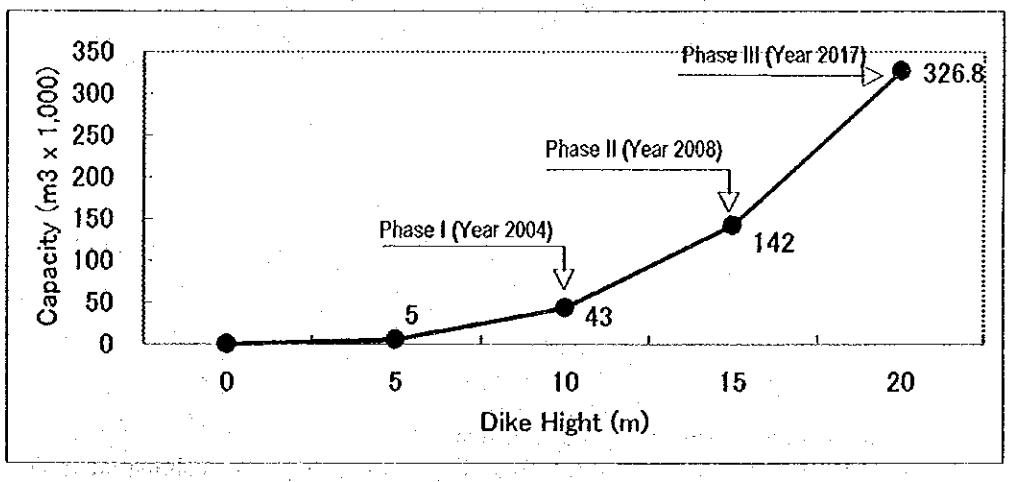
Capacity of the final disposal site at Aimeliik State is shown in Table 10.2.10. A dike is constructed by three phases to secure enough capacity. As the third dike (Phase III) is completed in 2017, the final disposal site will have a capacity of about 327,000 m^3, and will have the life span to be operated for about 30 years. The phased development of the disposal site is illustrated in Figures 10.2.6, 10.2.7 and 10.2.8.

Table 10.2.10 Capacity of Final Disposal Site (2005-2034)

Item	Unit	Phase I (H=10m)			Phase II (H=5m)		Phase III (H=5m)	
Above sea level	m	5	10	15	15	20	20	25
Height	m	0	5	10	0	5	0	5
Area	m^2	0	2,000	13,200	10,600	29,000	24,800	49,100
Volume	m^3		5,000	38,000		99,000		184,750
Accumulated Volume	m^3		5,000	43,000		142,000		326,750
Year of Construction		Year 2004			Year 2008		Year 2017	

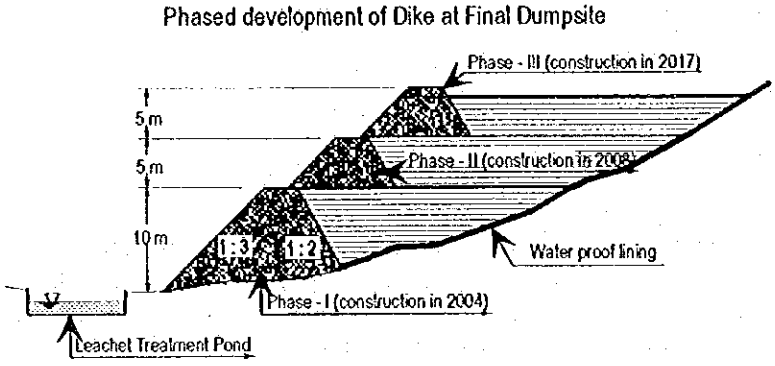
Source: JICA Study Team

Figure 10.2.6 Graph of Capacity of Final Disposal Site



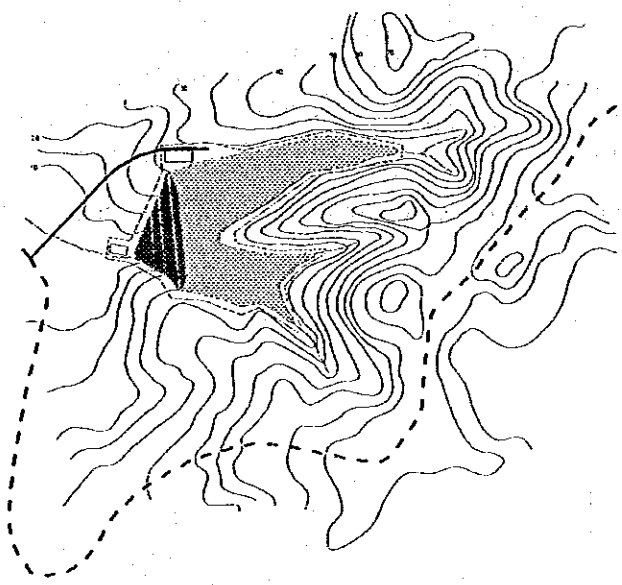
Source: JICA Study Team

Figure 10.2.7 Phased Development of Dike (Cross Section)



Source: JICA Study Team

Figure 10.2.8 Phased Development of Final Disposal site (Layout)



Source: JICA Study Team

Construction volume of final disposal site

Construction volume of the new final disposal site by phase is shown in Table 10.2.11.

Table 10.2.11 Estimated Construction Volume of Final Disposal site

Work Item	Unit	Phase			Remarks
		I	II	III	
Earth Works					
Clearing & Grubbing	ha	7.0	2.0	3.0	
Excavation	m^3	5,000	9,000	13,000	
Embankment	m^3	5,000	9,000	13,000	Dike (H=10m and 5m)
Earth Lining	m^2	14,000	20,000	20,000	
Slope Protection	m^2	3,000	3,000	3,500	Slope of dike (grass)
Access Road	m	300			Asphalt pavement, W=5.5m (18feet)
Rainwater Drainage System	m	700	1,200	1,400	Open ditch
Groundwater Discharge System	m	500	300	100	Pipe (average diameter 20cm)
Leachate Treatment Plant	sum	1			Pond
Leachate Collection System	m	500	300	300	Pipe (average diameter 15cm)
Gas Extraction System	sum	1	1	1	
Building	m^2	500			Administration building, Storage and Workshop, Scale house, Gatehouse
Utilities	sum	1			Water Supply, Sewerage, Electricity
Weighbridge	item	1			
Truck Wash	item	1			
Fencing	m	2,000			Surrounding

Source: JICA Study Team

10.2.3 Closure of the Existing Disposal site in Koror

The closure plan and design of the existing disposal site has been prepared by a foreign consulting firm and approved by the Government of Palau (GOP). The closure work of the existing disposal site must be implemented very carefully so as not to affect the environment of the surrounding area.

The new final disposal site in Aimeliik State is expected to start operation in 2005 after the completion of the Compact Road. Therefore, the closure work of the existing disposal site should be started in 2005, the year when the new disposal site will be utilized.

The study proposed the development of a marine center on the location of the closed disposal site. However, from an environmental standpoint, it will take about five years for landfill gases and land subsidence to settle and for the quality of leachate to reach the standard level, and only after this is accomplished could the land be converted to a tourism development area. Precise consideration is described in the "IEE," which is found in Section 10.7.

10.3 Waste Reduction

10.3.1 Pollution Risks

From the pollution control aspect, the present solid waste management in Palau is not appropriate and insufficient. The present disposal site is almost full and it is improperly managed. For example, it is reported that used lead and alkaline batteries are scattered along the near shore of the site. As mentioned before, the present waste generation rate is estimated at 1.0 kg per person per day in Koror, which is a rate higher than that in countries of the same income level. Also, inorganic wastes, such as plastic bottles and bags, have been increasing in recent years in Palau. Most of the dumping sites in rural states are located near swamp or mangrove areas, where garbage remains unmanaged. Furthermore, there is illegal dumping of waste, which may include toxic materials, observed on land as well as in sea.

None of the toxic substances near the existing disposal site in Koror exceeds the environmental standards in Palau, according to a risk assessment in 1997. However, it is not enough to confirm the environmental conditions related to wastes. Considering the present situations of waste management, high pollution risks, such as water contamination as well as soil contamination, should be urgently mitigated through appropriate waste management program especially for reduction of wastes.

10.3.2 Waste Reduction Possibilities in Palau

Table 10.3.1 shows waste composition by weight of the existing disposal site in Koror. Comparing with the waste composition of other countries in the South Pacific Region, Koror and Fiji in Suva have very high ratios of paper and cardboard, which reflects consumer patterns similar to those in western developed countries..

Table 10.3.1 Waste Composition by Weight of the Existing Disposal site in Koror

Category	Ratio of Waste Stream (%)	Daily Weight (ton)	Annual Weight (ton)
Paper & Cardboard	29.9	4.72	1,724
Food/Kitchen Waste	7.8	1.23	449
Garden	17.4	2.75	1,004
Other Organic	11.1	1.75	639
Glass	5.0	0.79	288
Aluminum	4.2	0.66	241
Recyclable Plastic	7.1	1.12	409
Other Plastic	8.9	1.41	515
Ferrous Substance	7.1	1.12	409
Other	1.5	0.24	87
Total	100.0	15.79	5,765

Source: Golder Associates Pty. Ltd., 1999

In general, waste reduction could be achieved through the 3 R's: reduce, reuse, and recycle. In the case of recycling in Palau, recyclable materials must be shipped off the island for recycling, because all of the above recyclable materials are too small in quantity for creating a domestic market. Table 10.3.2 shows the possibility of materials for reuse or recycling in Palau based on the present economic viability, mainly due to marketability and shipping cost.

Table 10.3.2 Possibility of Reusing or Recycling Materials in Palau

Materials	Reuse	Recycle
Aluminum cans	Few viable	Most viable
Plastic bottle	Few viable	Not viable
Glass bottle	Few viable	Not viable
Scrap metals	Few viable	Not viable
High grade paper	Few viable	Viable
Cardboard	Viable	Viable
Auto batteries	Not viable	Not viable
Old tires	Viable for another use	Not viable

Source: JICA Study Team

The reuse of materials holds very dim prospects in Palau. There is no actual mechanism to undertake this type of activity. However, as there is scarcity of cardboard in Palau, it seems to be the only material with the possibility for reuse at present.

A couple of the most difficult barriers to recycling are market prices and volumes for recyclable materials. Prices are impossible to control. In Palau, the volumes of the recyclable materials are very small and the materials need to be stored for a long time. The shipping cost from Palau is approximately $750-$900 per container, according to a recycling company. As the shipping costs are based on volume, higher density materials such as compressed cans, metals and paper have lower shipping costs per ton.

Aluminum cans are the most economically viable for recycling in Palau. However, it should be kept in mind that Palau has very limited reused and recyclable materials, while the materials are increasing in Palau.

Table 10.3.3 shows expected waste reduction of possible recyclable and reuse materials.

Table 10.3.3 Expected Waste Reduction of Possible Recyclable and Reuse Materials

Materials	Expected Reduction Ratio for Daily Total Waste Generation (%)	Expected Weight Reduction (ton/day)
Aluminum	2	0.44
Cardboard	5	1.09
Total	-	1.53

Source: JICA Study Team

The above estimations are based on a daily total generation amount of waste in 2005 (21.81 ton/day), which was described in Section 10.2.1. In terms of the expected reduction ratio, the ratio is estimated based on the data of Table 10.3.1 and interviews to a recycling company and a cardboard collector.

Assuming that a reduction of 1.53 tons/day of waste is obtained, total volume reduction, which consists of waste volume and cover soil volume, will be approximately 2.19 m^3. It is estimated that the reduction of annual average landfill volume will be approximately 10,450 m^3, which consists of 9,650 m^3 (waste volume) and 800 m^3 (cover soil volume).

It is concluded that the new final disposal site should have a capacity of approximately 169,000 m^3 for a 16-year (2005 to 2020) life span. The reduction of waste explained earlier will give the disposal site an extension of approximately 1.3 years. Considering this scenario, the total life of the final disposal site will be approximately 17.3 years.

10.3.3 Waste Reduction through Cooperation and Participation of Residents

The implementation of a solid waste management program relies strongly on the cooperation and the participation of residents. The generators of the wastes are the residents themselves and the volumes and the types of wastes generated depend on the people. Considering the serious budget deficits of the ROP, the waste reduction must be implemented at first through voluntary participation in order to reduce the burden to the GOP. Although Palau will need to introduce a user charge system as an effective policy

for waste reduction, the system will cause strong opposition from the residents or users.

It is recommended that the residents should participate in the following actions in order to contribute to the waste reduction with little assistance from the Government. These activities depend fully on voluntary participation, but they could be facilitated through development of the people's awareness to the importance of waste reduction.

(1) Recommended actions and measures

Participation with waste segregation

Households could carry out waste segregation of recyclable materials for recycling. This would make the collection of recyclable materials, such as cans, more effective, and more importantly, eliminate segregation costs to Koror State. The segregated wastes could be collected on a designated day, say, once a week.

Waste segregation should become a regular part of the residents' daily activities. According to the residents themselves, they understood the need for such concrete action, which would allow them to contribute to the reduction of waste. However, GOP has not initiated any concrete action, even though EQPB and other agencies have disseminated the importance of waste reduction through posters, signboards and other forms of media.

Recycling by individual participation

At present, some individuals in Palau carry out recycling activities on their own. They bring aluminum cans to a scrap metal company in Malakal and are paid a small amount for their effort. Although the present participants are limited, this mechanism could be utilized and expanded in Palau.

To serve as The government should not change the basic mechanism of recycling activities and recycling business in Palau. They should promote this activity by just providing a space within the transfer station to serve as temporary storage for recyclable materials.

10.3.4 Present Government Actions and Recommended Policies for Waste Reduction

At present, EQPB conduct the following environmental education campaign related to waste management.

