(4) Problems and Issues

Simple Trunk Road Network in Koror State

More than 70% of the total population is living in Koror State. Therefore, the roads in Koror State are comparatively well developed both in network and surface condition. However, the road network pattern is relatively simple and all major roads are connected to the national road, which consists of only one trunk road stretching from the west to the east in the center of the Koror Island. In addition, car ownership is relatively high indicating 0.28 cars per person in Palau. Consequently, the national road is always congested by chronic heavy traffic at present. However, future traffic growth depends on development conditions. Much attention has to be paid on transition of the traffic growth on the trunk road in Koror Island.

Insufficient Road Maintenance

On the other hand, roads in the states except Koror State, especially in the Babeldaob Island, are seriously deteriorated, since the geometric alignment is out of normal standard and surface conditions are devastated due to lack of proper maintenance. Currently, the Airai, Melekeok and Ngchesar States have own road maintenance equipment and assuming responsibility of state road maintenance though the equipment is not enough to meet the maintenance requirements, while other states have not equipment and do not held sufficient maintenance of the state roads. The Bureau of Public Works has maintained the national road in the Babeldaob Island. However, the Bureau of Public Works has not also enough road maintenance equipment and maintenance has been delayed and lost the timing.

8.2.2 Airport

(1) Existing Airport Facility

There are three airports in Palau; those are in the Airai (Palau International Airport), Angaur and Peleliu States. Respective airport has the following runways:

- Palau International Airport: 7200 feet,
- Angaur: 7000 feet, and
- Peleliu: 6000 feet.

Table 8.2.2 shows the existing facilities in Palau International Airport.

Table 8.2.2 Airport Facilities in Palau Int'l Airport

1	R/W: 2194.45meter x 45.72 width
2	Distance measuring equipment (DME)
3	No-directional beacon (NDB)
4	VASI and Rotating beacon light
5	Identifier light system (REILS/ODALS)

Source: JICA Study Team

(2) Air Flight Service

There are three air flight companies serving to and from Palau International Airport; those are the Continental Airlines, Far East Airlines and Japan Airline. The Continental Airlines has regular services only while the Far East Airlines has both regular and charter services, and the Japan Air Lines has charter services only.

Table 8.2.3 shows the regular flight service frequencies by respective airline company.

The charter services by Japan Airlines reached 24 flights in 1999.

Table 8.2.3 Flight Service by Airline Company

Airline	Departure	Destination	Fright No.	Weekly Frequency	Stop
Continental Micronesia Airlines	Koror	Gum	954	6	
	Gum	Koror	953	6	
	Gum	Koror	863	1	Yap
	Koror	Manila		1	
	Manila	Koror	864	1	
	Koror	Gum		1	Yap
	Gum	Koror	863	1	
	Koror	Manila		1	
	Manila	Koror	864	1	
	Koror	Gum		1	
	Gum	Koror	951	1	Yap
	Koror	Gum	952	1	Yap
	Sub. Total			22	
Far Eastern Airlines	Taipei	Koror	EF033	1	
	Koror	Kaoshung	EF002	1	
	Kaoshung	Koror	EF001	1	
	Koror	Taipei	EF034	1	
	Sub Total			4	

Source: JICA Study Team

(3) Passenger Traffic and Occupancy

The past passenger traffic transition is shown in Table 8.2.4. The number of passengers is stable in recent years.

Table 8.2.4 Passenger Traffic by Air Line

(Unit: Passenger/year)

Year	Continental	Far East	JAL	Total
1995	120,448	4,442		124,890
1996	117,497	26,006	4001	147,504
1997	94,797	30,205	3845	128,847
1998	94,230	27,099	7002	128,331
1999	92,050	21,365	10628	124,043

Source: Division of Transport
Note: Enplaned and deplaned

Occupancy ratio (load factor) is estimated as shown in Table 8.2.5.

Table 8.2.5 Occupancy Ratio (load factor)

Year	Continental			JAL*		
	Passenger	Seats	O. Rate	Passenger	Seats	O. Rate
1999	92,050	172,172	0.53	4,409	5,290	0.83

Source: Transport Division and airline companies concerned.
Note: *Charter service only

(4) Cargo Transport

Table 8.2.6 sets forth amount of cargo by air at Palau International Airport. Inbound cargo consists of daily goods and food, while almost all of outbound cargo is fresh tuna for "sashimi use".

Table 8.2.6 Air Cargo In 1994

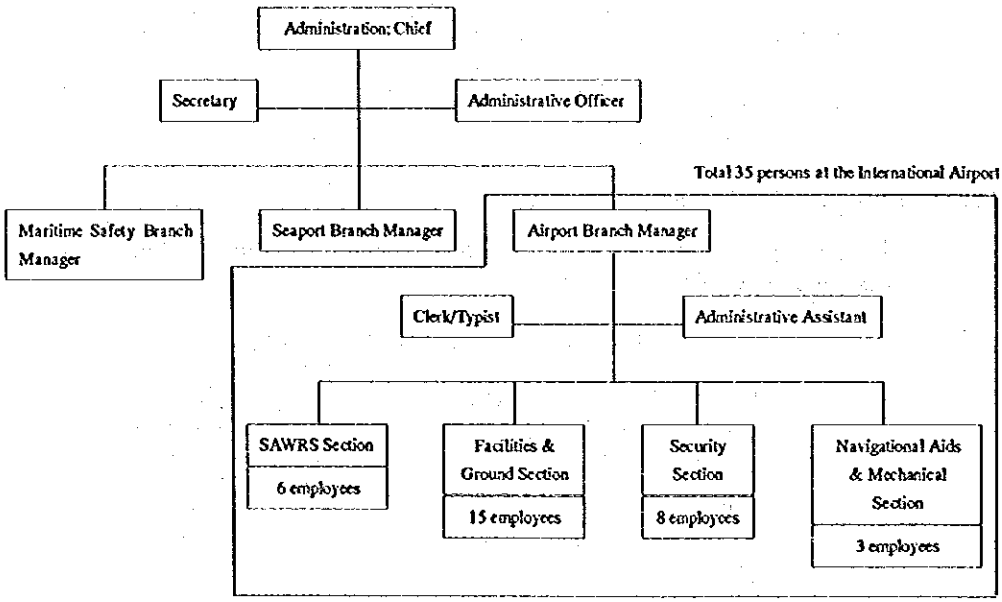
	Inbound (Discharged)	Outbound (Loaded)	Total
Pound	1,428,350	2,859,231	4,287,581
Tonnage	648	1,298	1,947

Source: Division of Transport

(5) Organization

Airport Branch in Division of Transport, Ministry of Commerce and Trade manages Palau Inter National Airport. Airport Branch has total 35 employees and workers at present.

Figure 8.2.2 Organization Chart of Palau Inter National Airport



Source: Division of Transport

8.2.3 Port

(1) Port Facility

Malakal Port is only one commercial port in Palau. The port is owned by the local government, Koror State, and leased out to the Belau Transfer and Terminal Company to operate. A power plant serving electricity to all Babeldaob Island and partly to Koror State is located alongside Gamliangel Bay in the Aimeliik State. One tanker terminal is in use in order to unload fuel for the power plant. As the depth of the water is not enough for a large tanker, fuel is transferred to the storage tank by horse.

Table 8.2.7 sets forth the major port facilities in use.

Table 8.2.7 Major Facilities in Malakal Port

Facility	Name		Length (m)	Depth (m)	Remarks
Wharf	Pier No.1	East face	160	8.84	
	Pier No.2	South West face	168	8.84	By Mobile and Shell
	Private Wharf	West Face	170	8.84	Tuna fishing company
Crane	20 ton electric mobile crane (1)				
	16 hydraulic mobile crane (1)				
Storage	Buoy and horse				Four dry cargo warehouse and no refrigerated storage
Tanker Terminal	Less than 2000Grt				Garnliangel Bay

Source: Transport Division

(2) Number of Vessels and Cargo

Table 8.2.8 shows the number of vessels and inbound and outbound cargo from 1995 to 1999.

Within Palau, there are three major carriers under the licensed by the Micronesian Shipping Commission; these are Palau Shipping Company, Kyowa Line, and Philippines, Micronesia and Orient Line (PM&O). Six to seven cargo vessels per month arrive at Malakal Port on average.

There are big differences between inbound and outbound cargo. Main import cargo is general consumer goods and construction materials, while export cargo mainly consists of fresh fish.

Table 8.2.8 Vessels and Cargo

	Unit	1995	1996	1997	1998	1999
No. of Vessels	Vessels	91	95	101	91	103
Inbound	Tonnage	72,827	204,849	95,339	105,301	106,721
Outbound	Tonnage	4,402	7,064	7,932	8,263	9,496
Total	Tonnage	77,229	211,913	103,271	113,564	116,217

Source: Division of Transport
Note: More than 65 feet vessels

As for container handling, in-bound volume reaches around 2,740 units (one unit is equivalent to a 20 feet container) in 1998. Monthly handling volume is fluctuating from 126 to 322 units. On the other hand, current container working space in the Malakal Port is around 6,400 m^2 including wharf space. It is necessary to provide the space for around 500 units for maximum monthly handling to relieve the current congestion and to cope with future increase. In this view, additional around 2500 m^2 is required for handling and stock space for the future container units.

In the meantime, there is no additional space in Malakal Port at present. In this view, it is necessary to shift the front line of the current wharf toward the sea by landfill with a view to supplement the container handling space.

(3) Sea Transport Among Islands

Almost all states have docks for sea transport and fishing boats, since inland transport is inconvenient in the Babeldaob Island and sea transport is only one means of transport among islands. There are commercial regular ship services between Koror and Angaur, Hatohobei/Sonsorol, Kayangel and Peleliu; some are daily, some are every two weeks or every three months.

Table 8.2.9 sets forth the docks by state.

Table 8.2.9Docks by State

States	Docks
Aimeliik	Aimeliik Dock
Airai	Airai Dock
Angaur	Angaur Dock
Hatohobei	Hatohobei Dock
Kayangel	Kayangel Dock
Koror	T Dock, M Dock
Melekeok	Melekeok Dock
Ngaraard	Ngaraard Dock
Ngarchelong	Ollei Dock, Ngrebaru Dock, Ngarchlong Dock
Ngardmau	Ngardmau Dock
Ngatpang	Ngereklmadel Dock A, Ngereklmadel Dock B
Ngchesar	Ngchesar Dock, Rrai Dock
Ngeremlemgui	Ngeremlemgui Dock
Ngiwal	Ngwal Dock
Peleliu	Peleliu Dock
Sonsorol	Sonsorol Dock

Source: JICA Study Team

(4) Traffic of Small Boat

There are many small boats, which are used for private trips and leisure purposes. Many sea markers are installed indicating channels and the shallows for securing small boats from accidents. Some of them are damaged and some are broken due to inadequate maintenance.

More installation of markers will be required for safe navigation of small boats in order to cope with increase of small boats for future tourism development.

(5) Problems and Issues

Problems and issues on the port facilities are summarized as follows:

- Although Malakal Port is handling around 120,000 tons of cargo per year and has still capacity for additional cargo to handle, backyard space is insufficient, especially for operation of containers.
- It is inefficient to transfer the fuel to the power plant by horse in Gamliangel Bay. In some cases, fuel leaks into the sea and the sea will be likely to be contaminated though the situation is not so serious at this moment.
- Sea maker installation for safe navigation of small boats is required, since safe navigation is the most essential point for all users of small boats. In addition, small boat traffic to transport divers toward diving spots is expected to increase in accordance with the future tourism development, so that safe navigation is also a key to the success for tourism promotion.

8.3 Telecommunications

8.3.1 Program Outputs of National Master Development Plan

Central Office Equipment Installed

PNCC currently uses a Northern Telecom DMS-10 (genetic 400) switch in a container at the Koror Central Office in downtown Koror. This switch is state-of-the-art digital technology currently equipped for 2,500 lines with an ultimate capacity limit of over 10,000 lines. The Corporation would expand the line capacity of the Koror switch and purchase and install a second DMS-10 switch in Airai at its new Headquarters and Central office complex due for completion in 1996.

The Corporation would also install small class 5 central offices or remote switches for the other exchanges (States). The last rural telephone system projected to be built in Kayangel State is expected to be in operation by 1996. The Corporation also plans to purchase a packet switch to provide on-demand access to the global X.25 data network. The REA loan includes money for a new switching system in Koror. However, this purchase is expected to be deferred to the end of the REA "A" loan period. The estimated cost is $7,218,000, funded through both the REA loan and retained earnings.

Electronic Equipment Installed

With the purchase of the Koror earth station from COMSAT in October of 1993, PNCC assumed full responsibility for international communications to and from Palau. A project contracted with AT&T refurbished the 13-meter antenna and upgrade the station to digital "IDR" standards scheduled for completion by late 1994. The multi-destination IAT equipment from AT&T would provide greatly increased capacity at a reduced space segment cost due to 4 to 1 compression. The dynamic allocation of bandwidth provided by this new equipment will make high speed applications possible in Palau, including compressed video conferencing, medical imaging, interactive learning, and so on.

PNCC will also be installing a second satellite earth station to provide redundancy in the international network in the near future. This station is likely to have a smaller aperture antenna (9 meters or less) and will track an alternative satellite. The addition of a second earth station will ensure that Palau is never out of touch with the global network.

