NO

BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR IMPROVEMENT
OF
INTERISLAND ACCESS ROAD
IN
REPUBLIC OF PALAU

MARCH 2004

JAPAN INTERNATIONAL COOPERATION AGENCY

NIPPON KOEI CO., LTD.
ORIENTAL CONSULTANTS CO., LTD.

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PREFACE

In response to a request from the Government of Republic of Palau, the Government of Japan decided to conduct a basic design study on the Project for Improvement of Inter-island Access Road in the Republic of Palau and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Palau a study team from October 30 to November 28, 2003.

The team held discussions with the officials concerned of the Government of Republic of Palau, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Palau in order to discuss a draft basic design, and as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of Republic of Palau for their close cooperation extended to the teams.

March 2004

Kunimitsu Yoshinaga
Vice-President

Japan International Cooperation Agency

March 2004

LETTER OF TRANSMITTAL

We are pleased to submit to you the basic design study report on the Project for Improvement of Inter-island Access Road in the Republic of Palau.

This study was conducted by the joint venture between Nippon Koei Co., Ltd. and Oriental Consultants Co., Ltd. under a contract to JICA, during the period from October, 2003 to March, 2004. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Palau and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

Finally, we hope that this report will contribute to further promotion of the project.

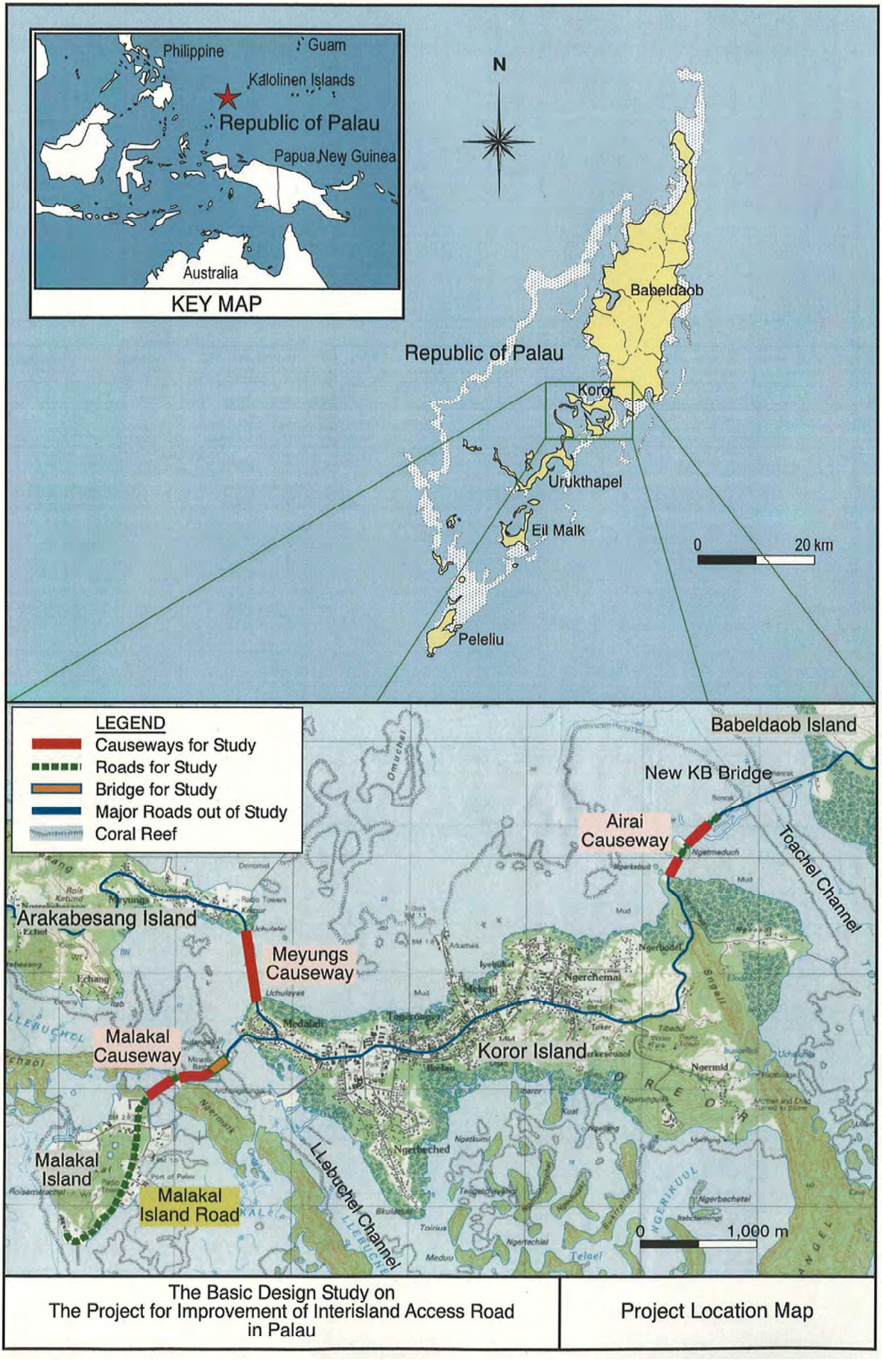
Very truly yours,

Koki Kaneda

Project Manager

Basic design study team on the Project for Improvement of Inter-island Access Road in the Republic of Palau

Joint venture between Nippon Koei Co., Ltd. and Oriental Consultants Co., Ltd.



The Basic Design Study on
The Project for Improvement of Interisland Access Road in Palau

Project Location Map

The Basic Design Study on The Project for Improvement of Interisland Access Road in Palau	Perspective of Improved Causeway (Meyungs Causeway)

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Abbreviations

AASHTO	American Association of State Highway and Transportation Officials
BAC	Bureau of Arts and Culture
B/D	Basic Design Study
BLS	Bureau of Land and Surveys
BMR	Bureau of Marine Resources
BPW	Bureau of Public Works
CIP	Capital Improvement Program
CW	Causeway
DDE	Department of Design and Engineering
DEIS	Draft EIS
EA	Environmental Assessment
EDP	Economic Development Plan 1995-1999
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EQPB	Environmental Quality Protection Board
FEIS	Final EIS
GDP	Gross Domestic Product
GIS	Geographic Information System
JICA	Japan International Cooperation Agency
KSG	Koror State Government
MOCCA	Ministry of Community and Cultural Affairs
MOCT	Ministry of Commerce and Trade
MOF	Ministry of Finance
MOJ	Ministry of Justice
MRD	Ministry of Resources and Development
NEPA	National Environmental Policy Act of 1969
NGO	Non Government Organization
NMDP	National Master Development Plan (2020)
NOD	Notice of Determination
NWB	National Weather Bureau
OEK	Olbil Era Kelulau
OP	Office of the President
PALARIS	Palau Automated Land and Resource Information System
PCS	Palau Conservation Society
PICRC	Palau International Coral Reef Center
PMDC	Palau Mariculture Demonstration Center
PNC	Palau National Code
PNCC	Palau National Communications Corporation
PPR	Palau Pacific Resort
PPUC	Palau Public Utilities Corporation
PVA	Palau Visitors Authority
ROP	Republic of Palau
S/W	Scope of Work
TNC	The Nature Conservancy

Summary

SUMMARY

Koror City is the capital of Republic of Palau with the population of about 15,000, and consists of Koror Island, where the major governmental offices and business facilities are concentrated, and parts of three islands of Babeldaob in the north, Malakal in the southwest, and Arakebesang in the northwest.

Palau has established the "Public Sector Investment Program (2003-2007)" in April 2003 as its national development plan for public sector. This Program gives the highest priority and urgency on the improvement/development project of metropolitan trunk roads.

The majority of existing trunk roads in the capital area were constructed during the former Japanese administration era. Although these trunk roads are still in services, damages of roads are remarkably progressing in recent years, due to the insufficient road structures to cope with the traffic volume, which shows rapid growth in these years, and latest vehicle size, which becomes bigger and heavier than before.

The four islands, which form the metropolitan area, are connected by bridge and causeways. As each causeway attaches public utilities of water supply, sewer, power lines and telecommunications, these are the lifeline of metropolitan, and given a quite important role to Palau. When the old KB Bridge, connecting Airai area and Koror, was collapsed in September 1997, Palau Government dared to declare the state of emergency. The causeways are having structural troubles such as collapses of bank slope protection, pavement depressions caused by the fill material loss due to suction behavior of tide, or self-collapse of culverts installed in causeways, which are beyond the affordable scale of repair by Palau. Thus, these lifelines, causeways, are still in critical conditions to cause serious affect on metropolitan activities by their sudden collapses. Furthermore, the existing narrow width of causeways is no more sufficient to cope with the recent traffic volume, reported as 6,000 to 10,000 vehicles per day, and running speed. Consequently, traffic accidents in the causeway sections are increasing.

Based on the above mentioned background, the Government of Palau requested the Government of Japan, in July 2002, to implement the improvement of urban roads in metropolitan area by Japanese Grant Aid system. The request was to cover the improvement of whole trunk roads, 17.4 km in total. In response to the request, the Preliminary Design Study Team was dispatched to clarify the section-wise urgency and priority of the proposed trunk roads. The Team identified the highest urgency and priority on the improvement of causeways among the requested sections, and recommended to implement the improvement of three causeways inclusive Minato-Bashi Bridge and Malakal Island Road through Japanese Grant Aid system.

Based on this recommendation, the Basic Design Study Team was dispatched to Palau, between October and November 2003, for site studies including topographic survey, geotechnical investigation, natural environmental survey, etc. The Study Team continuously

carried out the basic design study, project cost estimation, and prepared the Basic Design Study Report in Japan. In order to explain the study report and to get the concurrence of Palau, the Team revisited Palau between end of February and early March 2004.

The outline of scope of works and quantities to be implemented by Japanese Grant Aid, which was agreed between both Japanese and Palauan sides, are summarized in the following table.

Road Section	Airai Causeway	Meyungs Causeway	Malakal Causeway	Malakal Island Road	Minato Bridge
Length	0.73 km	0.67 km	0.51 km	1.63 km	0.08 km

Widening of Roadway Width	Common in all causeways and island road. Widen roadway width from the existing 7 to 8 m (with no sidewalk) to 13.8 m (for 2 roadway lanes and sidewalks both sides)				No widening.
Repair and Addition of Rock Mound Bank	9,000 m^3	8,800 m^3	4,800 m^3	-	-
Repair and Addition of Base Course (30 cm)	11,000 m^2	7,800 m^2	7,300 m^2	16,300 m^2	-
Placement of Pavement (10cm)	7,000 m^2	6,700 m^2	4,700 m^2	15,600 m^2	-
Installation of Sidewalks	3,040 m^2	4,750 m^2	2,650 m^2	-	36 m^2
Placement of Roadside Ditches					
U-type:	41 m	-	40 m	1,660 m	-
V-type:	164 m	-	164 m	1,220 m	-
Crossing Pipe :	-	-	-	66 m	-
Repair and Addition of Retaining Walls	-	-	-	2 locations 23 m & 13 m	-
Repair and Addition of Culverts	-	5 locations 106 m in total.	3 locations 64 m in total.	-	-
Repair of Bridge	-	-	-	-	Repair & Relocation /1
Installation of Traffic Safety Facilities					
Traffic Markings	280 m^2	250 m^2	220 m^2	610 m^2	-
Traffic Signs	4 pcs	1 pcs	4 pcs	4 pcs	
Installation of Public Service Facilities					
Water and Sewer Pipes	-	-	-	-	-
Electric Power Lines	-	-	-	-	-
Communication Conduit	730 m	670 m	510 m	-	-

/1: Substructure: Corrosion Protection on Steel Pier Columns and Repair of Cracks on Pier Head Beam

Superstructure: Relocation of Guardrails on Approach Slabs

On the execution of the design and the construction of this project, the followings are taken into consideration:

1. As the project causeways are located inside of coral reef, the surrounding sea of causeways is generally in calm conditions. However, treating the causeway as maritime structures, it was proposed to design causeways durable against the design wave height of 50 year return period.

2. The 2-lane road width was proposed as 9.6 m with 3.6 m wide travel lane and 1.2 m wide shoulder. This proposed road width is the same as the causeway of Compact Road, now under construction in Babeldaob Island by the Department of Interior, USA, and follows Palau design standards.

3. On the both sides of road, 1.2 m width of sidewalk was designed to ensure the safety of pedestrians and the safety of vehicles not to jump into the sea, while the vehicle running speed would be faster after the project completion. (Palauan side strongly requested to install only one side sidewalk and to install heavy concrete barriers on the both sides of causeway. However this request was not adopted by Japanese side with the reason that the such facilities would be requested for the protection of drunk drivers or speeding drivers, in addition to the facts that the application of Palauan request will need wider space of causeways and additional treatments for substructure reinforcement below concrete barriers, and would worsen the aesthetic view).

4. The culvert installed in the causeways, to ensure the free seawater flow, shall be expanded along with the causeway widening. The seriously damaged slabs shall be all replaced and the vertical walls shall be strengthened. The collapsed two culverts in Meyungs Causeway will be reinstated.

5. The local materials will be utilized for the construction as much as possible. The largest volume required in such materials is stones for the causeway bank slope protection of about 23×10^3 m^3. They will be supplied from the quarry in Malakal Island. The study was executed on aggregate materials for the pavement and concrete. The aggregate produced in Koror area has enough specific gravity, and slight deviation in water absorption ratio, abrasion ratio and stability for sodium liquid, from the requirement of international standards. As those deviations are not the subject of absolute requirement of international standards, it was finally decided to utilize these local materials for the Project with careful quality control, taking into consideration their usual usage in local projects, and the savings in the future maintenance cost.

6. Pavement thickness was designed to meet to the design number of axle load to be passed over the project life. Silty materials in the existing pavement will be replaced with coral aggregate, which was proposed to use for the base/subbase course, considering its strength under saturated conditions and availability of procurement in local market.

7. The repair of Minato-Bashi Bridge was proposed to focus in removing the rust of pile bent piers, filling of cracks on the pile bent cross beam, partial repair of retaining wall in front of abutments and relocation of hand-railing to widen the bridge approach area.

8. The improvement of street light system was not included in the Project. Because PPUA, the maintenance agency for street lighting, explained that the existing lighting luminance is reduced intentionally to save the maintenance cost. Moreover there are unsolved problems for the influence over the sea creatures in Japan due to the strong lighting near the sea shore.

9. The horizontal and vertical alignment of the project roads were proposed to keep the existing alignment as much as possible, as requested by Palauan side. However, as all sections of project roads will be widened to almost two times from existing width, the land acquisition is necessary at several areas, such as both ends of causeway or at the intermediate islands of causeways.

10. In the section of Malakal Island Road, down south from the 3-leg intersection of the Malakal Port entrance, it was judged that the traffic volume will be small even in future. Consequently, at these sections where available road width is not sufficient to provide the proposed standard design width, it is decided to allow narrower road shoulders to avoid additional land acquisition, if difficult.

11. Water main and sewer pipe embedded along Malakal Island Road, of which improvement was included in the original request of Palau, were investigated and judged in still sound conditions. Therefore, it was proposed not necessary to include in the Project.

12. During the causeway construction, the existing traffic will be managed as follows. First, the both side of the causeway will be widened to almost two times from the existing width, by bank slope protection works. Second, temporary traffic lanes will be established on the widened area and divert the existing traffic. Then, thirdly, the central area (exiting travel lane section) will be improved. Fourth, after the completion of central area works, the existing traffic will be allowed to drive the proposed travel lanes, and the final works for sidewalks will be carried out. By this traffic management, the construction will be continued without interruption of existing traffic flow.

13. To eliminate the sea water contamination due to the earth work during the construction, the construction area will be enclosed by two layers of silt fence. The causeway construction will be executed in two stages dividing the causeway into two sections in order to secure the crossing sea water flow through the culvert of under the causeway.

It is estimated 6 months for the detailed design, and 19 months for the entire construction.

Also, an approximate total project cost is estimated as 894 million Yen (790 million Yen to be borne by the Grant Aid of Japan and 104 million Yen by the Government of Palau).

As the Grant Aid Project is proposed to implement the improvement of most seriously damaged sections out of the originally requested roads as mentioned above, the drastic improvement of traffic accessibility and safety is expected after the completion of the Project. At the same time, the public service facilities (water supply and sewer pipes, and power lines) along the project roads will be improved and become more reliable and durable, for they are planned to be replaced with new ones by the Government of Palau along with the road improvement project. It is, therefore, expected to save the maintenance cost for both the road and the public service facilities.

Thus, the Project to improve the interisland road will contribute directly to attain the better living environment of 15,000 citizens in the metropolitan area. Moreover, the project is considered to contribute indirectly to the national finance of Palau, as the more comfortable interisland road transport would attract the more tourists, while the tourism is the major industry of Palau, and reported to have annual visitors of 50,000 currently. Thus, the Project is quite valuable to implement, and would contribute to celebrate the 10th anniversary of Palau's independence in 2005 as a symbol of the historic friendship between Japan and Palau.

The Government of Palau allocates around 540 million US dollars for the operation and maintenance cost of roads, total length of around 210 km, while the said costs currently allocated to the project roads of 3.62 km is estimated as around 25,000 dollars per year. As the improvement by the Project will remarkably reduce the required operation and maintenance costs for the project roads, it is judged that the Project implementation will not have any restriction of the financial status of the Government of Palau, except the unforeseeable budget disbursement against damages caused by the disaster.

The causeway will be improved as undivided 2-lane roadway, which has a capacity to accommodate traffic volume, up to twice of the present level, which will be a traffic demand of 10 years after. However, in accordance with the degree of traffic growth onward, it may be necessary to review the traffic capacity aspects. In such cases, widening of inland roads would be the must condition for the further improvement. For example, the further widening of Meyungs Causeway, more than 2 lanes, would have no meaning unless the improvement of Medalaii Intersection and even the roadway widening in inland built-up area. In Koror City, where flat area is limited, it is not easy to secure lands for road widening. Thus it is requested for the Government of Palau to establish a long-term development plan based on a steady land acquisition policy for public purposes.

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THE BASIC DESIGN STUDY
ON
THE PROJECT FOR IMPROVEMENT OF INTERISLAND ACCESS ROAD

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Chapter 1
Background of the Project

1. BACKGROUND OF THE PROJECT

The annual budget of Ministry of Resources and Development (MoRD), the executing agency of highway sector, was around 5 million US dollars, and is showing the almost constant allocation or even decrease in these years, due to the insufficient budgetary condition of the government after their independence. Therefore, it is possible for MoRD to carry out routine road operation and maintenance works, but is difficult to implement large scale of road improvement projects by their own budget. The deterioration of pavement structure and base /subbase course of existing road networks is progressing. Superannuation of pavement structures is remarkable especially in causeway sections, and even collapses are observed. It would be noted that the drainage system or road facilities such as sidewalks and shoulders are not sufficiently provided. It is observed that the provision of safety devices such as traffic signs or guardrails is also not sufficient. Further, there are many traffic accidents in causeway sections due to narrow carriageway width and lack of appropriate safety devices. At the same time, the number of vehicle registration shows the sharp increase in recent years which resulted in the increase of traffic volume and serious traffic jam.