- Signs and posters with simple environmental awareness messages
- Community education meeting in rural areas
- Aluminum collection in cooperation with school students (4 times/year)
- Experimental compost plant pilot program funded by SPREP
- Clean-up campaign of car batteries and aluminum cans (2 times /year)

EQPB should focus these above-mentioned campaign activities on the following objectives in order to support practical actions by the people. These campaigns should be continued with involvement of community leaders as well as several agencies and NGOs.

- Promote voluntary waste segregation and recycling;
- Facilitate anti-littering and anti-illegal dumping; and
- Enlighten the people's awareness of waste reduction for a healthy environment and the promotion of nature-based tourism development.

On the other hand, it is imperative to introduce the Polluter-Pays-Principle (PPP), such as garbage fee, in Palau in order to promote effective waste reduction as well as to reduce the burden to the ROP.

The introduction of PPP should be linked with the above campaign. If the people will realize the importance and practical actions for waste reduction through the campaign, gaining public acceptance for the introduction of PPP will be enhanced. The residents

could save money, if they could achieve the waste reduction by themselves.

Based on this recognition, the following should be introduced by strong government leadership based on the acceptance of the people.

(1) Recommended policies

- Introduction of garbage fee on residential waste
- Modification of existing garbage fee on industrial and commercial waste aiming full cost recovery

These garbage fees are main policies and may be effective for waste reduction. On the other hand, introduction of garbage fee sometimes causes the illegal dumping of wastes on roadside, on public spaces, such as park, or in the sea. Introduction of fine for illegal dumping should be considered.

Introduction of deposit-refund scheme
Although there are many economically unviable recyclable materials in Palau, plastic bottle is the most difficult to recycle mainly due to higher shipping costs. Plastic bottles are also drastically increasing in Palau. Deposit-refund schemes will work reasonably well for the reduction of the use in case of beverage containers including aluminum cans and plastic bottles.

Introduction of environmental cleanup tax
The ROP proposes and legislates an environmental cleanup tax in order to generate special governmental revenue for environmental improvement through taxation for any non-biodegradable beverage containers (Appendix 1 shows the details of the environmental cleanup tax).

It proposed legislation would require the assessment of $0.05 tax per any non-biodegradable container imported into Palau. The tax is to be collected at gateway of Palau, such as commercial port, before releasing the merchandise to the importer. The collected revenue is to be placed in a special account, which shall be called the "Environmental Cleanup Fund Account."

It is estimated that approximately $400,000 per year could be collected by the tax, if the legislation enacted and the collection process are implemented without any interference.

10.3.5 Waste Reduction through Commercial Sector Participation

The commercial sector, such as hotels, is also main waste generators in Palau. The waste generation rate is estimated at 2.6kg per room per day. Although each waste generator of commercial sector should cover the costs from their activities, there is still a need to promote waste reduction effort with little governmental assistance. Therefore, it is recommended that the GOP develop an award or certification program for enterprises that achieved waste reduction.

Considering the tendency of Palauans, many enterprises, such as hotels and restaurants, will promote waste reduction in order to get an award or certification from EQPB. Many certifications and awards are observed in restaurants and hotels in Palau. These are believed to enhance the marketability of their products and services.

10.4 Implementing Organization

10.4.1 Organization

At present, Koror State is responsible for the collection and haulage of municipal waste to the disposal site, while the Bureau of Public Works in the GOP is the one that operates and maintains the disposal site in Koror State. Ten states in Babeldaob collect and haul waste to their own disposal sites, which they themselves operate and maintain. However, operation at each of the disposal site is poor.

Two big projects are now implemented in Babeldaob Island. Construction of Compact Road has already started and its completion is expected by the end of 2003. Construction of the New Capital in Melekeok State has also started. These projects are expected to contribute to the future regional development of the area. It will also cause a relocation of inhabitants and industries from Koror.

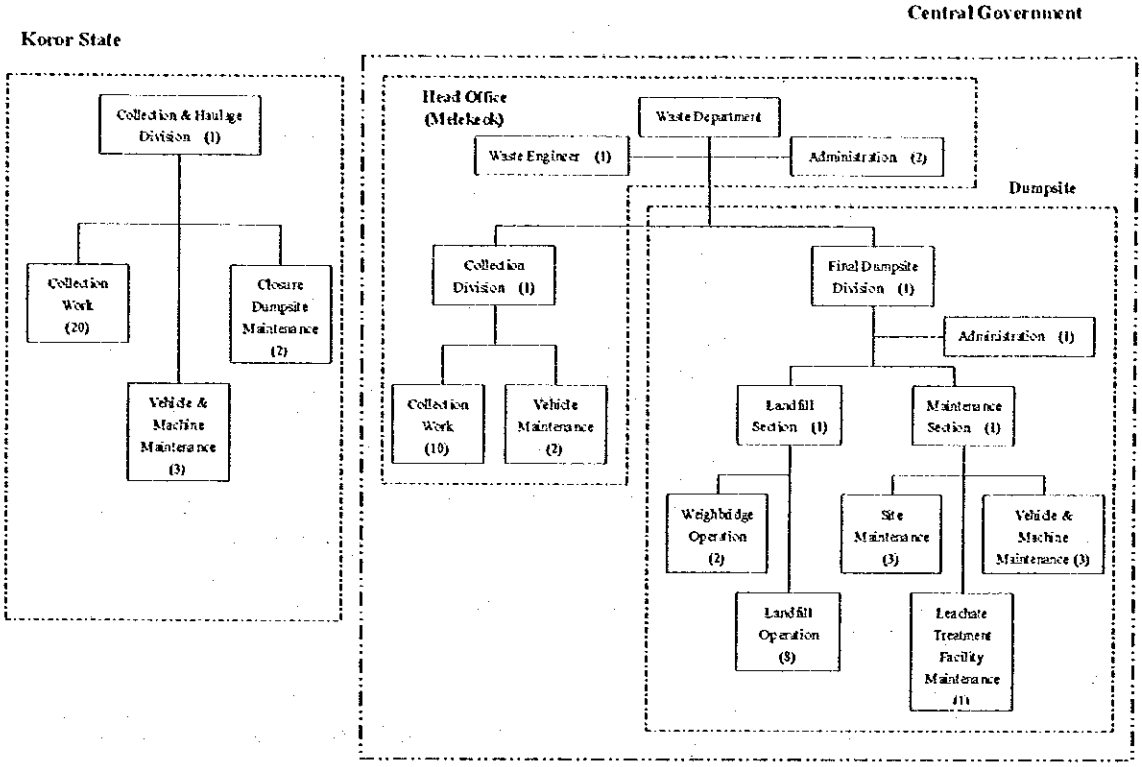
The GOP is planning to construct a new final disposal site in the Aimeliik State. This new facility should accept waste not only from Koror State but also from the ten states in Babeldaob Island. In order to operate and maintain a new final disposal site in environmentally sound condition as well as to collect and haul waste effectively, reorganization for a new waste management is required.

Figure 10.4.1 shows a new organization recommended for the management of the K-B SWMP. Amount of waste generated in each state in Babeldaob Island will remain small even in the future. It is wasteful and uneconomical to provide vehicles, employees and a disposal site in each state. The central government should, therefore, be responsible for collection and haulage of municipal waste generated in the ten states of Babeldaob. It is proposed that a new organization be established to operate and maintain a new final disposal site and that this organization should also be responsible for the management of collection and haulage in Babeldaob.

On the other hand, Koror State, which will remain a big waste generator even in the future, should be a responsible for the collection and haulage of municipal waste generated within the State.

Business establishments and industries should be responsible for the collection and haulage of waste generated by them.

Figure 10.4.1 Recommended New Organization for Waste Management



Source: JICA Study Team

10.4.2 Employees and Workers

(1) Central Government

To properly manage the disposal site, the Central Government would have to assign to the new organization a total of 38 employees and workers to handle daily collection and haulage services in Babeldaob.

Table 10.4.1 Number of Employees and Workers (Central Government)

Items	Employee/Worker	Head	Remarks
Head Office	Department Manager	1	
	Waste Engineer	1	
	Secretary/Administrator	2	Administration
	Sub-total	4	
Collection & Haulage	Division Manager	1	
	Driver	4	3 Compactors and 1 Truck
	Waste Collector	6	3 Compactors x 2 Collectors
	Maintenance Worker	2	Vehicle & Machine
	Sub-total	13	
Final Disposal site	Division Manager	1	
	Administrator	1	
	Landfill Manager	1	
	Weighbridge Operator	2	
	Foreman	1	
	Driver (Landfill Work)	5	Special Vehicle
	Driver (Truck)	2	Water Spread and Soil Haulage
	Maintenance Manager	1	Engineer
	Maintenance Worker	3	Vehicle & Machine
	Maintenance Worker	1	Leachate Treatment Facility
	General Worker	3	Site Maintenance
	Sub-total	21	
Total		38	

Source: JICA Study Team

(2) Koror State

Koror State will need 32 employees and workers for collection and haulage of waste as shown in Table 10.4.2.

Table 10.4.2 Number of Employees and Workers (Koror State)

Item	Employee/Worker	Head	Remark
Collection & Haulage	Division Manager	1	
	Driver	10	8 Compactors, 1 Container and 1 Truck
	Waste Collector	16	8 Containers x 2 Collectors
	Maintenance Worker	3	Vehicle & Machine
	General Worker	2	
Total		32	

Source: JICA Study Team

10.5 Development Costs

Development cost of the K-B SWMP is estimated under the following assumptions:

- Cost is estimated using the prices as of June 2000 and inflation is not taken into account.
- Land cost is not included in the estimates.
- The following exchange rate as of June 30, 2000 is used: $1.00=Japanese Yen 105.00,
- Physical contingency is estimated at 5-15% of the total cost based on the kind of project components.
- Average life span of the facilities is assumed as follows: Final disposal site 30 years, Transfer station 25 years, Vehicle 8years

10.5.1 Initial Investment Cost

(1) Construction cost of new final disposal site

Construction cost for the final disposal site is shown in Table 10.5.1 (Phase I), 10.5.2 (Phase II) and 10.5.3 (Phase III).

Table 10.5.1 Cost Estimate for Final Disposal Site (Phase I)

Work Item	Unit	Quantity	Unit cost ($)	Cost ($ thosand)	Remarks
Design & Survey					
Design	sum	1		500	
Topographic Survey	sum	1		100	
Soil Survey	sum	1		150	
Total*				750	
Construction					
Mobilization and Site Preparation	sum	1	10,000	10	
Earth Works				1,765	
Clearing & Grubbing	ha	7	20,000	140	
Excavation	m^3	5,000	25	125	
Embankment	m^3	5,000	20	100	
Earth Lining	m^2	14,000	100	1400	
Slope Protection	m^2	3,000	10	30	
Access Road	m	300	2,000	600	W=8m
Rainwater Drainage System	m	700	50	35	
Groundwater Discharge System	m	500	250	125	
Leachate Treatment Plant	sum	1	500,000	500	
Leachate Collection System	m	500	150	75	
Gas Extraction System	sum	1	30,000	30	
Building	m^2	500	500	250	
Utilities	sum	1	30,000	30	
Weighbridge	sum	1	200,000	200	
Truck Wash	sum	1	10,000	10	
Fencing	m	2,000	50	100	
Sub-total**				3,760	
Engineering Service (5% of sub-total**)				188	
Contingency (15% of sub-total 1)				564	
Sub-total***				752	
Total**** (Sub total** + Sub-total***)				4,512	
Environmental Impact Assessment					
Environmental Impact Appraisal (Total*****)	sum	1	8,000	8	EQPB
Grand total (Total* + Total**** + Total*****)				5,270	

Source: JICA Study Team

Table 10.5.2 Cost Estimate for Final Disposal Site (Phase II)

Work Item	Unit	Quantity	Unit Cost ($)	Cost (1,000$)
Construction				
Earth Works				2,045
Clearing & Grubbing	ha	2	20,000	40
Excavation	m^3	9,000	25	225
Embankment	m^3	9,000	20	180
Earth Lining	m^2	20,000	80	1600
Slope Protection	m^2	3,000	10	30
Rainwater Drainage System	m	1,200	50	60
Groundwater Discharge System	m	300	250	75
Leachate Collection System	m	300	150	45
Gas Extraction System	sum	1	30,000	30
Sub-total				2,285
Contingency (10% of sub-total)				229
Grand total				2,514

Source: JICA Study Team

Table 10.5.3 Cost Estimate for Final Disposal Site (Phase III)

Work Item	Unit	Quantity	Unit Cost ($)	Cost ($ thousand)
Construction				
Earth Works				2,245
Clearing & Grubbing	ha	3	20,000	60
Excavation	m^3	13,000	25	325
Embankment	m^3	13,000	20	260
Earth Lining	m^2	20,000	80	1600
Slope Protection	m^2	3,500	10	35
Rainwater Drainage System	m	1,400	50	70
Groundwater Discharge System	m	100	250	25
Leachate Collection System	m	300	150	45
Gas Extraction System	sum	1	30,000	30
Sub-total				2,450
Contingency (10% of Sub-total)				245
Grand total				2,695

Source: JICA Study Team

(2) Construction of transfer station

Construction cost for the transfer station is estimated and shown in Table 10.5.4.