The "Electronic Equipment" category of projects includes state-of-the-art distribution technology, using a "fiber to the distribution node" design with subscriber carrier systems directly interfaced to the DMS-10 system in Koror. The design is compatible with a future migration to a "fiber-to-the-curb" and, ultimately "fiber-to-the-home" architecture.

PNCC is also using or has plans to use wireless (radio) telephone and microwave trucking technology to provide communications to outlying areas of Palau. The EXICOM "Hawk" radio telephone systems, which are currently being installed in all states outside of Koror and Airai (except Sonsorol and Hatohobei) are to provide basic telephone service. The total estimated cost is $9,146,000 to be funded from the REA loan and retained earnings.

Outside Plant Installed

A major project began in 1994 to place a buried outside plant distribution system in Koror and Airai to replace current overburdened and undersized aerial facilities. During the construction phase of this project, PNCC construction personnel performed placing and inspection functions alongside the contract personnel in order to gain first hand, on-the-job experience in buried placing techniques. Outside (distribution) plants in the rural states of Palau will initially be a combination of buried and aerial plants (both fiber and copper), designed and installed by PNCC employees. Emphasis is being placed on the use of fiber optic cable for all inter-office trunking.

Discussions have also been initiated with several providers of undersea fiber cable about the technical and economic viability of a festooned fiber optic ring around Babeldaob and a link to Peleliu using newly available shallow depth materials and placing methods. Such facilities could also provide capacity for the distribution of educational and public services, such as interactive distance learning and television. In the long term, there is recognition that Palau must be linked to the outside world via undersea fiber optic facilities. This is a project that is beyond Palau's ability to finance alone. However, PNCC will watch for any opportunity to participate in future projects, such as the proposed Indonesia to Guam cable, which could reach Palau. The total

estimated cost is $11,670,000 to be funded by the REA loan and retained earnings.

Station Equipment Installed

This equipment includes the purchase and installation of telephone instruments, key and PBX systems, and pay phones. With the exception of pay phones, PNCC is moving toward a complete "deregulation" of customer premises equipment (CPE) in accordance with global trends. The estimated cost is $1,237,000 to be funded by the REA loan and retained earnings.

Land Secured and Buildings Developed

The most significant facility planned is the Headquarters and Central Office complex at the Airai airport. This multi-million dollar facility is the primary administrative office for PNCC and communications hub for the nation. The facility has 15,000 square feet (1,350 m²) of office/public floor space and 6,000 square feet (540 m²) of equipment/technical space. The facility was completed by 1996.

Support facilities in rural states are generally limited to small central office structures to house electronics switching and trunking equipment. These small "equipment hut" are either prefabricated containers or are constructed from hollow blocks and concrete. PNCC needed to secure sites for these small structures and approached each state to determine the best location. The total estimated cost is $4,608,000 to be funded by the REA loan and retained earnings.

Support Systems Established and Equipment Purchased

This equipment includes test equipment and tools, vehicles and construction equipment, computer systems, and office fixtures. The construction of the central office facilities in Airai and planned reconstruction of the downtown Koror business office will require a significant investment in office furnishings and computer equipment. The estimated cost is $1,427,000, to be funded by the REA loan and retained earnings.

Engineering Fund Allocated

All projects require engineering and architectural work to be done. The REA program requires that this work be done by the REA certified engineer. This category provides engineering funds of up to 15 percent of the project cost. Since much of the work is internally funded, PNCC did not anticipate spending the full amount budgeted under this category. The estimated cost is $6,153,000, to be funded by the REA loans and retained earnings.

Table 8.3.1 Telecommunications

(Unit: $ million)

Program/Project	1996	1997	1998	1999	2000
Central Office Equipment	2.7	0.5	0.3	0.2	3.6
Electronic Equipment	1.9	2.9	2.2	1.5	0.7
Outside Plant	5.6	2.4	1.8	1.2	0.6
Station Equipment	0.6	0.3	0.2	0.1	0.1
Land and Buildings	2.7	1.8	0.1		
Support Systems & Equipment	0.4	0.5	0.2	0.2	0.2
Engineering	2.4	1.5	0.8	0.6	0.9
Total	16.1	9.8	5.6	3.8	6.1

Source: Palau National Master Plan Development Plan, August 1995
Note: Funding source is REA loan and retained earnings (all expenditure)

8.3.2 Present Condition

In the past 5 years (1994-1999) PNCC has concentrated all its efforts on the physical implementation and completion of the "Lightnet-2000" project, for which the total costs has reached 39.1 million dollars, and for which a soft loan has been provided by RUS, U.S.A. The number of subscribers has been increased during this period from 2,700 to 6,100 lines

Telephone penetration rate has reached 35%. Accordingly, pending demands have almost been resolved (more than 95% satisfaction level).

Central Office Equipment (Public Switched Telephone Network)

New international gateway switching equipment was installed at the Airai PNCC Headquarters building, located adjacent to the International airport. The following equipment were installed:

Lucent 5ESS CDX-2000 digital switch
Trunk capacity is 240 trunks.

New domestic switching equipment was installed.

New main switching equipment was installed at Airai PNCC HQ building.
Lucent 5ESS CDX-2000 digital switch
New remote switching module was installed at Koror telephone exchange.
Switching equipment capacity is 16,000 lines.

New containerized carrier equipment was installed.

New containerized carrier equipment was installed in Babeldaob, Peleliu, Angaur and Kayangel.
SLC 2000 model
Line capacity is 768 lines/container regardless of installed location.
Total 14 locations
All equipment is served through the main switch at Airai.

Trunking and Others

All trunking is out of the tandem switch in the Central Office Equipment building.
The tandem switch provides CAMA/LAMA recording capabilities.
Both domestic and international facilities have SS7 capabilities.
High accuracy cesium reference clock is provided for synchronization of the network.

Telex Network

Telex system has been abolished in the year 1993.
Data Communication Network
No data circuit exchange system and data packet exchange system have been installed in Palau.

Mobile Telephone Network

An analog AMPS cellular system was utilized by PNCC for internal maintenance
PNCC is planning to introduce an analog type new cellular mobile telephone system throughout the Palau islands, the service area of which will cover the land and coastal area of the Palau islands. A total of 4 antennas will be installed and each antenna will cover an area with a radius of about 30km.
Introduction of this system will serve for the safety of divers' and fishery boats. However, the mobile telephone system shall be distinguished strictly from maritime safety and distress rescue functions.

Fiber Optics Transmission

A fiber optic cable connects the gateway switch trunks and satellite earth station.
Fiber optic undersea transmission networks connect the local networks of all the states with the main switching equipment located at the Airai new central office building. The fiber optic network constitutes a ring network.
12 core fiber optic cables are terminated at the Airai central office.
A OC3 SONET (156 Mbps STM-1, SDH) ring system is applied for the fiber optic undersea cable network.
Newly developed shallow-depth fiber optic cable was installed and linked to the island of Peleliu. A folded SDH ring (6x6 cores) system is applied in this section.
There are 14 locations of undersea F/O cables landing sites to interface with containerized carrier equipment.
These facilities will have the capacity for distance learning, telemedicine, and cable television.
The transmission network, consisting of fiber optic undersea cables, microwaves and HF radio systems Transmission Network in Palau.

Microwave Transmission

A GHz digital microwave radio systems links the containerized carrier equipment on the Islands of Kayangel and Angaur and the fiber optic SONET ring with the main switch at Airai.
Frequency and space diversities are applied to these microwave sections.
A 2/5/7 MHz HF radio system links Angaur with the Sonsorol and Hatohobei States.

Local Distribution System

A buried outside plant distribution system has replaced the obsolete aerial cables in Koror and Airai areas. The buried cable networks have also been installed in other states.
This practice leads to dramatic decrease in cable related troubles.
A "fiber to the distribution node" design with subscriber carrier systems, which link directly to the main switch with a 1.5 Mbps PRI (Primary Rate Interface), is applied.
A HDSL (high-speed digital subscriber line) service has been implemented to requesting subscriber.

Wireless System

A WLL (Wireless Local Loop) service is provided to customers beyond the wire line system (distance to subscriber is more than 7-8 km).
PNCC anticipates an expansion of the WLL services in Palau, due to growth resulting from the new Compact road now under construction.

Support Facilities

A new PNCC HQ and central office complex was constructed in Airai State as a primary administrative office for PNCC and the communications hub for the ROP.
The office and public floor space has an area dimension of 15,000 feet^2 (1,350 m^2) and equipment space with 6,000 feet^2 (540 m^2).
The site also has a large warehouse/shop building.

International Connection

Satellite transmission equipment was installed in 1993, with the number of telephone lines increased from 10 to 24 lines.
In 1994, the earth station was completely refurbished and upgraded to a digital Standard-B station, which is fully owned and operated by PNCC.
Number of voice circuits: 67 lines
Number of data circuits: 8 lines
Lines are linked to 6 international carriers: AT&T, MCI, Sprint, KDD, GTE-Hawaiian Tel and IT&E.

Submarine Cable Development

PNCC is involved with Project Oxygen; a MOU (Memorandum of Understanding) has been signed and sent to the Project Oxygen's HQs.
Project Oxygen has confirmed that Palau region will be a part of its construction phases scheduled for completion in the 3rd quarter of 2001.

Demand versus Installed Capacities

PNCC has been able to meet the demand for telephone service, since installation of the new network has been completed over the last several years.
Today, the number of pending applications has been reduced drastically to an average of 20 or less per month, formerly counted at over 800.
Number of subscribers increased to 6,100, more than doubling from 2,700 before completion of the project.
Subscribers are utilizing a variety of services related to voice, data and Internet communications.
The number of installed telephone lines, the rates of penetrations in each state and final capacities of the installed switching facilities are shown in Table 8.3.2.

Table 8.3.2 Number of Telephone Subscribers and Installed Equipment Capacity

State name	Code	Household 1995	Population 1995	No. of Subs.	Telephone density (%) Tel/100 cap.	SW/SLC equipment capacity
Kayangel	876	26	124	40	32.3	768
Ngarchelong	855	65	253	94	37.2	768
Ngaraard	824	91	421	121	28.7	768
Ngiwal	679	47	176	59	33.5	768
Melekeok	654	54	261	89	34.1	768
Ngechesar	622	67	228	96	42.1	768
Airai	587	245	1,481	661	44.6	(16,000)
Almeliik	544	66	419	66	15.8	768
Ngatpang	535	37	221	35	15.8	768
Ngardmau	747	40	162	54	33.3	768
Ngeremlengui	733	65	281	85	30.2	768
Angaur	277	46	193	55	28.5	768
Peleliu	345	129	575	178	31	768
Koror	488	1,964	12,299	5074	41.3	16,000
Sonsorol	255	19	80	2	2.5	
Hatohobei	255	12	51	2	3.9	
Total		2,973	17,225	6,711	39.0	25,216

Source: PNCC Telephone Directory 2000

New and Enhanced Services, International Services

International Direct Dial service was implemented in 1993. PNCC has currently over 600 IDD customers.

A debit and credit card system is utilized for international calls. Average 3,000 cards per month are purchased by customers (over 600 users).

Dedicated international leased circuits are being served to 6 customers.

Internet Service

PNCC offers Internet and E-mail services to Palau (palaunet).

PNCC has expanded the capacity of its pipeline directly into the Internet gateway.

The number of registered Internet subscribers is about 1,031 in March 2000.

14 subscribers have high bit rate transmission of 64 kbps.

Internet users sometimes encounter a line busy signal for international connection in the morning and evening busy times.

Broadband Applications

PNCC is providing broadband applications including the use of ISDN (Integrated Service Digital Network) and DSL (Digital Subscriber Line) technologies.

These technologies are providing remote schools with distance learning capabilities.

Soon to be provided with should be medical clinics with telemedicine capabilities.

Value Added Services

Provision of the following new customer services became available by the introduction of the new switching system: Call waiting, Cal forwarding, Caller ID, Speed dialing, and ISDN services.

PNCC is planning to provide the following new services: Voice mail, Multi-distinctive ringing, Automatic redial, Account and authorization codes, Automatic callback, and others.

Commercial Enterprises and Government Agencies

2 way radio communications are concentrated in the 27 MHz citizen band.

Other bands are 150 MHz VHF band, 800 MHz and 450 MHz UHF ranges.

Radio Broadcasting

The GOP owns and operates 2 local broadcasting stations.

AM broadcasting station (government):

Call sign: T8AA,
Frequency band: 1,584 kHz
Output: Nominal 5 kW. However, the actual output is limited to not more than 2 kW, due to obsolete condition of the antenna,
Antenna tower: 60 m height lattice type antenna tower with stays,
Location: South cape of Malakal island,
US Army installed this tower for HF telecommunications use at first.

FM broadcasting station (government):

Call sign: ECO Paradise,
Frequency band: 87.9 MHz,
Output: 500W, single system,
Antenna tower: Yagi antenna on top of a wooden pole
Location: East end of Ngerekebesang island,
FM Tokyo donated this broadcasting equipment.

A Missionary group owns and operates a FM broadcasting station KRST for religious programs, the frequency band is 88.5 MHz and the output is 1.7 kW.
Local companies own and operate 2 other FM broadcasting stations KRFM, the frequency band 88.9 MHz owned by KR center, and WWFM, the frequency band 89.5 MHz worldwide.
Assigned broadcasting frequencies to the above 4 FM stations are close to each other, in spite of the allowable frequency band range of 88-108 MHz.