In these situations, Government of Palau has requested to implement the improvement of trunk roads in metropolitan area by Japanese Grant Aid Program, in July 2002. The request includes comprehensive repair and improvement of metropolitan trunk roads of 17 km in total. In response to the application for Japanese Grant Aid, JICA dispatched the Preliminary Design Study Team to Palau, in March 2003, for the clarification of degree of road deterioration, necessity of improvement and priorities of section by section. The Study Team identified the priority and urgency of improvement for causeways of around 2 km which connect Koror Island to neighboring 3 islands (Babeldaob Island, Malakal Island and Arakebesang Island) and a trunk road of about 1.6 km in Malakal Island. Based on this study result, the scope of works for Basic Design Study was established, and, consequently, the study name was amended from the “Metropolitan Road (Koror & Airai) Improvement Project” to “Improvement of Interisland Access Road”

In November 2003, The Basic Design Study Team was dispatched to Palau.

When the Team explained the inception report and the policy of the study, Palauan side strongly stated that their highest priority was given to the improvement of trunk road in Koror urban area, and requested the inclusion of the said road section into the scope of Basic Design Study. The Study Team explained the policy of Japanese Grant Aid system, and the difficulty of inclusion of Palauan request into the scope of works. However the Team's explanation was not accepted by Palauan side. Therefore, the Minutes of Discussion was prepared to state the Palau request be conveyed to the Japanese Government, and agreed/signed by both sides on 5th November 2003.

After the return of Study Team to Japan, the meeting for the project policy decision was held between MoFA, JICA, and the Study Team to finalize the scope of works to be implemented by Japanese Grant Aid scheme. The meeting conclusion was informed to the Government of Palau, prior to the revisit of Study Team. The Study Team prepared the Basic Design Study Report, and visited Palau in late February 2004 to explain the results of the basic design study. Then, the Basic Design Study Report was accepted by the Government of Palau upon the decision of the President of Palau.

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Chapter 2
Content of the Project

2. CONTENTS OF THE PROJECT

2-1 BASIC CONCEPT OF THE PROJECT

The "Development of Trunk Road in Koror Urban Area" (Total length is around 17 km), which was originally applied for Japanese Grant Aid Program, is the one of the highest priority project in Palau's Public Sector Investment Program (PSIP), 2003~2007.

The project target of the development of trunk road in Koror urban area was identified by PSIP 2003~2007 as follows:

(1) Short Term Target : Urgent repair/improvement of damaged sections, inferior sections and other necessary sections of urban trunk roads in Koror/Airai area. Improve the road operation/maintenance ability by reinforcing maintenance equipments, such as road sweeper, ditch cleaner, mower for the slope, and etc.

(2) Medium and Long Term Target : Widening and improvement of three causeways linked to the Koror Island.

Due to the insufficient governmental budget, Palau has intended to implement the projects proposed in PSIP 2003~2007 through the assistances of foreign donor countries as introduced in Chapter 1-4.

In response to the Japan Grant Aid Application by Palau, the Preliminary Design Study Team was dispatched to identify the project scope. The team concluded the required objectives of Japanese assistance to improve three causeways and Malakal Island Road as illustrated in Figure 2-1. Three causeways were selected due to the urgent necessity to improve the structural collapse and inadequate traffic safety due to narrow roadway width. Malakal Island Road was selected to improve the drainage system which is currently not appropriate and causes traffic close during the heavy rain.

In relation to the "Development of Trunk Road in Koror Urban Area", it is noted that the Compact Road is now under construction in Babeldaob Island by Department of Interior, USA, with the project budget of US$ 113 million. Compact Road and "Trunk Road in Koror Urban Area" would be connected by Airai Link Road (estimated project cost: US$ 3.8 million). However the definite implementation schedule of the said Airai Link Road has not established yet, due to the financial restriction.

Palau Government also has a construction plan of Koror Coastal Road (required project cost: US$ 10 million), which will run northern coastal area, parallel to the existing

Koror trunk road, as shown in Figure 2-1.

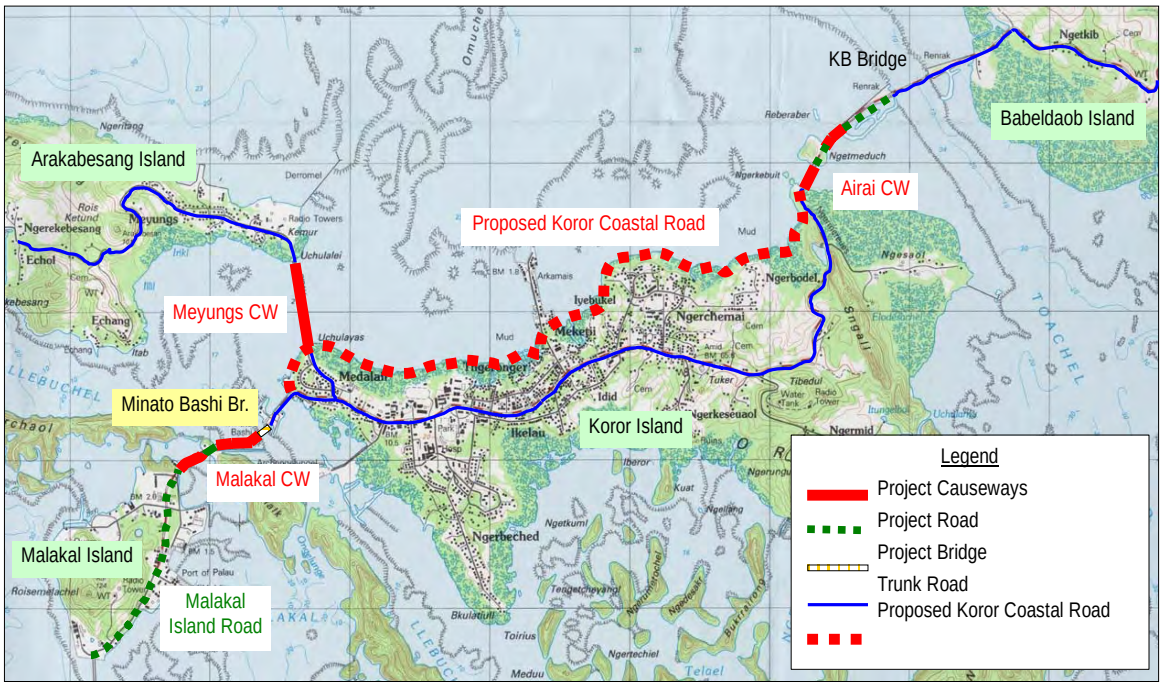


Fig. 2-1 General View of Project Area

In order to achieve the Public Sector Investment Program 2003~2007, the "Development of Trunk Road in Koror Urban Area" was intended to improve the urban trunk roads and causeways to enhance the traffic safety and provide enough traffic capacity to cope with the increasing traffic demand. It is expected to improve the durability of trunk roads, optimize the disbursement of operation/maintenance cost, improve the safety of both vehicles and pedestrians, and realize more smooth transport activities.

The Project by Japanese Grant Aid Scheme will assist the realization of "Development of Trunk Road in Koror Urban Area" by the implementation of improvement of causeways which are in danger of collapse, and of the Malakal Island Road with the rehabilitation of its drainage system.

2-2 BASIC DESIGN OF THE REQUESTED JAPANESE ASSISTANCE

2-2-1 Design Policy

2-2-1-1 Basic policy

The project objectives, three causeways inclusive Minato-Bashi Bridge and Malakal Island Road, were divided into subsections, and studied urgency and priority of each subsection as indicated in Table 2-1.

Table 2-1 Urgency and Priority of Subsections

Subsection No.	Subsection Name	Current Traffic Volume (vehicles/day)	Structural Damage	Pavement Conditions	Accident Ratio	Urgency
1	Airai causeway North/1	5,000		bad	high	high
2	Airai causeway South			partially bad	high	high
3	Meyungs causeway	9,000	very dangerous	very bad	high	highest
4	Minato-Bashi Bridge	7,000	need repair	fair	high	high
5	Malakal causeway North		need repair	fair	rather high	high
6	Ditto intermediate Is.			fair		low
7	Malakal causeway South			fair	rather high	high
8	Ditto Improved section/2			good	high	high
9	Malakal Is. Rd. North	7,000~5,000		partially bad		high
10	Malakal Is. Rd. South		2 landslides	partially bad		high

Notes, /1 : This subsection is not in the Scope of JICA, and listed for reference only.
/2 : This subsection is located in the west end section of Malakal CW South, and completed repair from May to October 2002. It is decided to exclude from the scope of the project to avoid the double investments.

The above evaluation in regard to the urgency and priority of each subsection was agreed on the meeting for the project policy decision, between MoFA, JICA, and the Study Team, in February 2004, and decided to implement the improvement of three causeways, inclusive Minato-Bashi Bridge, and Malakal Island Road by Japanese Grant Aid scheme, except subsections No. 1 and No. 8 in Table 2-1.

As for the basic policy of the project basic design, the following six aspects were taking into account.

1. To provide safety in roads/structures design.
2. To keep full attention on environmental issues and eliminate adverse influences to the existing environment by the Project as much as possible.
3. To minimize the required land acquisition for the Project.
4. To attain the full requirement of the Project with the least construction cost.
5. To apply practical and reasonable design criteria for the required functions of the Project.
6. To implement the Project with the least construction period, comply with Japan Grant Aid program operated under fiscal year basis.

In order to improve the main objective of the Project, "causeway", it would need the following three considerations:

a. Causeway bank slope shall have an appropriate height against the wave height of 50 years return period, and be protected by armour stone.
b. To design the improved carriageway width to meet the Palau's Trunk Road Standards, and to meet the required traffic capacity.
c. To provide sidewalks in order to secure the safety for both vehicles and pedestrians.

2-2-1-2 Design policies for natural conditions

1) Design policy for drainage system

The design policy of drainage for causeways and Malakal Island Road are as follows:

Causeways	Drain water from roadway surface will be discharged to the adjacent sea in a dispersed manner through PVC pipes, installed under sidewalk up to armour rock with appropriate intervals.
Malakal Island Road	The drainage system will be improved, as the existing system is not enough in capacity and not maintained well. The design rainfall intensity will be the value of 25 years return period. The drain water from island road will be discharged to the neighboring sea utilizing existing outlets.

2) Design policy against the potential area of landslide

There are two locations showing land slide trace on the road surface in southern hilly area of Malakal Island Road. It would be settled by the countermeasure with bench cut down to the sliding face, refill by selected material laying around every 20 cm thick with compaction, and stone masonry slope protection at sea side.

2-2-1-3 Design policies for social conditions

1) Minimize the land acquisition, relocation/demolition of buildings and facilities

There are no PAPs (project affected people) who are requested to relocate due to the Project. However, the widening of the existing road may need, in some extent, private land acquisitions. Therefore, the alignment design will be carried out in order to minimize the necessity of additional land acquisition for the Project, by following the existing road alignment as much as possible.

In the several areas of southern Malakal Island Road, it is quite difficult to widen

the existing road without large scale of land acquisition or demolition of existing properties, due to the steep terrain condition, or the existence of hotels close to the road. From the viewpoint of minimizing land acquisition/property demolition, it was allowed to reduce the roadway width from the proposed standard width by curtailing shoulder width or changing the side ditch dimensions, based on the following reasons:

a) As the south end of Malakal Island Road is dead-end, it was judged that both present and future traffic demand would be quite small compared with the other sections of the Project.
b) Malakal Island Road traverses steep hilly area in the southern section. The full road width construction requires considerable scale of cut/fill earth works which would possibly give adverse environmental impact on the area adjacent to the Project.
c) It is desirable to implement the project within available right-of-ways, and to avoid any private land acquisition activities at the area where hotels are located close to the both sides of project road.

It is noted that there is no historical or artistic monument, archaeologies affected by the project implementation.

2) Maintain the easy access between project roads and adjacent buildings/facilities

It was observed that the steep vertical alignment over the culvert at the south end of Meyungs Causeway would be better to improve, where the alignment forms a convex summit against adjacent approaches. The improvement will be achieved by setting smoother vertical curve along with the lowering of culvert height. However, as this culvert point is the only place where boats can cross under Meyungs Causeway, it is not possible to lower the culvert height from the viewpoint of keeping the present navigation clearance. Furthermore, the block-house of old Japanese army, located on the small hill top, adjacent to the south end of Meyungs Causeway, also makes the improvement of vertical alignment quite difficult.

Malakal Island Road traverses hilly area in the southern part of island, and has a section of steep vertical grade of around 10%. However, in order to maintain the current access condition between neighboring buildings/facilities and the project road, this steep grade was not changed to attain gentle vertical grade. It was judged that the application of 10% vertical grade to the project road is allowable, since AASHTO accepts 10% grade for a road with design speed of 50 km/h (Exhibit 5-4, Maximum Grades for Local Rural Roads, A Policy on Geometric Design of Highways and Streets).

3) Design of suitable road width to the existing traffic volume

It is necessary to design suitable road width for the current traffic volume of 6,000 to 10,000 per day on the project roads. (refer to chapter 1-1-1 and appendix)

4) Application of V-shaped side ditch

It was observed that the use of around a meter wide V-shaped side ditch is prevailed in Palau. In addition to the easy cleaning, V-shaped side ditch has a merit not to cause a wheel drop of vehicles. The Project also followed to apply this V-shaped side ditch to the sea side of Malakal Island Road and causeways in intermediate island section. For the section, mainly mountain side of Malakal Island Road, where the required drainage capacity exceeds V-shaped side ditch capacity, U-ditch was applied.

2-2-1-4 Design policies for local construction conditions

1) Utilization of pavement material by local products

In Palau, to open a new quarry site for aggregate, or new dredging site for coral, it is requested to make an environmental clearance by EQPB. As the process to obtain the EQPB's clearance may require a certain period prior to the commencement of construction works, it is not applicable for the Project implemented under Japanese Grant Aid system. Therefore aggregate and coral for the pavement works will be supplied from existing quarries and dredging sites through market basis. As coral has ample deposits along Palau coastal area, and shows stable and strong characteristics when compacted well, it is scheduled to use coral as a base course material.

Based on the comparative design study and cost comparison, it was proposed to apply an asphalt concrete pavement for the project road. However, as stated below, it is noted that the supply of asphalt mixture by the local supplier would be not stable, and the construction cost of cement concrete pavement is quite competitive, or sometimes cheaper than the asphalt paving in Palau. Since the Japanese Grant Aid Project is strictly required to keep the original construction period, it is recommended to leave the possibility of applying the cement concrete pavement for the causeway section, in order to make a smooth work progress, not suffered by the unstable or insufficient asphalt mixture supply. Malakal Island Road will be applied an asphalt concrete pavement only, due to the viewpoint of work efficiency with ample roadside spaces.

a. In Palau, it was found that the unit prices of asphalt concrete pavement and cement concrete pavement are competitively close, or sometimes cement concrete pavement shows cheaper price. This may come from the reason that every material for pavement works is imported material, except aggregates, and import price of bitumen is quite excessive. Table below shows the price comparison of asphalt

products between quoted price in Palau, Japanese price shown in "Construction Price" published monthly by Construction Research Institute, Japan, and, for reference, imported price to Palau from Taiwan.

Table 2-2 Price Comparison of Asphalt Products

Unit: US$

Price per Ton	Palau /1	Japan /2	Import /3
Asphalt Mixture	320.00	64.08	
Straight Asphalt	2,614.50	254.43	476.60

Remarks, /1 : Quoted price in Palau
/2 : Japanese price by Construction Research Institute, Japan
/3 : CIF price at Malakal Port imported from Taiwan

b. Palau will have concurrently three big scale projects of Compact Road Project (ongoing), International Airport Runway Improvement Project, and this project. The other two projects are scheduled to have their asphalt plants. Although it was studied to equip an asphalt plant for the Project, it was judged not feasible as the required quantity of asphalt concrete would be relatively small amount around 8,000 ton. There is one asphalt plant available in the project area, which is operated by the local contractor, Socio. It was judged that the production capacity, 50 ton/hour, of Socio's plant is mathematically enough for the project requirement. However when the pavement works of all project roads, three causeways and Malakal Island Road, happen to be overlapped, the supply of asphalt concrete would face the shortage.

c. It is assumed that the Project will be implemented by the Japanese main contractor having supporting staff/crew from local general contractors. Local general contractors, except Socio, are familiar with cement concrete pavement works, and their output is done in a satisfied level.

d. Local environmental NGOs recommend the cement concrete pavement as environmental friendly pavement.

2) Apply armour stone to the causeway bank protection

The superannuated causeway bank protection will be replaced with armour stone slope protection, utilizing rocks available to procure enough quantities in Palau. The armour stone slope protection will enhance the stability of widened project causeways.

Although endangered species of coral/mangrove were not found along the project causeways, the construction method, which will give no adverse impact to the existing environment as much as possible, will be selected. For this reason, inverted-T type retaining wall, instead of armor rock, will be applied at the Long Island side of Malakal Causeway to secure the area where living corals were observed.

2-2-1-5 Design policies for utilization of local contractors

Majority of registered 30 contractors in Palau are architectures. Number of contractors who is able to carry out civil work construction is quite limited. Taking into consideration such condition, the Project was aimed to design by applying general construction methods as much as possible. Table 2-3 shows the list of potential contractors possible to deploy for the Project.

Table 2-3 Major Contractors in Metropolitan Area

Contractors	Civil	Architect	Equipment Materials
Black Micro Corporation	⑥	⑥	⑥
Socio Micronesia Incorporated	⑥	⑥	⑥
Surangel & Sun's Construction	⑥	⑥	⑥
Fortune Investment & Dev't. Corp., Ltd	⑥		⑥
Palau Transportation Company (PTC)	⑥		
FR Construction Company	⑥		

2-2-1-6 Design policies for operation and maintenance ability of executing agency

Avoid increase of maintenance cost

The existing street lights along project roads are attached to power poles located in roadside. Intervals of these power poles are wider than the required one to get the specified luminance. It was also observed that the maintenance works seemed not conducted efficiently, as a number of light bulbs were left in out of order.

Although Palauan side requested the improvement of street light system, it was decided to exclude from the project scope, based on the following 2 reasons:

a. Renewal of street light will need the lighting post intervals of 30 to 50 m, if followed the Japanese specification, and will need an additional operation and maintenance costs of around $20,000 per year. It was informed by PPUC, who is the direct operator of street light and bear the operation and maintenance cost, that they are trying to reduce the cost expenditure, and lowering the luminance for that purpose. It is questionable that the improved street light system would be fully accepted by Palauan side.
b. The influence of bright luminance to marine creatures has not clarified yet, and adverse affect is suspected.