Table 10.5.4 Cost Estimate for a Transfer Station

Work Item	Unit	Quantity	Unit Cost ($)	Cost ($ thousand)
Design & Survey				
Design	sum	1	200	200
Topographic Survey	sum	1	50	50
Soil Survey	sum	1	50	50
Total*				300
Construction				
Mobilization and Site Preparation	sum	1	10,000	10
Earth Works				470
Clearing & Grubbing	ha	1	20,000	20
Excavation	m^3	10,000	25	250
Piling	m^3	10,000	20	200
Access Road	m	200	2,000	400
Rainwater Drainage System	m	1,000	50	50
Building	m^2	500	500	250
Transfer Facility	sum	1	100,000	100
Utilities	sum	1	30,000	30
Truck Wash	sum	1	10,000	10
Vegetation	m^2	2,000	50	100
Fencing	m	400	50	20
Sub-total**				1,430
Engineering Service (5% of Sub-total**)				72
Contingency (10% of Sub-total**)				143
Sub-total***				215
Total**** (Total of Construction Cost)				1,645
Environmental Impact Assessment				
Environmental Impact Appraisal (Total*****)	sum	1	3,000	3
Grand total (Total* + Total**** +Total*****)				1,948

Source: JICA Study Team

(3) Closure of existing disposal site in Koror

Cost for closure of the existing disposal site in Koror State is shown in Table 10.5.5.

Table 10.5.5 Cost Estimate for Closure of Existing Disposal site in Koror

Work Items	Units	Quantity	Unit Cost ($)	Cost ($ thousand)	Remarks
Construction					
Mobilization and Site Preparation	sum	1	10,000	10	
Clear and Grub	sum	1	5,000	5	
Clean-up	sum	1	1,000	1	
Submittals	sum	1	1,000	1	
Excavate and Move Waste from Strip	m^3	9,100	8.9	81	
Place, Grade, and Compact Waste	m^3	9,100	2.9	26	
Supply and Haul Select Fill	m^3	31,350	11.0	345	
Place, Compact and Grade Select Fill	m^3	31,350	9.6	301	
Waste Oil Pit Remediation	m^3	550	13.7	8	
Relocation Scrap Metal on Site	m^3	730	7.4	5	
Supply and Haul Coral	m^3	5,470	23.3	127	
Place, Compact and Grade Foundation Layer	m^3	5,470	6.9	38	
Install Gas Venting System (4" PVC Piping)	m	1,440	16.7	24	
Supply and Haul Gas Venting Layer (Sand)	m^3	7,290	27.4	200	
Place and Grade Gas Venting Layer	m^3	7,290	4.1	30	
Supply Geomembrane	m^2	441,450	0.3	115	
Install Geomembrane	m^2	441,450	0.1	53	
Supply and Haul Vegetative Layer (Topsoil)	m^3	18,950	11.0	208	
Place, Compact and Grade Vegetative Layer	m^3	18,950	4.1	78	
Revegetation and Erosion Control	m^2	32,370	0.3	8	
Cut and Grade Surface Water Ditches	m	810	2.2	2	
Supply and Haul Rock Armoring for Ditches	m^3	220	38.4	8	
Place Rock Armoring	m^3	220	6.9	2	
Install Filter Fences	m	3,330	5.6	19	
Supply and Haul Riprap for Shoreline	m^3	180	44.0	8	
Install Riprap Along Shoreline	m^3	180	25.2	5	
Sub-total 1				1,707	
Contingency (5% of Sub-total)				85	
Construction Management (2.7% of sub-total)				46	
Sub-total 2				131	
Total 1 (Sub-total 1 + Sub-total 2)				1,838	
Environmental Impact Assessment					
Environmental Impact Appraisal (Total 2)	sum	1	3,000	3	EQPB
Grand Total (Total 1 + Total 2)				1,841	

Source: Final Closure and Post-closure Maintenance Plan

(4) Cost for purchasing vehicles

Cost for purchasing vehicles needed for collection and haulage of waste and for operation of the final disposal site is shown in Table 10.5.6 (Central Government) and 10.5.7 (Koror State).

Table 10.5.6 Cost for Purchasing Vehicles (Central Government)

Work Item	Type of Vehicle	Quantity	Unit Price ($)	Price ($1,000)	Remark
Collection & Haulage	Compactor (4m³)	4	33,000	132	All the vehicles are used of 4 to 5 years.
	Truck (4 m³)	1	15,000	15	
	Sub-total*			147	
Final Disposal site	Service Pick-up	1	10,000	10	
	Crawler Tractor (15t)	2	150,000	300	
	Steel Wheel Compactor (15t)	1	150,000	150	
	Power Shovel	2	50,000	100	
	Water Tank Truck (3m³)	1	25,000	25	
	Dump Truck (4t, 2m³)	1	30,000	30	
	Truck (1t)	1	10,000	10	
	Sub-total**			625	
Total (Sub-total* + Sub-total**)				772	
Spear Parts (total* x 15%)				116	
Total				888	

Source: JICA Study Team

Table 10.5.7 Cost for Purchasing Vehicles (Koror State)

Work Item	Type of Vehicle	Quantity	Unit Price ($)	Price ($ thousand)	Remarks
Collection & Haulage	Compactor (4m³)	9	33,000	297	All the vehicles are used of 4 to 5 years.
	Truck (8 m³)	2	20,000	40	
	Container Truck (15 m³)	2	35,000	70	
Sub-total				407	
Spear Parts (Sub-total x 15%)				61	
Total				468	

Source: JICA Study Team

10.5.2 Annual Operation and Maintenance Cost

Annual operation and maintenance cost for collection and haulage of waste, landfill at the final disposal site, and closure of the existing disposal site in the Koror State is shown in Tables 10.5.8, 10.5.9, 10.5.10 and 10.5.11, respectively.

Table 10.5.8 Annual Operation and Maintenance Cost of Collection and Haulage (Central Government)

Work Items	Employee	Head	Unit Cost ($)	Cost ($)	Remarks
Head Office	Department Manager	1	22,000	22,000	
	Waste Engineer	1	25,000	25,000	
	Secretary/Administrator	2	9,000	18,000	
Collection & Haulage	Division Manager	1	15,000	15,000	
	Driver	4	9,000	36,000	
	Waste Collector	6	5,000	30,000	
	Maintenance Worker	2	11,000	22,000	Vehicle & Machine
Sub-total		17		168,000	
Miscellaneous				67,200	40% of sub-total
Fuel				70,000	
Grand Total				305,200	

Source: JICA Study Team

Table 10.5.9 Annual Operation and Maintenance Cost of Collection and Haulage (Koror State)

Items	Employee	Head	Unit Cost ($)	Cost ($)	Remarks
Collection & Haulage	Division Manager	1	15,000	15,000	
	Driver	10	9,000	90,000	
	Waste Collector	16	5,000	80,000	
	Maintenance Worker	3	11,000	33,000	Vehicle & Machine
Sub-total		24		218,000	
Miscellaneous				87,200	40% of sub-total
Fuel				30,000	
Grand Total				335,200	

Source: JICA Study Team

Table 10.5.10 Annual Operation and Maintenance Cost of Land Fill at New Final Disposal Site

Items	Employee	Head	Unit Cost ($)	Cost ($)	Remarks
Final Disposal site	Division Manager	1	15,000	15,000	
	Administrator	1	9,000	9,000	
	Landfill Manager	1	15,000	15,000	
	Weighbridge Operator	2	9,000	18,000	
	Foreman	1	13,000	13,000	
	Driver (Landfill Work)	5	11,000	55,000	
	Driver (Truck)	2	9,000	18,000	
	Maintenance Manager	1	15,000	15,000	Engineer
	Maintenance Worker	3	11,000	33,000	Vehicle & Machine
	Maintenance Worker	1	8,000	8,000	Leachate
	General Worker	3	5,000	15,000	Site Maintenance
Sub-total		21		214,000	
Miscellaneous				85,600	40% of sub-total
Fuel				70,000	
Grand Total				369,600	

Source: JICA Study Team

Table 10.5.11 Annual Operation and Maintenance Cost of the Closure of Existing Disposal Site

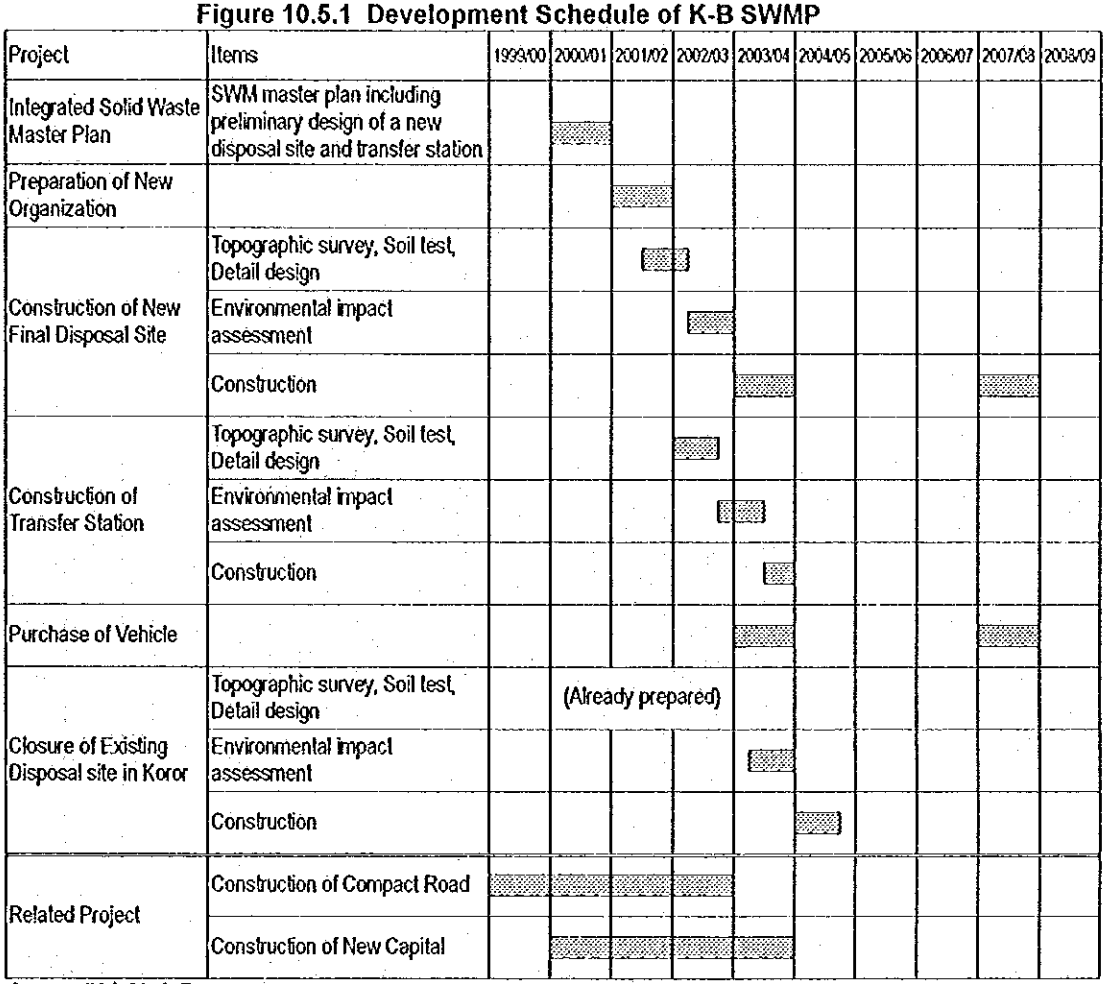
Items	Employee	Head	Unit Cost ($)	Cost ($)	Remarks
Maintenance	General Worker	2	5,000	10,000	
Contingency				2,000	20% of sub-total
Grand Total				12,000	

Source: JICA Study Team

10.5.3 Development Schedule

Figure 10.5.1 shows the development schedule of the K-B SWMP for the mid-term period.

Figure 10.5.1 Development Schedule of K-B SWMP



Source: JICA Study Team

Based on the development schedule and the cost estimates, the investment schedule is prepared in Figure 10.5.2 and summarized in Table 10.5.12 at constant 2000 prices. The total capital investment cost is estimated at $17.5 million for the project period from 2000/01 to 2019/20, of which $13.4 million is the cost allocated for the mid-term period from 2000/01 to 2008/09. From 2009/10 to 2019/20, an additional capital investment amounting to $4.1 million is required for the costs of Phase III development of the disposal site and replacement of vehicles. Total O/M cost aggregates $ 16.5 million up to 2019/20.