CATV Services

PNCC is part owner of a cable television station ICTV (Island Cable Television), which carries CNN and NHK news and one-week late programs from TV stations from the San Francisco and Los Angeles areas of California.
The ICTV service area is limited at present within Koror and Airai States. Expansion of the CATV service to other states is possible through utilization of the recently installed nationwide undersea fiber optic cable system.
About 3,500 CATV subscribers receive 30-channel TV broadcasting services, 180 MHz band (30x6MHz) NTSC system, through connection to bury and aerial distribution coaxial cables (single direction).
Monthly charge is $28.00.

8.3.3 Challenges for PNCC

Continuous capital investment efforts are needed for PNCC to pursue significant and rapid changes in technology renovation, which requires the removal and revision of obsolete equipment, in order to maintain its network and to offer modern yet affordable services.
Services must be more cost reflective and must factor in today's global changes (i.e., impact of re-filing, callback and forced reductions in the settlement rates).
In the past, the local service rates were subsidized in attempts to offer affordable universal service. However, these global changes are pressuring PNCC into re-balancing its tariffs
Today's technology is electronic, software driven and constantly changing. Therefore, migration from the old antiquated network to a complex network with a myriad of sophisticated systems requires a substantial and continuous investment in re-training and education of technical personnel.
To stay connected to the global network and to meet new service demands, PNCC must consider frequent enhancements and upgrades to its existing infrastructure.
Determining a reasonable level of re-balancing versus domestic spending capacity will be the

challenge not only to PNCC, but also to all parties concerned.

(1) Organization of PNCC and Number of Employees

The PNCC was incorporated as a government corporation in 1982 by enactment of the ROP Public Law No. 1-40 (approved by the President of Palau on 23rd August 1982), to establish, provide and operate the existing government-owned telecommunications system. Said Law established the corporation's charter including operating conditions and parameters. PNCC was able to secure low-interest financing from U.S. Government. The corporation is managed by a general manager, who reports to a 5-member Board of Directors, whose members are appointed by the President of Palau with advice and consent of the Senate. PNCC is relatively autonomous in terms of the status of its income. Income of PNCC is not available to the ROP National Treasury, and therefore is not subject to being appropriated for supplementing the Palau National Unified Budget by the National Congress (OEK).

The number of employees of PNCC is 75 at present. Productivity of employees is 81.3 main telephone lines/employee. The world data reveals that the average productivity of 80 lines/employee at a telephone density of 10% and average productivity of 200 lines/employee at a telephone density of 50%. Because of the particular features of Palau, scattered islands with sparse population, PNCC pursues an effective maintenance method that the maintenance staffs are principally stationing at PNCC Headquarters and repair personnel will be dispatched from the HQ whenever and wherever trouble occurs. The majority of telephone subscribers are concentrated in the Koror and Airai State areas (about 85% of total subscribers). Therefore, the above mentioned maintenance system is judged to be appropriate.

(2) Recently Completed Projects Financed by RUS

Several years ago, PNCC secured a $39.1 million, long-term loan from RUS to rebuild and modernize Palau's existing telecommunications outdated infrastructure. RUS specializes in providing financial, technical and management assistance to utilities for infrastructure development. RUS provides traditional "asset based" financing. Pac's assets and revenues collateralize pac's loan. PNCC's infrastructure projects are built according to stringent specifications and standards established by RUS. RUS standards and specifications encompass buildings, material, equipment and systems; and are based on industry standards and codes (such as Bellcore, ITU, ASTM, TLA and ANSI) as well as transmission, central office and outside plant standards developed by RUS engineers.

(3) Financial situation of PNCC

PNCC's balance sheets for the period ending December 31, 1998 shows the corporation being capitalized at $52.2 million. Statements of earnings and retained earnings for the same period show total operating revenues at $6.4 million and operating expenses at $5.6 million. It is to be noted that PNCC has a $39,143,000 mortgage loan from RUS. Said loan bears interest at 4.59% per annum and is due November 2029 in monthly installments of variable amounts, including interests, beginning December 16, 1997. The loan is collateralized by substantially all PNCC assets and pledge of its revenues.

(4) Analysis of Present Conditions

Demand and Installed Capacities

GDP/capita of ROP is $7,222 in the year of 1997with about 35% telephone densities. On the other hand, GNP/capita of Saudi Arabia is $7,150 in the same year with 11.7% telephone density, GNP/capita of Korea is $10,550 with 44.4% telephone density and GNP/capita of Argentina is $8,950 with 19.1% telephone density.

ROP is positioned 10th from the top among 58 countries.

Satisfied Demand Ratio and Telephone Density are set as follows:

- Relationship between Satisfied Demand Ratio and Telephone Density
- Data have been assembled from 157 countries in order to analyze the relationship between satisfied demand ratio and telephone density. The countries for which telephone density exceeds 30% will have more than 95% satisfaction degree.

Mobile Telephone

A broad variety of relationships are observed between mobile telephone ratio and fixed telephone density. Malaysia, Lebanon, Kuwait and Brunei have high mobile telephone densities. Cambodia's ratio of 64% is particularly high which means the number of mobile telephones is more than that of fixed telephones. Table 8.3.3 shows the number of subscribers of each category in Japan in March 1999.

Table 8.3.3 No. of Telephone Subscribers In Japan In 1999

Category	No. of subscribers
POTS telephone	58,470,000
ISDN line	*4,000,000
Mobile telephone	41,530,000
PHS	5,780,000
Pager	3,770,000

Source: Information Communication Handbook 2000

Note: * the number of equivalent POTS telephones is 8,390,000

PNCC to Introduce a Mobile Telephone System

PNCC is now trying to introduce a cellular mobile telephone system covering most parts of the main islands and coastal areas of Palau, except far areas. The application of this mobile system will contribute to improvement of safety sailing of fishery and divers' boats moving along the coastal area of the islands. However, this system does not address maritime safety and distress rescue, which shall be distinguished clearly.
Four antennas will be built in the suitable locations to cover the above mentioned areas. An analog type mobile system is to be installed considering as first priority cost effectiveness and area size to cover.

In Determining Mobile Telephone Tariff System, the following aspects are considered:

- The number of mobile telephone users is rapidly expanding as a worldwide trend. Customers are not only business users, but use is also spreading to broad society and more to younger generations. The number of mobile telephones is becoming comparable to the number of traditional fixed telephone users in the world and the number of mobile telephone users still continues to increase.
- Therefore, the mobile telephone tariff system to be applied has to be carefully studied. In the urban areas, the meaning of carrying a mobile telephone is not only a good tool to increase the business opportunities and convenient, but also to show instant status symbol. Anyway, it is a great revolution in the field of communications; it belongs entirely to a personal communication system.
- Provision of cellular mobile system at highly populated areas, i.e., Koror and Airai, will be extremely important.
- On the other hand, people have already fixed telephones in their offices, as well as at their homes. Mobile telephone subscribers will be able to stand for imposition of higher rates of monthly basic and call charges, unlike is the case for fixed telephones.

International Fiber Optics Submarine Cable

It is good and sole opportunity to connect international circuits through fiber optic submarine cable transmission system called "Project Oxygen", having ultra high capacity with high quality of circuits. However, it is still necessary to confirm the possibility of realization of the project itself especially in the field of funding.

PNCC found recently that the required cost for routing the global fiber optic submarine cable via Palau is rather expensive. Therefore, PNCC is studying an alternative plan as a means to increase the number of international circuits through new 2nd earth station. The additional international circuits will mainly be used for Internet connections.

PNCC has increased in 1994 the number of international circuits from 24 circuits to 75 circuits. The present number of international circuit capacity is still able to manage the present level of traffic volume. Therefore, careful study to all aspects of requirements, i.e., demand increase trends of voice, data, Internet, in relation with the country's economic development trend and its development directions is earnestly required.

Re-assignment of the number of international circuits from voice channels to Internet channels may be required, in order to compete with the growth of the Internet users.

PNCC's Financial Condition

Prevailing tariff system of PNCC is shown in Table 8.3.4 to

As telephone subscriber class and service rate, tariff system consists of monthly, call and occasion bases shown in Table 8.3.4.

Table 8.3.4 Monthly Basic Charges

Class	Monthly charge	Smart call	Monthly charge
Residential line	11.00	Caller ID	4.95
Business line	22.00	*Call waiting	1.75
Monthly charge for Extension	2.50	*Call forwarding	1.75
Unlisted number	1.00	*Three-way calling	1.75
Non-published number	1.00	*Speed dialing-8 numbers	1.75
*Directory assistance (411)	0.50 per each	*Speed dialing-30 numbers	2.75

Source: PNCC
Note: * First five calls/month are free and any three or more services will be $1.50 each.

Table 8.3.5 Service Charge per Call (minute)

Area	Charge per call	Service	Charge
Domestic call	Free	Standard installation	20.00
International call		Reconnect	5.00
USA, Canada, Japan, China, Taiwan Philippines, Guam, Northern Marianas	1.50/minut	Transfer/Relocation/Extension	10.00
		Change number	5.00

Source: PNCC

As for Internet and e-mail service rate, tariff system consists of monthly, on-line, byte and occasion bases.

Table 8.3.6 Dial access service (E-mail, BBS, and Internet)

Service	Charge ($)
Dial access service	15.00
Connection fee	10.00
Internet "on-line" charges	0.24/minute
*File transfer charges	0.40/100KB
Web link	10.00 for initial setup/revision 5.00/month
Web Storage Site	10.00 for initial setup/revision 10.00/MB of data stored

Source: PNCC
Note: * subscribers will be given 7,200 credits/month for free (One credit equals one second or plus one kilobyte).

Table 8.3.7 Palaunet LAN connection service

Service	Charge ($)
Connection fee (Initial or reconnection)	500
Remote dial-in access from LAN to Palaunet	200/IP address
Number of Computers and IP Addresses	
1 to 5 computers	500
6 to 10 computers	650
11 to 20 computers	800
More than 20 computers	800 plus 40 per computer

Source: PNCC

Assumed Annual Revenue calculated from the above Charges

Assumed revenue consists of telephone monthly, international call, Internet monthly and Internet on-line and byte bases revenues.

Table 8.3.8 Estimation of Annual Revenue

Residential telephones	$11 x 4,200 sub x 12 = $554,400
Business telephones	$22 x 1,900 sub x 12 = $501,600
Smart call services	$4.50 x (1,900x0.6+4,200x0.3[1]) x 12=$129,600
Others (10% of tel.)	$1,185,600 x 0.1 = $118,560
Telephone monthly	$1,304,000
International	$(1.50/2) x (67circuits) x (average 17%[2] occupied) x telephone call charges (60 minx24hoursx365days) = $4,490,000
Internet monthly	$15 x 1,000 sub x 12 = $180,000
Internet on-line	$(1.10[3]/2) x (8circuits) x (average 24%[4] occupied) x (60 minx24hoursx365days) = $555,000
Others (10% of Internet)	$735,000 x 0.1 = $73,500
Internet total	$808,500
Total revenue	$6,602,500

Source: JICA Study Team

Note: Revenues from originating and terminating international calls are assumed to share equally by both originating and terminating carriers.

Assumed Annual Expenses

Assumed expenses are calculated by following simple formula:

Expenses = Operation and maintenance cost (3% of assets value) + General administrative cost (80% of operation and maintenance cost) + Depreciation + Interest payment:

- 3% of the installed assets is assumed operation and maintenance cost:
- $52,200,000 x 0.03 = $1,566,000
- General administrative cost is assumed 80% of operation and maintenance cost:
- $1,566,000 x 0.8 = $1,252,800
- Depreciation of the installed equipment for a period of 20 years:
- $52,200,000/20 years = $2,610,000Annual interest payment for loan balance is assumed $2,000,000
- Total assumed expenses is $7,429,000

Call Charges for Domestic Calls

At present domestic telephone call charges are not requested, even the calls between far islands. The free call charge system has following disadvantages:

- The equipment and transmission lines are not used effectively.
- Customers do not care to meaningless holding of the lines for a long period, long time talking and no hung up of telephone set without using the telephone.
- Accordingly, PNCC has to provide unnecessarily excessive number of equipment in order to avoid congestion of traffic without increase of revenues. Therefore, it is recommended to apply call-by-call charging system for domestic telephone calls. As an example, the following trial calculation is made based on a rate of call at $0.05/minute.
- Average number of telephone calls per subscriber per day and the total holding time in Japan is 4.1 times and 10.8 minutes/day. (12.4 minutes/day in UK, 10.2 minutes/day in France, 10.6 minutes/day in Germany and 26.2 minutes/day in USA, by Information Telecommunication 2000)
- If the call charge rate of $0.05/minute and holding time of 11 minutes would be applied for calculation, the increase of domestic call charge revenue should be:

[1] 60% of business subscribers and 30% of residential subscribers are assumed to have Smart services, three services combined.

[2] Average occupancy rate of international telephone circuits is assumed 17%.

[3] $1.10 = ($0.24/min on-line service) + $0.4 x 60sec/(100KB x 8bits/28.8kbps)

[4] Average occupancy of international data circuits is assumed 24%.

$0.05 x 11 min/day x 6,100 subs. x 365 days = $1,225,000.

Accordingly, the increased amount of revenues by means of adopting a domestic call system will be able to compensate the assumed amount of deficit.

Mobile Telephone Tariff System

An example of tariff calculation is shown for reference as follows:

- Average number of cellular calls per subscriber per day and the total holding time in Japan are 1.8 times and 2.9 minutes/day difficult to simply compare the level of tariff systems among different countries
- Now rather complicated tariff systems are applied in the world. It is, therefore following is an example of a simplified comparison regarding the level of tariffs in some countries.