2-2-1-7 Design policies for environmental considerations

Based on the review of preliminary report, the results of the field survey, and the comments from the related agencies, identification of environmental impacts and the mitigation measures are summarized in Table 2-4.

Table 2-4 Environmental Impacts and Mitigation Measures

Environmental Impacts	Mitigation Measures
Before Construction (Design Stage)	
Encroachment to private property and historic/cultural sites	➢ To minimize the impact on properties and ensure a peaceful land acquisition
Water contamination due to runoff water on causeway	➢ Adopting adequate runoff drainage system
Temporary yard for stockpiling	➢ To plan the location of the temporary yard for stockpiling at the area as near as possible to the Project site in order to minimize the negative impact along the road
Impact to aquatic life by widening of road	➢ To consider the condition of the habitat along the causeway (especially at the south side of the Malakal causeway the corals grow well and "Long Island Park" is located) ➢ To apply an appropriate causeway bank protection, such as armour stone, which would provide living spaces for marine creatures, in addition to the causeway structural stability.
Construction Stage	
Air pollution/Noise/Vibration	➢ Equipment and machinery with air pollution control and noise dampening devices that are operating correctly. ➢ Vehicles transporting sand and soil shall be covered with a tarpaulin. ➢ The operation of heavy equipment in daylight hours. ➢ Spraying of bare areas with water. ➢ Equipment with scheme for excessive noise control.
Spoil and Construction Waste Disposal	➢ Estimate the amounts and types of spoil and waste. ➢ Investigation of reusing of waste. ➢ Designated appropriate disposal sites.
Damage to aquatic life (corals and mangroves) caused by siltation	➢ Installation of silt curtains with floats to enclose the construction site, in order to prevent damages to aquatic life by siltation. ➢ Instead of armour stone, provide retaining wall structures at Long Island Park side of Malakal causeway, where no direct storm wave is expected, to minimize the adverse affect to living corals and mangroves, although no endangered species are observed.
Water contamination by accidental oil spills from construction equipment	➢ Proper construction management such as training of operators, labors and workers shall avoid oil pollution of water bodies by operating the construction equipment. ➢ Providing spill kits and training in their usage for construction personnel.
Traffic condition	➢ Installation of traffic warning signs. ➢ Information dissemination in densely populated areas. ➢ Assign traffic man. ➢ Introducing traffic rerouting schemes for the construction. ➢ Planning stock piling area at nearest place to the site to avoid traffic jam.

2-2-1-8 Design policies for setting of facility grade

1) Follow Palau Trunk Road Design Criteria

As the project roads are major trunk roads running through the main four metropolitan islands of Palau, it is understood that the road class of project roads would be within a category of primary national highways. Since the Compact Road, which is under construction in Babeldaob Island, seems to be in an equivalent road class, it was decided to apply the same width of carriageway (3.6 m) and shoulder (1.2 m) with the Compact Road. Figure 2-2 shows the typical cross section of Compact Road.

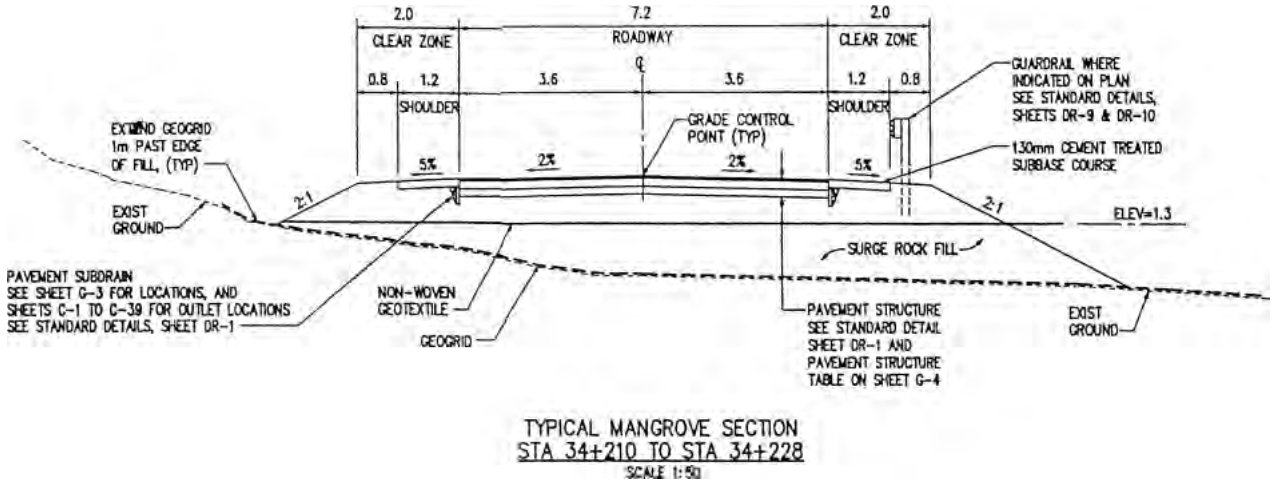


Fig. 2-2 Typical Cross Section of Compact Road (Sheet No. G-6)

Palau applies AASHTO design standards. AASHTO specifies the carriageway width as 9 to 12 feet, and shoulder width as 2 to 12 feet. The 12 feet carriageway width is recommended by AASHTO to apply to the high standard highways, while the selection of shoulder width is recommended to decide based on the site conditions, traffic conditions, etc.

2) Achieve traffic safety

a) Design Speed

Although the present speed limit specified by traffic signs is 20 to 25 mph in the project area, actual driving speed in a Koror central area was observed around 5 to 10 mph. However, driving speed in causeway section was much faster due to its location in suburbs and structures not having any crossing roads. The traffic accident record shows that the occurrence of accident in causeway section is twice of that in inland roads. Taking into account that roads with high design speed (40 mph as requested by Palaun side) tend to result in higher speed driving, the design speed of 30 mph (≈50 km/h) would be recommended for the Project as same as those of KB bridge, to avoid the increase of traffic accidents due to the road improvement by the Project. This design

speed is the same value with the previous New KB Bridge Construction Project.

b) Median

Palauan side requested the installation of 1.6 m wide median strip, or 3.6 m wide open space for emergency traffic, in the middle of causeways. However the introduction of median will cause the difficulties in traffic operation when a traffic accident takes place on the divided 1 lane of the project road. For the ambulance or emergency vehicle operation, it was judged that the compulsory traffic rule for normal traveling cars to move roadside and halt would provide an enough space for the operation. Therefore, the project roads were designed as undivided 2-lane roads, with the provision of rib type centerline marker and road studs, which will prevent an abnormal drive by giving warning noise and vibration to the driver.

c) Sidewalks

In general, Palau has no sidewalk or has a sidewalk at only one side of road. However it was judged as necessary to deploy the sidewalk in both side of causeway, since drivers would be able to drive faster than before on the improved roadway, and would threaten the pedestrian safety if no sidewalk was installed.

As illustrated in Figure 2-3, the proposed side walk is 1.2 m wide with 10 cm thick cast in place plain concrete slab, and installed on both sides of armour stone slope protection top. The sidewalk at west side of Meyungs CAUSEWAY, where utility pipes (water main and sewer) are located, were designed to enclose pipes with plain concrete of 50 cm thickness in total. Utility pipes are to have sealing treatment prior to the concrete casting.

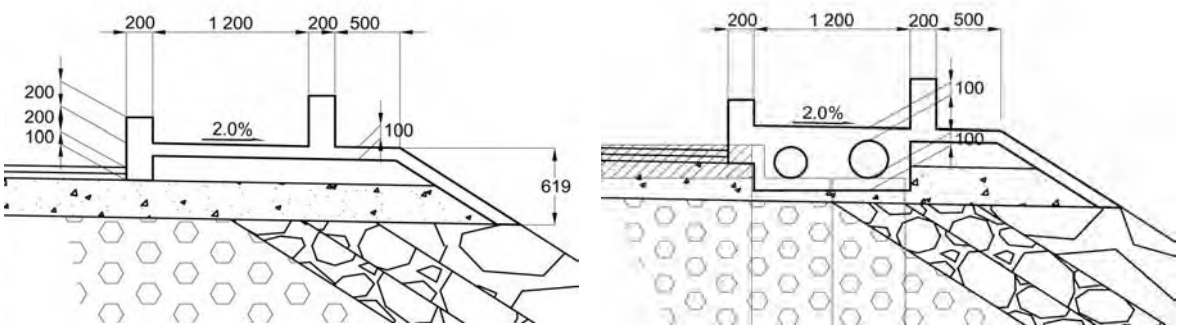


Fig. 2-3 Cross Section of Sidewalks (Left: General, Right: Meyungs causeway west side)

Malakal Island Road and intermediate islands in causeways have rather small number of pedestrians. In addition to this, there are spaces along the road where are passable for pedestrians. Therefore the deployment of sidewalks would not be necessary in these sections.

3) Consideration of maritime phenomena for causeway height

Palau consists of more than 200 islands, and the reef of Palau encloses all of the islands. Offshore waves, which developed at the sea area adjacent to Palau, reach the reef edge through diffraction and refraction, and then proceed on the reef flat deeply up to the shore decreasing their heights. Thus, as the reef forms the natural breakwater, surrounding sea waves of Palau is perennially calm. However, it was proposed for the causeway design to take into consideration the high tide of 50 years return period (DHT: Design High Tide), and probable maximum wave height (DWH: Design Wave Height), refer to Technical Standards and Commentaries for Port and Harbor Facilities in Japan, 1999.

The crest elevation of a causeway is determined by one of the following two principles, and method b) was selected from economic viewpoint. In case of b), the crest elevation of the causeway is calculated by summation of DHT and 60% of DHW.

Methods	Issues
a) To take the wave runup height as the reference and to set the crest of the causeway higher than the runup height so that no wave overtopping will occur.	There are some difficulties to estimate the proper runup technically as well as the possibility of unfeasible crest elevation economically.
b) The other is to take the wave overtopping amount as the reference and to set the crest of the causeway at such a height as to keep overtopping below some maximum tolerable quantity.	There are also some difficulties to estimate the rate accurately without hydraulic model tests because the wave-overtopping rate is affected by many kinds of factors. Furthermore, it is problematic to determine the allowable wave-overtopping amount.

Table 2-6 shows the estimated provable tides by return period in Palau based on the actual tidal record including astronomical tide and meteorological tide between 1985 and 2003. In the Project, 50-year provable tide of 2.83 m was defined as DHT.

Table 2-5 Provable Tides in Palau

Return Period (Year)	10	20	30	40	50
Non-Exceeding Provability (%)	90	95	97	98	98
Variable (rv)	1.52	1.73	1.84	1.92	1.98
Provable Tide Level (m)	2,722	2,772	2,799	2,818	2,831
Bench Mark Level (m)	1.17	1.22	1.25	1.27	**1.28**

With regard to the probable maximum wave height, 6.5 m was recorded in the offshore wave record of 37 years observation period. This maximum wave height of 6.5 m is decreased by the shallow reef flat, and DWH is estimated as 1.5 m in front of causeway when high tide sea depth is 2 m. Then, the required causeway crest elevation is estimated as 1.28 m (DHT)+1.5 m (DWH) x60%=2.2 m (bench mark level).

Average elevation of existing causeways is around 1.8 m, and lower than the proposed crest elevation of 2.2 m by around 40 cm. In order to attain the proposed causeway crest elevation, the project causeways were designed to raise the elevation (higher embankment), or to install parapet walls at outside of sidewalks to prevent wave overtopping.

2-2-1-9 Design policies for construction methodology/construction period

Minimize possible disturbance to the existing traffic during the construction

As the causeway section has no detour route at all, it is essential to secure appropriate scale of open spaces nearby the causeway construction site, to minimize the possible disturbance to the existing traffic during the construction. These open spaces will be used as a temporary yard for material stocking, or parking space cum turning point for construction equipments.

The way to secure such open spaces was planned as follows for each project causeway:

Airai Causeway :Working space used for KB Bridge is available with temporally construction office space, although they need some repairing work. There is a vacant space in an island, but the area belongs to private property and arrangement is necessary by the government of Palau.

Malakal Causeway :There is a vacant space (government property) in the Long Island.

Meyungs Causeway :As there is no appropriate space near the site, an island is planned to be constructed at the middle of causeway. The island is installed both side of existing causeway with 15m of radius and area of 350m2 as shown in bellow. This middle island will be useful to prevent further traffic jam at the Medalaii junction, and as a emergency parking space even after completion of the project.

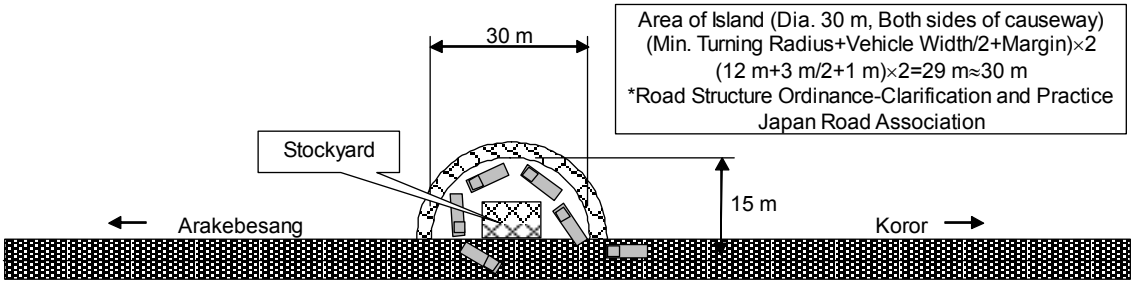


Fig. 2-4 Meyungs causeway Island for Construction

Traffic management during causeway construction

During the construction, the project causeways is expected to be opened to the public of around 6,000 vehicles per day. Therefore it was proposed to utilize widened portions as temporary access roads for the main road construction. As a result, the installation of sidewalks would be taken place after the main road construction.

2-2-2 Basic Plan

2-2-2-1 General Plan

The project road lengths are, based on the field topographic survey, as listed bellow:

Project Roads	Length
Airai Causeway Improvement and Widening	0.73 km
Meyungs Causeway Improvement and Widening	0.67 km
Malakal Causeway Improvement and Widening	0.51 km
Malakal Island road Improvement	1.63 km
Repair of Minato Bridge	0.075 km
Total length	3.62 km

Above mentioned works are analyzed by dividing as follows:

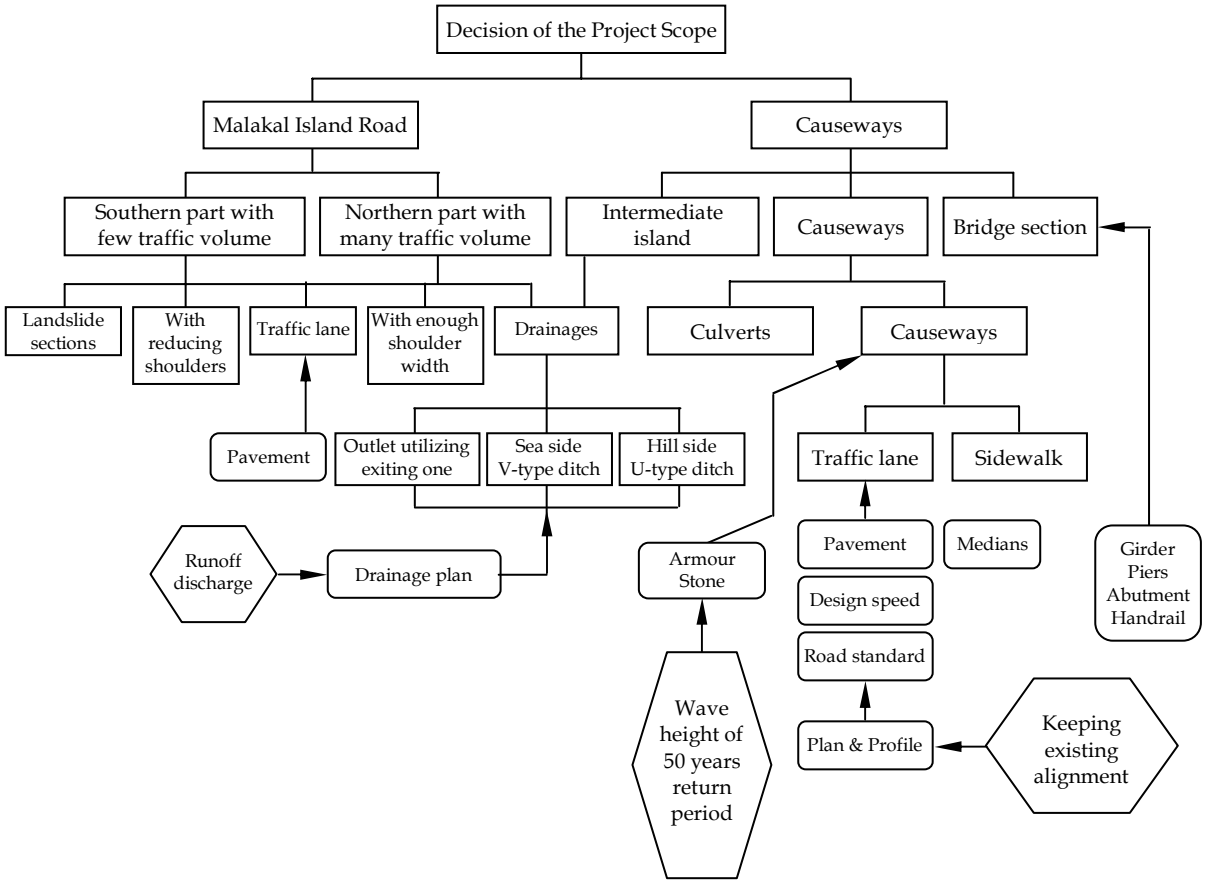


Fig. 2-5 Planning Flow of the Project

For the project basic design, international design standards as listed in Table 2-6 were applied.

Table 2-6 Applied Design Standards to the Project

Design Item	Applied Design Standards
Highway design	- A Policy on Geometric Design of Highways and Streets, 2001 - Japanese Road Structure Ordinance, 2003
Structural design	- Specifications for Highway Bridges, Japan Road Association, 2002 - Standard Design Drawings, Ministry of Construction, Japan, 2000
Pavement design	- AASHTO Guide for Design of Pavement Structures, 1986 - Manual for Asphalt Pavement, Japan Road Association, 1996 - Manual for Cement Concrete Pavement, Japan Road Association, 2000
Maritime structures	- Technical Standards and Commentaries for Port and Harbor Facilities In Japan, 1999
Utilities (water main/sewer pipe)	- Guidelines of American Water Works Association

2-2-2-2 Difference between Request of Palau and the Project

Table 2-7 shows the details of Palauan request by their original application to Grant Aid Assistance and items approved to implement by the Project.

