No.

BASIC DESIGN STUDY REPORT
ON THE PROJECT
FOR
THE RECONSTRUCTION OF BRIDGES
IN EAST GUADALCANAL
IN
THE SOLOMON ISLANDS

JULY 2006

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to a request from the Federal Government of the Solomon Islands, the Government of Japan decided to conduct a basic design study on Basic Design Study Report on the project for the reconstruction of bridges in East Guadalcanal in the Solomon Islands and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to the Solomon Islands a study team from November 23 to December 28, 2005.

The team held discussions with the officials concerned of the Government of the Solomon Islands, 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 the Solomon Islands 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 the Solomon Islands for their close cooperation extended to the teams.

July, 2006

Masafumi Kuroki
Vice-President
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

July, 2006

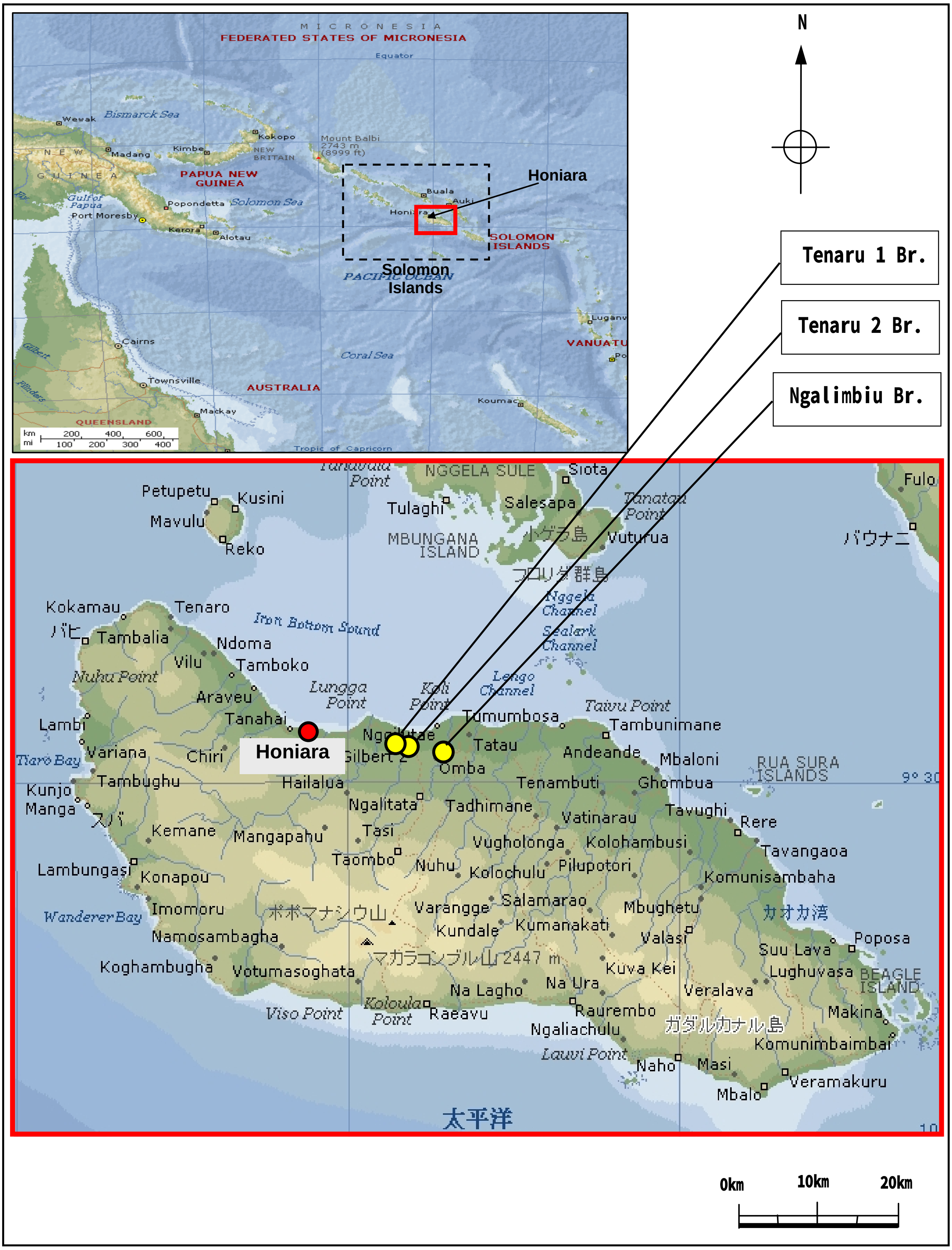
We are pleased to submit to you the basic design study report on Basic Design Study Report on the project for the reconstruction of bridges in East Guadalcanal in the Solomon Islands.