Condition: destination within 160 km fixed telephone, 89 seconds holding time, No. of calls 63 at busy hour and 42 at off peak, destination more than 160 km fixed telephone, 152 second holding time, No. of calls 1.8 at busy hour and1.2 at off peak:

- NTT docomo: 1.00, AT&T wireless: 0.56, BT celnet: 0.93, T-mobile: 0.97, FT mobile: 0.49, Telia: 0.997
- If the monthly charge of $30.00 and call charge of $0.10/minute are assumed, and the number of mobile subscribers 1,000, 2,000 and 3,000 are assumed, the annual revenues will be calculated as: Monthly charge: $30 x 1,000/2,000/3,000 subs. x 12 months = $360,000/$720,000/$1,080,000
- If the holding time of 3 minutes is assumed, the call charge revenue will be: $0.10 x 3 min/day x 1,000/2,000/3,000 subs. x 365 days = $109,500/$219,000/$328,500

Therefore, the total annual revenues will be:

- $470,000 for 1,000 subscribers,
- $940,000 for 2,000 subscribers,
- $1,410,000 for 3,000 subscribers.

The amount of investment is $3 million according to PNCC.

8.4 Public Utilities

8.4.1 Water Supply

(1) Past Project related to Water Supply

Between 1993 and 1999, lots of projects for an improvement of the water supply system had been implemented in states at the Republic of Palau. Table 8.4.1 shows an implemented or an on going projects related to water supply. Therefore, all the communities in 13 states except Kayangel, Hatohobei and Sonsorol State have their own water supply system.

Table 8.4.1 Implemented or on-going project related to Water Supply

Project Name	Funded by	Project Cost ($)	Location (State)	Project Period	Status
Koror-Airai Water System Pretreatment Plant Design	DOI	350,000	Koror, Airai	Feb. 95-Oct. 95	Completed
Koror-Airai Water System Improvement	DOI	500,000	Koror, Airai	Jun. 94-Jun. 97	Completed
Koror-Airai Water System Improvement for water pre-treatment	ROP	3,750,000	Airai	May 96-Dec. 96	Completed
Palau Rural Water System Project	DOI	9,985,000 For 9 States 3,082,399.06	Ngatpang, Ngaraard, Peleliu, Sonsorol, Hatohobei, Kayangel, Angaur, Other 2 states	For 9 States Dec.91-Nov. 97	Completed
Koror-Airai Water System Improvement	DOI	486,827	Koror, Airai	Jun. 95-May 97	Completed
Ngerikiil and Ngeruluobel Water Pump	ROP	125,000	Airai	Sep. 98-Jul. 99	Completed
Rural Water Systems Project Ngardmau water system Imeyong water system Ibobang water system	ROP	1,500,000 191,500 235,000 420,000	 Ngardmau Ngeremlengui Ngatpang	1998-1999	 Completed Completed Completed
Water System Up-Grade	ROP	675,000	Koror, Airai	May 99-Jan. 00	Completed
Ngchesar Water System Project Phase I	ROP	333,079	Ngchesar	Mar. 99-Mar. 00	May 2000
Ngardmau Water System Project Phase II	ROP	220,000	Ngardmau	May 99-May 00	May 2000

Source: CIP Office

(2) Water Supply System

Table 8.4.2 shows the present water supply condition in the ROP.

Table 8.4.2 Existing Water Supply System In Palau (2000)

State	Population*	Production Capacity (m^3)	Water Demand (m^3) **	Source of Water	Treatment Installed
Koror/Airai	16,321	15,140	7,345	Surface	PR, F, C
Aimeliik	365	490	164	S	F, C
Ngatpang	213	490	96	S	F, C
Ngchesar	185	490	83	S	F, C
Ngeremlengui	240	490	108	S	F, C
Melekeok	180	490	81	S	F, C
Ngardmau	145	490	65	S	F, C
Ngiwal	141	490	63	S	F, C
Ngaraard	408	490	184	S	F, C
Ngarchelong	194	490	87	S	F, C
Peleliu	531	N.D.	239	Groundwater	C
Angaur	164	N.D.	74	G	C

Source: JICA Study Team
Note: PR=Pre-treatment, F=Filtration (rapid sand filter), C=Chlorination
* Estimation by JICA Study Team
** Population x 450lt/day x 1/1,000 (1gallon = 450lt)

Koror and Airai States

Koror and Airai State, as one service area with having population of approximately 16,320, are being supplied drinking water by the largest water supply system (Koror-Airai water supply system) in the ROP.

This system derives its water sources from Ngerikiil river diversion dam and Ngerimel Dam with a storage capacity of 75,700 m^3 (20 million gallons). The most important

source is Ngerikiil River with an average daily flow of 75,700 m^3 (20 million gallons).

This system consists of raw water transmission pipes, a water treatment plant, potable transmission mains, storages and distribution popes.

- Raw water transmission pipe: Two 12-inch diameter, 3.2 mile long from the Ngerikiil diversion dam pump station to the Ngerime Dam, and a 16-inch and a 12-inch diameter, 1.1 mile long from the dam to the Airai Water Treatment Plant (WTP)
- Airai water treatment plant (Capacity of water production: 15,140 m^3 per day): Pre-treatment facility (coagulation and sedimentation), Filtration facility (rapid sand filter), Flocculation & Clarifier Tank, Clearwell, Sludge Drying Yard
- Potable transmission mains and distribution pipes: Over 100,000 linear feet of transmission mains (12-inch and 10-inch diameter), distribution mains (8, 6 and 4-inch diameter) and smaller pipes for service connections
- 5 storage tanks with a total capacity of 15,140 m^3 (four million gallons): Three (Airai, Ngermid and Ngerkesewaol) 3,785 m^3 (1-milliongallon) and two (Arakabesang and Malakal) 1,893 m3 (0.5-million gallon). It was estimated that the volume of water consumed by about 16,320 persons was approximately 7,345 m^3 per day. Current volume of water produced at the Airai WTP was approximately 14,380 m^3 per day and was pumped into transmission lines. This volume of water is almost 2 times compare with the volume of water which almost all the people living in Koror and Airai State are estimated to consume in one day.

States in Babeldaob Islands

Small hamlets are located along a coastal line at Babeldaob Island. These communities in 9 states except Airai State derived their water source from dammed streams.

As mentioned earlier above, the community water system in these states have been improved. The improved water systems have features such as rapid sand filters, chlorination appurtenances and electric powered pumps.

Total of 2,071people in 9 states receive potable water from each water supply system. This system has an enough capacity of water production and distribution of about 490 m^3 per day.

Moreover, almost all the households in 9 states have water tanks to store rainwater. They prefer to drink rainwater rather than piped water.

Other States

Angaur, Peleliu Kayangel, Hatohobei and Sonsorol State have no surface water source. Communities with about 700 people living in Angaur and Peleliu State get chlorinated water from a water supply system used groundwater as a source. However, water from these systems is brackish. Therefore, this water is used only for washing clothes and bathing. People uses rainwater caught off house roofs and stored in tanks for drinking and cooking purposes.

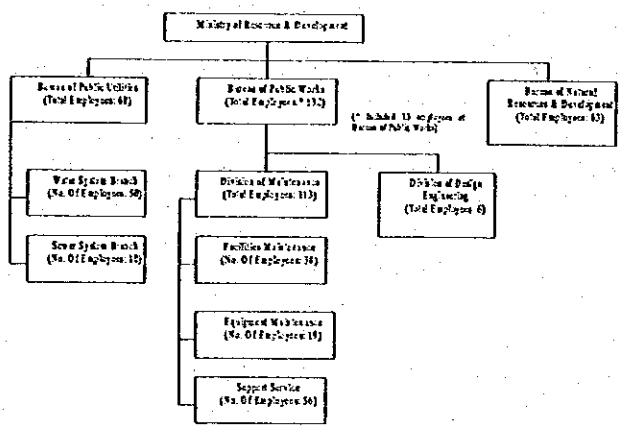
Communities in Kayangel, Hatohobei and Sonsorol State have no water supply system. Therefore, people in these states use groundwater from shallow wells for bathing and washing (this water is brackish) and mainly rely on rainwater for drinking and cooking.

(3) Operation and Maintenance

The Water Branch of Bureau of Public Utilities, within the Ministry of Resources and Development, is responsible for an operation and maintenance of the Koror-Airai water system. 21 persons are assigned for an operation and maintenance in the Water Branch

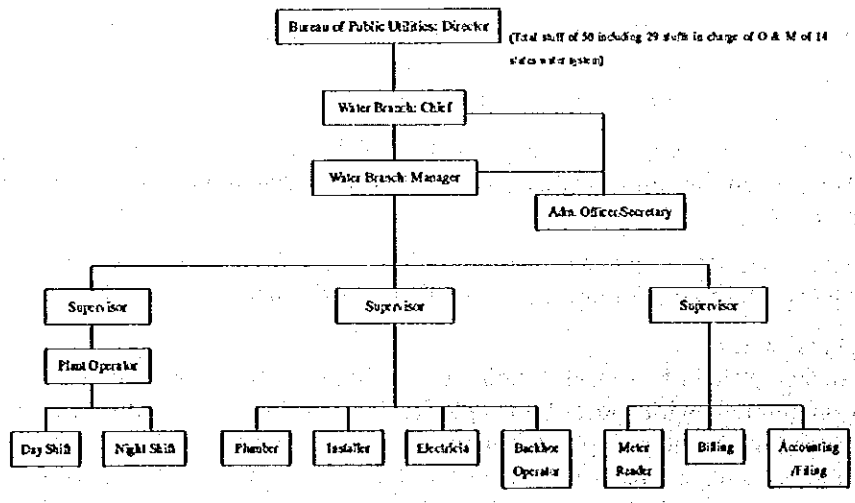
office in Koror. Water systems in the outlying states are also operated and maintained by the Water Branch of Bureau of Public Utilities. 29 operators are in other states to operate and maintain a water system (see Figure 8.4.1 & 2).

Figure 8.4.1 Organization Chart of Ministry of Resources and Development



Source: CIP Office

Figure 8.4.2 Organization Chart of Water Branch in Bureau of Public Utilities



Source: CIP Office

Budget for operation and maintenance of water supply system in FY2000 is shown in Table 8.4.3 below.

Table 8.4.3 Staff and Budget for Operation and Maintenance of Water Supply in FY2000

State or Area	No. of Staff	Total	Budget ($)	Remarks
Koror-Airai	21	50	1,280,000	Including $300,000 for purchasing chemical
Other States	29			

Source: CIP Office

Almost all potable transmission mains and distribution pipes have been constructed under roads. However, any drawing and maps of those lines are not provided at the office. Maintenance and connection works to houses newly constructed are implemented based on a memory of maintenance workers.

(4) Water Charge

The water charge for metered customers is 85 cents per 3,785lt (1,000 gallons) and customers who do not set a meter are charged a flat rate of $17 per month in Koror and $5 per month in Airai. Approximately 3,000 connections are within this service area, the majority of which are metered.

An amount of the water charge collected has been rapidly increased year by year recently. Approximately $660,000 was collected by the effort of people in charge of collection of the water charge in Koror-Airai at FY1999. However, this does not cover the cost for operation and maintenance of a water system.

Table 8.4.4 Amount of Water Charge collected by year

	1997	1998	1999
Water Charge collected ($)	202,000	378,000	660,000

Source: JICA Expert's Report (Water Supply Management in the ROP 1999)

Connectors in other states have no meter and are charged a flat rate of $5 per month.

Connectors without meter do not know how much volume of water has been used at each house. This is one of reasons water has to be produced exceeding the consumption volume estimated.

(5) Training

Training for water system operators had been implemented several times before.

In 1993, EQPB put on a three-day training for operators of the rural water system on a basic water quality, an operation and maintenance.

In 1994, EQPB, Bureau of Public Utilities, Palau Community College (PCC), and Operations and Maintenance Improvement Program (OMIP) continued developing the training programs in Palau. Various training covers basic science and math, operation and maintenance of small water treatment and distribution systems, regulations and monitoring.

In 1998, a training program for water operators was also initiated in PCC. 2 operators from Koror-Airai water system attended a 3-month training program in 1998. Rural operators received a training of 40 hours on small water systems and a computer training of 40 hours in 1999.

(6) Issues

Excessive Use, Metering and Charging

The Koror-Airai area has a population of about 14,000. It is assumed that about 1.7 million gallons in one day are consumed in this area, to follow the U.S. standard of water consumption per person per day of 120 gallons (455 litters).

The Airai WTP has an enough capacity of water production of 4 million gallons per day.

And currently, approximately 3.8 million gallons of potable water per day were produced at this plant. However, this volume of water produced and pumped into the transmission system could not be accounted for in total in the distribution system within the service area. 2.1 million gallons of water are not accounted, disappeared somewhere.

Leak of water, wasteful use of water by unregistered customers, and even malfunctioning of water meters contribute to the difficulty of accounting the total volume of water in the service area.

To consume water produced effectively, it is very important to reduce volume of leakage and excessive use. Therefore, it is needed to accelerate installing a meter at every connector and introduce a meter charge system. Furthermore, awareness activity not to use water wasteful is needed to customers. It will contribute to reduce production volume of water, operation and maintenance cost, and to increase collection of water charge.