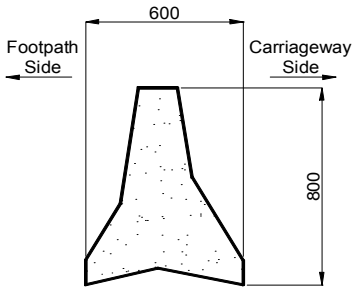
Table 2-7 Difference between Request of Palau and Basic Design Policy

No.	Requested Item (Total length 17 km)	The Project Total length 3.6 km
(i)	Repair of road surface cracks, potholes, etc.	Improve
(ii)	Repair of subgrade, subbase course and base course	Improve
(iii)	Widening of roadway where necessary /1	Widen
(iv)	Provision of sidewalk, guardrail and concrete barrier	Improve
(v)	Improvement of road drainage system (side ditch, cross drainage, catch basin, outlet, etc.)	Improve
(vi)	Junction improvement (incl. widening, sidewalk, traffic signal)	Not implement
(vii)	Provision of street light	Not implement
(viii)	Causeway improvement (widening, sidewalk, concrete barrier /2, guardrail)	Improve and widen
(ix)	Widening and repair of minato-bashi bridge, or replacement /3	Repair
(x)	Implementation of petromat and 5 cm thick asphalt concrete pavement	Improve
(xi)	Provision of road markings and traffic signs	Newly install
(xii)	Adjustment of utilities inclusive manhole covers, power poles, water main, telecommunication lines, etc./4/5	Not implement
(xiii)	Supply of road maintenance equipment	Not implement

Notes,/1: Culvert repair and extension

Side walls and top slabs of culverts (slab bridges), which were provided in causeways to ensure the sea current, are superannuated and damaged. It was recommended to repair at the time of extension works by replacement of top slabs and reinforcement of side wall with adding around 20 cm thick reinforced concrete. Furthermore two culverts in Meyungs Causeway, which were collapsed sometime back, will be reinstated to improve the adjacent sea water quality.

Notes,/2: Concrete barrier



Palau requested strongly to install continuously concrete barriers of 0.8 m high, 0.6 m wide and 2.4 m long with the weight of 1.5 t as illustrated in the right. It is understood that the barrier is required to protect accident vehicles from diving into adjacent sea water. However, according to the accident record maintained by Traffic Police, such serious traffic accidents were caused by over-speed, and/or drunk driving. It is expected to rectify such dangerous driving behavior by legal traffic rules with penalty, not by the installation of concrete barriers.

It was decided to provide common safety measures by the Project, not concrete barriers, based on the consideration on safety, landscape, construction costs, deemed to be appropriate and agreeable for the Project by Japan Grant Aid program. Common safety measures will include mount-up concrete curb between roadway shoulder and sidewalk (refer to the perspective of the project causeway in top page).

Notes,/3:Minato-Bashi Bridge

Based on the visual inspection of the bridge, it was judged that the substructures, and composite superstructure of main girder and deck slab are in structurally sound condition. Therefore the following repair works, instead of the replacement of bridge, will be adopted to enable the safe operation of the bridge.

- Repair of abutments
- Repair of corroded steel enclosing pile-bent piers
- Repair of lateral girder of pile-bent piers
- Extension of guardrail with roadway widening
- Widening of approach slab

Notes/4 Consideration on the existing utilities along the project roads

Water Mains/Sewer Lines

The existing water supply and sewer system in the project area are summarized in Table 2-8.

Table 2-8 Existing Water Supply and Sewer System in the Project Area

Road	Airai causeway		Meyungs causeway		Malakal causeway	Malakal Island	
Water Supply							
Length (km)	1.12		0.67		0.97	1.58	
Purpose	Trans-mission	Distri-bution	Trans-mission	Distri-bution	Distribution	Distribution	
Diameter (mm)	250	200	250	200	200	200	
Materials	DCIP	AC	SP	AC	AC	AC	
Pipe Installation	Under-ground	Under-ground	Exposing	Under-ground	Underground	Underground	
Construction Year	1991	1978-80	1991	1977-80	1977-80	1977-80	
Sewer							
Length (km)	-		0.67		0.97	0.97	0.60
Conveyance Type	—		Pressure		Pressure	Gravity	Pressure
Diameter (mm)	—		300		300	300	300
Materials	—		DCIP		DCIP	AC	DCIP
Pipe Installation	—		Exposing		Underground	Underground	
Construction Year	—		2001		-	-	-

Note) DCIP: Ductile Cast Iron Pipe, SP: Steel Pipe, AC: Asbestos Concrete Pipe

In the original application for Japanese Grant Aid, Palau included the improvement of water mains/sewer lines within the Project. However, based on the site reconnaissance and interviews with concerned agencies, it was concluded that the urgent repair works is not necessary at this moment. Palau has agreed to make a new application for Japanese Grant Aid to improve the present water main/sewer line networks.

Existing active water main and sewer pipe along Meyungs Causeway will be located in sidewalk portion of widened project road. It will be designed to accommodate these utility pipes under the sidewalk. Existing telecommunication lines (copper cable and optical cable) will be relocated by PNCC to the PVC conduit provided by the Project under the sidewalk.

Notes/5 Telecommunication lines

The existing telecommunication cables installed under the side of roads are to be re-installed, prior to the pavement construction, in the PVC pipes which will be installed by the Project under the sidewalk.

2-2-2-3 Facility plan

1) Proposed structure for causeway bank protection

a) The standard cross section of the causeway bank is illustrated in Figure 2-6.

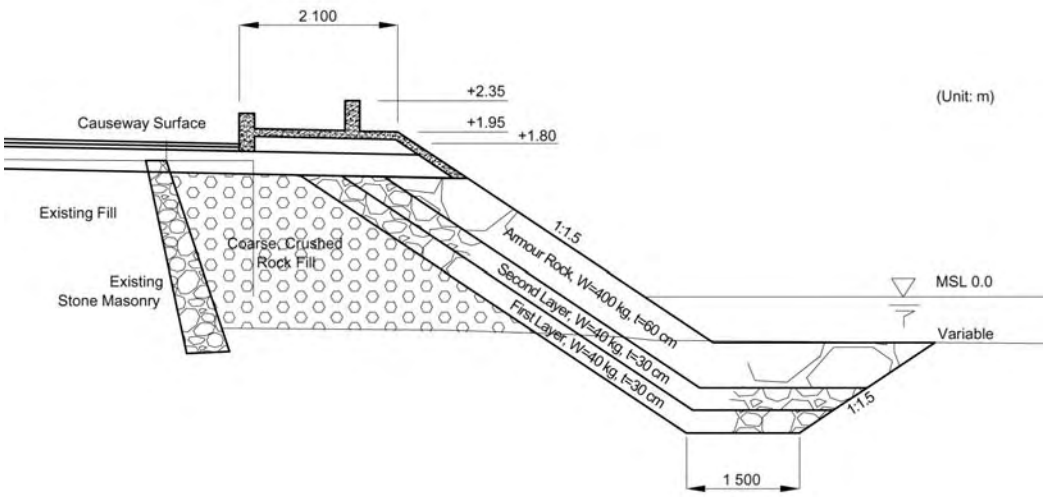


Fig. 2-6 Cross Section of Causeway Bank

The slope of causeway bank is composed of armor rock and under layer stone. Dimensions of each composition were designed as follows:

Table 2-9 Outline of Causeway Bank Protection

	Armor rock	Under layer stone
Number of Layer	1	2
Minimum weight of rock (kg)	400	40
Thickness (m)	0.6	0.3
Gradient of slope	1:1.5	1:1.5
Allowable unevenness of layer surface (m)	±0.15	±0.1

Pore spaces of armor rocks shall not be filled so as to keep their surface rough to maintain wave dissipating function. The installation tolerance of armor rocks, measuring the gap difference from the design slope line to apexes of rocks, shall not exceed 20mm in dent but not specified in protrusion.

b) Design basis

Bank slope protection by armor stone is composed of armor rocks, sized according to the design wave height and gradient of slope, under layer rocks and fill material. Under layer generally consists of 2 layers and is designed to distribute the weight of the armor rock and to prevent the loss of fill material through voids in the rocks.

The weight of armored rock covering the slope surface of a structure receiving the wave action is calculated using the formula by Hudson R.Y.

As a result, unit weight of an armored rock is required 0.4ton in minimum.

According to the Technical Standards and Commentaries for Port and Harbor Facilities in Japan, 1999, the required unit weight of an under layer stone is designated about 10% of an armored rock.

The slope angle is decided 1:1.5 from workability and economical efficiency.

Bank slope protection by armor stone is a time-proven shore protection measure. Design parameters are well based on model studies and empirical data. Properly designed armor stone slope protections are durable, flexible, and highly resistant to wave damage. The structure can settle and adjust without major failure, and a revetment can still function effectively even if damaged. The rough surface reduces wave run-up and overtopping.

2) Design of Pavement Structure

a) The pavement structure was determined based on the sub-grade condition and the estimated future traffic volume, as follows:

Considering the procurement condition of asphalt materials in Palau that there is only one asphalt plant operated in the country and so the price of asphalt paving material is comparatively high, the merits and demerits was studied between asphalt and cement concrete pavements. The result was to adopt asphalt pavement based on the plan to produce asphalt paving material with the asphalt bitumen imported from the third countries and using the said plant.

Table 2-10 Thickness of Pavement

		Surface Course	Granular Base C.
Alternative 1	As	5 cm+5 cm	30 cm
Alternative 2	Con	25cm	15 cm

(Design period 10 years, CBR=10, 18kips: 5~7 million)

b) Typical Cross Section of Pavement

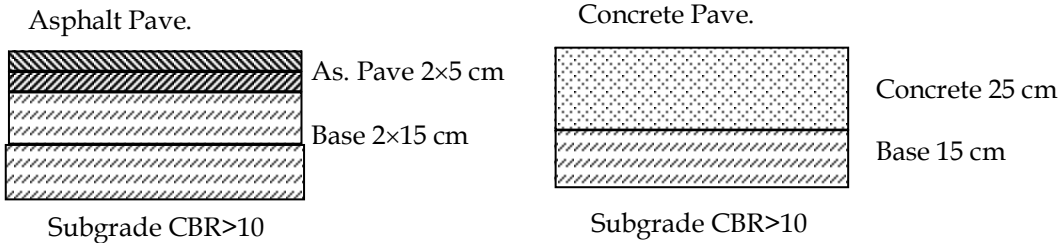


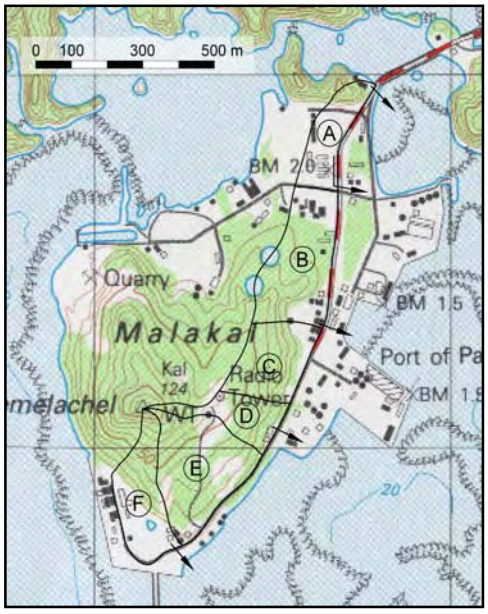
Fig. 2-7 Typical Cross Section of Pavement

2-2-2-4 Malakal Island Road Drainage Design

The drainage design along Malakal Island Road was carried out based on the design runoff from the adjacent areas. Catchment areas were estimated as listed in Table 2-25, based on the topographic map of scale in 1:25,000, prepared by Department of the Interior, USA, 1983 (see a map right).

Table 2-11 Estimated Catchment Area

Catchment No.	Catchment Area (m^2)
A	15,700
B	55,100
C	42,000
D	72,400
E	3,800
F	75,800



Based on the above mentioned factors, the design runoff for drainage system was estimated for each catchment, as shown in Table 2-12.

Table 2-12 Design Runoff of each Catchment Area

Catchment	A	B	C	D	E	F
Catchment Area (m2)	15,700	55,100	42,000	72,400	3,800	75,800
Runoff Coefficient	0.7	0.5	0.7	0.7	0.7	0.7
Time of Concentration (min)	13.8	33.9	23.5	26.4	19.7	27.1
Design Rainfall Intensity (mm/h)	101.0	66.4	78.8	74.6	85.6	73.3
Design Runoff (m3/sec)	0.308	0.508	0.644	1.050	0.063	1.086

Figure 2-8 shows a planned layout of road drainage system. The drainage flow analysis is given in the Appendix.

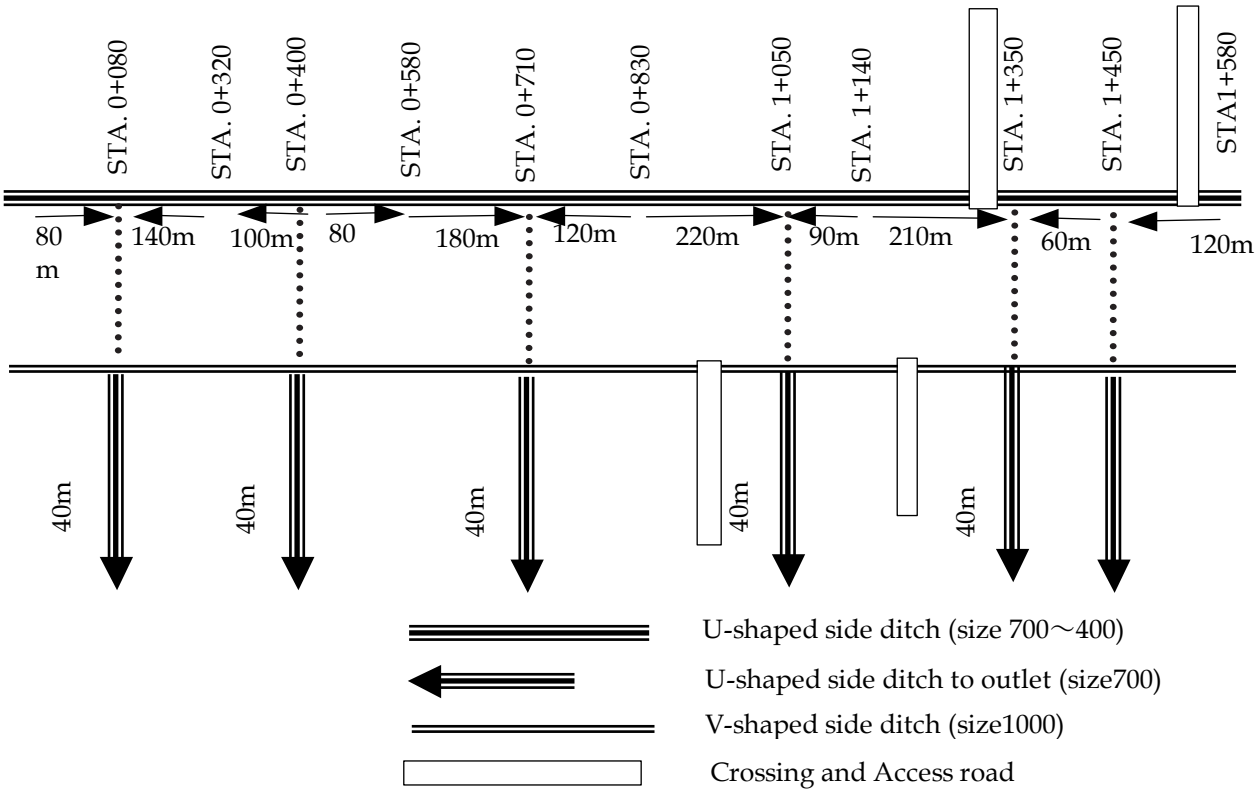


Fig.2-8 Layout of Road Drainage System

2-2-2-5 Design of Repairing, Minato-Bashi Bridge

The proposed repair works for Minato-Bashi Bridge were summarized as below.

1) Construction of Stone Masonry & Removal of Existing Retaining Wall
2) Installation of FRP Protecting Cover with Anti-Corrosion System for P1 & P2
3) Repairing of Cracks on Pile Bent of P2
4) Relocation of Guard Railing & Widening of Sidewalk on Approach Slabs

In the following, the detail study procedures for those repair works were described.

1) Construction of Stone Masonry & Removal of Existing Malakal Left-side Retaining Wall

The crack widths were too large to apply the mortar injection method. Accordingly, the removal of damaged portion and construction of new retaining walls were proposed. After the comparison with the alternative "Mat Gabion", "Stone Masonry" was adopted for the new retaining walls because of its endurance and familiarity for the local contractor

The crack width on the retaining wall on Koror side was relatively small, and they shall be repaired with mortar injection method.

2) Installation of FRP Protecting Cover with Anti-Corrosion System for Piles

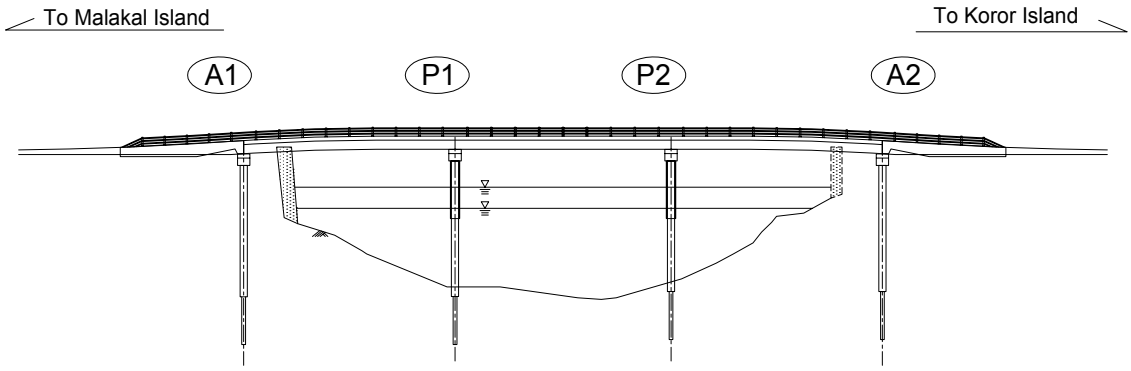


Figure 2-9 Side view of Minato bashi

Based on the results of structural analysis, repairing works for anti-corrosion was proposed for whole 6 piles of 2 Piers as shown in right figure.

"Petrolatum Lining" methods are adopted for the anti-corrosion methods for the tidal area from workability, term and economic efficiency.

The results of structural analysis of the existing piers are summarized in Appendix .