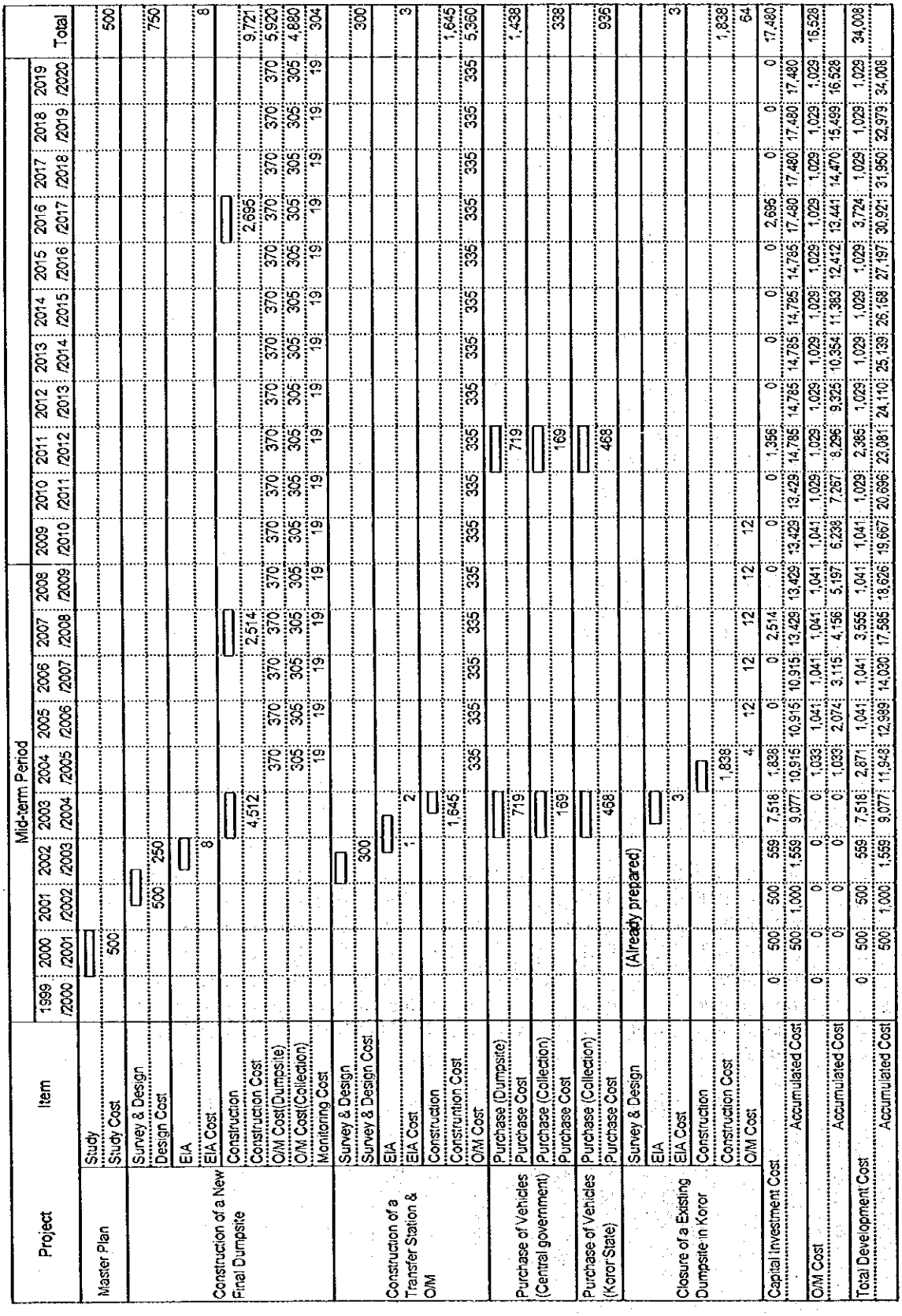
Table 10.5.12 Total Initial Investment Cost of K-B SWMP

(Unit: $ million)

	Mid-term Period (2000/01-08/09)	Long-term Period (2009/10-19/20)	Total
Investment cost	13.4	4.1	17.5
O/M cost	5.2	11.3	16.5
Total cost	18.6	15.4	34.0

Source: JICA Study Team

Figure 10.5.2 Investment Schedule of K-B SWMP



Project	Item	Mid-term Period																				Total
		1999 /2000	2000 /2001	2001 /2002	2002 /2003	2003 /2004	2004 /2005	2005 /2006	2006 /2007	2007 /2008	2008 /2009	2009 /2010	2010 /2011	2011 /2012	2012 /2013	2013 /2014	2014 /2015	2015 /2016	2016 /2017	2017 /2018	2018 /2019	2019 /2020	
Master Plan	Study																					
	Study Cost		500																			500
Construction of a New Final Dumpsite	Survey & Design																					
	Design Cost			500	250																	750
	EIA																					
	EIA Cost				8																	8
	Construction																					
	Construction Cost					4,512				2,514								2,696				9,721
	O/M Cost(Dumpsite)						370	370	370	370	370	370	370	370	370	370	370	370	370	370	370	5,920
	O/M Cost(Collection)						305	305	305	305	305	305	305	305	305	305	305	305	305	305	305	4,880
	Monitoring Cost						19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	304
Construction of a Transfer Station & O/M	Survey & Design																					
	Survey & Design Cost				300																	300
	EIA																					
	EIA Cost				1	2																3
	Construction																					
	Construction Cost					1,645																1,645
	O/M Cost						335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	5,360
Purchase of Vehicles (Central government)	Purchase (Dumpsite)																					
	Purchase Cost					719							719									1,438
	Purchase (Collection)																					
	Purchase Cost					169							169									338
Purchase of Vehicles (Koror State)	Purchase (Collection)																					
	Purchase Cost					468							468									936
Closure of a Existing Dumpsite in Koror	Survey & Design				(Already prepared)																	
	EIA																					
	EIA Cost					3																3
	Construction																					
	Construction Cost						1,838															1,838
	O/M Cost						4	12	12	12	12	12										64
Capital Investment Cost		0	500	500	559	7,518	1,838	0	0	2,514	0	0	1,356	0	0	0	0	2,696	0	0	0	17,480
	Accumulated Cost		500	1,000	1,559	9,077	10,915	10,915	10,915	13,429	13,429	13,429	14,785	14,785	14,785	14,785	14,785	17,480	17,480	17,480	17,480	
O/M Cost		0	0	0	0	1,033	1,041	1,041	1,041	1,041	1,041	1,041	1,029	1,029	1,029	1,029	1,029	1,029	1,029	1,029	1,029	16,528
	Accumulated Cost		0	0	0	1,033	2,074	3,115	4,156	5,197	6,238	7,267	8,296	9,325	10,354	11,383	12,412	13,441	14,470	15,499	16,528	
Total Development Cost		0	500	500	559	7,518	2,871	1,041	1,041	3,555	1,041	1,041	2,385	1,029	1,029	1,029	1,029	3,724	1,029	1,029	1,029	34,008
	Accumulated Cost		500	1,000	1,559	9,077	11,948	12,989	14,030	17,585	18,626	19,667	20,696	23,081	24,110	25,139	26,168	27,197	30,921	31,950	32,979	34,008

10.6 Financial and Economic Evaluation

10.6.1 Public Investment Requirement

Total cost of the K-B SWMP amounts to $34.0 million at constant prices in 2000. Based on the proposed implementing organization, $28.5 million is allocated to the central government. Out of that amount, $20.6 million is for the development of the final disposal site including the closure cost of the existing disposal site, and $5.2 million is for the collection and haulage services in Babeldaob Island. Remaining $8.2 million is allocated to Koror State for the collection haulage services within the state.

Table 10.6.1 Total Cost of K-B SWMP by Implementing Body (at 2000 Price)

(Unit: $ thousand)

Cost items	Mid-term period (2000/01-08/09)	Long-term period (2009/10-19/20)	Total cost (2000/01-19/20)	Implementing body		
				Central government		State government (Koror State)
				Final disposal site	Collection & haulage in Babeldaob*	
Master plan study	500	0	500	500		
Closure of existing disposal site	1,906	15	1,921	1,921		
Capital cost						
New final disposal site	7,784	2,695	10,479	10,479		
Purchase of vehicles (Disposal site)	719	719	1,438	1,438		
Transfer station in Koror	1,948	0	1,948			1,948
Purchase of vehicles (Koror)	468	468	936			936
Purchase of vehicles (Babeldaob)	169	169	338		338	
Sub-total of capital cost	11,088	4,051	15,139	11,917	338	2,884
O/M cost (2004/05 - 2019/20)**						
New final disposal site	1,945	4,279	6,224	6,224		
Collection & haulage in Koror	1,675	3,685	5,360			5,360
Collection & haulage in Babeldaob	1,525	3,355	4,880		4,880	
Sub-total of O/M cost	5,145	11,319	16,464	6,224	4,880	5,360
Grand total	18,626	15,382	34,008	20,546 60%	5,218 15%	8,244 25%

Source: JICA Study Team
Note: * Collection & haulage service in Babeldaob is provided by Central government.
** O/M cost includes the cost of new disposal site and collection and haulage cost after the operation of new disposal site in 2005, while collection and haulage cost from 2001 to 2004 is not included.

10.6.2 Unit Cost

(1) Amount of waste

Amount of waste, which is collected and disposed of at the final disposal site through public and private collections, aggregates 117,600 tons over the period from 2005 to 2020.

Table 10.6.2 Total Amount of Waste Collected and Disposed (2005-2020)

(Unit: ton)

	Koror State	Babeldaob	Total
Municipal waste collected by public collection	60,700	25,700	86,400
Industrial waste collected by private collector	29,400	1,800	31,200
Total waste disposed at final disposal site	90,100	27,500	117,600

Source: JICA Study Team

(2) Cost for the project period

The life span of the project components of the K-B SWMP is assumed as follows:

- New final disposal site is designed to manage the waste demand of 30 years;
- Life span of transfer station in Koror is assumed to be 25 years with proper maintenance; and

- As the life span of vehicle is assumed to be 8 years, replacement cost is allocated in 2012.

Based on the above, the residual value of capital is estimated for each facility. Total residual value is calculated to be $5.6 million in 2020. Assuming the residual value as an inverse cost in 2020, the corresponding cost of the K-B SWMP for the project period is estimated at $28.4 million as shown in Table 10.6.3 at 2000 prices.

(3) Unit cost of K-B SWMP

The average cost of final disposal is calculated to be $113 per ton at constant 2000 prices, of which $48, $12 and $53 are expenditure for infrastructure development, purchase of vehicle and O/M cost, respectively. It is noted that opportunity cost of capital is not taken into account in the calculation.

As shown in Table 10.6.3 and Figure 10.6.1, $237 per ton is required for the SWM in Koror. Out of that, $113 and $124 are expenditure for final disposal and collection and haulage, respectively. On the other hand, $316 per ton is required in Babeldaob, which is higher by 33% compared with the cost in Koror. The collection and haulage is very costly in Babeldaob, because the households are scattered over the Island except in Airai State, and the collection works is sometimes inefficient.

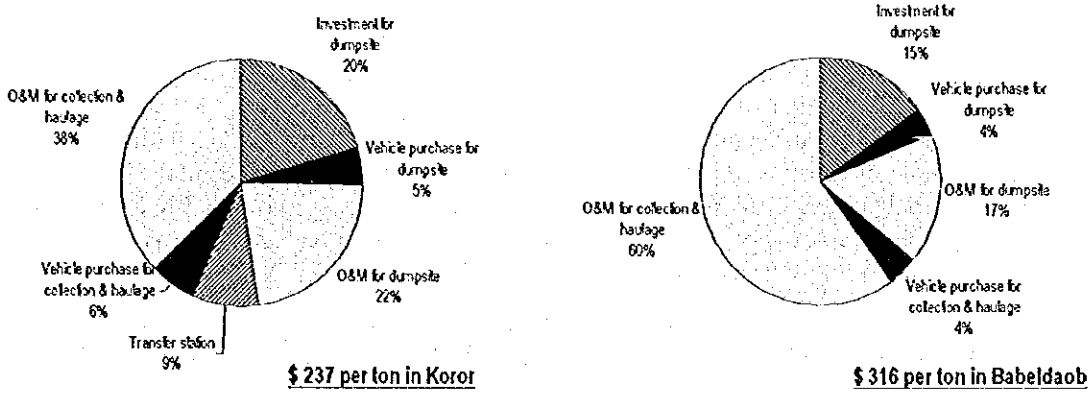
It also reveals that the SWM is recurrent cost-intensive. Out of $237, for example in Koror, 60% is allocated to O/M costs for final disposal site and collection and haulage. In Babeldaob, 77% of total cost is used for O/M for collection and haulage and disposal site. Thus, there is a continuous need for financing sources to meet the substantial costs for operation and maintenance of the disposal site.

Table 10.6.3 Unit SWM Cost (at 2000 Price)

	Development cost ($ thousand)	Residual value of capital in 2020 ($ thousand)	Cost for the waste management 2005-2020 ($ thousand)	Waste demand 2005-2020 (ton)	Cost per ton for the waste 2005-2020 ($ per ton)
Final Disposal site				117,600	
Infrastructure development	10,479	4,890	5,589		48
Purchase of vehicles	1,438	0	1,438		12
O/M cost	6,224	0	6,224		53
Sub-total	18,141	4,890	13,251		113
Collection and haulage by public					
Koror				60,700	
Transfer station	1,948	701	1,247		21
Purchase of vehicles	936	0	936		15
O/M cost	5,360	0	5,360		88
Sub-total	8,244	701	7,543		124
Babeldaob				25,700	
Purchase of vehicles	338	0	338		13
O/M cost	4,880	0	4,880		190
Sub-total	5,218	0	5,218		203
Total (Koror and Babeldaob)	13,462	701	12,761	86,400	148
Others					
Master plan study	500	0	500		
Closure of existing disposal site	1,905	0	1,905		
Sub-total	2,405	0	2,405		
Grand total	34,008	5,591	28,417		

Source: JICA Study Team
Note: Waste demand of final dump includes the waste collected and dumped by private haulers.

Figure 10.6.1 Unit Waste Management Cost In Koror and in Babeldaob



Source: JICA Study Team

10.6.3 Cost Recovery

(1) Polluter-pays-principle

It is widely recognized that the introduction of the Polluter-Pays-Principle (PPP) is an urgent requirement to reduce the budget deficits of the ROP. However, there is a great deal of difficult to implement it due to public opposition. Full cost recovery of the SWM by user charge is hardly realized even in the industrial countries.

Affordability and willingness of household to pay

To implement the PPP, there is a serious argument over affordability and the willingness of households to pay the charges. In Chapter 3, the affordable level of payment for the SWM is computed at $10 per month and $20 per month for households with income of minimum wage rate and median income level in urban areas in Palau, respectively.

In spite of the results of calculation, however, even average income households hardly showed willingness to pay additional charges, because they considered that those costs should be borne by the government. The imposition of charges needs public acceptance. Strong political leadership is required to initiate special and careful provisions in order to gain acceptance. The households' willingness-to-pay will be increased by their growing awareness of the importance of environmental protection as well as the improvement of service level of SWM.

Industrial and commercial waste

On the other hand, regarding the industrial and commercial waste, it is rational that polluters are charged the full cost of SWM generated from their economic activities. Afterwards, the beneficiaries of their economic activity will have to shoulder part of the cost through a market mechanism.