Poor Maintenance of System

Several water meters had been set on water mains to control water transmitting. An automatic control valve had been put on at 4 storage tanks. However, these meters and valves have not worked for about 10 years because of damage and accident. Lack of skilled technicians and spare parts are major reasons.

Replacement of broken and damaged meters and control valves should be needed immediately. Constant training to staffs is very important to operate and maintain facilities properly.

Protection of Water Source

The construction of the Palau Compact Road was started at Babeldaob Island and will be completed by end of year 2003. Many people living in Koror and Airai State coming from states in Babeldaob will return to their home villages and commute to Koror when this project will be finished. This will accelerate many kinds of development such as new residential and commercial area developments and industrial developments in many states in Babeldaob.

Therefore, it will be very important to control any developing activity at upstream area of the water intake place not to be contaminated.

(7) Water Demand in future

Unit Water Requirement in future

As one water supply area, Koror - Airai area is supplied water. Volume of water needed per head per day was adopted US standard of 450lt (120gallons). Considering living style of Palauan people and industrial activity in Palau, this figure is too large. However, shortage of water volume supplied is sometime occurred because of leakage of water from pipes and wasteful use at each house. 450lt/head/day will be able to be reduced gradually to 250lt/head /day as facilities will be fixed and/or replaced and water will be used effectively.

Water demand per head per day in Melekeok and Peleliu State will increase because of New Capital Construction and New Resort Development. Volume of water per head per day of 150lt in Hatohobei and Sonsorol will be same even in the future. Volume of water per head per day in other 10 states will increase from 150lt to 200lt because future development will contribute improvement of living condition and change of living style.

Table 8.4.5 shows volume of water per head per day by state in future.

Table 8.4.5 Unit Water Requirement (lt/head/day)

State/Area		Original	2000	2005	2010	2015	2020
Koror	One Supply	450	350	300	250	250	250
Airai	Area	450	350	300	250	250	250
Melekeok, Peleliu		150	150	200	250	250	250
Hatohobei, Sonsorol		150	150	150	150	150	150
Other 10 states		150	150	200	200	200	200

Source: JICA Study Team

Hotel industry is the largest water consumer among the industries in Palau. Therefore, water demand for hotel is calculated separately.

Lots of visitor, with having different purpose such as conference, study, business, diving and site seeing, come and stay at various types of hotel in Koror-Airai area. Therefore, water demand per room per day of average 400lt is adopted. Melekeok will be a new capital, and therefore will have hotels for mainly conference. Ngarchelong State will be one of the tourist spots in Palau. Therefore, hotels in those two states will also need water volume of average 400lt/room/day. Village tourism development will be implemented in Ngatpang, and water of average 200lt/room/day will be necessary. There exist small hotels and/or inns, which require average 200lt/room/day in Peleliu at present. New resort area with several classes of hotel will be developed in the future and water demand will increase to average 400lt/room/day. Exclusive hideaway type resort will be developed in Kayangel and will need 600lt/room/day.

Table 8.4.6 shows unit water requirement of hotel in the future.

Table 8.4.6 Unit Water Requirement (lt/Hotel Room/day)

State/Area	Development Type	2000	2005	2010	2015	2020
Koror-Airai,	Commercial/Business	400	400	400	400	400
Melekeok	New Capital	0	0	400	400	400
Ngarchelong	New Tourism Spot	0	400	400	400	400
Ngatpang	Village Tourism	0	0	200	200	200
Peleliu	New Resort Area	200	200	400	400	400
Kayangel	New Resort Area	0	0	600	600	600

Source: JICA Study Team

Water Demand in future

Table 8.4.7 shows a future water demand by states up to year 2020.

A future water demand by state is calculated based on a future population projection and number of hotel room.

Water demand in Koror-Airai area is estimated to gradually decrease because of diminution of population and unit water requirement in future. However, Koror-Airai area will be the biggest water consumer in Palau even in future.

Water demand in Melekeok, Ngarchelong and Peleliu State will rapidly increase because of future development. A new water supply system should be developed in Peleliu before operation of hotels.

Water demand in Kayangel will also increase, however, private sector that will develop a resort area will provide water supply system and supply water to residents.

Table 8.4.7 Future Demand of Water (m^3/day)

(Unit: lt/head/day, lt/room/day)

Supply Area/State	2000 Population Hotel Ro.	2000 Unit	2000 Demand (m3/day) (m3/day)	2005 Population Hotel Ro.	2005 Unit	2005 Demand (m3/day) (m3/day)	2010 Population Hotel Ro.	2010 Unit	2010 Demand (m3/day) (m3/day)	2015 Population Hotel Ro.	2015 Unit	2015 Demand (m3/day) (m3/day)	2020 Population Hotel Ro.	2020 Unit	2020 Demand (m3/day) (m3/day)
Koror -	14,734			15,799			14,183			13,687			13,956		
Airai	1,587			1,506			1,610			1,691			1,764		
sub-total	16,321	350	5,712	17,305	300	5,192	15,793	250	3,948	15,378	250	3,845	15,720	250	3,930
Hotel Ro.	860	400	344	860	400	344	850	400	340	830	400	332	800	400	320
Total			**6,056**			**5,536**			**4,288**			**4,177**			**4,250**
Airnelik	365	150	**55**	354	200	71	361	200	**72**	413	200	83	426	200	**86**
Melekeok	180	150	27	1,264	200	253	1,746	250	437	1,795	250	449	1,799	250	450
Hotel Ro.	0		0	0		0	30	400	12	30	400	12	30	400	12
Total			**27**			**253**			**449**			**461**			**462**
Ngaraad	408	150	**61**	359	200	**72**	363	200	**73**	437	200	**87**	445	200	**89**
Ngarchelong	194	150	29	245	200	49	323	200	65	439	200	88	520	200	104
Hotel Ro.	0		0	30	400	12	60	400	24	90	400	36	120	400	48
Total			**29**			**61**			**89**			**124**			**152**
Ngardmau	145	150	**22**	143	200	**29**	146	200	**29**	164	200	**33**	170	200	**34**
Ngatpang	213	150	32	219	200	44	224	200	45	244	200	49	253	200	51
Hotel Ro.	0		0	0		0	20	200	4	25	200	5	30	200	6
Total			**32**			**44**			**49**			**54**			**57**
Ngchesar	185	150	**28**	171	200	**34**	174	200	**35**	207	200	**41**	213	200	**43**
Ngeremlemg	240	150	**36**	230	200	**46**	235	200	**47**	271	200	**54**	279	200	**56**
Ngiwal	141	150	**21**	129	200	**26**	132	200	**26**	157	200	**31**	162	200	**32**
Peleliu	531	150	80	645	150	97	2,046	200	409	2,606	200	521	3,027	200	605
Hotel Ro.	28	200	6	50	200	10	300	400	120	450	400	180	600	400	240
Total			**85**			**107**			**529**			**701**			**845**
Angaur	164	150	**25**	157	200	31	160	200	**32**	185	200	**37**	191	200	**38**
Kayangel	108	150	16	105	200	21	130	200	26	157	200	31	171	200	34
Hotel Ro.	0		0	0		0	20	600	12	30	600	18	40	600	24
Total			**16**			**21**			**38**			**49**			**58**
Hatohobei	41	150	**6**	38	150	**6**	39	150	**6**	46	150	**7**	48	150	**7**
Sonsorol	76	150	**11**	77	150	**12**	79	150	**12**	86	150	**13**	90	150	**14**

Source: Study Team

8.4.2 Wastewater

(1) Past Project related to Wastewater

Lots of projects for an improvement of the wastewater system in Koror had been implemented (Table 8.4.8).

Table 8.4.8 Implemented or on-going project related to Wastewater

Project Name	Funded by	Project Cost ($)	Location (State)	Project Period	Status
Wastewater System Rehabilitation	DOI	158,000	Koror (Malakal)	Feb. 89-Sep. 89	Completed
M-Dock Sewer Project	USA	262,293	Koror	Mar. 95-Dec. 95	Completed
Malakal Sewer System Project	USA		Koror	Mar. 95-Dec. 95	Completed
Koror Wastewater Systems Pump Station Up-Grade	DOI	483,000	Koror	Late 94-Dec. 97	Completed
Ngerkebesang Sewer System Improvement	ROP	170,000	Koror	1997	Completed
Sewer System Improvement	ROP	1,983,000	Koror	Oct. 96-Mar. 98	Completed
Babeldaob Sewage Treatment Study	ROP	300,000	States in Babeldaob	Proposed only	Not started
To connect private houses to the central sewer system	ROP	50,000	Koror	1997-1998	Completed
Koror Wastewater Deficiencies	DOI	654,000	Koror	91-Dec. 99	Completed
Echang Sewer System Project	DOI	671,600	Koror	Nov. 94-Jul. 99	Completed
Koror Sewer Treatment Plant Expan.	DOI	5,150,000	Koror	Mar. 98-Mar. 99	Bidding
Ngermid Sewer System Project	ROP	93,000	Koror	Jun. 98-Jun. 99	Completed
Koror Drainage	ROP	30,000	Koror (Malakal)	Jul. 99-Nov. 99	Completed
Koror Drainage	ROP	85,000	Koror	Aug.99-Feb. 00	Completed

Source: CIP Office

(2) Sewer collection and Treatment System

Koror State

The only one centralized wastewater (sewer system) existing in the ROP is operating in Koror State. The service area includes the three main islands of Koror, Arakabesang and Malakal that make up the State of Koror.

The existing system is comprised of gravity collector sewers, sewer force mains, sewer manholes, pump stations, lift stations, a sewer treatment plant, and an ocean outfall pipeline.

- Gravity collector sewers: over 22 miles
- Sewer force mains: 9 miles
- Sewer manholes: 600
- Major pump stations: 3
- Lift stations: 45
- A sewer treatment plant: a designed capacity of 3,785m^3 (1 million gallons) per day
- An ocean outfall pipeline: 2,000 foot length

Recently, there are approximately 2,000 service connections to the sewer system, consisting of residential, commercial, institutional and industrial facilities. However, more than 800 houses still do not receive the service.

Due to the topography of the service area, the majority of the gravity sewer systems are arranged in 41 satellite or regional collection areas where empty into their own individual sewage pump stations. These satellites pump stations and the three major pump stations pump the collected wastewater into the main sewer pipe. The main

sewer pipe then conveys the wastewater to the Malakal Sewage Treatment Plant (STP). At the plant, the water is treated and the effluent goes out through a sewage outfall leading from the plant into 60-foot deep water in the Malakal Harbor.

The Malakal STP was designed as a secondary treatment plant employing the trickling filter treatment process. It had been started operation in 1970s. Sewer collection system was designed as the sewerage of separate system. However, lots of rainwater flows into the system from manholes due to poor maintenance and shortage of drainage facilities. As a result, a volume of waste flew into the plant has exceeds the design capacity during every rainy seasons.

The Malakal STP has stopped its main function (secondary treatment) for years because of the poor maintenance due to the lack of skilled workers, the lack of adequate maintenance supplies, funding, and over capacity.

Other States

Rural Sanitation Program had been implemented by the financial assistance from the U.S. Environmental Protection Agency (EPA) to the ROP at outlying states several years ago.

As a result, houses and buildings in the outlying states have a new toilet system (flush toilet, septic tank, and leaching field) at present. However, a lot of houses and buildings are still using an old stile pit latrine. This facility is common breeding ground for houseflies, cockroaches and other vermin.

(3) Operations, Maintenance and Fee

Koror sewer system is a public utility operated by the Sewer Branch of the Bureau of Public Works, Ministry of Resources and Development (see Figure 8.4.3).

18 persons are assigned for an operation and maintenance in the Sewer Branch office in Koror.

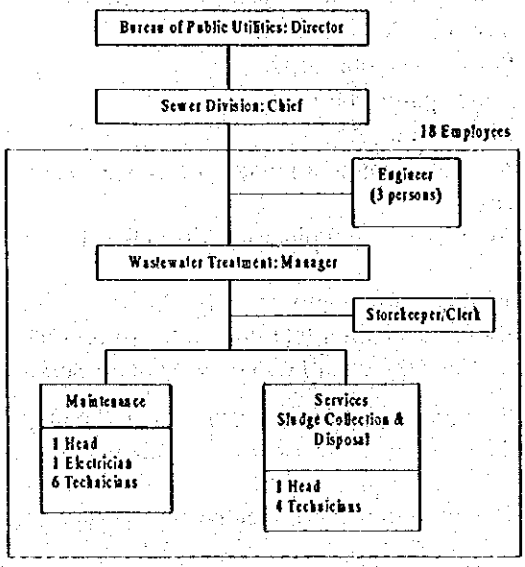
Table 8.4.9 Staff and Budget for Operation and Maintenance of Sewer System in 1999/00

State or Area	No. of Staff	Budget ($)
Koror Area	18	820,000

Source: CIP Office

There is no sewer charge system in ROP at present.

Figure 8.4.3 Organization of Malakal Wastewater System of Sewer Division



Source: CIP Office

(4) New STP Plan

To improve the existing STP situation and to expand its treatment capacity, the National Government and the Koror State Government respectively made a different plan on the new STP. They had discussed many times to reach a final conclusion on a treatment system and a location of a new plant. Finally, they selected integrated pond-mechanical-wetland wastewater treatment systems. This new system can treat average daily wastewater flows of 2.0 million gallons per day (MGD) and peak hourly flows of 5.3 MGD.

Currently, the National Government advertised for the bidding on the new STP and chose one company among three for the design-build.