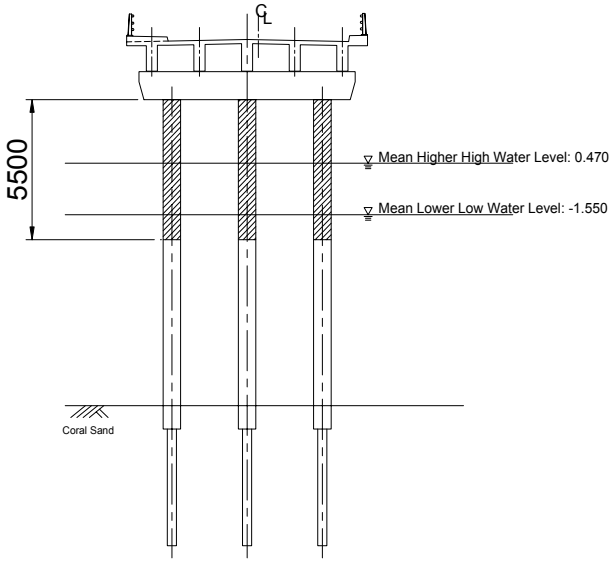


Figure2-10 The area of piles to be repaired

3) Repairing of Cracks on Pile Bent

Cracks detected on the Pile Bent of Pier on Koror side (P2) come from the swelling of corroded reinforcement steels of the concrete, and the repairing of cracks only by mortar injection will not be sufficient for such large cracks. To complete the repairing, the following procedure is proposed.

① Chip off concrete around the cracks (not whole surface of pile bent)

② Clean the rust and apply rust-proof treatment on exposed reinforcement steels.

③ Inject mortar into cracks

④ Install a cathodic protection system for reinforcement steels

⑤ Cover the whole surface of pile bent with carbon fiber sheets to reinforce the tensile strength of corroded reinforcement steels.

4) Relocation of Guard Railing & Widening of Sidewalk on Approach Slabs

At the both sides of Minato-Bashi Bridge, the approach slabs with 40 feet length exist. At the connecting point with bridge, the carriageway width on the approach slabs is 32 feet (about 9.7m). However, it was reduced to 28 feet (about 8.5m) at the connecting point with the approach road section (Refer to Figure 2-11 & Photo). Furthermore, the width of sidewalk on the approach slabs was also reduced along the longitudinal direction, and it was terminated at the connecting point with the road section.

Present Road Condition at Approach Slab
(View from Koror side to Malakal side)

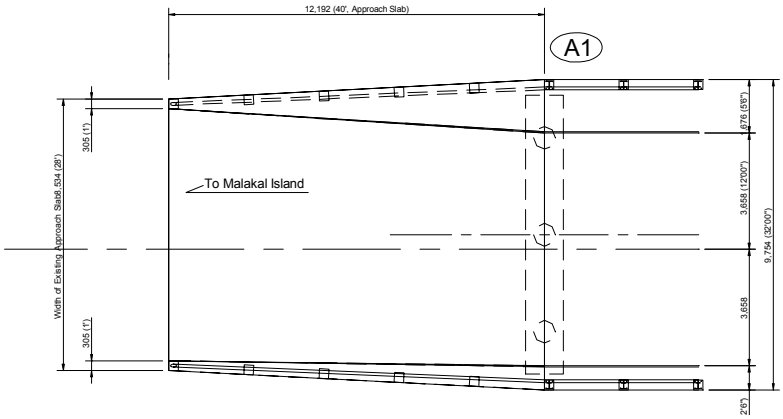


Fig. 2-11 Present Road Condition of Approach Slab

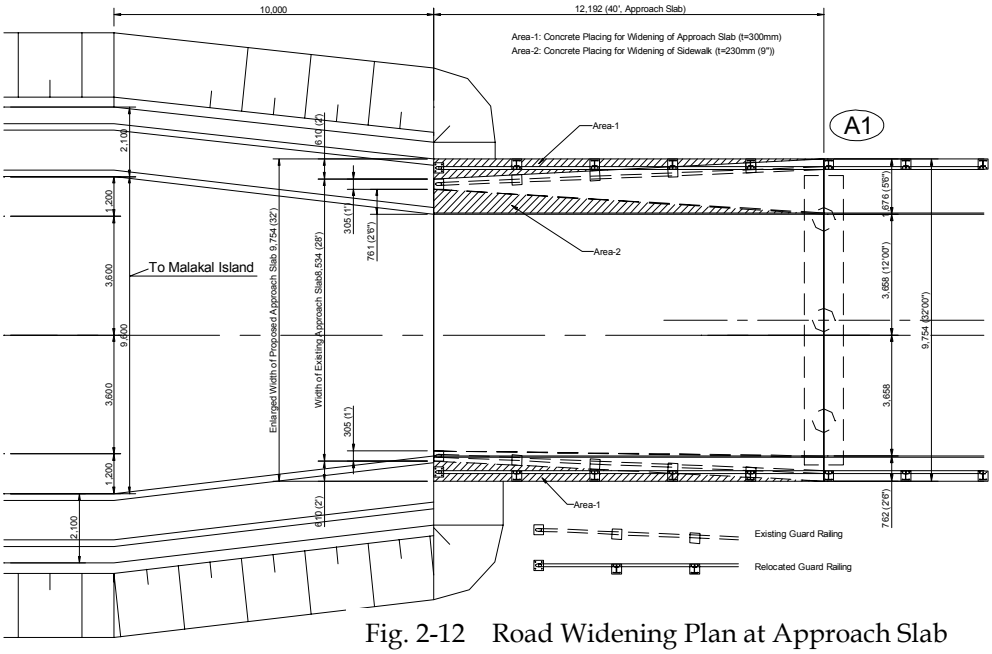


Fig. 2-12 Road Widening Plan at Approach Slab

To solve this problem, the widening of sidewalk by placing of concrete and relocation of guard railing is proposed. The transition length to the road section on Malakal side is 10m (Refer to Figure 2-12)

2-2-2-6 Culverts on Causeway

1) General description of repair of causeways

Because all culverts were constructed 60 years ago, and 2 culverts on Meyungs Causeway were already collapsed, the reinforcing of substructures for all culverts is proposed. The adopted reinforcing works of substructures are extension of front-side footing width and increase of front wall thickness by placing concrete.

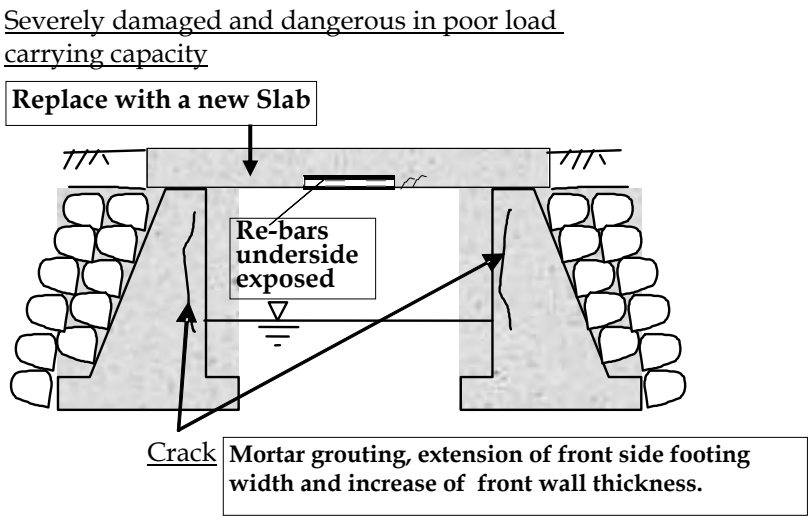


Fig. 2-13 Repairing of Culverts

The collapsed two culverts on Meyungs Causeway are proposed to be re-constructed to improve the quality of surrounding water. Construction methods and required work items are almost same as for other culverts to be repaired.

Based on the results of site inspection, repairing methods for culverts were studied to summarize in Table 2-13.

Table 2-13 Repairing Methods for Culverts

Type of Damage		Repairing Methods	
Slab	-Cracks, -Exposure & Corrosion of Reinforcement Steels,	Because the chloride damage can not be cured by repairing, replacement of a whole slab was adopted.	
Front Wall	-Cracks	Injection of mortar	Applicable for the relatively wide cracks with 0.5mm width or more. Adequate for the repairing of cracks on front walls
		Extension of front side footing width and increase of front wall thickness	Extension & increase of structural members by placing new concrete. Not only for the crack repairing but also the reinforcing of structural members was anticipated.

2) Widening of Substructures

In the highway design, the centerline of the widened causeways was not so much shifted from the centerline of the existing causeway. Accordingly, the widening is to be conducted by extending same width in either side of causeway. The widening of culverts at one side are about 2m on Malakal Causeway, and about 2.5m to 3.0m on Meyungs Causeway, respectively.

The typical cross sections of widened culverts are shown in Figure 2-14 and 2-15.

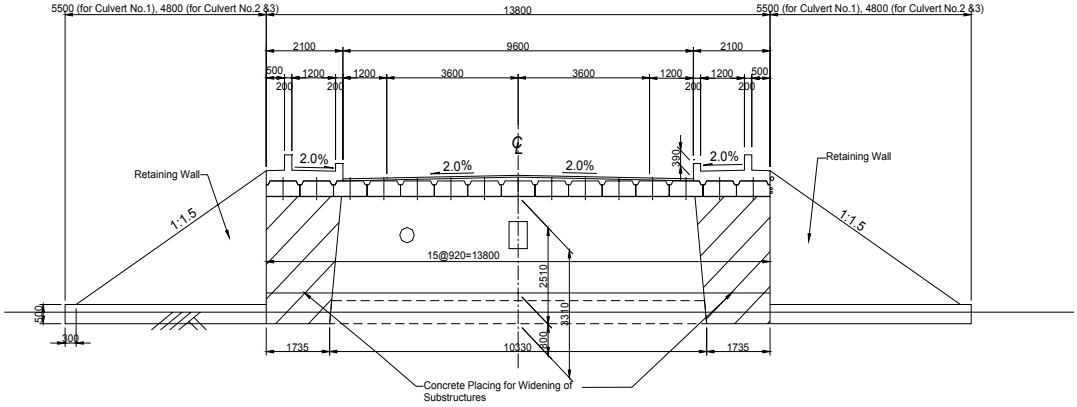


Fig. 2-14 Typical Cross Section of Widened Culverts on Malakal Causeway

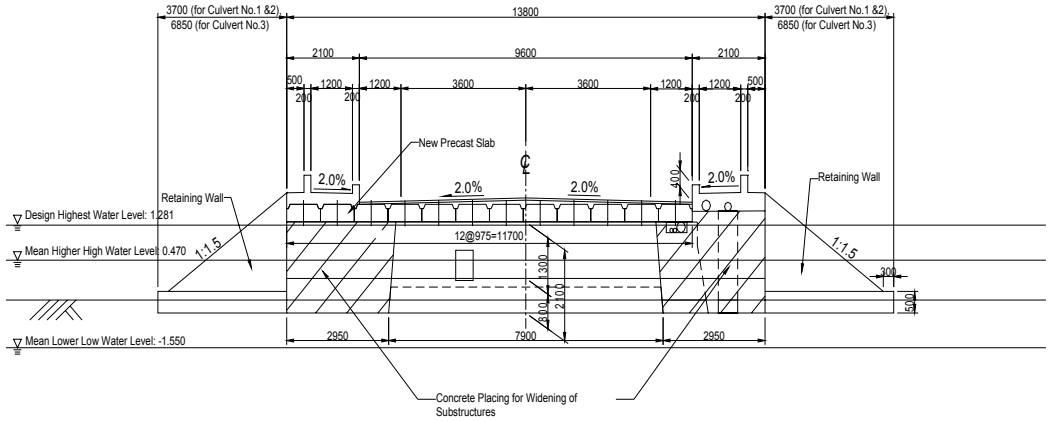


Fig. 2-15 Typical Cross Section of Widened Culverts on Meyungs Causeway

There are two pipes for water supply and sewer laid on the right road side of Meyungs causeway. For widening of culvert and providing sidewalks, the space for these pipes shall be secured in the new structural placement.

3) Extension of front-side footing width and increase of front wall thickness

This repair work was adopted to aim at repairing of cracks and reinforcing of aged substructure concrete. Concrete shall be placed with 20cm thickness on the front walls and front-side footing as shown in Figure 2-16.

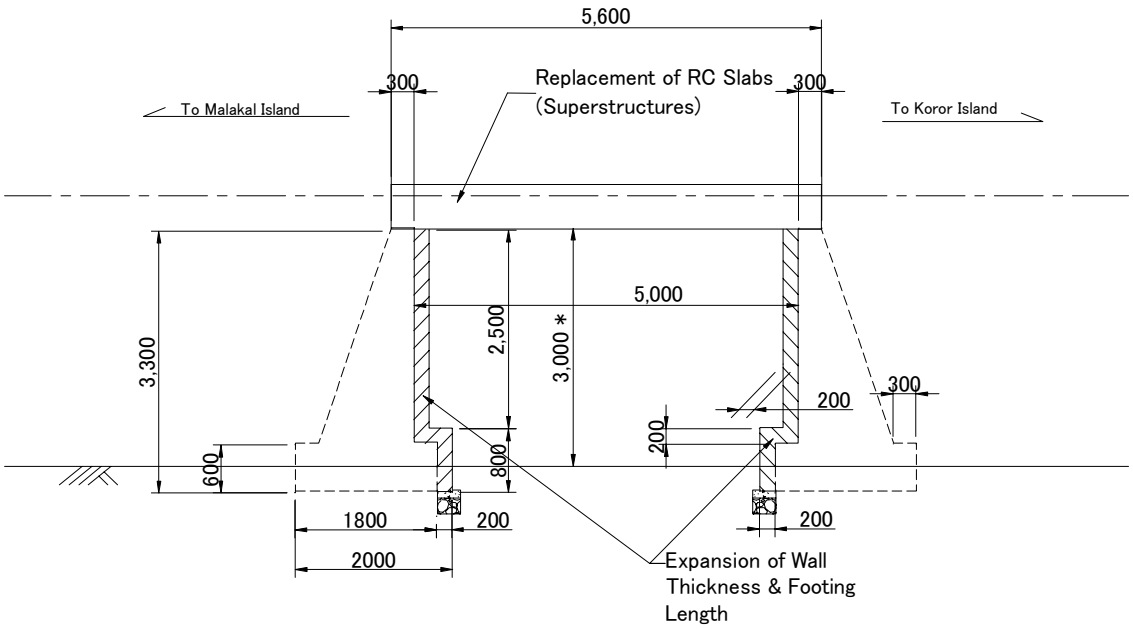
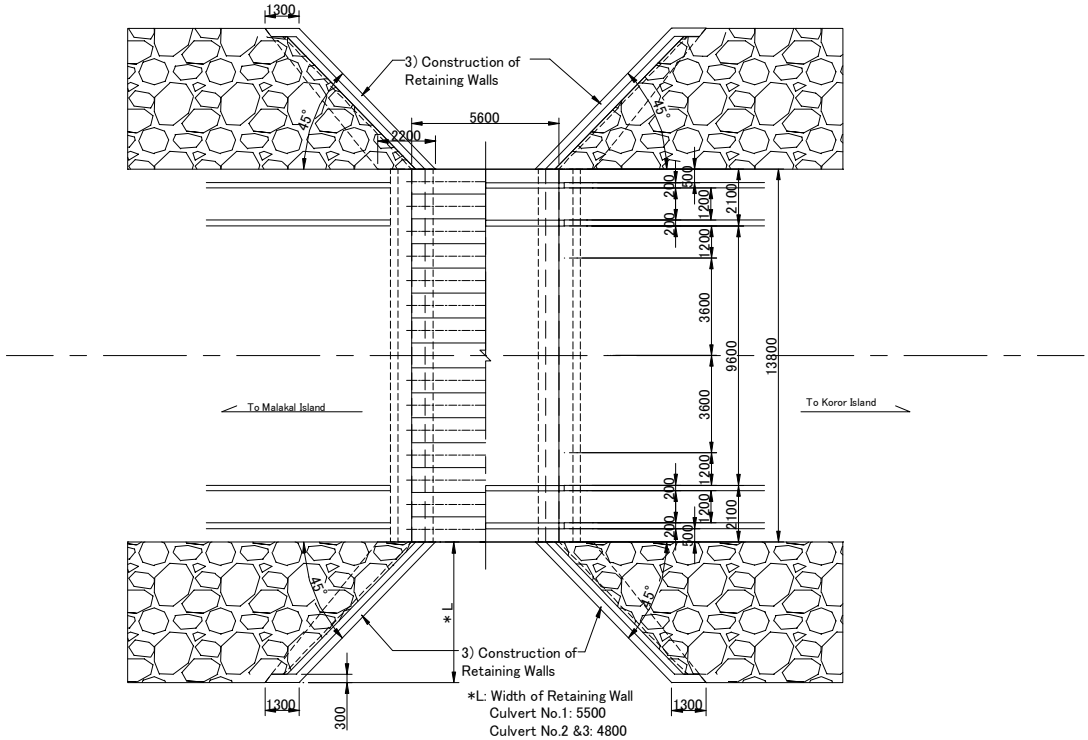


Fig. 2-16 Concrete Placing for Substructure Repairing

4) Construction of Retaining Walls

The layout and plan view of retaining walls are shown in Figure 2-17 and the front view in Figure 2-18. The direction of retaining walls is designed so as to provide a open angle of 45 degree at inlet and outlet of culverts for smooth water flow.



* Bold lines indicate Retaining Walls.

Fig. 2-17 Layout of Retaining Walls (Malakal Causeway)

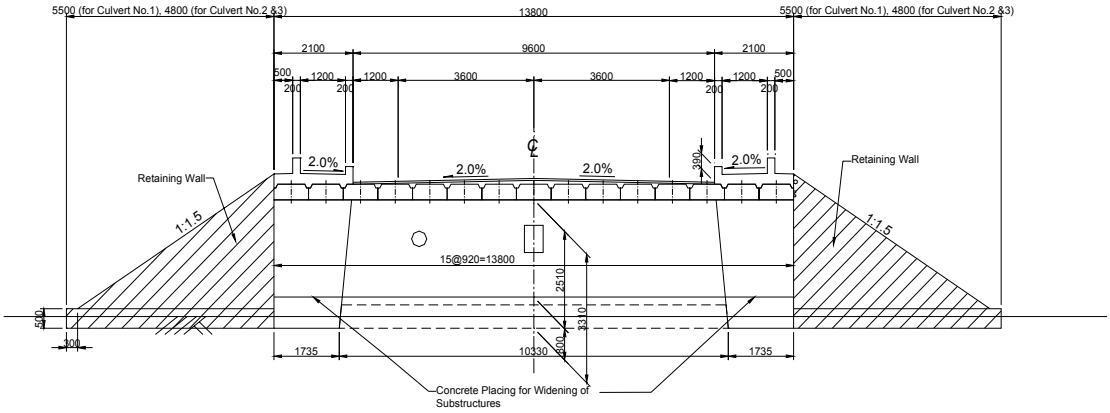


Fig. 2-18 Front View of Culvert with Retaining Walls (Malakal Causeway)

5) Replacement of Deck Slabs

Based on the site inspection and comparison study of repairing works, deck slabs of all culverts are proposed to be replaced. In Figure 2-19 and Figure 2-20, the arrangement of new precast RC Slabs and typical cross section of a slab unit are indicated. The design strength of concrete for new precast RC Slab is 40N/mm2, and the slab length is 5.6m.