This study was conducted by Construction Project Consultants, Inc., under a contract to JICA, during the period from November, 2005 to July, 2006. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of the Solomon Islands and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

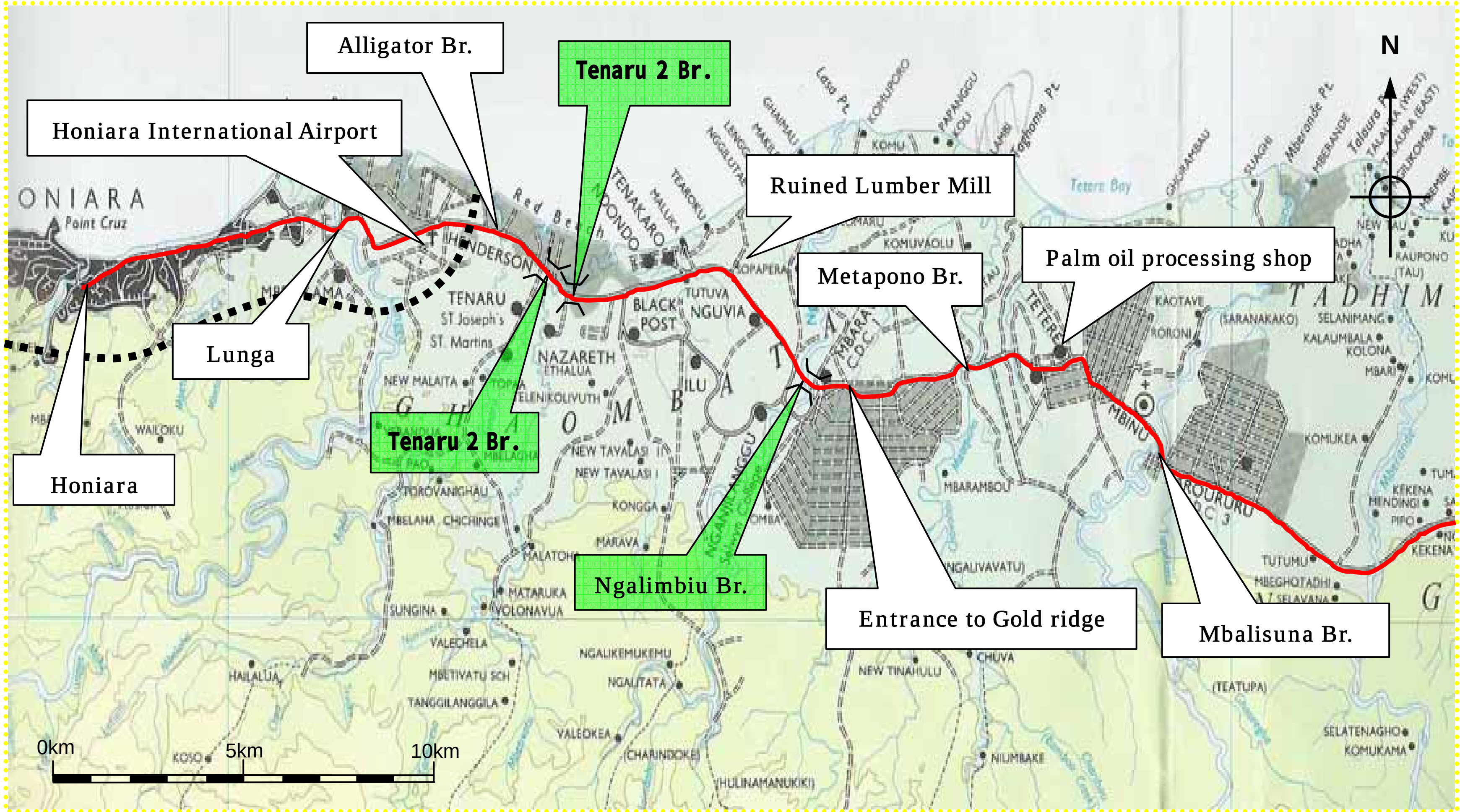
Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