The U.S. Department of Interior (DOI) funded the project cost of about $5.2 million.

(5) Issues

Expansion of Service Coverage in Koror
There still exist many households unconnected to the sewer system in Koror area. Design and construction of a new STP will be started soon. A capacity of this plant will be 2 times of an existing STP. Housing density in Koror is high. Therefore, to utilize a new STP and to improve a living environment in Koror, service coverage of wastewater should be expanded.

Poor Maintenance
A lot of rainwater run into the sewer pipes from manholes and flow into the existing STP because of improper construction of manholes and maintenance, and lack of drainage facilities. No engineer, poor technique and knowledge of maintenance on wastewater facilities, no well-developed data are contributing poor maintenance of facilities.

No User Fees
At present, connectors to the system in Koror are not charged for sewerage services. Appropriate user fee system should be considered and introduced for proper operation and maintenance of wastewater facilities in Koror.

Expansion of New Toilet System in Outlying States
Lots of projects for an improvement of sanitation (a new toilet system: flush toilet, septic tank, and leaching field) in the outlying states at the ROP had been implemented.

However, a few houses and buildings are still using an old stile pit latrine. This project should be continued.

(6) Future Wastewater Generation

Future Wastewater Generation
Volume of wastewater daily discharged is estimated same as volume of water needed per day.

Table 8.4.10 shows volume of wastewater generated by states in future.

Expansion project of an existing treatment plant in Malakal Island in Koror State is being implemented. Treatment capacity will be double (7,570m^3/day) in near future. This will be enough capacity compared with volume of wastewater generated in Koror State.

Airai State is one of the largest wastewater generators. However, volume of wastewater will gradually decrease in future.

Volume of wastewater daily generated in Melekeok, Ngarchelong, Peleliu and Kayangel State will increase rapidly because of a development such as a new capital construction

and a tourism development.

In other 10 states, volume of wastewater will be almost same or gradually increase in future.

Table 8.4.10 Future Wastewater Generation (m³/day)

(unit: kg/head/day, kg/room/day)

Generation Area	2000			2005			2010			2015			2020		
	Population Hotel Ro.	Unit	Generation (ton/day) (ton/day)	Population Hotel Ro.	Unit	Generation (ton/day)	Population Hotel Ro.	Unit	Generation (ton/day)	Population Hotel Ro.	Unit	Generation (ton/day)	Population Hotel Ro.	Unit	Generation (ton/day)
Koror (General Waste *1)	14,734	1.0	14.73	15,799	1.0	15.80	14,183	1.0	14.18	13,687	1.0	13.69	13,956	1.0	13.96
(*1 x 60%)*2			8.84			9.48			8.51			8.21			8.37
(*2 x 80%)			7.07			7.58			7.66			7.39			7.54
(*1 x 40%)			5.89			6.32			5.67			5.47			5.58
Hotel Ro.	860	2.6	2.24	860	2.6	2.24	850	2.6	2.21	830	2.6	2.16	800	2.6	2.08
sub total			15.20			16.14			15.54			15.02			15.20
Airai	1,587	1.0	1.59	1,506	1.0	1.51	1,610	1.0	1.61	1,691	1.0	1.69	1,764	1.0	1.76
Aimeliik	365	0.5	0.18	354	0.5	0.18	361	0.5	0.18	413	0.5	0.21	426	0.5	0.21
Ngatpang	213	0.5	0.11	219	0.5	0.11	224	0.5	0.11	244	0.5	0.12	253	0.5	0.13
Hotel Ro.	0		0.00	0		0.00	20	2.6	0.05	25	2.6	0.07	30	2.6	0.08
sub-total			0.11			0.11			0.16			0.19			0.20
Ngchesar	185	0.5	0.09	171	0.5	0.09	174	0.5	0.09	207	0.5	0.10	213	0.6	0.13
Melekeok	180	0.5	0.09	1,264	1.0	1.26	1,746	1.0	1.75	1,795	1.0	1.80	1,799	1.0	1.80
Hotel Ro.	0		0.00	0		0.00	30	2.6	0.08	30	2.6	0.08	30	2.6	0.08
sub-total			0.09			1.26			1.82			1.87			1.88
Ngeremlengui	240	0.5	0.12	230	0.5	0.12	235	0.5	0.12	271	0.5	0.14	279	0.5	0.14
Ngiwal	141	0.5	0.07	129	0.5	0.06	132	0.5	0.07	157	0.5	0.08	162	0.5	0.08
Ngardmau	145	0.5	0.07	143	0.5	0.07	146	0.5	0.07	164	0.5	0.08	170	0.5	0.09
Ngaraad	408	0.5	0.20	359	0.5	0.18	363	0.5	0.18	437	0.5	0.22	445	0.5	0.22
Ngarchelong	194	0.5	0.10	245	0.5	0.12	323	0.5	0.16	439	0.5	0.22	520	0.5	0.26
Hotel Ro.	0		0.00	30	2.6	0.08	60	2.6	0.16	90	2.6	0.23	120	2.6	0.31
sub-total			0.10			0.20			0.32			0.45			0.57
Total of Koror/Babeldaob			**17.82**			**19.91**			**20.16**			**20.05**			**20.48**
Peleliu	531	0.5	0.27	645	0.5	0.32	2,046	0.5	1.02	2,606	0.5	1.30	3,027	0.5	1.51
Hotel Ro.	28	2.6	0.07	50	2.6	0.13	300	2.6	0.78	450	2.6	1.17	600	2.6	1.56
Total			**0.34**			**0.45**			**1.80**			**2.47**			**3.07**
Angaur	164	0.5	**0.08**	157	0.5	**0.08**	160	0.5	**0.08**	185	0.5	**0.09**	191	0.5	**0.10**
Kayangel	108	0.5	0.05	105	0.5	0.05	130	0.5	0.07	157	0.5	0.08	171	0.5	0.09
Hotel Ro.	0		0.00	0		0.00	20	2.6	0.05	30	2.6	0.08	40	2.6	0.10
Total			**0.05**			0.05			**0.12**			**0.16**			**0.19**
Hatohobei	41	0.5	**0.02**	38	0.5	**0.02**	39	0.5	**0.02**	46	0.5	**0.02**	48	0.5	**0.02**
Sonsorol	76	0.5	**0.04**	77	0.5	**0.04**	79	0.5	**0.04**	86	0.5	**0.04**	90	0.5	**0.05**

Source: Study Team

8.4.3 Solid Waste

(1) Past Project related to Solid Waste

Table 8.4.11 shows implemented and on-going projects related to solid waste.

Table 8.4.11 Implemented and/or on-going projects related to Solid Waste

Project Name	Funded by	Project Cost ($)	Location (State)	Project Period	Status
To construct retaining wall/fence at Dump Site	ROP	50,000	Koror		Completed
Ngerbeched Dump Closure and Study	ROP	250,000	Koror, Aimeliik	Jul. 95-Jun. 98	Not yet May 2000
Solid Waste Management Study	DOI	55,000	Koror	Feb. 99-Oct. 99	Completed

Source: CIP Office

(2) Existing Legislation on Solid Waste

National Legislation

There is legislation in Palau. Title 24 of the Palau National Code (Environmental Protection) establishes the Environmental Quality Protection Board (EQPB) and gives the Board responsibility for a range of environmental protection functions, including solid waste management and pollution prevention.

The EQPB Regulations include regulations of the National Government concerning solid waste management.

The regulation include requirements for:

- Storage of solid wastes: 2401-31-04 to 08
- Conduct of solid waste collection operations: 2401-31-09 to 12
- Allocation of responsibility for solid waste storage and disposal: 2401-31-13
- Design and operation of solid waste disposal facilities: 2401-31-14 to 19
- Operation of transfer stations: 2401-31-20
- Allocation of responsibility for disposal of hazardous waste, design and operating requirements for hazardous waste disposal facilities: 2401-31-21
- A requirement for a permit for solid waste disposal facilities: 2401-31-23 to 33
- A requirement for a Solid Waste Management Plan, and
- A requirement of preparation of solid waste master plans to all states

State Legislation

Only Koror State has legislation on waste management.

Koror State Ordinance number K2-34-89 regulates waste as follows:

- Prohibition of littering on any state lands
- Dumping of waste to a designated dumping ground, and
- Prohibition of accumulating waste on private property

(3) Existing Solid Waste Management Practices

Solid waste collection and disposal system is one of the most important things to protect a natural environment of Palau. National Government and each state are responsible for collection and disposal of solid waste.

Collection System

Each State is responsible for the collection of the waste in Palau. Separate collection of waste is not implemented at any state.

In Koror State, the Public Works department of Koror State is responsible for the

collection and hauling of waste in the dump.

Currently, there are 5 stuffs in charge for the collection and hauling of waste and 5 garbage collection trucks what were purchased second-hand from Japan in Koror State. In addition, prison labors are utilized for garbage collection.

- 4 trucks with a capacity of 2,000 kg/4.1 m^3
- 1 truck with a capacity of 4,000 kg/8m^3

Waste from each hamlet is collected and dumped at the Ngerbeched landfill

Waste collection is conducted 4 days from Monday to Thursday in one week. Each household and some commercial premises can get a collection service once a week. However, a lot of commercial premises, such as WCTC, transport their own waste to the landfill.

Volume of the waste collected, hauled and dumped at the Ngergehed landfill site was estimated about 16 tones per day and running cost for the collection and haulage of waste were also estimated about $140,000 in 1999.

Many other states also have a collection system. In most states, waste is collected once a week from households using a pick-up or small tray-truck.

Disposal Practices

The Ngerbeched Dump is located in an area of former shallow reef and mangrove wetland adjacent to M-Dock in the hamlet of Ngerbeched in Koror State. The dump has an area of about 15 acres at present. The land is owned by Koror State.

It is said that the dumping of waste at this site has been commenced since late 1950s or early 1960s, but is unclear.

A marina, hotel, restaurant and tourist diving operation locate at southeast of the site at present. In addition, residential areas lie to the north and east of the site. The site is visible from the marina and dock area and from hotel rooms.

The Bureau of Public Utilities in The Ministry of Resources and Development operates the dumpsite. There are 5 full time workers (2 equipment operators and 3 staffs), one bulldozer and a loader at site.

Any kind of waste is disposed in this dump. Waste dumped in the site is not covered by any proper way, only bulldozed around. Therefore, this place is presently a breeding ground for flies, rats and other vermin.

Otherwise, other states have their own dumps and operate. However, a condition of dumps is not good because of unsuitable management.

As for Hazardous Waste Management, there is no formal government operated facility available for treatment, storage or disposal of waste oil and waste chemicals in Palau.

Waste oil is disposed of to the Aimeliik power station where it is filtered and mixed with fuel oil and burnt in the generators. The Aimeliik power station has reused an average of 45,000 gallons per year since starting operations in 1986.

Sewage Sludge from the Malakal WTP had been disposed of in a dedicated sludge and waste oil pit at the Ngerbeched dump.

(4) Existing Waste Reduction and Recovery Programs

Metals

A private company carries out the recycling of metal in Palau. This company purchases aluminum cans from the public and exports them to the US for recycling. Annual average of 44 tones/year was exported in 1997 and 1998. This was

approximately 25% of total aluminum can imported to Palau.

Solid Waste Composting Pilot Project

The EQPB has applied to South Pacific Region Environment Program (SPREP) for funding for a composting pilot project to be based in Koror. The project has been modified several times and the final proposal was submitted to SPREP for approval late in 1998. This project focused on a composting of green waste. However, the EQPB has not received the approval yet.

Food Scraps

A number of restaurants and fresh produce retailers save food scraps for use at commercial pig farms and individuals who keep pigs. The pig farmers/owners arrange collection of the food scraps, usually on a daily basis.

New Landfill Plan

Existing Ngerbeched Dump in Koror State has several problems.

- The site is over capacity
- The site is too close to a marina, hotel, restaurant, tourist diving operation and residential area.
- The site is presently a breeding ground for flies, rats and other vermin.
- Contaminated water from the site flows and/or leaches out to the surrounding sea.

To solve these problems, the National Government made a site location study for a new landfill and negotiated with Aimeliik State. Recently, one site was selected as a sanitary landfill (see Figure 8.4.4). This landfill site is expected to receive solid waste from Koror and 10 states in Babeldaob for 50 years.

Design and construction cost for a new landfill in Aimeliik is estimated about $2 million. However, this does not include an improvement of an access road from a new site to Compact Road what will be completed in 2003.