(2) User charge collection

Garbage fee

An average SWM cost per household per month including final disposal and collection/haulage is calculated under the following assumptions:

- Average garbage generation of residential waste per person is 0.6 kg per day in urban area and 0.3 kg per day in rural area;
- Average number of members in a household is five (5) persons both in urban and rural areas; and

- Garbage amount per household per month therefore is estimated at 0.09 tons in urban area (0.6kg per person per day x 5 persons x 30 days), and 0.045 tons in rural area (0.3kg per person per day x 5 persons x 30 days)

Accordingly, in urban area an average SWM cost is estimated at $21.3 and $28.5 per household per month in Koror and Babeldaob, respectively, based on the unit SWM cost as shown in Table 10.6.4. If Koror State could impose the garbage fee at a rate of $21.3 per household per month, the full cost recovery can be achieved, excluding the cost for closure of existing disposal site and the opportunity cost of capital. However, an affordable level of monthly fee rate of residential waste could probably be estimated at $ 10 per household paid with minimum wage rate in the urban area such as in Koror, Airai and Melekeok State as examined in Chapter 3.

In the rural area in Babeldaob, however, the rate will be reduced to $5 per month, because the income level of those states is less than half as that in urban area and waste amount generated per household is also just half.

Thus, the cost of K-B SWMP for residential waste cannot be fully recovered by user charges. Furthermore, even the cost for collection and haulage cannot be recovered.

Table 10.6.4 SWM Cost per Ton and per Household per Month

	Cost per ton ($ per ton)*		Cost per household per month ($)		
			Urban area		Rural area
	Koror	Babeldaob	Koror	Babeldaob	
Final Disposal Site					
Capital investment cost	60	60	5.4	5.4	2.7
O/M cost	53	53	4.8	4.8	2.4
Sub-total	113	113	10.2	10.2	5.1
Collection and haulage					
Capital investment cost	36	13	3.2	1.2	0.6
O/M cost	88	190	7.9	17.1	8.6
Sub-total	124	203	11.1	18.3	9.1
Total cost					
	237	316	21.3	28.5	14.2

Source: Study Team
Note: * Refer to Table 10.6.3

Industrial and commercial waste is currently collected both by private collection and by public collection in Koror. Koror State imposes $10 per month on the wastes from hotels, motels and restaurants. However, only about 40 firms use the services currently, while others carry and dump their garbage in the final disposal site by themselves or throw it in with residential waste collected by the state.

From the viewpoint of full cost recovery of industrial and commercial waste, Koror State should impose a garbage fee at the rate of $237 per ton on every industrial and commercial waste. The charge for industrial and commercial enterprises should be principally collected based on actual quantity and type of waste collected and frequency of collection. However, it is not effective, because of the difficulty and large cost to measure the amount of waste. It is realistic to collect the fee on the basis of area, number of employees, gross revenue of enterprises and/or volume of water consumption.

The administration cost of billing and collecting fees is costly. Moreover, separate collection of garbage fee is difficult to do. It will be more effective to add SWM fees to the existing bills, such as water service bills and electricity bills, business license fees or the Gross Revenue Tax.

Tipping fee at Disposal Site

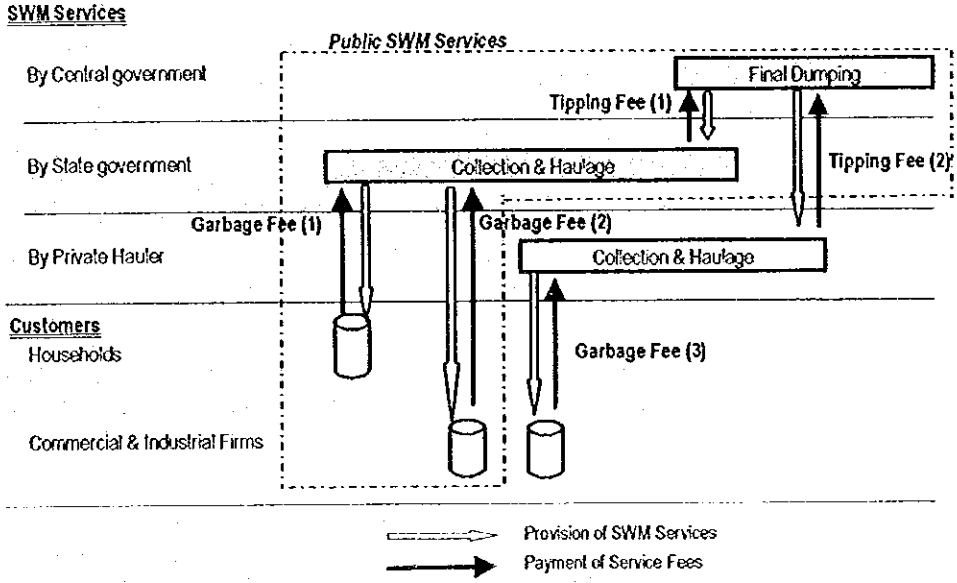
The cost of final disposal service can be recovered through tipping fees. At the gate of the

disposal site, weight of waste can be measured by the weighbridge. The rate of tipping fee should be determined so as to recover the full cost of the proposed final disposal. It is recommended that the Central government collect tipping fees from Koror State as well as from private haulers. The tipping fee rates should be the same for both public and private haulers, for the efficient management of weighing at the disposal. Rate is estimated at $113 per ton to recover the cost of disposal service. It is expected that the imposition of tipping fee will also encourage the State government to seriously consider a waste reduction program.

Burden of SWM cost in Koror

Figure 10.6.2 illustrates SWM services and proposed service fees on waste generated in Koror State. Table 10.6.5 summarizes payers, receivers of the fees and the proposed level of fee rates.

Figure 10.6.2 SWM Services and Service Fees Proposed to be Imposed in Koror



Source: JICA Study Team

Table 10.6.5 Payers, Receivers and Level of Garbage Fee Rate in Koror

Fees*	Payer of Fees	Receiver of Fees	Proposed Fee Rate Levels
Garbage Fee (1)	Households	Koror State	Within estimated affordability by households and recovery of O/M cost of collection & haulage costs, at least
Garbage Fee (2)	Commercial & industrial firms	Koror State	To recover full cost of collection & haulage and final disposal costs
Garbage Fee (3)	Commercial & industrial firms	Private haulers	Determined through market mechanism
Tipping Fee (1)	Koror State	Central government	To recover full cost of final disposal costs
Tipping Fee (2)	Private haulers		

Source: JICA Study Team
Note: * Refer to Figure 10.6.2.

10.6.4 Financial Evaluation

(1) Assumptions

Financing plan of the K-B SWMP is examined under the following assumptions:

- Project period is up to 2019/20. Tipping fee and garbage fee are regarded as the revenue of the K-B SWMP from 2004/05, when the new disposal site will be

utilized.

- The cost of the K-B SWMP is primarily allocated to the implementing bodies as shown in Table 10.6.1.
- Annual inflation rate is assumed at 4% for the cost and revenue over the project period. The rates of fees, such as garbage fee and tipping fee, will correspondingly increase with the inflation rate.
- Residual value of the capital is estimated as an inverse cost in 2020 based on the life span of each facility as follows: New final disposal site 30 years, Transfer station in Koror 25 years, Vehicle 8 years.
- Residential monthly garbage fee is collected based on the following rates at constant 2000 prices: $10 per household in the urban area, $5 per household in the rural area.
- For the public collection and haulage of industrial and commercial garbage, a fee is imposed at the rate of $237 per ton at constant 2000 prices both in Koror and Babeldaob, based on the estimated unit SWM cost for the waste generated in Koror.
- Central government will impose tipping fee at the new disposal site. Tipping fee is $113 per ton at constant 2000 prices, which will recover the full cost of disposal.

In the following section, individual cash flows of implementing bodies are firstly examined and then a whole cash flow of the K-B SWMP is demonstrated and evaluated considering the above assumptions.

(2) Financial evaluation by implementing body

Koror State

As presented in Table 10.6.1, the total amount of the K-B SWMP cost for Koror State is estimated at $8.3 million for the project period at constant prices of 2000. On the other hand, the state will have revenue through garbage fees from households and commercial and industrial firms.

Table 10.6.6 shows a cash flow of the Koror State for the K-B SWMP, in terms of constant and current prices. At constant 2000 prices, the total cash outflow including the capital cost, O/M cost and payment of tipping fees to the central government for final disposal is estimated at $15.1 million. On the other hand, the total revenue from garbage fees will amount to $8.8 million during the project period under the proposed garbage fee schedule. Therefore, accumulated balance of the cash flow will be a deficit of $6.3 million.

In order to cover the deficit, there will be three kinds of potential financial sources for Koror State as follows:

- General budget revenues collected by the State;
- Additional garbage service fees from residential and commercial and industrial customers; and
- Special subsidies or grants from the central government.

Table 10.6.6 Cash Flow of Koror State of K-B SWMP

	2000/01-03/04	2004/05-08/09	2009/10-19/20	Total	2000/01-03/04	2004/05-08/09	2009/10-19/20	Total
	($ million at 2000 price)				($ million at current price)			
Cash Outflow								
Capital Investment Cost								
Transfer Station and Purchase of Vehicle	2.4		0.5	2.9	2.8		0.7	3.5
O/M Cost		1.7	3.7	5.4		2.2	6.7	8.9
Tipping Fee Payment for Final Disposal		2.2	4.6	6.8		2.9	8.5	11.4
Total Cash Outflow	2.4	3.9	8.8	15.1	2.8	5.1	15.9	23.8
Cash Inflow								
Garbage Fee Revenue Revenue								
Residential (Koror)		1.5	3.3	4.8		2.0	6.0	8.0
Commercial and Industrial		1.3	2.7	4.0		1.7	4.8	6.5
Total Fee Revenue		2.8	6.0	8.8		3.7	10.8	14.5
Balance	-2.4	-1.1	-2.8	-6.3	-2.8	-1.4	-5.1	-9.3
Subsidies								
Capital Investment Budget	1.9			1.9	2.3			2.3
Refund of Tipping Fee		1.1	2.4	3.5		1.4	4.2	5.6
Total Subsidies	1.9	1.1	2.4	5.4	2.3	1.4	4.2	7.9
Total Cash Inflow	1.9	3.9	8.4	14.2	2.3	5.1	15.0	22.4
Net Cash Flow after Refund	-0.5		-0.4	-0.9	-0.5		-0.9	-1.4
Residual Value of Capital			0.7	0.7			0.8	0.8
Deficit				-0.2				

Source: JICA Study Team

The budget revenue of Koror State was about $2 million in 1998/99 including fees, fine, etc. However, it is hardly an option of source for the cost of K-B SWMP, because it will be overburdened by the other recurrent costs of the State and the deficit of the project is a significant amount compared with the size of the budget of Koror State.

Under the current tax system in the ROP, where tax can be imposed only by the central government, the budgetary autonomy of Koror State is very limited. Even with the garbage fee collections, it is simply impossible for Koror State to increase its budget on SWM. On the other hand, the proposed level of garbage fee rate would be the maximum rate for households with minimum income level considering affordability as well as the willingness-to-pay of households, though it can be increased in the long-term period. Regarding the fee rate for industrial and commercial waste, no additional charges could be required from the firms, as it has been already assumed so as to recover the full cost.

Under the circumstances, it is required that the central government provide Koror State with the following subsidies to compensate for the state's shortage of fund:

- The capital investment costs for transfer station will be subsidized from the central government.
- The central government and Koror State will share the burden of the cost for final disposal of municipal waste generated in Koror. Therefore, the central government should subsidize the SWM cost of Koror State by refunding 50% of what the latter paid as tipping fees.

Consequently, provided Koror receive the subsidy mentioned above, the accumulated deficit of Koror State will be reduced to almost $0.9 million from $6.3 million in 2019/20 and it is almost offset, taking into account the residual value of the transfer stations.

Central Government

In the K-B SWMP the central government has the responsibility to implement the following:

- Development and O/M of the final disposal site for Koror and Babeldaob; and
- Collection and haulage services in Babeldaob.

Moreover, the central government should provide subsidies to Koror State to compensate for the state's deficiency of budget for collection and haulage services. Table 10.6.7 shows a cash flow of the central government.

Table 10.6.7 Cash Flow of Central Government of K-B SWMP

	2000/01-03/04	2004/05-08/09	2009/10-19/20	Total	2000/01-03/04	2004/05-08/09	2009/10-19/20	Total
	($ million at 2000 price)				($ million at current price)			
Cash Outflow								
Capital Investment Cost								
Final Disposal site	6.5	4.4	3.4	14.3	7.5	5.7	6.4	19.6
Collection and Haulage in Babeldaob	0.2		0.2	0.4	0.2		0.3	0.5
Sub-total	6.7	4.4	3.6	14.7	7.7	5.7	6.7	20.1
O/M Cost								
Final Disposal site		1.9	4.3	6.2		2.6	7.8	10.4
Collection and Haulage in Babeldaob		1.5	3.4	4.9		2.0	6.1	8.1
Sub-total		3.4	7.7	11.1		4.6	13.9	18.5
Subsidies to Koror State								
Investment cost of Transfer Station	1.9			1.9	2.3			2.3
Refund of Tipping Fee (50%)		1.1	2.4	3.5		1.4	4.2	5.6
Sub-total	1.9	1.1	2.4	5.4	2.3	1.4	4.2	7.9
Total Cash Outflow	8.6	8.9	13.7	31.2	10.0	11.7	24.8	46.5
Cash Inflow								
Garbage Fee Revenue								
Residential (Babeldaob)		0.5	1.2	1.7		0.6	2.2	2.8
Commercial and Industrial (Babeldaob)		0.5	1.3	1.8		0.7	2.4	3.1
Tipping Fee (Private Haulers)		1.1	2.4	3.5		1.5	4.4	5.9
Tipping Fee (Koror State)		2.2	4.6	6.8		2.9	8.5	11.4
Total Cash Inflow		4.3	9.5	13.8		5.7	17.5	23.2
Net Cash Flow	-8.6	-4.6	-4.2	-17.4	-10.0	-6.0	-7.3	-23.3
Residual Value			4.9	4.9			6.9	6.9
Deficit				-12.5				

Source: JICA Study Team

An aggregate cash outflow of the central government is estimated at $31.2 million over the project period at constant prices. Out of $31.2 million, $14.7 million, $11.1 million and $5.4 million are allocated to the development of final disposal site, collection and haulage services in Babeldaob and the subsidies for Koror State, respectively.