Youichi Higaki
Project Manager,
Basic Design Study Report on the Project for
the reconstruction of bridges in East Guadalcanal in
the Solomon Islands
Construction Project Consultants, Inc.



PROJECT LOCATION MAP



Location of bridges and major bases of key industries along East Road

PERSPECTIVE (Tenaru 1 Bridge)

PERSPECTIVE (Tenaru 2 Bridge)

PERSPECTIVE (Ngalimbiu Bridge)

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Abbreviation

ADB	:	Asian Development Bank
BDS	:	Bridge Design Specification
CPGSDDB	:	Code of Practice for General Structural Design and Design Loading for Buildings
DBST	:	Double Bituminous Surface Treatment
DFEC	:	Department of Forestry, Environment and Conservation
DID	:	Department of Infrastructure and Development
DLS	:	Department of Lands and Surveys
EDF	:	European Development Fund
EODU	:	Explosive Ordnance Disposal Unit
JICA	:	Japan International Cooperation Agency
KSA	:	Key Strategy Area
MAL	:	Ministry of Agriculture and Lands
MID	:	Ministry of Infrastructure and Development
MNR	:	Ministry of Natural Resources
MTWC	:	Ministry of Transport, Works and Communication
NAARSA	:	National Association of Australian State Road Authorities
NERRDP	:	National Economic Recovery, Reform and Development Plan 2003 - 2006
NZSA	:	New Zealand Standard Association
PCERP	:	Post Conflict Emergency Rehabilitation Project
RAMSI	:	Regional Assistance Mission for Solomon Islands

SUMMARY

SUMMARY

Prior to the outbreak of ethnic conflict in 2000, palm oil, gold mining and timber industries formed the principal driving forces of the economy of the Solomon Islands. The destruction of the palm oil and gold mining industries as well as infrastructure (roads and bridges) by the conflict, however, impoverished the national economy, creating a mono-culture structure totally dependent on the export of timber. To improve this situation, the Government of the Solomon Islands formulated the National Economic Recovery, Reform and Development Plan (NERRDP) in October, 2003 and set out five priority areas. “Restoration of the productive sector and the rebuilding of supporting infrastructure” is one of these five areas. While public peace in the country has now been restored, the recommencement of the palm oil and gold mining industries and the restoration of infrastructure to support economic activities are now urgently required to facilitate the economic recovery as well as the general reconstruction of the country.

On Guadalcanal Island, apart from sea routes, a road which stretches east and west from Honiara, the capital, is the only land transportation route and plays an extremely important role to support not only industrial activities but also the daily lives of citizens. As mentioned earlier, this road and its many bridges were damaged by the conflict in addition to their more natural deterioration due to aging. The road itself is currently undergoing rehabilitation work under the Post-Conflict Emergency Rehabilitation Project (PCERP) of the ADB. Meanwhile, many of the bridges are dangerous because of the halving of the original girder plate thickness near the supporting points due to corrosion over 20 – 50 years, falling of lime resulting from cracks of the concrete slabs and other reasons. The superstructure of some bridges has completely collapsed and has been temporarily repaired to ensure the use of these bridges despite the apparent risk of collapse. This situation cannot be sustained in the light of the increasing number of heavy vehicles passing over these bridges in the coming years as the restoration of key industries is underway. The introduction of urgent measures, including the reconstruction of bridges, is therefore essential.

Against this background, the Government of the Solomon Islands made a request to the Government of Japan in March, 2004 for the provision of grant aid for the restoration and improvement of the trunk road from Honiara and road bridges. In response, the Japan International Cooperation Agency (JICA) dispatched the Preliminary Study Team to the Solomon Islands for the period from August to September, 2005 to confirm the contents of the request. Having confirmed that the request was for the reconstruction of Ngalimbiu Bridge, Tenaru 1 Bridge and Tenaru 2 Bridge, the JICA dispatched the Basic Design Study Team to the Solomon Islands for the period from 23rd November to 23rd December, 2005 to conduct a field survey on these three bridges.