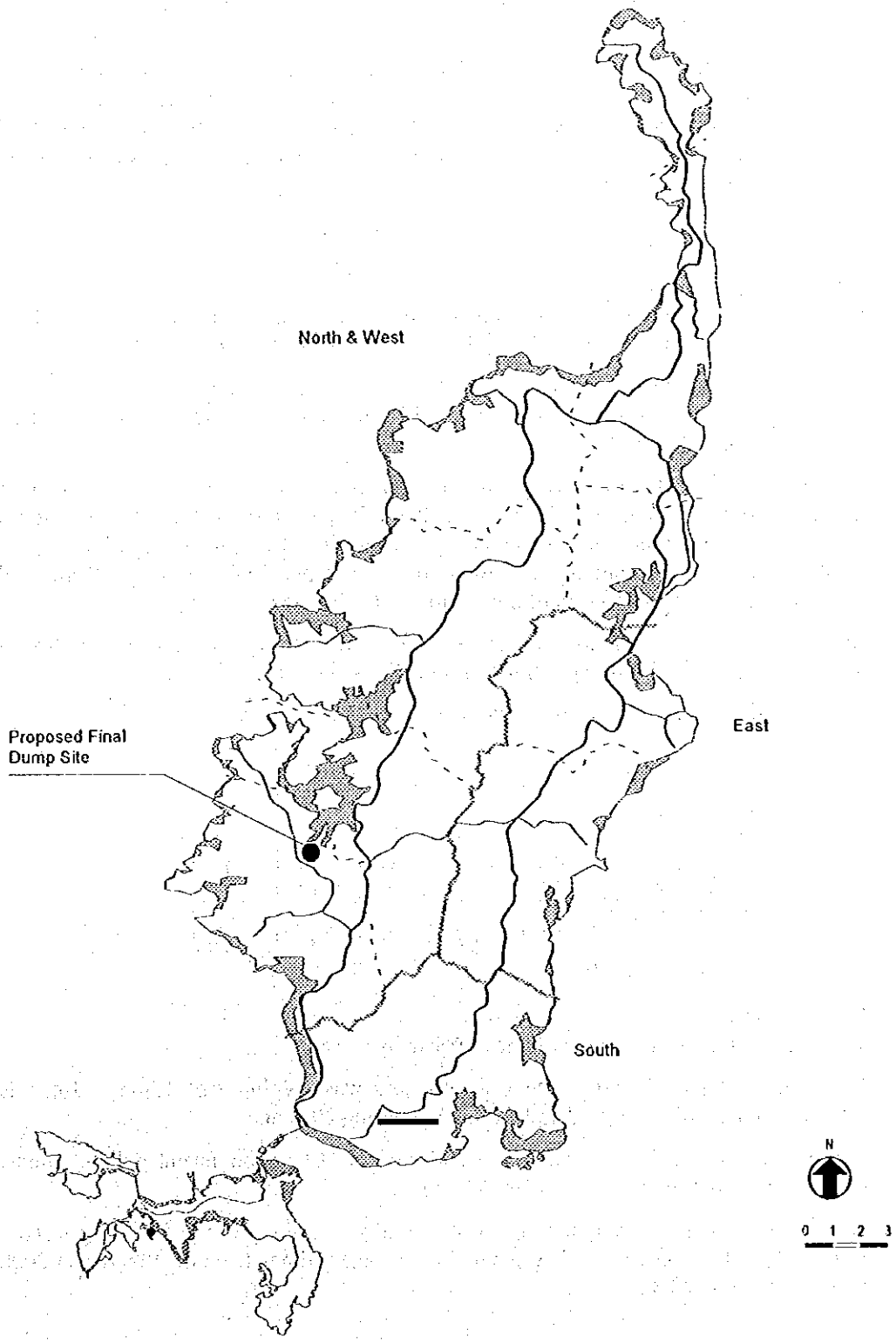
A final closure and post closure maintenance plan of Ngerbeched Dump was also made by the National Government in 1998. Existing landfill site will be closed when new one is constructed.

(5) Issues

Poor operation and maintenance of collection and haulage system and dump

Collection and haulage system does not work well in Palau because of shortage of staff and vehicle. All dumpsites in Palau are not operated and maintained properly because of shortage of knowledge on a dumpsite management, skilled worker. Every kind of waste is collected and hauled into dumps, and this makes environment of sites and surrounding areas very bad.

Figure 8.4.4 Location of Selected Final Dumpsite



Source: JICA Study Team

Closure of Existing Landfill

Existing dumpsite in Koror is almost full and there is no space to expand to the surrounding area. To keep urban and natural environment in Koror good condition, a closure of existing dump in Koror and a construction of a new dump at proper place should be considered as soon as possible.

There is no waste reduction system in Palau. Only one private company carries out the recycling of metal. Can collected is exported to US. This amount is not so big compared to the volume of can wasted in Palau. Palau is a beautiful but small island country. To keep this island beautiful and to save the land, reduction system of solid waste should be introduced in Palau.

(6) Amount of Waste in future

Waste Generation Unit

Waste generation unit is set based on the Integrated Solid Waste Management Plan conducted by Bureau of Public Works, the Republic of Palau, at June 1999.

Waste generation rate at Koror and Airai State is estimated to be 1.0kg/person/day. This includes 40% of waste generated by several business activities (restaurants, markets, stores, factories, offices etc).

A new capital construction project is now undergoing at Melekeok State. Present waste generation unit in Melekeok is small (0.5kg/person/day) same as other states because of a population size and no industry. However, after transferring of the capital to Malakal, waste generation rate will become 1.0kg/person/day same as Koror and Airai because of a rapid growth of population and industries.

Generation unit of municipal waste at other states at present is estimated to be 0.5kg/person/day, and future generation rate will also be same.

Hotel is estimated to generate waste volume of 2.6kg/room/day.

Table 8.4.12 Unit Waste Generation

State	2000	2005	2010	2015	2020
Municipal Waste					
Koror & Airai	1.0	1.0	1.0	1.0	1.0
Melekeok	0.5	1.0	1.0	1.0	1.0
Other states	0.5	0.5	0.5	0.5	0.5
Industrial Waste (Hotel)					
All states	2.6	2.6	2.6	2.6	2.6

Source: JICA Study Team

Waste Volume

Table 8.4.13 shows the future volume of waste by states.

Koror State is the biggest waste generator and waste volume of 15ton ~ 16ton is estimated to be daily collected and discharged during 20 years.

Volume of waste daily generated and collected in Babeldaob Island will be almost double from 2.62ton in 2000 to 5.29ton in 2020.

Daily waste volume in Peleliu and Kayangel will increase rapidly in future. Especially in Peleliu, generation volume is estimated to become 9 times from 0.34ton/day at 2000 to 3.07ton/day at 2020.

Table 8.4.13 Future Waste Generation

(unit: lt/head/day, lt/room/day)

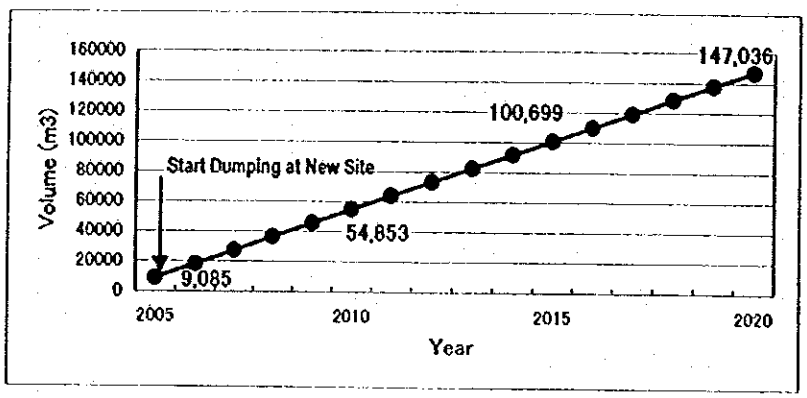
Generation Area/State	2000			2005			2010			2015			2020		
	Population Hotel Ro.	Unit	Generation (m3/day) (m3/day)	Population Hotel Ro.	Unit	Generation (m3/day) (m3/day)	Population Hotel Ro.	Unit	Generation (m3/day) (m3/day)	Population Hotel Ro.	Unit	Generation (m3/day) (m3/day)	Population Hotel Ro.	Unit	Generation (m3/day) (m3/day)
Koror	14,734	350	5,157	15,799	300	4,740	14,183	250	3,546	13,687	250	3,422	13,956	250	3,489
Hotel Ro.	860	400	344	860	400	344	850	400	340	830	400	332	800	400	320
sub-total			**5,501**			**5,084**			**3,886**			**3,754**			**3,809**
Airai	1,587	350	**555**	1,506	300	**452**	1,610	250	**403**	1,691	250	**423**	1,764	250	**441**
Aimeliik	365	150	**55**	354	200	**71**	361	200	**72**	413	200	**83**	426	200	**85**
Melekeok	180	150	**27**	1,264	200	**253**	1,746	250	**437**	1,795	250	**449**	1,799	250	**450**
Hotel Ro.	0		0	0		0	30	400	12	30	400	**12**	30	400	**12**
Ngaraad	408	150	**61**	359	200	**72**	363	200	**73**	437	200	**87**	445	200	**89**
Ngarchelong	194	150	**29**	245	200	**49**	323	200	**65**	439	200	**88**	520	200	**104**
Hotel Ro.	0		0	30	400	**12**	60	400	**24**	90	400	**36**	120	400	**48**
Ngardmau	145	150	**22**	143	200	**29**	146	200	**29**	164	200	**33**	170	200	**34**
Ngatpang	213	150	**32**	219	200	**44**	224	200	**45**	244	200	**49**	253	200	**51**
Hotel Ro.	0		0	0		0	20	200	**4**	25	200	**5**	30	200	**6**
Ngchesar	185	150	**28**	171	200	**34**	174	200	**35**	207	200	**41**	213	200	**43**
Ngeremlemg	240	150	**36**	230	200	**46**	235	200	**47**	271	200	**54**	279	200	**56**
Ngiwal	141	150	**21**	129	200	**26**	132	200	**26**	157	200	**31**	162	200	**32**
Peleliu	531	150	**80**	645	150	**97**	2,046	200	**409**	2,606	200	**521**	3,027	200	**605**
Hotel Ro.	28	200	**6**	50	200	**10**	300	400	**120**	450	400	**180**	600	400	**240**
Angaur	164	150	**25**	157	200	**31**	160	200	**32**	185	200	**37**	191	200	**38**
Kayangel	108	150	**16**	105	200	**21**	130	200	**26**	157	200	**31**	171	200	**34**
Hotel Ro.	0		0	0		0	20	600	12	30	600	**18**	40	600	**24**
Hatohobei	41	150	**6**	38	150	**6**	39	150	**6**	46	150	**7**	48	150	**7**
Sonsorol	76	150	**11**	77	150	**12**	79	150	**12**	86	150	**13**	90	150	**14**

Source: Study Team

Amount of Waste Volume in Koror-Babeldaob

Total waste volume of 9,085m^3 from Koror-Babeldaob is estimated to dump at a new final dumpsite in 2005. Accumulated volume of waste discharged to a new dumpsite from Year 2005 to Year 2020 will reach about 147,000m^3.