Regarding revenues, the central government will receive a total amount of $13.8 million over the project period through tipping fees at the disposal site and garbage collection fees in Babeldaob.

Consequently in 2019/20, an aggregate deficit is estimated at $12.5 million at constant 2000 prices taking account of residual value of capital.

Cash flow of K-B SWMP

Table 10.6.8 shows a combined cash flow of the K-B SWMP, in terms of constant 2000 prices and current prices. An annual cash flow is prepared in Table 10.6.10 and Figure 10.6.3.

During the project period up to 2020, total cash outflow of the K-B SWMP is estimated at

$ 34.0 million at constant 2000 prices. Cash inflow from garbage fees of municipal waste and tipping fees of private haulers is estimated at $ 15.8 million at constant prices, although the tipping fees from municipal waste is excluded from the cash inflow because they are internal transfers between the central government and the state government.

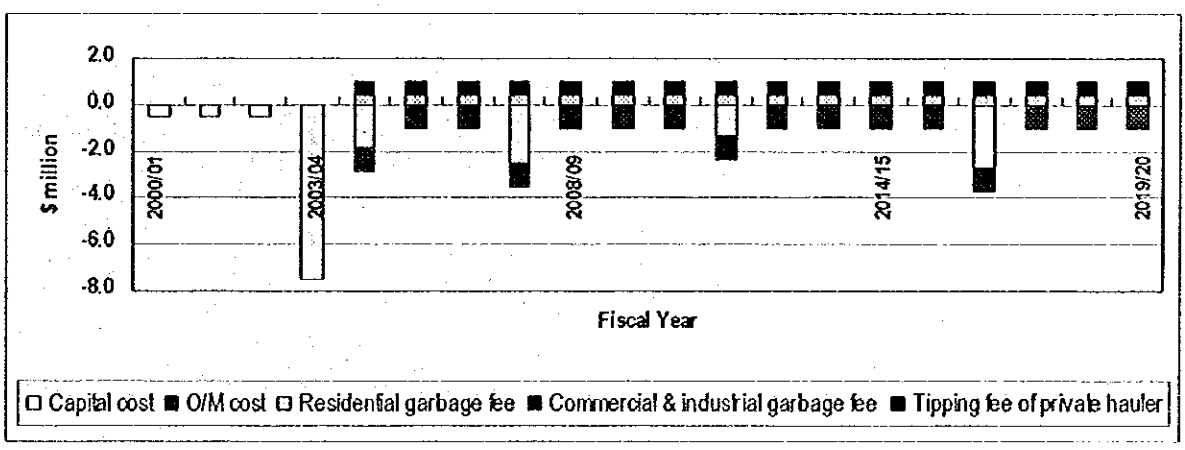
In 2019/20, there will be an accumulated deficit of $ 18.2 million. Taking account of the residual value of the capital, calculated to be 5.6 million in 2019/20, the deficit will reduce to $ 12.6 million. Consequently, 63% of the cost of the K-B SWMP will be recovered by tipping fees and garbage collection fees over the project period. However, the opportunity cost of capital is not taken into account in the calculation.

Table 10.6.8 Cash Flow of K-B SWMP

	2000/01-03/04	2004/05-08/09	2009/10-19/20	Total	2000/01-03/04	2004/05-08/09	2009/10-19/20	Total
	($ million at 2000 price)				($ million at current prices)			
Cash Outflow*								
Capital Investment Cost	9.1	4.4	4.0	17.5	10.5	5.7	7.4	23.6
O/M Cost		5.1	11.3	16.4		6.8	20.6	27.4
Total Cash Outflow	9.1	9.6	15.3	34.0	10.5	12.5	28.0	51.0
Cash Inflow								
Residential Garbage Fee		2.0	4.5	6.5		2.6	8.2	10.8
Commercial and Industrial Garbage Fee		1.8	4.0	5.8		2.4	7.2	9.6
Tipping Fee (Private Haulers) **		1.1	2.4	3.5		1.5	4.4	5.9
Total Cash Inflow		4.9	10.9	15.8		6.5	19.8	26.3
Net Cash Flow	-9.1	-4.7	-4.4	-18.2	-10.5	-6.0	-8.2	-24.7
Residual Value			5.6	5.6			6.9	6.9
Deficit				-12.6				

Source: JICA Study Team
Note: * Details are referred to Figure 10.5.2
** Tipping fee of municipal waste is not included in the revenue, because it is internal transaction between the central government and the state government.

Figure 10.6.3 Cash Flow of K-B SWMP (at constant prices in 2000)



Source: JICA Study Team

As examined above, the K-B SWMP will yield an aggregate deficit at $12.6 million over the project period. From the viewpoint of cash flow of K-B SWMP, a shortage of cash flow is prominent in the initial investment stage as shown in Figure 10.6.3. Except the capital investment cost, however, annual revenue is estimated to be almost equal to annual cost.

The government may have potential financial sources or combination of the sources to finance the deficits of the K-B SWMP as follows:

- Allocation of capital investment budget in the general budget;
- Allotment of the "Compact Trust Fund 211 (f)";
- Imposition of new tax on property, such as property tax and land tax;
- Increase of the fee rate of residential waste; and
- External assistance

Under the assumptions of financial arrangement from some of the sources mentioned above, the Net Present Values (NPV) of the K-B SWMP are estimated as shown in Table 10.6.9.

General budget allocation for the capital investment:
If the capital investment cost is allocated from the general budget, the NPV of the K-B SWMP will be $ 1.0 million with a discount rate at 8%.

Increase of garbage fee in the long-term period:
Even if the government could increase the garbage fee to such a level as the full cost recovery in the long-term period from 2009/10 as the following rates, the aggregated cash flow will reduce to $5.3 million from $12.6 million in "base case" over the project period:

- Residential garbage fee in urban area: to $25 from $10 per month per household
- Residential garbage fee in rural area: to $15 from $5 per month per household; and
- Commercial and industrial garbage fee: from $237 to $250 per household.

Table 10.6.9 NPV of K-B SWMP with Additional Financial Arrangement

	NPV with a discount rate ($ million)		
	0%	4%	8%
(1) Base case:	-12.6	-11.8	-10.6
(2) Capital investment cost is allocated from the general budget	4.9	2.2	1.0
(3) Increase of residential garbage fee in the long-term period	-5.3	-7.5	-8.1
(4) Combination of (2) and (3)	12.2	6.4	3.5

Source: JICA Study Team

For the implementation of the K-B SWMP, the GOP needs to settle the budget for the initial investment or need to seek the financing sources for the initial investment.

Table 10.6.10 Annual Cash Flow of K-B SWMP at 2000 Price

	1999 /2000	2000 /2001	2001 /2002	2002 /2003	2003 /2004	2004 /2005	2005 /2006	2006 /2007	2007 /2008	2008 /2009	2009 /2010	2010 /2011	2011 /2012	2012 /2013	2013 /2014	2014 /2015	2015 /2016	2016 /2017	2017 /2018	2018 /2019	2019 /2020	Total
1. Garbage Amount																						
(1) Daily Waste Generation Amount (ton per day)																						
Koror (Public collection/Residentialcial waste)						7.6	7.6	7.6	7.7	7.7	7.7	7.6	7.6	7.5	7.4	7.4	7.4	7.5	7.5	7.5	7.5	
Koror (Public collection/Industrial & commercial waste)						3.2	3.1	3.0	3.0	2.9	2.8	2.8	2.8	2.8	2.8	2.7	2.7	2.8	2.8	2.8	2.8	
Koror (private collection)						5.4	5.3	5.3	5.2	5.1	5.0	5.0	5.0	5.0	4.9	4.9	4.9	4.9	4.9	4.9	4.9	
Babeldaob (Public collection/Residential waste)						2.6	2.7	2.7	2.8	2.9	3.0	3.0	3.1	3.1	3.2	3.3	3.3	3.3	3.3	3.4	3.4	
Babeldaob (Public collection/Industrial & commercial waste)						1.1	1.2	1.2	1.2	1.3	1.3	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	
Babeldaob (Private collection)						0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.5	
Total						19.9	20.0	20.0	20.1	20.1	20.2	20.1	20.1	20.1	20.1	20.1	20.1	20.2	20.3	20.4	20.5	
(2) Annual Waste Generation Amount (ton per year)																						
Koror (Public collection/Residentialcial waste)						2,768	2,779	2,787	2,793	2,795	2,795	2,776	2,756	2,737	2,718	2,698	2,709	2,720	2,730	2,741	2,752	44,053
Koror (Public collection/Industrial & commercial waste)						1,153	1,130	1,106	1,082	1,059	1,035	1,028	1,021	1,014	1,007	999	1,003	1,007	1,011	1,015	1,019	16,690
Koror (private collection)						1,971	1,945	1,919	1,893	1,868	1,842	1,831	1,820	1,809	1,799	1,788	1,786	1,784	1,782	1,780	1,778	29,395
Babeldaob (Public collection/Residential waste)						944	974	1,003	1,033	1,062	1,092	1,111	1,130	1,150	1,169	1,188	1,199	1,209	1,219	1,229	1,240	17,951
Babeldaob (Public collection/Industrial & commercial waste)						404	422	439	456	473	490	494	498	501	505	509	511	513	516	518	520	7,769
Babeldaob (Private collection)						28	44	59	76	89	104	111	118	124	131	138	144	151	158	164	171	1,809
Total						7,270	7,293	7,313	7,333	7,346	7,358	7,350	7,343	7,335	7,328	7,320	7,352	7,384	7,416	7,448	7,480	117,668
2. Household																						
(1) Population																						
Koror	14,734	14,941	15,151	15,364	15,580	15,799	15,462	15,132	14,809	14,493	14,183	14,082	13,982	13,883	13,785	13,687	13,740	13,794	13,848	13,902	13,956	
Melekeok and Airai	1,767	1,933	2,115	2,314	2,532	2,770	2,878	2,991	3,108	3,230	3,356	3,382	3,408	3,434	3,460	3,486	3,501	3,516	3,531	3,546	3,563	
Other states in Babeldaob	1,890	1,882	1,874	1,866	1,858	1,850	1,871	1,892	1,914	1,936	1,958	2,027	2,099	2,173	2,250	2,331	2,358	2,385	2,412	2,440	2,468	
Total (Koror+Babeldaob)	18,391	18,756	19,140	19,544	19,970	20,419	20,211	20,015	19,831	19,659	19,497	19,491	19,489	19,490	19,495	19,504	19,599	19,695	19,791	19,888	19,987	
(2) Number of Household																						
Koror	2,947	2,988	3,030	3,073	3,116	3,160	3,092	3,026	2,962	2,899	2,837	2,816	2,796	2,777	2,757	2,737	2,748	2,759	2,770	2,780	2,791	
Melekeok and Airai	353	387	423	463	506	554	576	598	622	646	671	676	682	687	692	697	700	703	706	709	713	
Other states in Babeldaob	378	376	375	373	372	370	374	378	383	387	392	405	420	435	450	466	472	477	482	488	494	
Total (Koror+Babeldaob)	3,678	3,751	3,828	3,909	3,994	4,084	4,042	4,002	3,967	3,932	3,900	3,897	3,898	3,899	3,899	3,900	3,920	3,939	3,958	3,977	3,998	
(3) Collection coverage ratio																						
Koror						80%	82%	84%	86%	88%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	
Babeldaob						100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
3. Fee Rate																						
(1) Residential Garbage Fee ($ per month per households)																						
Urban Area (at constant 2000 prices)						10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	
Urban Area (at current prices)						12.2	12.7	13.2	13.7	14.2	14.8	15.4	16.0	16.7	17.3	18.0	18.7	19.5	20.3	21.1	21.9	
Rural Area (at constant 2000 prices)						5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	
Rural Area (at current prices)						6.1	6.3	6.5	6.8	7.1	7.4	7.7	8.0	8.3	8.7	9.0	9.4	9.7	10.1	10.5	11.0	
(2) Industrial and Commercial Garbage Fee ($ per ton)																						
At constant 2000 prices						237.0	237.0	237.0	237.0	237.0	237.0	237.0	237.0	237.0	237.0	237.0	237.0	237.0	237.0	237.0	237.0	
At current prices						288.3	299.9	311.9	324.4	337.3	350.8	364.9	379.4	394.6	410.4	426.8	443.9	461.7	480.1	499.3	519.3	
(3) Tipping Fee at Final Dumpsite ($ per ton)																						
At constant 2000 prices						113.0	113.0	113.0	113.0	113.0	113.0	113.0	113.0	113.0	113.0	113.0	113.0	113.0	113.0	113.0	113.0	
At current prices						137.5	143.0	148.7	154.6	160.8	167.3	174.0	180.9	188.2	195.7	203.5	211.6	220.1	228.9	238.1	247.6	