Through consultations with the Solomon Islands side, the Basic Design Study Team agreed the scope and contents of the requested Japanese grant aid with the Ministry of Infrastructure and Development (MID), taking the PCERP and other relevant plans/programmes into consideration. On its return to Japan, the Basic Design Study Team finalised the scope of the grant aid as shown below based on the field survey results.

Bridge Name	Tenaru 1	Tenaru 2	Ngalimbiu
Rehabilitation Method	Reconstruction	Reconstruction	Reconstruction
Location of New Bridge	14 m inland from the existing bridge	9 m towards the sea from the existing bridge	12 m inland from the existing bridge
Design Bridge Surface Elevation	Elevation : 7.6 m	Elevation : 5.4 m	Elevation : 17.1 m
Crossing River	Tenaru River	Tenaru Creek	Ngalimbiu River
Length	55.0 m	25.0 m	120.0 m
Width	Carriageway : 4.0 m	Carriageway : 4.0 m	Carriageway : 4.0 m
	Sidewalk : 1.2 m	Sidewalk : 1.2 m	Sidewalk : 1.2 m
Type of Superstructure	Three span continuous non-composite girder	Simple composite girder	Three span continuous non-composite girder
Substructure	Inverted T abutment	Inverted T abutment	Inverted T abutment
	Cantilevered oval column pier		Cantilevered oval column pier
Foundations	Steep piles (∅600 mm; L = 28 m)	Steep piles (∅600 mm; L = 18 m)	Steep piles (∅600 mm; L = 27 m)
Approach Roads	West side : 144.60 m	West side : 190.00 m	West side : 205.02 m
	East side : 203.40 m	East side : 190.00 m	East side : 174.98 m
Abutment Protection Work	Placement of wire mats	-	Placement of wire mats

The planned scope and contents were then compiled in the Summary Report for the Basic Design and a mission was dispatched to the Solomon Islands for the period from 19th to 28th May, 2006 to explain the said Report and the Government of the Solomon Islands afforded its basic consent to the contents of the said Report.

The Basic Design Study Team found that the implementation of the project would take 5.5 months for the detailed design (including the tender process) and 13 months for the construction work and that the overall project cost would be approximately ¥944 million (Japanese portion of approximately ¥913 million and Solomon Islands portion of approximately ¥31 million) in the case of the project's implementation under Japan's grant aid scheme.

With the implementation of the project, reliable access to Honiara, the capital, in particular and a safe trunk transportation route from the eastern part of Guadalcanal Island will be secured to facilitate the restoration of social and economic activities in the said eastern part, benefiting some 60,000 residents in Honiara and neighbouring areas. The expected effects of project implementation are further described below.

Direct Effects

- The increased bearing capacity of each subject bridge will allow the safe passage of large vehicles and will also secure the safety of pedestrians through the introduction of a sidewalk.
- The increase of the allowable live load from the present 20 tons to 66 tons will mean the reliable and effective transportation of more passengers and cargo.

Indirect Effects

- The safe and smooth transportation of palm trees from plantations to the processing plant and the processed palm oil from the plant to Port Honiara and between Honiara and gold mines will contribute to the restoration of social and economic activities.
- The smooth passage of vehicles and pedestrians will facilitate the access of local residents to medical and educational facilities and markets, etc.

The relevance of the project to the objectives of Japan's grant aid scheme can be ascertained as the reconstruction of Ngalimbiu Bridge, Tenaru 1 Bridge and Tenaru 2 Bridge will secure safe and reliable transportation along the trunk road linking important bases for principal industries located in the eastern part of Guadalcanal Island and Honiara. For the implementation of the project, it will be essential to respect the customary ownership of land, trees, soil and gravel, etc. while maintaining close communication with the Department of Infrastructure (DID) which is the implementation agency for the project. In view of such ownership, careful attention should be paid to the collection and disposal of materials.