Figure 8.4.5 Accumulated Volume of Waste discharged



Source: JICA Study Team

Table 8.4.14 Amount of Waste Disposed

Generation Area		Unit	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Daily amount																			
Koror	Municipal Waste	ton/day	14.73	15.8	15.48	15.15	14.83	14.5	14.18	14.08	13.98	13.89	13.79	13.69	13.74	13.8	13.85	13.91	13.96
	Residential Waste (60% of Municipal Waste)	ton/day	8.84	9.48	9.29	9.09	8.9	8.7	8.51	8.45	8.39	8.33	8.27	8.21	8.25	8.28	8.31	8.34	8.38
	Business Waste (40% of Municipal Waste)	ton/day	5.89	6.32	6.19	6.06	5.93	5.8	5.67	5.63	5.59	5.55	5.52	5.48	5.5	5.52	5.54	5.56	5.58
	Collectable Residential Waste (80% in 2005 and 90% in 2010))	ton/day	7.07	7.58	7.61	7.64	7.65	7.66	7.66	7.6	7.55	7.5	7.45	7.39	7.42	7.45	7.48	7.51	7.54
	Public Collection Business Waste (20% of Municipal Waste)	ton/day	2.95	3.16	3.1	3.03	2.97	2.9	2.84	2.82	2.8	2.78	2.76	2.74	2.75	2.76	2.77	2.78	2.79
	sub-total 1	ton/day	10.02	10.74	10.71	10.67	10.62	10.56	10.49	10.42	10.35	10.28	10.2	10.13	10.17	10.21	10.25	10.29	10.33
	Privat Collection Business Waste (20% of Municipal Waste)	ton/day	2.95	3.16	3.1	3.03	2.97	2.9	2.84	2.82	2.8	2.78	2.76	2.74	2.75	2.76	2.77	2.78	2.79
	Industrial Waste (Hotel)	ton/day	2.24	2.24	2.23	2.23	2.22	2.22	2.21	2.2	2.19	2.18	2.17	2.16	2.14	2.13	2.11	2.1	2.08
	sub-total 2	ton/day	5.19	5.4	5.33	5.26	5.19	5.12	5.05	5.02	4.99	4.96	4.93	4.9	4.89	4.89	4.88	4.88	4.87
	sub-total 1	ton/day	15.2	16.14	16.02	15.9	15.78	15.66	15.54	15.44	15.33	15.23	15.13	15.02	15.06	15.09	15.13	15.16	15.2
		m3/day	30.4	32.28	32.04	31.8	31.56	31.32	31.08	30.88	30.67	30.46	30.25	30.05	30.12	30.19	30.26	30.33	30.4
Babeldaob Island																			
South	Airai	ton/day	1.59	1.51	1.53	1.55	1.57	1.59	1.61	1.63	1.64	1.66	1.67	1.69	1.71	1.72	1.73	1.75	1.76
		m3/day	3.17	3.01	3.05	3.1	3.14	3.18	3.22	3.25	3.28	3.32	3.35	3.38	3.41	3.44	3.47	3.5	3.53
West	Aimelik	ton/day	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.19	0.19	0.2	0.2	0.21	0.21	0.21	0.21	0.21	0.21
	Ngatpang (Residential)	ton/day	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.12	0.12	0.12	0.12	0.12	0.13	0.13	0.13
	Ngatpang (Hotel)	ton/day	0	0	0.01	0.02	0.04	0.04	0.05	0.05	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.08	0.08
	Ngeremlengui	ton/day	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.13	0.13	0.14	0.14	0.14	0.14	0.14	0.14
	sub-total	ton/day	0.41	0.4	0.41	0.42	0.44	0.45	0.46	0.47	0.49	0.5	0.51	0.53	0.53	0.54	0.55	0.55	0.56
		m3/day	0.82	0.8	0.83	0.85	0.88	0.9	0.92	0.95	0.97	1	1.03	1.05	1.07	1.08	1.09	1.11	1.12
East	Ngchesar	ton/day	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.1	0.1	0.1	0.11	0.11	0.12	0.12	0.13
	Melekeok (Residential)	ton/day	0.09	1.26	1.36	1.46	1.55	1.65	1.75	1.76	1.77	1.78	1.79	1.8	1.8	1.8	1.8	1.8	1.8
	Melekeok (Hotel)	ton/day	0	0	0.02	0.03	0.05	0.06	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
	sub-total	ton/day	0.18	1.35	1.46	1.57	1.69	1.8	1.91	1.92	1.94	1.95	1.96	1.98	1.98	1.99	1.99	2	2
		m3/day	0.37	2.7	2.92	3.15	3.37	3.6	3.82	3.85	3.87	3.9	3.93	3.95	3.96	3.98	3.99	4	4.01
North	Ngiwal	ton/day	0.07	0.06	0.06	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.08	0.08	0.08	0.08
	Ngardmau	ton/day	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.09
	Ngaraad	ton/day	0.2	0.18	0.18	0.18	0.18	0.18	0.18	0.19	0.2	0.2	0.21	0.22	0.22	0.22	0.22	0.22	0.22
	Ngarchelong (Residential)	ton/day	0.1	0.12	0.13	0.14	0.15	0.15	0.16	0.17	0.18	0.2	0.21	0.22	0.23	0.24	0.24	0.25	0.26
	Ngarchelong (Hotel)	ton/day	0	0.08	0.09	0.11	0.12	0.14	0.16	0.17	0.19	0.2	0.22	0.23	0.25	0.27	0.28	0.3	0.31
	sub-total	ton/day	0.44	0.52	0.54	0.56	0.59	0.61	0.64	0.68	0.72	0.75	0.79	0.83	0.86	0.88	0.91	0.93	0.96
		m3/day	0.89	1.03	1.08	1.13	1.18	1.23	1.28	1.35	1.43	1.51	1.59	1.67	1.72	1.77	1.82	1.87	1.92
Total of Babeldaob		ton/day	2.62	3.77	3.94	4.11	4.28	4.45	4.62	4.7	4.78	4.86	4.95	5.03	5.08	5.13	5.18	5.24	5.29
Total of Daily amount		ton/day	17.82	19.91	19.96	20.01	20.07	20.11	20.16	20.14	20.12	20.09	20.07	20.05	20.14	20.23	20.31	20.4	20.49
Daily incoming volume *1		m3/day	35.65	39.82	39.92	40.02	40.13	40.22	40.32	40.28	40.23	40.19	40.15	40.1	40.28	40.45	40.63	40.8	40.98
Daily disposal volume *2		m3/day	22.28	24.89	24.95	25.01	25.08	25.14	25.2	25.17	25.15	25.12	25.09	25.06	25.17	25.28	25.39	25.5	25.61
Daily covering soil volume *3		m3/day	3.34	3.73	3.74	3.75	3.76	3.77	3.78	3.78	3.77	3.77	3.76	3.76	3.78	3.79	3.81	3.83	3.84
Annual disposal volume		m3/year	8,132	9,085	9,108	9,130	9,155	9,176	9,198	9,188	9,178	9,168	9,158	9,148	9,188	9,228	9,268	9,308	9,348
Annual covering soil volume		m3/year	1,220	1,363	1,366	1,370	1,373	1,376	1,380	1,378	1,377	1,375	1,374	1,372	1,378	1,384	1,390	1,396	1,402
Accumulated waste volume		m3		9,085	18,193	27,323	36,478	45,654	54,852	64,040	73,219	82,387	91,545	100,693	109,882	119,110	128,378	137,686	147,033
Accumulated covering soil		m3		1,363	2,729	4,098	5,472	6,848	8,228	9,606	10,983	12,358	13,732	15,104	16,482	17,866	19,257	20,653	22,055
Total disposal volume		m3		10,448	20,921	31,421	41,949	52,502	63,080	73,646	84,202	94,745	105,277	115,797	126,364	136,976	147,634	158,338	169,088

Source: JICA Study Team

Note: *1=Total of Daily amount / 0.5ton/m3 (0

*2=Daily amount / 0.8ton/m3 (0.8ton/m3 is the apparent specific gravity of the disposal waste)

*3=Daily disposal volume x 0.15 (15% of the disposal waste volume is assumed as a required volume of the coverin

A new final dump in Babeldaob will be started the operating at year 2004

8.5 Electricity

8.5.1 Implemented and On-going Projects

Table 8.5.1 shows implemented and on-going projects related to electricity development. Existing situation on electricity in the Koror State and Babeldaob Island had been rapidly improved by several grant aid assistant projects by the Government of Japan.

Table 8.5.1 Implemented and/or on-going projects related to Solid Waste

Project Name	Funded by	Project Cost ($)	Location (State)	Project Period	Status
Koror/Airai Electrical Improvement	ROP	1,452,547	Koror, Airai	-	Completed
Outlying States Electrical Power	ROP	25,000	5 island states	Jul. 95-Oct. 95	Completed
Power Distribution Koror State-Phase I Ngchesar State-Phase II Melekeok, Ngatpang, Ngeremengui States -- Phase III	Japan	12,120,000	Koror, Ngchesar, Melekeok, Ngatpang, Ngeremlengui	1987-1999	Completed
Power Distribution IV Ngardmau, Ngiwal, Ngarrard, Ngarchlong States	Japan	25,000	Ngardmau, Ngiwal, Ngaraard, Ngarchelong		Completed
Outlying State Electrical Power System Project	ROP	5,145,000	5 island states	Jul. 99-Oct. 00	Complete in Nov. 2000

Source: CIP Office

8.5.2 Existing Condition

The Palau Public Utility Corporation (PPUC) and Bureau of Public Works generate almost all-electric power in Palau.

(1) PPUC

PPUC was established in 1994 to manage the electric power system of the ROP. This is an autonomous governmental entity that runs the Koror-Babeldaob electric power system as a utility power company.

Current Situation of Electric Power Generation

PPUC serves over 4,300 customers and supply electricity at present.

Table 8.5.2 shows current volume of electricity generated by PPUC.

Total production of electric power in 1999 was about 94,000 MwH. Almost all the people and building (over 4,300 customers) can receive electric power. The peak load demand of 14.5 Mw toke place in 1999. Power plants have enough generation capacity. However, technical/un-technical loss of about 21% is reported.

Table 8.5.2 Electric Generation Volume in Palau

	Generation capacity (MW)	Yearly Generation (KWH)	Hourly Generation (MW)
Malakal Power Plant			
1997/98	12.05	33,921,030	3.87
1998/99	12.05	38,180,132	4.36
Aimeliki Power Plant			
1997/98	12.80	53,370,760	6.09
1998/99	12.80	55,856,498	6.38
Total			
1997/98	24.85	87,291,790	9.96
1998/99	24.85	94,036,630	10.73

Source: PPUC
Note: Peak Demand in 1997/98 was 14.0 and in 1998/99 14.5

Existing Facility

PPUC has three diesel power generation facilities with total generation capacity of 24.85 megawatt (Mw) in the Koror-Babeldaob. The transmission and distribution systems include approximately 275 kilometers of line throughout the main island of Koror and the big island of Babeldaob.

- Aimeliik Power Plant: 4 x 3.2 megawatt (total 12.8 Mw)
- Malakal Power Plant: Old 3 x 1.75 megawatt (total 5.25 Mw), New 2 x 3.4 megawatt (total 6.8 Mw)

PPUC has a plan to install a new 5Mw generator at Malakal Station.

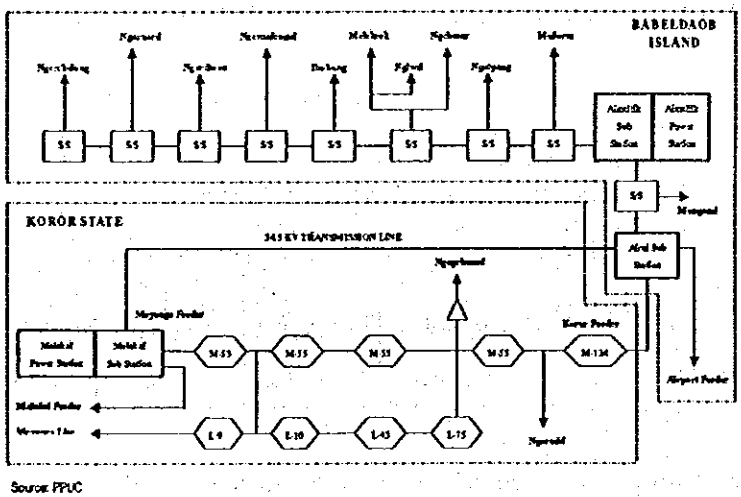
Existing Feeder System

There are 3 main sub-stations and 9 smaller sub-stations (235kva average) built to supply power to Koror and Babeldaob. The 3 main sub-stations are described as follows:

- The Aimeliik sub-station which is a 20mva step up transformer feeding Babeldaob and linked to Malakal sub-station with a 34.5kva line
- The Malakal sub-station has a buss capacity of 20mva and distributes at 13.8 kv through 2 feeders (Malakal and Koror South).
- All feeders from both Airai and Koror sub-stations have a 3 shot recloser on each feeder.

Figure 8.5.1 shows a distribution network of power in Koror and Babeldaob by PPUC.

Figure 8.5.1 Power Distribution Network



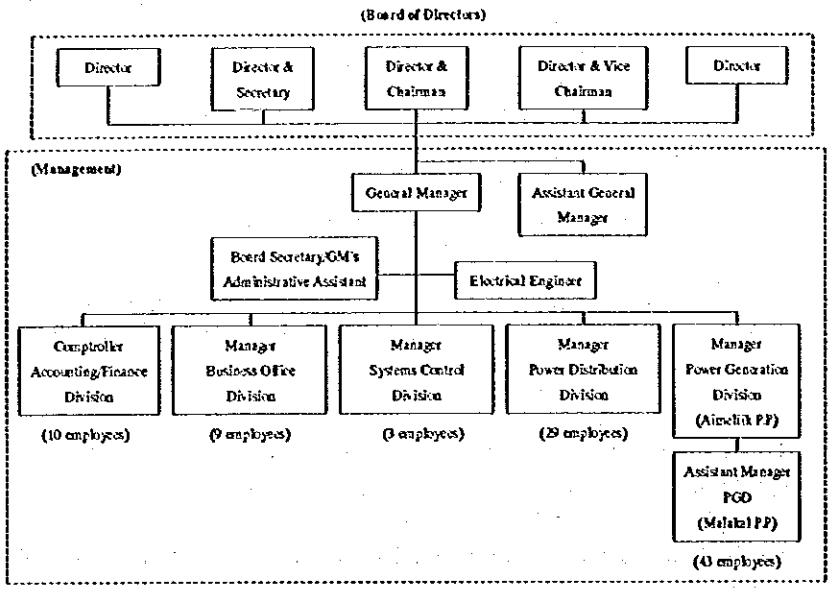
Source: PPUC

Organization

PPUC consists of mainly two organizations. One is Board of Directors and the other is Management. Board of Directors has 5 members who have vote. Management consists of 7divisions and has total 105 employees including one foreign engineer.

Figure 8.5.2 shows an organization chart of PPUC.

Figure 8.5.2 Organization Chart of PPUC



Source: PPUC

Implementation Plan of FY 2000

Table 8.5.3 shows an implementation plan of FY 2000 which has been approved by the Board.

Total operating expenditure of $11.2 million and revenue of $9.3 million in FY2000 are estimated by PPUC. They also estimate to generate electric power volume of 98,000Mwh. Distribution and supply volume will be 73,990Mwh because of loss of 24.5%. Customers will be charged average 0.151$/kwh.

Table 8.5.3 Implementation Plan of FY 2000

Operating Expenditures ($)	Revenues ($)	Generation Amount (Kwh)	Supply Amount (Kwh)	Cost per kwh Generated ($/kwh)	Cost per kwh Billed ($/kwh)	Remarks
11,194,663	9,307,843	98,000,000	73,990,000	0.114	0.151	Loss of 24.5% is estimated.

Source: PPUC

PPUC set up a new electrical service rates to improve their financial condition and applied to Congress to start a new service rates at April 01 2000. However, PPUC has not received approval yet.

(2) Bureau of Public Works

Bureau of Public Works is responsible for operation and maintenance of power plants in Peleliu, Angaur and Kayangel.

Peleliu will soon have two units of 750kw diesel generators and transmission/distribution system (Almost completed). This system will be handed over to PPUC in May 2000.

Angaur and Kayangel will have tow units of 200kw and tow units of 120kw diesel

generators respectively soon. These two sets of system will be transferred to PPUC in October 2000.

Budget for operation and maintenance of power plants in FY2000 is $252,000.