Table 10.6.10 Annual Cash Flow of K-B SWMP at 2000 Price

	1999 /2000	2000 /2001	2001 /2002	2002 /2003	2003 /2004	2004 /2005	2005 /2006	2006 /2007	2007 /2008	2008 /2009	2009 /2010	2010 /2011	2011 /2012	2012 /2013	2013 /2014	2014 /2015	2015 /2016	2016 /2017	2017 /2018	2018 /2019	2019 /2020	Total
4. Cost of K-B SWMP ($ thousand at constant 2000 prices)																						
(1) Final Dumpsite																						
Capital investment cost		0	500	258	5,231	0	0	0	2,514	0	0	0	719	0	0	0	0	2,695	0	0	0	11,917
Maintenance cost		0	0	0	0	389	389	389	389	389	389	389	389	389	389	389	389	389	389	389	389	6,224
Sub-total		0	500	258	5,231	389	389	389	2,903	389	389	389	1,108	389	389	389	389	3,084	389	389	389	18,141
(2) Collection and haulage																						
Koror																						
- Capital investment		0	0	301	2,115	0	0	0	0	0	0	0	468	0	0	0	0	0	0	0	0	2,884
- Maintenance cost		0	0	0	0	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	5,360
Sub-total		0	0	301	2,115	335	335	335	335	335	335	335	803	335	335	335	335	335	335	335	335	8,244
Babeldaob																						
- Capital investment		0	0	0	169	0	0	0	0	0	0	0	169	0	0	0	0	0	0	0	0	338
- Maintenance cost		0	0	0	0	305	305	305	305	305	305	305	305	305	305	305	305	305	305	305	305	4,880
Sub-total		0	0	0	169	305	305	305	305	305	305	305	474	305	305	305	305	305	305	305	305	5,218
(3) Others																						
- Master plan study		500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	500
- Closure of existing dumpsite		0	0	0	3	1,842	12	12	12	12	12	0	0	0	0	0	0	0	0	0	0	1,905
Sub-total		500	0	0	3	1,842	12	12	12	12	12	0	0	0	0	0	0	0	0	0	0	2,405
Total Cost		500	500	559	7,518	2,871	1,041	1,041	3,555	1,041	1,041	1,029	2,385	1,029	1,029	1,029	1,029	3,724	1,029	1,029	1,029	34,008
5. Revenue of K-B SWMP ($ thousand at constant 2000 prices)																						
(1) Residential Garbage Fee Revenue (State Revenue)																						
Koror						303	304	305	306	306	306	304	302	300	298	296	297	298	299	300	301	4,826
Melekeok and Airai						66	69	72	75	78	81	81	82	82	83	84	84	84	85	85	86	1,276
Other states inBabeldaob						22	22	23	23	23	24	24	25	26	27	28	28	29	29	29	30	412
Total (Koror+Babeldaob)						392	396	399	403	407	410	410	409	408	408	407	409	411	413	415	417	6,514
(2) Industrial and Commercial Garbage Fee Revenue (State Revenue)																						
Koror (Public collection/Industrial & commercial waste)						273	268	262	257	251	245	244	242	240	239	237	238	239	240	241	242	3,956
Babeldaob (Public collection/Industrial & commercial waste)						96	100	104	108	112	116	117	118	119	120	121	121	122	122	123	123	1,841
Total (Koror+Babeldaob)						369	368	366	365	363	361	361	360	359	356	357	359	360	362	363	365	5,797
(3) Tipping Fee at Final Dumpsite (Central Government's Revenue)																						
Municipal Waste in Koror						443	442	440	438	436	433	430	427	424	421	418	419	421	423	424	426	6,864
Municipal Waste Babeldaob						152	158	163	168	173	179	181	184	187	189	192	193	195	196	197	199	2,906
Private Haulers						226	225	224	222	221	220	219	219	218	218	218	218	219	219	220	220	3,526
Total tipping Fees at constant prices						821	824	826	829	830	831	831	830	829	828	827	831	834	838	842	845	13,296
(4) Total Revenue						1,583	1,588	1,592	1,596	1,600	1,603	1,601	1,599	1,596	1,594	1,592	1,599	1,606	1,613	1,620	1,627	25,607
Internal trasfer (Tipping Fee for Municipal Waste)						-596	-599	-603	-606	-609	-612	-611	-611	-610	-610	-610	-613	-616	-619	-622	-625	-9,770
Total Revenue						987	988	989	990	991	992	990	988	986	984	982	986	990	994	998	1,002	15,837
6. Balance of K-B SWMP ($ thousand at constant 2000prices)																						
(1) Net revenue		-500	-500	-559	-7,518	-1,884	-53	-52	-2,565	-50	-49	-39	-1,397	-43	-45	-47	-43	-2,734	-35	-31	-27	-18,171
(2) Residual Value of Capital																					5,591	5,591
(3) Balance		-500	-500	-559	-7,518	-1,884	-53	-52	-2,565	-50	-49	-39	-1,397	-43	-45	-47	-43	-2,734	-35	-31	5,564	-12,580
7. Budget Allocation of Central Government		500	500	559	7,518	1,838	0	0	2,514	0	0	0	1,356	0	0	0	0	2,695	0	0	0	17,480
8. Net Cash Flow after Budget Allocation		0	0	0	0	-46	-53	-52	-51	-50	-49	-39	-41	-43	-45	-47	-43	-39	-35	-31	5,564	4,900
FIRR 23%																						

Source: JICA Study Team

10.6.5 Economic Evaluation

The K-B SWMP will provide significant impacts on the promotion of national economy. The important impacts would be:

- To improve health condition,
- To improve natural condition, in general, and water pollution, in particular
- To improve living conditions in Koror and Babeldaob,
- To improve urban environment as one of the resources for tourism development; and
- To convert the existing disposal site to tourism development area

However, it is very complicated to define and measure these benefits. Accordingly, the calculation of the Economic Internal Rate of Return (EIRR) is difficult. To estimate the increase of willingness to pay of the household and commercial and business firms may be one of the practical and effective measures to quantify the benefits for the calculation of the EIRR. Employing the increase of willingness to pay as the benefits of the K-B SWMP, the EIRR of the project is estimated under the following assumptions:

- The benefits of the project are the increase of willingness to pay of the household and commercial and business firms in Koror and Babeldaob;
- Increase of willingness to pay of households is usually estimated based on the results of a household survey. However such kind of survey has not been carried out in Palau, including in this study. Accordingly, the level of affordability to pay for SWM is assumed at 2% of disposable income of household (Refer to Chapter 3);
- Commercial and business firms are willing to pay garbage fee proposed in the financial analysis which is $237 per ton, which is a level that can recover the full cost of the project;
- The cost of the K-B SWMP is converted into economic cost using a conversion factor of 0.9 in order to eliminate the cost of internal transfer items in the country's economy, such as tax, import duty and subsidies.

Consequently, the EIRR of the project is estimated at 3.8% as shown in Table 10.6.11. The low EIRR is due to the higher waste generation rate per person compared with their income level as well as the higher SWM cost per ton in Palau. However, there will be other benefits, which are difficult to measure. Among them, land development impacts on tourism due to the closure of the existing disposal site will be significant.

Table 10.6.11 Economic Cost and Benefits of K-B SWMP

	1999 /2000	2000 /2001	2001 /2002	2002 /2003	2003 /2004	2004 /2005	2005 /2006	2006 /2007	2007 /2008	2008 /2009	2009 /2010	2010 /2011	2011 /2012	2012 /2013	2013 /2014	2014 /2015	2015 /2016	2016 /2017	2017 /2018	2018 /2019	2019 /2020	Total
1. Household																						
(1) Population																						
Koror	14,734	14,941	15,151	15,364	15,580	15,799	15,462	15,132	14,809	14,493	14,183	14,082	13,982	13,883	13,785	13,687	13,740	13,794	13,848	13,902	13,956	
Melekeok and Airai	1,767	1,933	2,115	2,314	2,532	2,770	2,878	2,991	3,108	3,230	3,356	3,382	3,408	3,434	3,460	3,486	3,501	3,516	3,531	3,546	3,563	
Other states in Babeldaob	1,890	1,882	1,874	1,866	1,858	1,850	1,871	1,892	1,914	1,936	1,958	2,027	2,099	2,173	2,250	2,331	2,358	2,385	2,412	2,440	2,468	
Total (Koror+Babeldaob)	18,391	18,756	19,140	19,544	19,970	20,419	20,211	20,015	19,831	19,659	19,497	19,491	19,489	19,490	19,495	19,504	19,599	19,695	19,791	19,888	19,987	
(2) Number of Household																						
Koror	2,947	2,988	3,030	3,073	3,116	3,160	3,092	3,026	2,962	2,899	2,837	2,816	2,796	2,777	2,757	2,737	2,748	2,759	2,770	2,780	2,791	
Melekeok and Airai	353	387	423	463	506	554	576	598	622	646	671	676	682	687	692	697	700	703	706	709	713	
Other states in Babeldaob	378	376	375	373	372	370	374	378	383	387	392	405	420	435	450	466	472	477	482	488	494	
Total (Koror+Babeldaob)	3,676	3,751	3,828	3,909	3,994	4,084	4,042	4,002	3,967	3,932	3,900	3,897	3,898	3,899	3,899	3,900	3,920	3,939	3,958	3,977	3,998	
(3) Collection coverage ratio																						
Koror						80%	82%	84%	86%	88%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	
Babeldaob						100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
2. Cost of K-B SWMP ($ thousand at constant 2000 prices)																						
(1) Total Financial Cost		500	500	559	7,518	2,871	1,041	1,041	3,555	1,041	1,041	1,029	2,385	1,029	1,029	1,029	1,029	3,724	1,029	1,029	1,029	34,008
(2) Total Economic Cost (SCF=0.9)		450	450	503	6,766	2,584	937	937	3,200	937	937	926	2,147	926	926	926	926	3,352	926	926	926	30,607
3. Benefits of K-B SWMP																						
(1) Willingness to Pay of Households																						
1) Average Household Income ($ per household per year) *1)																						
- Urban area (at constant 2000 pı	20,350	20,126	19,904	19,686	19469	19,625	19,782	19,940	20,099	20,260	20,524	20,790	21,061	21,335	21,612	21,893	22,199	22,510	22,825	23,145	23,469	
- Rural area (at constant 2000 pri	13,729	13,578	13,429	13,281	13,135	13,240	13,346	13,453	13,561	13,669	13,847	14,027	14,209	14,394	14,581	14,771	14,977	15,187	15,400	15,615	15,834	
2) Wiigness to Pay of Households ($ thousand at constant 2000 prices)																						
Koror 2% of disposal household income						893	903	912	922	930	943	948	954	960	965	971	988	1,006	1,024	1,042	1,061	15,424
Melekeok and Airai 2% of disposal household income						196	205	215	225	236	248	253	259	264	269	275	280	285	290	295	301	4,094
Other States inBabeldaı 2% of disposal household income						88	90	92	93	95	98	102	107	113	118	124	127	130	134	137	141	1,790
Total (Koror+Babeldaob)						1,177	1,198	1,218	1,240	1,261	1,289	1,304	1,320	1,336	1,353	1,369	1,395	1,421	1,448	1,475	1,503	21,307
(2) Willingness to Pay of Commercial and Industrial Firms																						
1) Public Collection of Commercial and Industrial Waste																						
- Koror (Public collection/Industrial & commercial waste)						273	268	262	257	251	245	244	242	240	239	237	238	239	240	241	242	3,956
- Babeldaob (Public collection/Industrial & commercial waste)						96	100	104	108	112	116	117	118	119	120	121	121	122	122	123	123	1,841
Total (Koror+Babeldaob)						369	368	366	365	363	361	361	360	359	358	357	359	360	362	363	365	5,797
2) Private Collection																						
Private Haulers						226	225	224	222	221	220	219	219	218	218	218	218	219	219	220	220	3,526
(3) Total						1,772	1,790	1,808	1,827	1,845	1,870	1,884	1,899	1,914	1,929	1,944	1,972	2,000	2,029	2,058	2,088	30,630
4. Balance of Benefits and Costs ($ thousand at constant 2000prices)																						
(1) Net Benefits		-450	-450	-503	-6,766	-812	853	871	-1,372	908	933	958	-248	988	1,003	1,018	1,046	-1,351	1,103	1,132	1,162	23
(2) Residual Value of Capital																					5,032	5,032
(3) Total		-450	-450	-503	-6,766	-812	853	871	-1,372	908	933	958	-248	988	1,003	1,018	1,046	-1,351	1,103	1,132	6,194	5,055
(4) EIRR 3.8%																						

Source: JICA Study Team

Note: Average household income is estimated based on the results of K-B Household Survey in 1997 and the future economic framework prepared by the Study.

10.7 Initial Environmental Examination (IEE)

(1) Objectives and methods

The first objective of the initial environmental examination (IEE) is to identify the significant possible environmental items/elements (screening) and to consider the magnitude of the each possible impact (scoping) caused by the Project implementation. The second objective is to decide the necessity of an environmental impact assessment (EIA), which is a detailed impact study and will be conducted at a later stage. If there is a need for an EIA, the important environmental elements are to be identified.

(2) Results and conclusion

Table 10.7.1 shows the results of the screening and scoping sessions. This Project will obviously cause significant favorable impacts especially for the wastes issues. On the other hand, it has a potential to cause significant or slight environmental adverse impacts on several environmental elements.

Based on the results of the screening and scoping sessions, it is concluded that the Project will need an EIA at a later stage, which should be focused on the following environmental elements:

- Threat to Public Health Condition
- Soil Erosion
- Groundwater
- Air Pollution
- Water Pollution
- Soil Contamination
- Land Subsidence
- Offensive Odor

In terms of the proposed final disposal site, threat to public health condition, soil erosion, groundwater contamination, air pollution, water pollution, soil contamination, and offensive odor are considered as possible significant adverse impacts.

For example, the proposed final disposal site, even though a sanitary landfill development has a potential to cause water quality change in terms of turbidity, pH, dissolved oxygen and other parameters. Also, it is reported that most of the soil types have low to moderate permeability and poorly drained. There is a need to conduct a boring survey at a later phase.