Moreover, it will be necessary for the Solomon Islands side to regularly and systematically inspect and maintain the entire road, including the subject bridges of the project, to ensure the serviceability of the road.

As mentioned earlier, the bearing capacity of each subject bridge will be increased to 66 tons. However, it must be noted that only one trailer truck weighing 66 tons can cross these bridges at a time. A traffic sign regulating the live load should be erected at all entry points of these bridges to ensure that road users are properly informed of and abide by this regulation.

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CHAPTER 1

BACKGROUND OF THE PROJECT

CHAPTER 1 BACKGROUND OF THE PROJECT

For the Solomon Islands which is earnestly proceeding with the restoration of its key industries in the post-ethnic conflict era, the rehabilitation of the principal road linking gold mines and plantations (palm oil, cacao and coconut) in the eastern part of Guadalcanal Island and Honiara, the capital which provides the main export port as well as the main consumption area, and bridges on this road is directly linked to the restoration of key industries through improved infrastructure for better transportation and also for the reconstruction of the national economy, including better access of the public to health care and education, etc.

Against this background, the Government of the Solomon Island made a request to the Government of Japan in March, 2004 to provide grant aid for the rehabilitation of parts of the trunk road running east and west from Honiara and three road bridges. In response, the JICA dispatched the Preliminary Study Team to the Solomon Islands for the period from August to September, 2005 to confirm the contents of the request and the situation of land expropriation.

From the results of the Preliminary Study, the entire route of the above-mentioned trunk road has been repaired through funding from the ADB and some bridges are also scheduled to be improved through the said funding. It was confirmed that Ngalimbiu Bridge, Tenaru 1 Bridge and Tenaru 2 Bridge were subject to the requested Japanese assistance. It was also confirmed that the Solomon Islands would secure land and complete its expropriation by June 2006. Moreover, from the results of an IEE (Initial Environmental Examination) conducted by the Solomon Islands, it was also confirmed that work required under the proposed project would be classified as Category B, which means it would have little social impact.

Based on the above results of the Preliminary Study, the Government of Japan decided to conduct the Basic Design Study on the three subject bridges from the viewpoint of developing the eastern part of Guadalcanal Island. The Basic Design Study has such purposes as confirming the necessity and relevance of the requested project, conducting appropriate basic design work as a grant aid project of Japan, formulating the project implementation plan and estimating the project cost.

CHAPTER 2

CONTENTS OF THE PROJECT

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2.1 Basic Concept of the Project

In 2003, the Government of Solomon Islands launched the policy that five areas below mentioned would be highlighted as the Key Strategy Area in the National Economic Recovery, Reform and Development Plan 2003-2006.

① Normalizing law and order and security situation
② Strengthening democracy, human rights and good governance
③ Restoring fiscal and financial stability and reforming the public sector
④ Revitalizing the productive Sector and rebuilding supporting infrastructure
⑤ Restoring basic social services and fostering social development

Among others “Revitalizing the productive sector and rebuilding supporting infrastructure” is the important area in order to restoring the economy now, when the public peace has been recovered by the dispatched Regional Assistance Mission for Solomon Islands (RAMSI).

Although palm oil, gold mining and timber industries had sustained the Solomon’s economy before the ethnic conflict between 1998and 2001, all of them were shut down by the conflict. But now the timber industry is immediately to restart its operation and furthermore gold mining and palm oil plantation will start within this year.

On the other hand, it is apprehended that Tenaru 1 Bridge, Tenaru 2 Bridge and Ngalimbiu Bridge might not secure stable and safe traffic due to the damages caused by the ethnic conflict, natural disasters and collisions by vehicles or future heavier vehicles. Restoration of trunk roads and bridges dose not only mean to provide the infrastructure aiming at improving the traffic convenience but also leads directly to the recovery of the national economy.

Constructing the three objective bridges will enable to secure safe and stable transportation between Honiara and major bases of operation of key industries such as timbering, gold mining and palm oil plantation in cooperation with the road rehabilitation works now implemented as part of the Post Conflict Emergency Rehabilitation Project (PCERP), and bridges granted by Japan, such as Lunga Bridge, Alligator Bridge and Metapono Bridge.