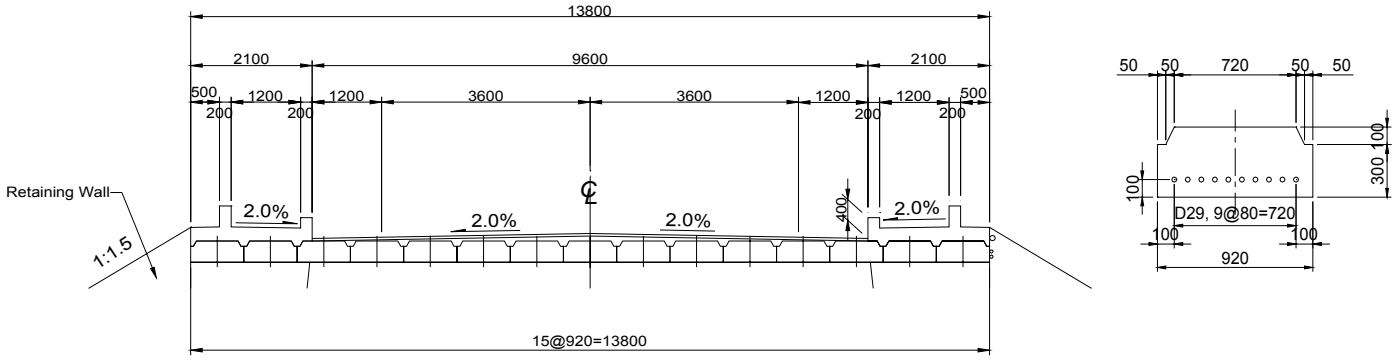


Fig. 2-19 Arrangement & Typical Cross Section of New Precast RC Slabs for Malakal Causeway

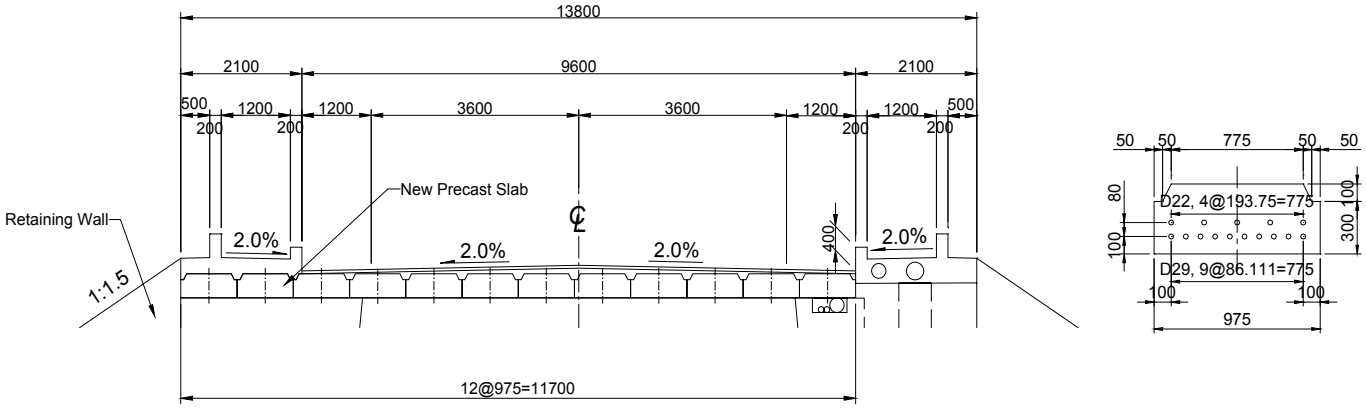


Fig. 2-20 Arrangement & Typical Cross Section of New Precast RC Slabs for Meyungs Causeway

2-2-3 Basic Design Drawing

Basic Design Drawings are provided in Appendix.

Typical cross sections of each causeway and Malakal Island Road are show bellow:

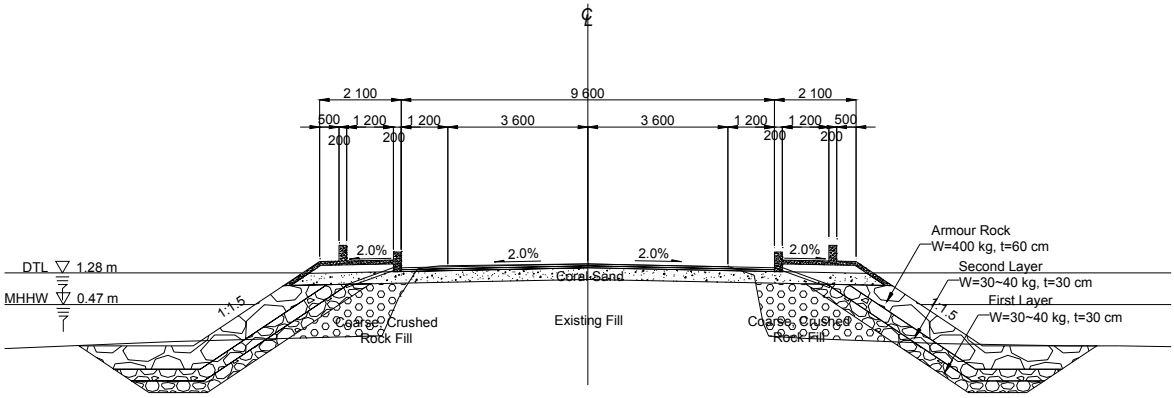


Fig. 2-21 Malakal/Airai Causeway Typical Cross Section

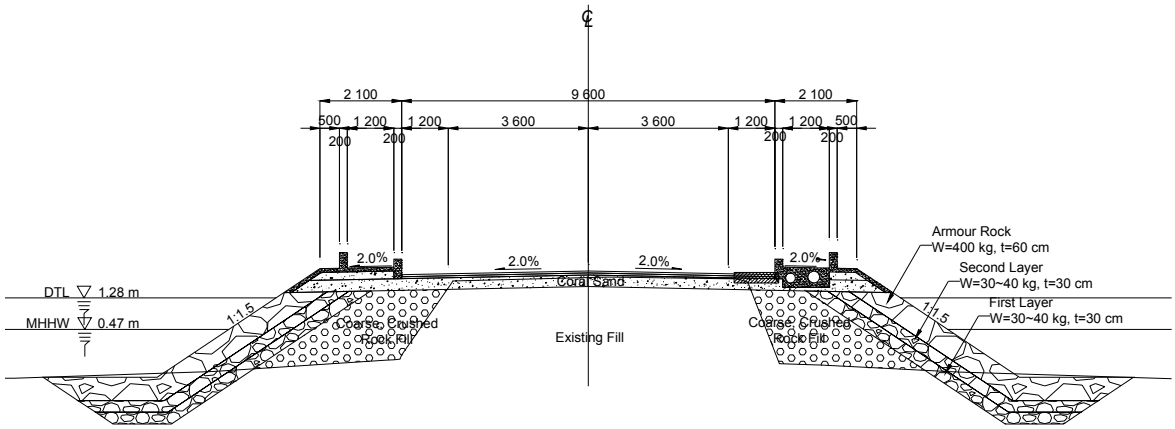


Fig. 2-22 Meyungs Causeway Typical Cross Section.

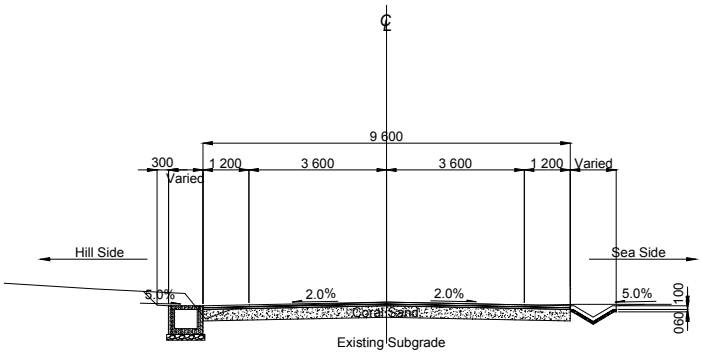


Fig. 2-23 Malakal Island Road Typical Cross Section

The scope, major improvement measures and construction volumes of the road improvement project agreed on with the Palau's side in the basic design to be provided under the grant aid of Japan are summarized in the following table.

Table 2-14 Major Improvement Measures and Construction Volumes

Road Section	Airai Causeway	Meyungs Causeway	Malakal Causeway	Malakal Island Road	Minato Bridge
Road Length	0.73 km	0.67 km	0.51 km	1.63 km	0.08 km
Widening of Roadway Width	Common in all causeways and island road. Widen roadway width from the existing 7 to 8m（with no sidewalk） to 13.8m （for 2 roadway lanes and sidewalks both sides）.				No widening.
Repair and Addition of Rock Mound Bank	9,000 m3	8,800 m3	4,800 m3	-	-
Repair and Addition of Base Course (30cm) Placement of Pavement (10cm)	11,000 m2 7,000 m2	7,800 m2 6,700 m2	7,300 m2 4,700 m2	16,300 m2 15,600 m2	- -
Installation of Sidewalks	3,040 m2	4,750 m2	2,650 m2	-	36 m2
Placement of Roadside Ditches	U-type: 41m V-type1:64m Crossing: Pipe :	- - -	U-type: 40m V-type: 164m Crossing Pipe :	U-type: 1,660 m V-type: 1,220 m Crossing Pipe: 66 m	- - -
Repair and Addition of Retaining Walls	-	-	-	2 locations of 23m & 13m.	-
Repair and Addition of Culverts	-	5 locations of 106m in total.	3 locations of 64m in total.	-	-
Repair of Bridge	-	-	-	-	Repair & Relocation *1
Installation of Traffic Safety Facilities					
Traffic Markings Traffic Signs	280 m2 4 pcs	250 m2 1pcs	220 m2 4 pcs	610 m2 4 pcs	- -
Installation of Public Service Facilities					
Water and Sewer Pipes Electric Power Lines Communication Conduit Pipes	- - 730m	- - 670m	- - 510m	- - -	- - -

*1 : Substructure: Corrosion Protection on Steel Pier Columns and Repair of Cracks on Pier Head Beam
Superstructure: Relocation of Guardrails on Approach Slabs

2-2-4 Implementation Plan

2-2-4-1 Implementation Policy

This grant aid project is scheduled to be conducted in two phases, and therefore the construction work is also divided into the following two phases by road section according to the level of urgency for improvement.

Phase 1	Meyungs Causeway Airai Causeway	The collapse of culverts needs urgent repair. Road width is narrow and traffic accident occurrence is high.
Phase 2	Malakal Causeway Malakal Island Road	

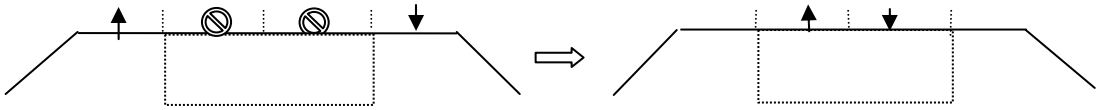
Figure 2-24 shows the locations and distances of construction-related facilities.

Fig. 2-24 Location Map of Construction-Related Facilities

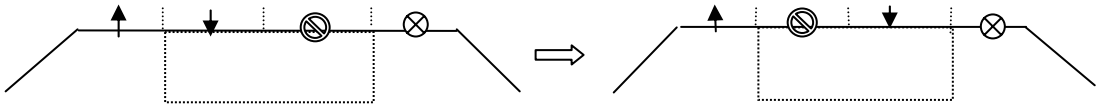
1) Causeway Works

a) Phased construction to maintain the existing traffic

The existing causeways (width of 7.4~8.0 m) will be widened by adding 3 m of stone revetment to both side and then, temporary road will be constructed to divert the traffic tentatively. Coral aggregate of 20~30 cm thick will be used for this temporary road and this aggregate will be used as foundation of sidewalks. Geo-textile will be inserted to prevent to drop out the aggregate into the stone revetment.



Along the Meyungs causeway, there are water supply pipe and sewer lines installed by Japanese grant aid and it is difficult to install temporary road at this side. Consequently, the temporary road will be installed in the following methods.



b) Phased construction to keep sea current

Silt fence is used to protect the contamination of the seawater due to the earth work. However the silt fence becomes the obstacles of tidal flow crossing the causeway, if installed to all the construction sections. Therefore, causeway works shall be executed by dividing the construction section into longitudinally two sections. Silt fence will be set up a half part and moved to new section after completion of the first section as show in the figure below.

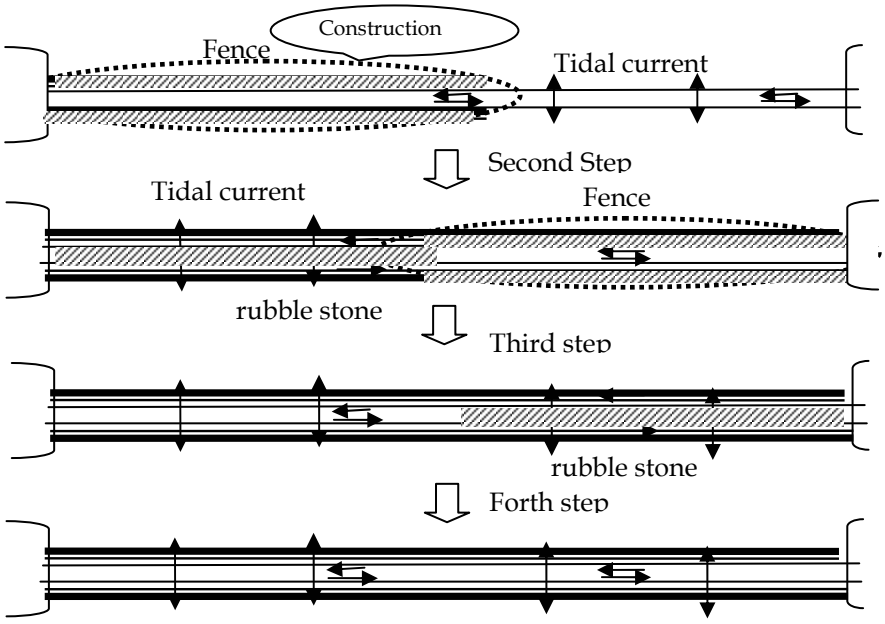


Fig. 2-25 Procedure of Construction

2) Causeway Bank Protection Work

Total excavation volume of foot protection is 23,200 m3 and actual construction period could be 3 months. The construction works should be carried out within silt fence to avoid outflow of earth and sand.

Total necessary stone volume of 3 causeways for foot protection could be 11,900 m3 of 40 kg class and 11,300 m3 of 400 kg class. 75 m3 per day is scheduled to transport these rubble stone.

The construction works are executed by backhoes in low tide. The deposit on the sea bottom shall be removed prior to the excavation of foot protection area. The excavated coral aggregate will be utilized as the filling materials of embankment. The following figure shows outline of construction works after the above.

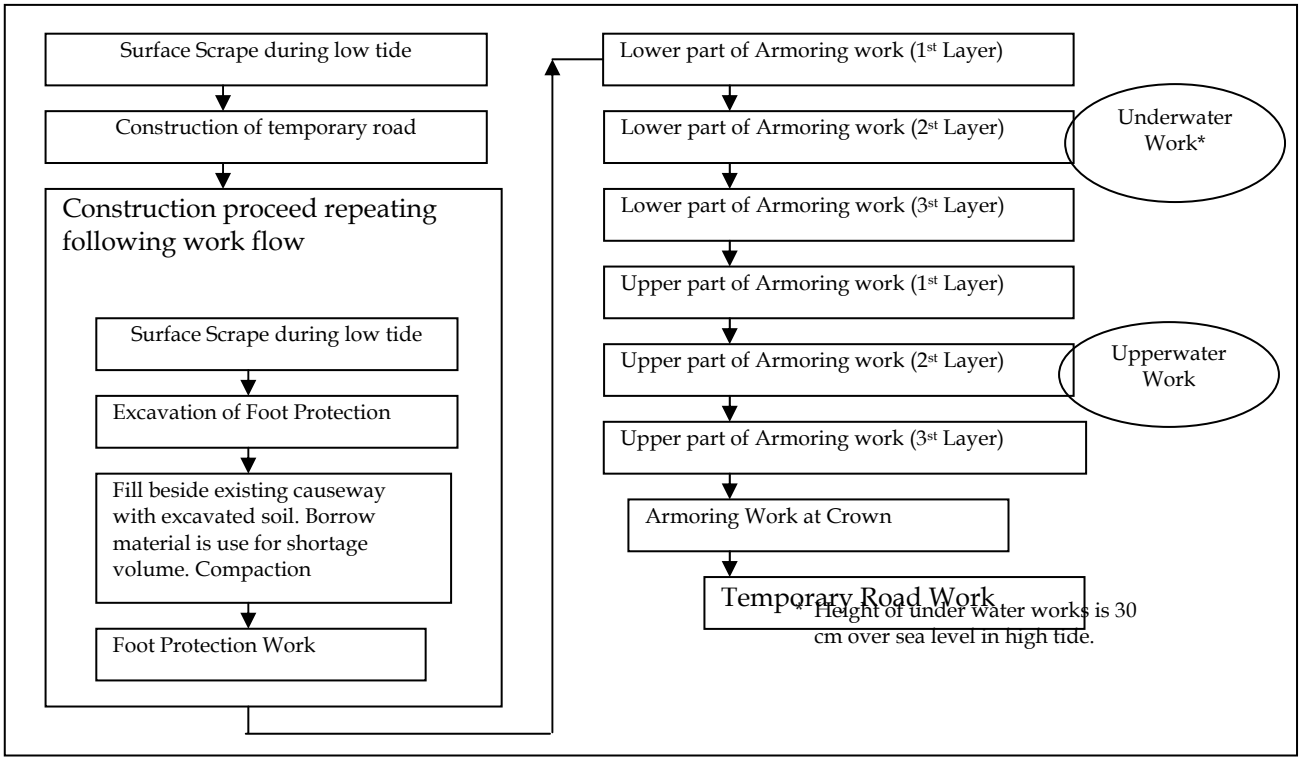


Fig. 2-26 Flow of Causeway Bank Protection Work

3) Causeway Pavement Works

Asphalt pavement is applied with surface course of 5cm thickness, binder course of 5cm and base course of 30cm. The pavement on the culvert is 5cm surface course only.

The base course material is coral aggregate. The aggregates for pavement and base course are procured from the existing quarry because the environmental clearance of EPQB is requested in case of development of new quarry. The process to get the permission take a long time and it is not suitable to complete the project within a limited time.

Total volume of asphalt mixture for this project is estimated to be about 8,000 tons. Straight asphalt and asphalt emulsion are imported from Taiwan. And the mixture is produced utilizing existing asphalt plant in Koror.

The equipment to be used for base course is motor grader (3.1m) and road roller (10t), tire roller (8～20t) and asphalt finisher (3～4.8m) are transported from Japan for the pavement works.

It is expected to take care about the existing under ground utilities on the execution of base course work.