With respect to the closure plan of the existing disposal site in Koror, threat to public health condition, soil erosion, air pollution, soil contamination, land subsidence, and offensive odor are considered as possible significant adverse impacts.

For example, soil erosion controls should be carried out at the construction phase of the closure plan. Until the existing disposal site is completely revegetated, rainfall will cause some amount of erosion and surface water runoff will carry sediment. Surface erosion on the closed landfill should be controlled by maintaining non-erodible ground cover.

Table 10.7.1 Results of the Screening and Scoping Sessions

Environmental Element	Evaluation	Main potential Impacts and Reasons
Social Environment		
Resettlement	-	Nobody will resettle by The Project 's implementation will not require resettlement of people.
Economic Activity	-	Direct impacts on economic activity will not be caused by the Project.
Traffic/Public Facilities	△(C) △(O)	Construction and haulage vehicles may cause limited access problems only near the residential areas of the Project site.
Community Severance	-	There is no village near the Project site.
Cultural Property	-	Important cultural properties are not found within the Project site.
Right of Common	-	Specific rights for water and fishing are not reported in the Project site.
Public Health Condition	▲ (C) ▲ (O)	Public health problems may occur, if the proposed final disposal site or the closure plan were not implemented with pollution control measures. There is a need to assess the health impacts to the workers and residents.
Waste	● (O)	The waste issues will be improved by the Project.
Hazards (Risk)	-	Natural hazard risks will not be increased by the Project.
Natural Environment		
Topography and Geology	-	As the proposed new facilities are not so huge, change of topography and geology will not occur as a result of the Project.
Soil Erosion	▲ (C)	The proposed final disposal site and the closure plan include revegetation on steep area. However, as the soils around the proposed are highly or moderately erodible, there is a need to assess the risk of erosion.
Groundwater	▲ (C) ▲ (O)	The proposed final disposal site includes mitigation measures for groundwater. However, as the groundwater table is shallow in some parts of the site, there is a need to assess the groundwater table/volume for the residents.
Hydrological Situation	△(C) △(O)	The proposed final disposal site includes a river. Change of water quality of the small river may occur upon the Project's implementation, because of discharges from the site.
Coastal Zone	△(C) △(O)	Sedimentation and pollution problems may occur in the coastal zone of the closure site, if the closure plan does not consider conservation measures, such as erosion control.
Fauna and Flora	△(C) △(O)	The proposed final disposal site is heavily forested. Although no protected species were reported within the site, present vegetation will be changed.
Meteorology	-	Change of meteorological conditions will not occur as a result of the Project.
Landscape	△(C) △(O)	The proposed final disposal site lies just outside the established Ngeremeduu conservation area. As the site is visible from some locations within the conservation area, it is recommended that there be an assessment of visual impacts.
Pollution		
Air Pollution	▲ (C) ▲ (O)	The proposed final disposal site is considered mitigation measures such as daily soil cover. However, there is a need to assess the air quality impacts such as dust, in the case of inappropriate management.
Water Pollution	▲ (C) ▲ (O)	The proposed final disposal site includes a leachate treatment plant. However, there is a need to assess the water quality, in the case of inappropriate management.
Soil Contamination	▲ (O)	Although leakage of polluted substances in the soil is considered for the final disposal site and the closure plan, there is a need to monito toxic substances.
Noise and Vibration	△(C)	It is recommended to assess the noise only near the residential areas.
Land Subsidence	▲ (O)	Although the closure plan includes soil stabilization measures, there is a need to assess the compacted land situations in the site taking into account the post closure land use plan.
Offensive Odor	▲ (O)	There is a need to assess the odor only in the residential areas near the post closure site and the final disposal site due to the mixed garbage dumping.

Note: Evaluation Categories ●: Potential significant favorable impact is expected. ○: Potential slight favorable impact is expected. ▲: Potential significant adverse impact is expected. △: Potential slight adverse impact is expected
(C) = Construction Phase, (O) = Operation Phase

(3) Recommendations

Based on the results of the IEE and EIS regulations in Palau, an Environmental Impact Statement (EIS), which is identified by EQPB, would be required prior to the implementation of the Project due to the significance of the possible impacts and the scale of the Project.

According to the EIS regulations in Palau, an EIS should pay close attention to alternatives to the Proposed Action. In the case of this Project, the location of the proposed final disposal site may need to be reconsidered, if the candidate site for the final disposal site, which is identified by Aimeliik government, will cause more significant adverse impacts than the alternative one.

Furthermore, although many mitigation measures for the possible adverse impacts are included by the Project, an environmental monitoring at construction and O/M phase of the proposed final disposal site as well as the closure of the existing disposal site is recommended. The reason is that the proposed final site is located very close to the established Ngeremeduu conservation areas, which is one of the most important conservation areas in Palau. Also, the candidate post closure land use plan for the existing disposal site in Koror is marine center development, an amenity which the people will enjoy. There is a need to monitor the adverse environmental impacts such as leachate and landfill gases from long-term perspectives.

Table 10.7.2 shows the monitoring items, the number of sampling points, and the frequency, which are recommended to be undertaken at the Project implementation phase.

Table 10.7.2 Recommended Environmental Monitoring for the KBSWMP

Monitoring Items	Sampling Items	The number of Sampling Points	Sampling Frequency
Proposed Final Disposal site			
Water Quality	PH, BOD, COD, TSS, Total Coliform Bacteria, Hg, Cd, Cr, As, Pb, Oil	4 points for each sampling item	12 times/year for each sampling item
Soil	Pb, Hg, Cd, Cu, Zn	2 points for each sampling item	4 times/year for each sampling item
Air Quality and Odor	TSP, H_2S, Methane	2 points for each sampling item	4 times/year for each sampling item
Closure of the Existing Disposal site			
Water Quality	PH, BOD, COD, TSS, Total Coliform Bacteria, Hg, Cd, Cr, As, Pb, Oil	3 points for each sampling item	4 times/year for each sampling item
Air Quality and Odor	TSP, H_2S, Methane	2 points for each sampling item	4 times/year for each sampling item

Source: JICA Study Team

It is estimated that the total monitoring cost of the above for the proposed final disposal site is approximately $300 thousand, from year 2004/2005 to 2019/2020. In terms of closure of existing disposal site, the monitoring cost includes the O & M cost (refer to Figure 10.5.2).

10.8 Conclusions and recommendations

The K-B SWMP will yield an aggregate deficit at $12.6 million over the project period. The GOP needs to settle the budget for the initial investment. The government may have potential financial sources or combination of sources to finance the deficits of the K-B SWMP as follows:

- Allocation of capital investment budget in the general budget;
- Allotment of the "Compact Trust Fund 211 (f)";
- Imposition of new tax on property, such as property tax and land tax;
- Increase of the rate of residential waste; and
- External assistance.

For Koror State, it is a crucial to impose and collect garbage fee both for residential and business wastes. Garbage fee rate of households should be increased correspondingly with the growth of per capita income. At the same time, the collection and haulage services need to be improved so as to satisfy the demands of the people. People's willingness-to-pay will increase based on the service level of SWM as well as the income level of household.

In order to understand the reality of public acceptance for the proposed K-B SWMP, especially for garbage fee collection and voluntary participation with the waste reduction, it is recommended that interview and questionnaire surveys be conducted at least at four sites. The reason for this is that the willingness-to-pay for the proposed K-B SWMP is strongly dependent on the local reality, such as characteristics of wastes, the people's awareness on environment, income level and social customs for resource uses. Also, as a further study, it is recommended that a pilot study on deposit of bottle and/or can be carried out to assess its viability and contribution for waste reduction.

A program on waste reduction is crucial for efficient SWM. Assuming that the reduction of waste will be realized in conjunction with the proposed recycling program of this Study, the volume of waste demand for final disposal will reduce by 8.5%. It means that the life span of the proposed final disposal site could be extended 2.5 years more than the current expected life span of 30 years.

It is also noted that an accounting system of the SWM should be established, as it will provide more explicit figures to seek financial improvement. An accurate data analysis on the cost-efficiency in SWM is important.

For the feasibility from the viewpoint of technical aspect, further study on the solid waste management is necessary to get more accurate data and secure the requirements of projects before their implementation.

Items required for further studies are as follows:

<u>Existing and/or current condition and/or situation</u>

- Population (Census 2000), Economic, Environment (Natural and Social), On-going and Future Development Plan/Project, Solid Waste Treatment (Organization, Regulation and Law, Discharge, Collection, Haulage, Intermediate Treatment, Final Disposal Amount, Quantity and Quality of Waste Generated Waste Stream)

<u>Forecast of future condition and/or situation</u>

- Population, Economy, Quantity and Quality of Waste generated in the future
- Solid Waste Management Plan and Feasibility Study
- System, Facilities and Organization (Collection and Haulage, Transfer Station, Final Treatment, Recycling and Reuse, Closure), Development Schedule

- Topographic Survey and Soil Survey
- Interview and Questionnaire Survey (Residents in Koror and two states in Babeldaob, Hotel and shops in Koror)
- Pilot Study on Deposit of Bottles and/or Cans

11. CONCLUSION AND RECOMMENDATION

The Government of Palau (GOP) should aim at the development goals of (1) self-reliant economy, (2) coordinated economic development with conservation of natural environment, and (3) sustainable regional development, before termination of the Compact Direct Payment from the United States in the year 2009. The recommended development strategies and directions are established and implementation programs are formulated in this Study and future socioeconomic and environmental conditions to be achieved in the year 2009 are illustrated in this Report.

Promotion of economic development is the most significant base for the national development to improve the budgetary imbalance of the government by expansion of the revenue sources. In accordance with the resource availability and socioeconomic conditions, the leading economic sector will be service and trade, especially tourism-related industries.

The reduction of the size of public sector, elimination of the inherent budget deficit, reduction of the dependency on external ODA resources, and establishment of self-sufficient budget structure should be realized. The Structural Adjustment Program for Palau, which is recommended in this Study, is indispensable to achieve the development goals set by the Government.

Projects and programs for social and economic infrastructure development together with environmental management to meet with the long-term development strategies are selected and compiled as proposed projects and programs in the mid-term. JICA Study Team pays attention to minimizing cost burdens on the government budget when priority projects and programs are selected. The development expenditure for the proposed projects and programs, which is required to maintain the target economic development, is estimated at $187 million at current prices. For operation and maintenance of those projects and programs about $70 million at current prices is additionally necessary during the same period.

Implementation of the selected development projects and programs, together with the structure adjustment, will provide the concrete base for the sustainable and self-reliant economic development after the year 2010.

Following development plan is recommended.

The diversification of tourism products in terms of location and type of tourism is recommended to accommodate increased number of tourists in the future. It is also important to develop tourism in Peleliu and Ngarchelong in order to formulate new tourist bases in Palau. Another recommendation is the promotion of village tourism in Babeldaob Island. Encouragement of community members, technical and institutional support is required to promote the village tourism. Participation of community members and strong will to implement the project by the community members are key for village tourism development.

The problem on Balance of Payment is also one of the key issues in Palau. In order to gain service trade surplus, service revenues from tourism should be promoted as described above. At the same time, import substitution should be promoted. Food and beverage is one of the major import items followed by transport equipment and machinery. The promotion of vegetable and fruit gardens at each household in Palau especially in the rural area is recommended. Another measure to be taken is the efficient use of food materials. Small-scale fish product processing factory is also recommended.

Although the private sector will be a main player of the economic development, especially the foreign direct investment (FDI), there will exist many legal and institutional constraints for not only FDI but also investment by local people. Provision

of preferable investment environment is indispensable. Institutional reform as well as legislative modification is required.

Conservation of natural environment and enhancement of natural resource management are significant for the sustainable development. Clear and integrated enforcement and management in conjunction with state government initiative and strengthening of EQPB, integrated management for critical watersheds with effective implementation of preservation and conservation system should be established. Integrated Ngaremeduu Watershed Management, decentralization of diving bases in conjunction with tourism development, comprehensive solid waste management and establishment of natural resources management inventory are recommended as the projects and programs to be implemented in the mid-term development plan.

The estimated population and labor force until 2020 are 23.5 thousand and 14.1 thousand respectively. Palauan labor force will increase from the present 4.5 thousand to 8.0 thousand in 2020. Generation of employment other than government sector is an urgent matter in order to absorb not only the newly generated labor force but also the labor force shifting from government service to the private sector. Proper training and education system to match labor demand is indispensable. The study recommends Government-Private-School cooperation in the vocational training to rationalize education and vocational training.

It is proposed that the GOP I challenge the reduction of the budget size to about 40% of the nominal GDP in 2009/10, which accounted for 60% of the nominal GDP in 1998/99. To reduce the recurrent cost, it is proposed that the number of government workers be decreased to 1,900 workers in 2008/09 from the current 3,200 workers at a reduction rate of 40% during an eight-year period.

To increase the government revenue, in addition to the currently proceeding Tax Reform Program, vehicle-operation-related taxes such as fuel levy, vehicle registration tax, auto tax are recommended. Other than vehicle-related taxes, property tax and utilities charge, following the introduction of the Polluter Pays Principle, are also proposed.

As a result of the structure adjustment program with development programs formulated in this study, the governmental budget will turn into a surplus of $6.5 million in the year 2009. Thereafter, the GOP would be able to balance the overall budget in the long-term perspective.

During the mid-term period, the annual budgetary balance of the GOP will remain in deficit at around $20 million on average. Therefore, external assistance will continue to be needed. Aid coordination and management in conjunction with implementation of structure adjustment program is recommended.

Pre-feasibility study on Peleliu tourism development plan and solid waste management program for Koror and Babeldaob were carried out. Implementation procedure to promote FDI is the key for the Peleliu tourism development plan. How to make the development sustainable by applying the appropriate user charges to the beneficiaries is the key for the implementation of the Solid waste management program. Institutional and legal reforms are proposed in both studies.