Locations of the objective bridges are shown in the Figure 2.1.

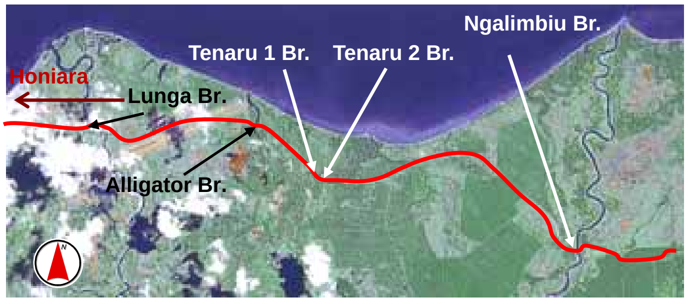


Figure 2.1 Location of the objective bridges

Table 2.1 shows distances between WESTPAC Bank in Honiara City, the origin of the chainage, and existing bridges together with major bases of key industries' operation.

Table 2.1 Location of bridges and major bases of key industries along East Road

Objects	Distance (km)	Notes
Honiara (WESTPAC Bank)	0.0	Origin of East Road in Honiara
Lunga Bridge	7.6	Steel Bridge (126.0m long,two lanes, one sidewalk), Japanese Grant Aid
Honiara Airport	8.5	International Airport
Alligator Bridge	12.5	Steel Bridge (56.0m long,two lanes, one sidewalk), Japanese Grant Aid
Tenaru 1 Bridge	14.6	**Objective Bridge (Old bridge with one lane without sidewalk)**
Tenaru 2 Bridge	15.2	**Objective Bridge (Old bridge with one lane without sidewalk)**
Ruin of lumber mill	17.6	Destroyed by the conflict and to be restored (Earth Mover)
West end of plantation	18.5	West end of the palm oil plantation
Ngalimbiu Bridge	22.6	**Objective Bridge (Old bridge with one lane with two sidewalk)**
Entrance of Gold Ridge	24.0	Junction of East Road and Gold Ridge Road
Metapono Bridge	27.3	Steel Bridge (72.0m long,one lane with one sidewalk), Japanese Grant Aid
Palm oil processing shop	30.9	Palm oil processing shop under restoration (GPOL)
Mbalisuna Bridge	34.0	Concrete bridge (one lane)
East end of plantation	39.1	East end of the palm oil plantation

2.2 Basic Design of the Requested Japanese Assistance

2.2.1 Design Policy

2.2.1.1 Basic Policy

The existing Tenaru 1 Bridge, Tenaru 2 Bridge and Ngalimbiu Bridge have been damaged during the conflict, clashed by the traffic, and will be overloaded by heavy vehicles in the very near future. It was decided that all the three bridges are to be reconstructed considering the results of the bridge investigation carried out by the Study Team.

2.2.1.1.1 Basic Policy on Repair/Reconstruction

(1) Results of the existing bridge study

1) Tenaru 1 Bridge

It is said that this bridge was built by Australia in 1950s.There remains neither drawing nor report of the bridge at the time of construction.

The Figure 2.2 indicates the structure of Tenaru 1 Bridge. It is an unequal three-span simply supported H-shape steel beam bridge with a single lane, without sidewalk.

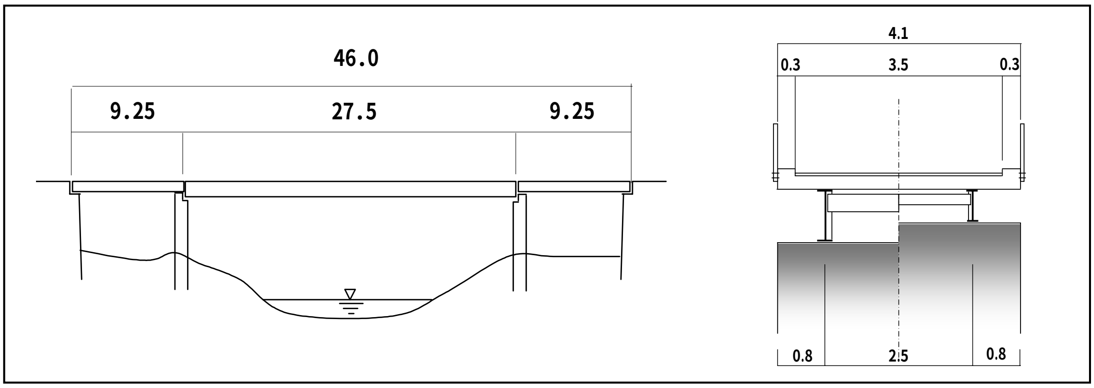


Figure 2.2 Existing Tenaru 1 Bridge

Found were these damages below due to the destructive conducts during the conflict in addition to the inappropriate maintenance for a long time.