4) Causeway Sidewalk Works

After completing the widening of causeway by the stone revetment, the pavement works of center area will be preceded by diverting the traffic to the widened sidewalk area. After completing the works of center area, the traffic is diverted to center and the sidewalk work will start.

Sidewalk is constructed by placing forms on the coral aggregate used as the temporary traffic lane. Supplemental aggregate is applied before the work. Connection bar is used on the execution of the out side vertical. The interval of the bar is every 3m.

The sidewalk concrete of the south side of Meyungs causeway is placed after the rapping exiting pipes by membranes.

5) Minato-Bashi Bridge Improvement Work

Almost of main works of Minato-bashi repairing will be conducted under the bridge. The one-way traffic treatment for the car of both direction is inevitable on the widening of approach slabs. The widening are of causeway will be utilized as the temporally access road for repair of Malakal side abutment

6) Malakal Island Road Improvement Works

The existing Malakal Island road is a two lane road. Fig. 2-27 shows the work flow for the improvement works of this road.

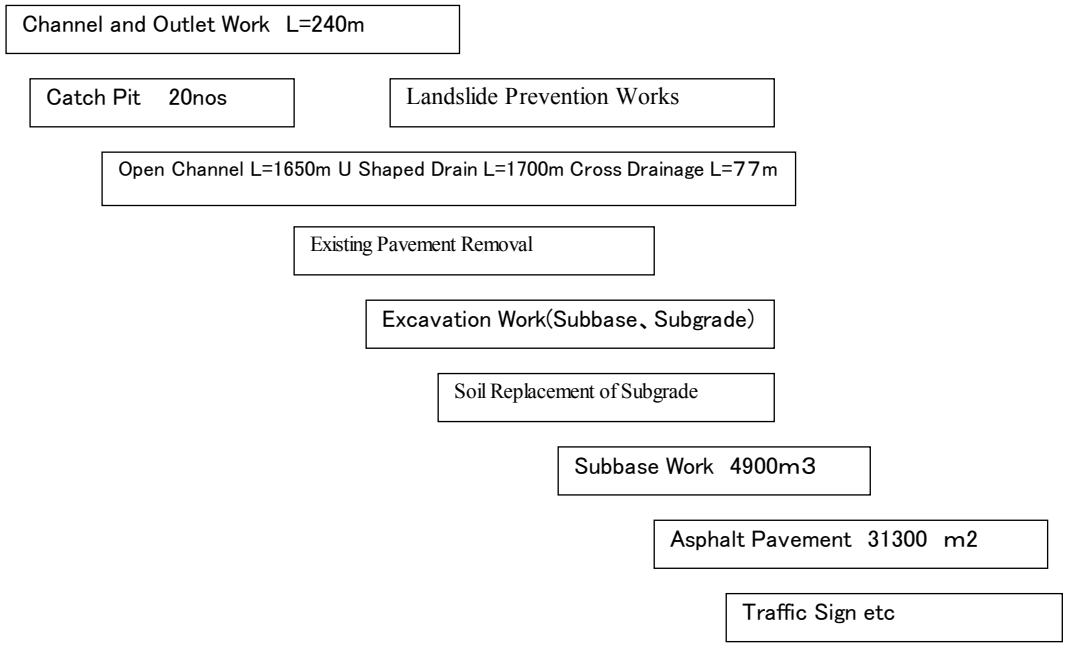


Fig. 2-27 Work flow for Malakal Island Road Improvement Works

The critical pass is the drainage works. And the installation capacity of form work for the cast in concrete is predominant in the whole work schedule as shown in the following table.

	Size	Length	/Day・Party	Working day	Area of Formwork	/Day・Party	Calendar day
U Shaped Drain	(400)	400m	2.2m	30 日	880 m2	29 m2	182 日
With cover	(700)	1 260m	3.9m	148 日	4300 m2	29 m2	322 日
Open Channel V Shaped	(1000)	1 220m	25m	49 日	1220 m	25 m	49 日

The works in the Malakal causeway will be conducted parallel with this island road works during about 10months, and the pavement works of the island road needs about 3 months. The number of working parties for the drainage works is necessary to be increased to meet the completion timing with the causeway works. 6 parties are expected to be engaged to finalize the all of U ditches of 400 and 700 within 5 months. [(182 +322 total number of working days)÷0.59÷(30days×5)parties]

2-2-4-2 Implementation/Procurement Conditions

1) General status of construction works in Palau

The population in Palau is about 20,000, and 15,000 in the capital area. Therefore the numbers of workers are limited. Actually many Pilipino are engaging to the works. All of equipment is imported. Almost of materials are also imported one. Consequently the general price index is high as same as developed countries.

2) Local Contractors and Suppliers

Palaun and International contractors are engaging the road works in Palau. Almost of the local registered contractors are architectural one and civil contractors are few. Architectures and civil contractors registered in Palau are quite limited.

The following table shows major contractors possible for road construction projects.

Table 2-15 Major contractors in Koror area

Contractors	Civil	Architect	Equipment Materials
Black Micro Corporation	o	o	o
Socio Micronesia Incorporated	o	o	o
Surangel & Sun's Construction	o	o	o
Fortune Investment & Dev't. Corp., Ltd	o	-	o
Palau Transportation Company (PTC)	o	-	-
FR Construction Company	o	-	-

3) Labor Management

Almost of available labor force in Palau is Pilipino. They need entry formalities and working permit. There was a problem in the process of such formalities in case of the project of KB Bridge construction. It is advisable that this kind of issue should be solved by the executing agency prior to starting project to ensure the smooth progress.

2-2-4-3 Scope of Works

The scope of work for which Japanese and Palau Governments are responsible is described as follows:

Table 2-16 Responsible work list by Japanese side and Palaun side.

Responsible works by Japanese side	Responsible works by Palaun side
• Detailed design, Preparation of Tender and Contract Documents, Assistance for Bidding and Supervisory works as difined in 「2-2-4-4 Consultant Supervision」 • Preparation of Temporary facilities, such as Camp yard, Offices etc. • Safety measures related to execution of construction works • Environmental protection measures during the construction. • Transportation of equipment and materials for the construction from Japan and from other countries.	• Relocation of telecommunication cables necessary on the execution of the construction. • Ensuring of necessary lands for camp yard and offices for the execution of the project. • Payment of banking arrangement (Application of banking arrangement and Authorization to Pay) • Arrangement for the entry permit for the third country personnel • Exemption of custom tax, domestic tax and other levies to be charged in Palau • Security for the temporary facilities and site related to the construction.

2-2-4-4 Consultant Supervision

Scope of works and assignment periods of consulting engineers for each construction stages are as follows:

Table 2-17 Duties and assignment period of Engineer

Team leader :	Duties:
Phase 1 Commencement of Work 0.5 month Completion of Work 0.25 month Phase 2 Commencement of Work 0.25 month Completion of Work 0. 5 month Defect liability Inspection 0.4 month Total 1.9 month	● Technical supervision and project coordination for smooth implementation of the project. ● Secure of base camp for construction, coordination and confirmation of permission required for the Project with the Government of Palau ● Coordination with environmental stakeholders
Resident engineer :	Duties:
From the commencement to the completion of Works 19 months	● Construction supervision, daily inspection and supervision, schedule management and payment, regular reports to related agencies ● Recruiting of local administrative and supporting staff and procurement of office equipment for a consultant office ● Secure safety of traffic management in diversion ● Coordination with the Government of Palau for the usage of former KB Bridge camp yard and Long Island camp yard ● Coordination and negotiation for place and method of construction waste disposal and disposed soil disposal ● Coordination with environmental stakeholders and supervising of contractors for environmental conservation ● Examination of concrete plant and asphalt plant, confirmation of specification and mixture of concrete ● Checking of construction plan

2-2-4-5 Quality Control Plan

Quality certificate by the supplier is required to be submitted for the construction materials to be procured from local suppliers, such as pavement materials, concrete and reinforcing bar, etc. If the supplier's testing seems not to be reliable, the material shall be tested by the third independent laboratory in Palau or outside of Palau.

The followings are necessary items for quality control.

Table 2-18 Quality Control Items

		Purpose	Remarks
Soil	CBR Test	Bearing capacity of sub base and sub grade	Mould: 3 nos./time×4 day=12 nos.
	Test for Moisture-Density of Soil	Maximum density	For CBR Test
	Specific-gravity test for fine aggregate	Specific Gravity for Mix proportion	
	PI Test		LL, PL
Aggregate	Sieve analysis test	Particle size	Automatic type
	Abrasion test	Hardness of aggregate	Los angels test
	Specific-gravity test for coarse aggregate	Specific Gravity for Mix proportion	
	Water absorption test	For Concrete Mix proportion	
Concrete	Salinity test	Salinity check	
	Slump test	Property test	
	Air Content test	-do-	
	Compressive strength test	-do-	Compression Test 100 t Mould 6 nos.×4 weeks=24 nos.
Asphalt bitumen and mixture	Penetration test	-do-	Automatic type
	Softening point test	-do-	Automatic type
	Moisture-Density relation of Soil	Maximum density	
	Marshall test	Property test	Mould 3 type 3 nos./type×4=12 nos.
	Asphalt extraction test	content of asphalt volume	Soxhlet type
	Field Compaction test	Measure of density and thickness	Core cutter D100 Spare bit 5 nos.

2-2-4-6 Procurement Plan

1) Construction Material

Materials produced in Palau are lime stone, basalt, and coral rocks. Most of these materials are available in the market of Palau. However, it is necessary to establish procurement measures to ensure enough quantities of the necessary materials prior to entering to the preparatory work by the contractor, because the time schedule is anticipated to be over-lapped with other major projects, such as the compact road

project and the airport runway improvement project. Table 2-37 shows the source countries for procurement of major materials.

Cement is not enough in quantity to procure all of its required volume in Palau. So that Philippine was selected as a source country for cement from the economical reason compared to Japan and the past import achievement from the country. Straight asphalt and asphalt emulsion are recommended to be procured from Taiwan from the reason of near location, lower prices and their past actual achievement. Table 2-19 shows the source countries of major material.

Table 2-19 Procurement Sources of Construction Materials

Material Items	Procured in Palau	Procured in Japan	from third country
Armor Stone	o		
Sand	o		
Crusher-run	o		
Aggregate for Concrete	o		
Cement Concrete	o		
Cement			o
Plywood for formwork	o		
Timber	o		
Reinforce bar			o
Straight Asphalt			o
Asphalt Emulsion			o
Diesel Oil	o		
Gasoline	o		
Hume pipe		o	
PVC pipe	o		
Road Marking Material		o	
Traffic Sign Board	o		
Petrolatum		o	
Geo-textile	o		
Silt Fence	o		
	Lime stone, basalt stone and coral aggregate are available in Palau.	Straight Asphalt and Asphalt Emulsion will be import from Taiwan in accordance with cost comparison with Japan. Since volume of cement on Palauan market is not sufficient for the project and will be import from Philippine	
Coral sand is planned to procure by the following priority.	1st proposed area	2nd proposed area	3rd proposed area
	Dredged one at Airai east port is about 100million m3	From north of Malakal Port	Near Sukoujou (Old Japanese navy air port)
	there is a possibility of shortage due to Compact road and airport runway project.	Palau Government agrees to get coral sands in these two points. However Mining permission from EQPB shall be attained.	

The route to procure the materials from the third countries

• Cement	• From Philippine to Malakal Port : Using Overseas Container Lines	• From Malakl Port to the base camp : Using Container truck
• Straight Asphalt・Asphalt Emulsion	• From Taiwan to Malakal Port : Using Overseas Container Lines	• ditto

2) Construction Equipment

○ Erath work equipment

Local contractors have bulldozers and back-hoes, but their numbers are not enough.

○ Equipment for paving work

Asphalt plant	There are three Asphalt plant in Palau. Available one for this project is (3) of the following list. The cost and the troubles for the sole plant are anxious. (1) 40 t capacity Plant of PWD in Peleliu (2)* 100 t plant of Daiu in the middle area of Babeldaob island (3) 30 t plant of Socio in Malakal island. * (2) is imported for the project of compact road, but the assembling .is not yet started because of environmental issues are not yet solved, and the delay of the project is anticipated.
Asphalt Finisher	Socio Co., Ltd. Has asphalt finisher
Compaction Roller	Socio Co., Ltd. and Surangel Co., Ltd. have tire rollers and road rollers, however the quantities are not enough for the execution of this project.
Concrete plant	Ther are four concrete plant in Koror area, and they are delivered to the project of Compact road, architectural using, and minor civil works. There are actual achievement of concrete pavement.

In Palau, there is a few number of leasing equipment. While construction companies have their own construction equipment such as asphalt finisher, crane tracks, etc., some equipment is available on lease in Palau. Based on the cost comparison between the lease price in Palau and bringing in from Japan, the equipment procurement source was decided as follow:

Table 2-20 Procurement Sources of Major Construction Equipment

Items	Specification	Procured in Palau	Procured in Japan	Procured from third country
Bulldozer	15 t		o	
Backhoe	0.8 m3		o	
Backhoe	0.45 m3		o	
Tractor shovel	4 t	o		
Dump Truck	10t	o		
Truck	3.1m	o		
Truck Crane	25t	o		
Grader	3.1m	o		
Asphalt Plant	40t	o		
Tire Roller	3.0 t～4.0 t		o	
Road Roller	10.0 t		o	
Asphalt Finishes	3 m～4.8 m	o		
Lane Marker	Rib Type		o	

The equipment to be transported from Japan will be carried by ships to the Malakal port and by trailer trucks to the construction site (distance is about 1.5km)

The largest work of the Project in volume is stone work of bank protection. Required number of power shovels for the stone work will be 9 at maximum.

In Palau, there are three asphalts plants. However available one for this project is only a 40t-class plant owned by Socio (Construction Company) in Malakal Island.

There are 4 concrete plants (capacity: 75m3/h each) near Koror City. These plants are supplying concrete for the Compact Road Project, building construction and small scale civil works.

2-2-4-7 Implementation schedule

The number of operating days for construction planning was determined based on the JICA guideline as shown in Table 2-21.

Table 2-21 Operation Days for Construction

Work Item	Weather condition	Holiday	Calculated Operation Rate
Pavement, Concrete, Earth work and others	Workable on the day of 10 mm/day precipitation or less	Sunday and national holiday (Saturday is assumed to be work day as a custom of the contractor in Palau)	59%
Silt fence installation, stone revetment	Workable on the day of 10 mm/day precipitation or less		69%

A draft of the project iimplementation schedule is suggested as follows:

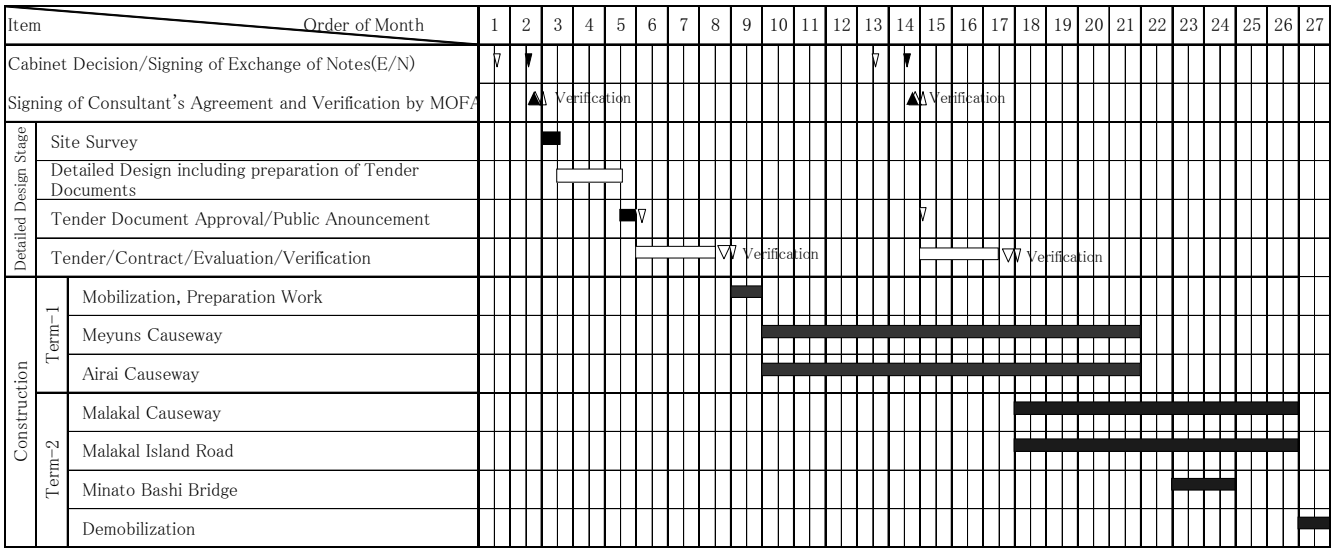


Fig. 2-28 Project Implementation Schedule (Draft)

2-3 OBLIGATION OF RECIPIENT COUNTRY

Scope of works for the government of Palau which were agreed in the Basic Design Study is summarized as follows.

Table 2-22 Works to be done by Palauan Side (Million Yen)

1	Secure lands for project implementation	For road improvement, President's private residence (40m), land in front of store in Malakal causeway Island on Meyungs (100m), and private land in Airai causeway Island on Meyungs widening (200m) is necessary to be expropriated. Stockyard, project office and accommodations are to be constructed in national land beside of KB Bridge. Some lands near Malakal land Meyungs causeway were requested by Japanese side to prevent traffic jam in main street caused by construction vehicles. Palau side will coordinate some appropriate lands before _____.	Cost for condemnation 340mx3=1020 ㎡ x $500-/㎡= $510,000 Cost for hire 2000m2 x $5 x 19=$190,000
2	Preparing of land	It is not necessary for the Project in principle.	
3	Construction of access road	It is not necessary for the Project in principle.	
4	Installation of electric distribution cable to construction land	Electric cable has been installed in the land beside KB Bridge. For the other lands, Palau side should install before _____.	$ 2000
5	Transfer of telecommunication cables	Two pipe including telecommunication cables (copper cable and optical cable) should be transferred in improvement works of the Project. Conduit will be set under sidewalks to transfer the cables as progress of the improvement works. The transfer plan should be discussed with PNCC.	$240,000
6	Opening of bank account with bearing A/P cost	The government of Palau has been experienced in KB Bridge construction project and international airport improvement project.	
7	Tax exemption for import of construction material and equipment		
8	Entry and working permission for Japanese personals and companies regarding to the Project		
9	Tax exemption for procurement of construction material and other related internal taxes		
10	Appropriate operation and maintenance of facilities and equipments constructed and provided by Japanese grant aid		
11	Costs for construction, transportation and installation other than those born by Japanese side		
		Total	$942,000-

2-4 PROJECT OPERATION PLAN

2-4-1 Ability for Operation and Maintenance of the Executing Agency

2-4-1-1 Road Operation Maintenance Organization

The Road Construction Machine Department of the Bureau of Public Works is in charge for maintenance of the national roads around Koror, Babeldaob and Peleliu. After the completion of this Project, the same department has responsibility for maintenance of the project road.

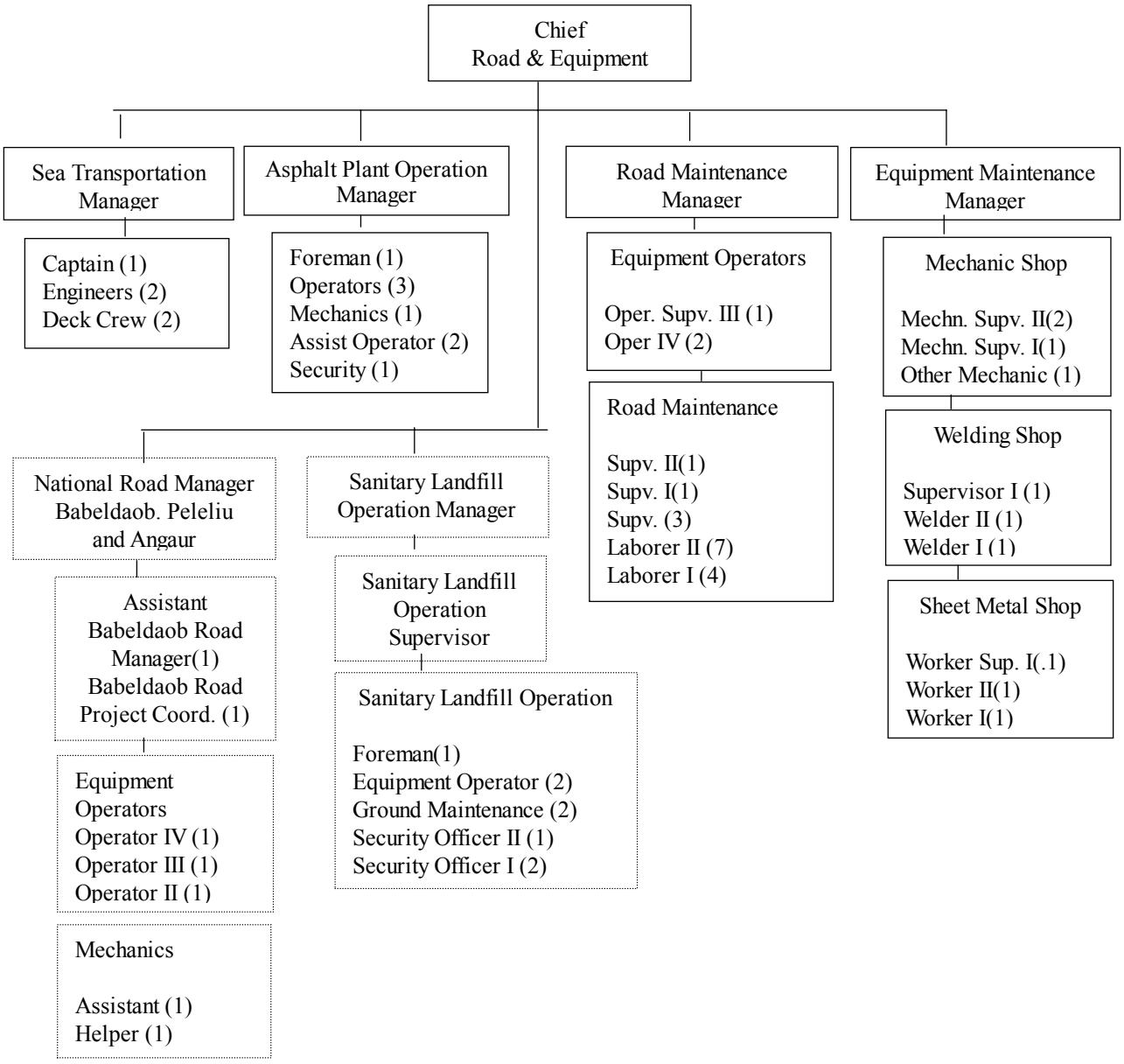


Fig. 2-29 Organization Chart of Bureau of Public Works

2-4-1-2 Facilities and Equipment

The Bureau of Public Works recently owns the following has road maintenance facilities and equipment:

Koror areas:

Bulldozer (D-4)	Caterpilla /Komatsu	2 nos
Wheel Loader (2.5 m3)		1 nos
Excavator (small)	Babeldaob	1 nos
Truck (5 ton)	Babeldaob	1 nos
Truck (1.5 ton)		4 nos
Truck with crane		1 nos
Roller (0.5t)		1 nos

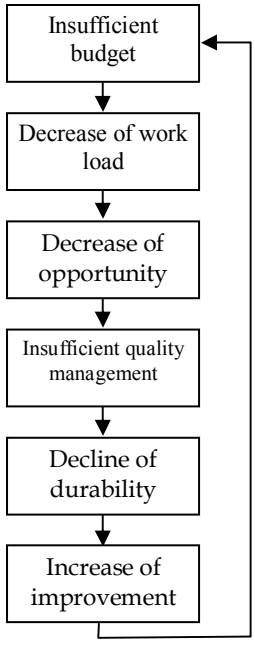
Peleliu Island:

Asphalt Plant	60t/h	1 nos
Wheel Loader(2.5 m3)		1 nos
Truck(5 ton)		3 nos
Truck(1.5 ton)		1 nos
Vibration Roller(5t)		1 nos
Roller(2t)		1 nos

2-4-2 Capacity building for maintenance ability of the executing agency

2-4-2-1 General Issues in Road Maintenance

Japanese government is strongly expecting practical maintenance from the point of view for efficiency of investment for the Project. The government of Palau is recognizing the importance of maintenance for the sustainability of the Project. However, maintenance in Palau is not executed sufficiently. General problems in road maintenance are as follows:



It is difficult in restricted national revenue to secure the budget for road maintenance. Generally, priority will be given to the new construction.

Decrease of work volume will cause the lack of experience in the executing agency and it will cause the decline of quality management ability and durability of the road. These spiral will cause increase of improvement costs as shown in the right figure.

Generally, people do not have consciousness for the standard of the road and no sufficient awareness of importance of

maintenance. Although new road is welcomed and appreciated, people will consider that the road is free of charge to use and has no attention for the occurring damages until they become serious. As a result, impossible large scale improvement works becomes necessary.

Executing agency has no consciousness for the responsibility of the maintenance of road. The responsibility means to satisfy the road user's requirement. Executing agency will not mind the traffic accident from the insufficient maintenance. Users are too weak to express their complaint.

The first conditions to decrease maintenance cost is to construct good road. Good and well qualified road will be produced from the well balanced and coordinated plan in construction to all the factors such as material, transportation, installation and operation etc.

Generous tolerance for the quality causes shortage of judgment for quality control. Furthermore the upper agency will be nervous for the delay of the project, and not for quality. Even if the road was damaged some years later, there is no person to take responsibility because the person in charge of the project has been moved to other department.

Maintenance works need not only engineering knowledge but also personal technique or skills backed up by the experience. However, it is not easy to train such kind of experienced and skilled personals in the developing countries.

2-4-2-2 Presuppositions for the Improvement of Maintenance Capacity

Reforming of the consciousness is necessary for the awareness to construct well qualified one and to use them with attention. Well maintenance will reduce the total cost of life cycle of road. Moreover the executing agency should have theoretical backup for the maintenance. As the results the following effect will be expectable.

Society could recognize the huge value of the road system and huge amount of money to be lost due to inappropriate maintenance procedures.

Executing agency could prove their work quality and contents.

Users could know the cost-effectiveness of their payment for road.

People could know the work efficiency of the executing agency and relevant authorities.

Users could request the executing agency to improve their works.

It is required for the executing agency to establish road evaluation methods, to evaluate regularly, and to publish the results of evaluation, road usage condition and construction information.

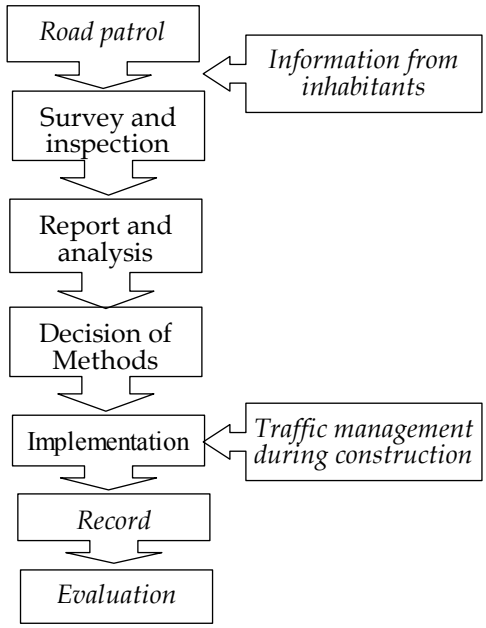
2-4-2-3 General Measurement for Maintenance

The figure in the right shows work flow of road maintenance.

For smooth implementation of road maintenance, "Establishment of maintenance manual", "Practice of road patrol" and "Establishment of road inventory" are required.

Road inventory should be newly established because there is no such an inventory in Palau. After establishment, updating should be maintained regularly to be sustainable.

Maintenance Flow



2-4-3 Recommendation

Palau is a small country and it is expected to establish its own suitable methods for the smooth maintenance of roads utilizing the chance of Japanese Grant Aid project under the consciousness for the responsibility of the executing agency.

Annual road maintenance cost is usually about 3% of construction cost. It is requested to reconsider the percentage of maintenance cost against road construction budget and secure the appropriate maintenance budget.

The following are examples of actual recommendations for Palau:

1) Establishment of road inventory (including estimation of road value and maintenance record)

2) Awareness and practice of quality management (utilizing the laboratory to be installed in the Project)

3) Training of experienced specialists

4) Secure of budget for maintenance

Japanese side could support for the improvement of maintenance capacity as follows:

On going measure	1)	Inviting trainees to Japan
	2)	Dispatching trainers
Suggestible new measure	3)	Establishment or improvement of training center, motor pool, laboratory and institute
	4)	On-the-job training during the Project
	5)	assistance for the research institutes including university
	6)	Promotion of craft unions
	7)	Supporting of introducing of official license system of engineer and technician

In the Project, the above 3) and 4) are possible with transferring technology of quality management during project implementation period.

2-5 PROJECT COST

2-5-1 Project Cost

The total cost of the Project by the Japanese Grant Aid is summarized in Table 2-43 and Table 2-44. This cost estimate is provisional and would be further examined by the Government of Japan for the approval of the Grant.

Approximate Project Costs Japanese Yen 893 million

Table 2-23 Project Cost to be born by Japanese Side (Million Japanese Yen)

Item			Phase One	Phase Two	Total
			Meyungs causeway	Malakal causeway	
Road Facilities	Road Work	Silt fence work, Excavation work, Fill work, Armor rock work, Sidewalk work, Pavement work	168	104	272
	Bridge Work	Culvert wall extension and slab replacement work	52	36	88
	Road Ancillaries	Traffic signs, Line marker	7	6	13
		Sub Total	227	146	373
			Airai causeway	Malakal Island Rd	
	Road Works	Silt fence work, Excavation work, Fill work, Armor rock work, Sidewalk work, Pavement work	155	152	307
	Road Ancillaries	Traffic signs, Line marker	8	16	24
		Sub Total	163	168	331
		Total	390	314	704
Detailed Design, Construction Supervisory			63	23	86
Grand Total			453	337	790

Table 2-24 Project Cost to be born by Palauan Side (Million Japanese Yen)

Items	Amount(US$)	By Yen (million)
Land Acquisition	510,000	56
Hiring temporary land	190,000	21
Installation of power supply line for the construction	2,000	0
Relocation of Telecommunication line	240,000	26
Total	942,000	103

Condition of Cost Estimate

1) Exchange rate: US$1.0 = J. Yen 116.12
(6 month average before November 30, 2003)
The above-mentioned Exchange rate is to be reviewed by the Japanese Government

2) Construction period Phase-1: 13 month Phase-2: 10 month

3) Others On condition that the Project implemented under the Japan's Grant Aid Scheme。

2-5-2 Cost for Operation and Management

Current road maintenance cost for the Koror area (around 24+108 miles) is about US$ 540,000. The project road length is in total 3.5 km, including 1.6 km island road. Necessary maintenance cost for the project road is estimated as follows:

Table 2-25 Cost for Operation and Maintenance

	Frequency	Place	Works	Unit Price/KM	Cost ($)
Cleaning of Drainage 16 km	2 times/year	Open Drain Culvert	Remove of Mud, Dust	1000	1,600
Maintenance for Safety Facilities 3.5 km	1 time/year	Marking	Repainting	500	1,750
Road Signs	2 times/year	Sign Plate	Cleaning Repair	100	350
Cutting Grass	2 times/year	Shoulders	Grass cutting	1000	3,500
	Annual Total				7,200
Repair of Pavement	Every 6 year	Surface	Patching Overlay	60000	10,000
Repainting of Hand-railing	Every 8 year	Surface Bulb	Changing	50000	6,250
Road lighting	Every 2 year	Electric wire	Repair of wire	2000	1,000
	Annual total				17,250
	Annual grand total				24,450

2-6 IMPORTANT NOTICES ON THE EXECUTION OF THE AID

This project is the improvement of the existing causeways and Malakal Island road, and there is no demolition of houses and resettlement of peoples. The certain execution of environmental assessment by the executing agency is requested from the EQPB.

The followings are the most important notice in the environmental prospect.

1) Countermeasures against soil contamination to sea water during the construction of the causeways

2) Reducing of noise and dust from construction vehicles

3) Safety measures for the public vehicles by the traffic control during the construction works

Land acquisition for road widening is expected at the following three locations.

1) Lands in middle island of Ngetmeduch on Airai causeway

2) Lands in middle island of Ngermalk on Malakal causeway

3) Lands of President Private house on the approach of Meyungs causeway

Chapter 3
Project Evaluation and Recommendations

3. PROJECT EVALUATION AND RECOMMENDATIONS

3-1 PROJECT EFFECT

Project effect will be considered as follows from the result of study for social, economic, traffic and engineering aspects.

Direct effect

Current status and issues	Countermeasures by the Project	Project effect and improvement degree by the Project
Deteriorations are remarkably progressing at the causeways connecting 4 islands of Koror metropolitan area.	Reinforce bank slope protection of causeways to increase the structural durability.	It is expected to increase the causeway durability remarkably by applying bank slope protection of armour stone taking into account of wave height of 50 years return period. It is also expected to attain the environmental improvement by giving living spaces for marine habitat among armour stones.
Rapid growing of traffic and the increasing of weight of vehicles in recent year are accelerating the damage of causeways and causing the traffic congestions and increasing traffic accident.	Widen the causeway width of currently 7 to 8 m, and provide sidewalks on both sides to enable the smooth traffic flow, and enhance safety of both vehicles and pedestrians.	Construct 3.6 m wide travel lane, 1.2 m wide shoulder and 1.2 m wide sidewalk. It will ensure the smooth traffic flow, and, at the same time, secure the safety of both vehicles and pedestrians.
Inadequate drainage system of Malakal Island Road causes over flooding frequently, during the heavy rain.	Provide sufficient drainage system with appropriate design rainfall intensity to reduce the flood, and to increase the durability of road pavement.	The Project will provide the drainage system with enough capacity for the frequent heavy rain, and secure the smooth traffic, along with the pavement improvement.

Indirect effect

Expected indirect effect	Details
Secure the stable lifeline	Improvement of causeways by the Project increases its structural liability. Hence, the stableness of lifeline such as water supply, sewerage, power supply and telecommunication lines, which are installed along causeways, would be enhanced. In addition to the upgrading of safety for vehicle traffic, the sidewalks will be provided by the Project. This will enlighten Palau on the importance of pedestrian safety, which are not enough yet in Palau.
Stimulate economic activities of Palau	The causeway traverses above the sea would be one of the tourist attractions. It is expected to contribute to encourage the tourist industry. The Project will eliminate the Malakal road over flooding during the heavy rain, and would enhance the warranty of transport activities between Koror and Malakal port, or transport services for tourists to dive shops located in Malakal Island.
Strengthening of friendship between Japan and Palau	Implementation of the Project would be highly appreciated as the milestone project for the both countries, Japan and Palau, maintaining long historical friendship, to celebrate the 10th anniversary of Palau independence.

Population to receive the project benefit and its scale

Population to receive the benefit	Resident of Koror State about 15,000 people and Tourist about yearly 45,000 (Source: Palau Visitors Authority)

3-2 RECOMMENDATIONS

In Palau, the importance of social infrastructure development has being increased steadily because transportation and communication industries show an upward trend while agriculture and fishing are on a decline. In order to achieve the sound national financial system, without any foreign aid assistance of United States or other countries, it would be quite essential to reform the national taxation system, and to implement infrastructure developments, through which the Palau Government will execute their policies to enable an increase of tax revenue. Moreover, it is difficult to ease the current traffic congestion in the city area by road improvement only. It is recommended to take concurrently all other measures such as suppression of car registration growth by means of taxation, enforcement of traffic controls and provision of public transportation system.

The designed roadway width (2 lanes) for causeway improvement was adopted the same width with the Compact Road, that is a standard width of the first-class national road in Palau. It has a capacity to accommodate traffic volume, up to twice of the present level, which will be a traffic demand of 10 years after. However, in accordance with the degree of traffic growth onward, it may be necessary to review the traffic capacity aspects. In such cases, widening of inland roads would be the must condition for the further improvement. For example, the further widening of Meyungs Causeway, more than 2 lanes, would have no meaning unless the improvement of Medalaii Intersection and even the roadway widening in inland built-up area. In Koror City, where flat area is limited, it is not easy to secure lands for road widening. Thus it is requested for the Government of Palau to establish a long-term development plan based on a steady land acquisition policy for public works.

For the implementation of the Project, it is requested to take into consideration the self efforts, and sustainability, which are the basic policy of Japanese Grant Aid scheme. For example, the Public Works Department, who is in charge of road maintenance, does not have quality control facilities applied for road construction works. It is recommended for the department to strengthen the quality control ability. For example, it is proposed to send staffs of the department to the contractor's laboratory, during the project construction, to give them basic laboratory training, and then send them to the JICA's group training course, Road Technology. After the completion of said training, it is also recommended to provide the department with laboratory equipment by applying the JICA's follow-up assistance.

Through these trainings, it would be possible to find an appropriate methodology to utilize domestic products as the construction materials, such as aggregate, which is one of the wishes of Palau.

The Government of Palau wants the Government of Japan to extend ODA assistance same as before. As Palau is expecting for help of other fields as well, such as several water supply and swage projects, it is desirable to carry out a comprehensive development study for the metropolitan area, prior to the establishment of individual aid program by Japanese Grant Aid scheme.

As for the coordination with other donors to the transport sector of Palau, it is suggested for the Public Works Department to establish the common design standard and material specifications throughout the projects under the grant aid of Japan and the projects by the Taiwanese help.