- Longitudinal cracks with white released lime on the east side-span concrete deck were observed, which might develop to hexagonal pattern, drop down in lumps of concrete and completely lose the function as the deck.
- As there was no expansion joint on the gaps between the decks, rain water and mud dropped through the gaps from the deck surface, heaped up on the top of the substructure and corroded the most important parts of the structure such as bearings and their surrounding elements. The remedy for these damages is to install expansion joints and reinforce the damaged elements.
- Missing was approximately 30cm long cantilevered portion of the concrete deck on the downstream side. It was damaged at the same time when the guardrail was destroyed
- As the bridge is as narrow as 3.5 meters wide, passing heavy vehicles have to reduce the speed.
- As there’s no sidewalk, the situation endangers pedestrians passing the bridge.
- The guardrails remain destroyed completely and endanger extremely the vehicles and pedestrians passing the bridge.

- The test result on the concrete substructure using a Schmitt Hammer revealed that there was no problem regarding the concrete strength. No inclination, depression nor erosion of the foundations was observed, and there appeared no serious problem.

2) Tenaru 2 Bridge

As is shown below, the structure is a simply supported H-shape composite girder with a single lane without sidewalk. This bridge is so closely located as within only 600 meters from Tenaru 1 Bridge. It is guessed that it was constructed at around same time under the same technical standards by the construction method as the other. Therefore, the problems on this bridge seemed almost same as the other.

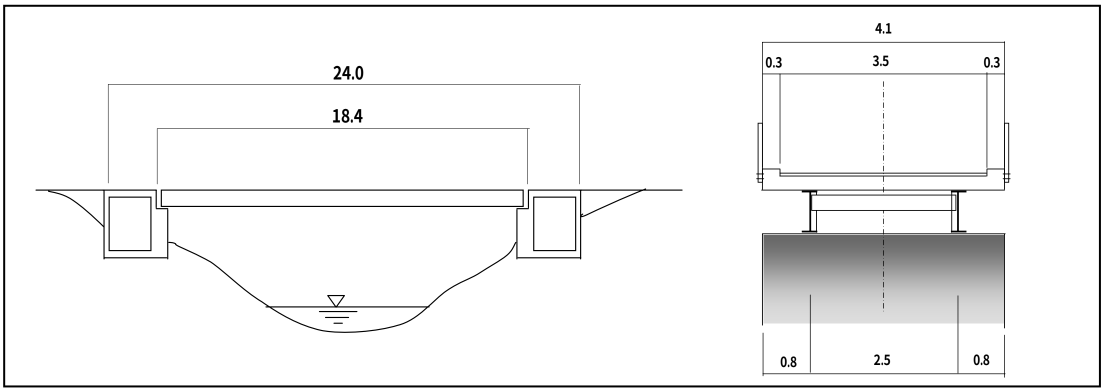


Figure 2.3 Existing Tenaru 2 Bridge

Characteristic of Tenaru 2 are described in detail below. The general condition of the corrosion on the main girders bearing the loads transferred through the deck is more serious than that of Tenaru 1 Bridge (Photo 2.1).

- As expansion joints are missing, mud drops from the gap of the deck and heaps as tall as 30cm on top of the substructures. Steel elements adjacent to bearings get rusty because of the wet mud. Among others steel plates used for lower flanges and web plates have become as thinner as half of the original thickness.
- Rainwater comes through the concrete deck slab, corrodes upper flange plates and also possibly makes rebars rusty inside the slab.

Photo 2.1 Steel elements near bearing

3) Ngalimbiu Bridge

Particulars of the damages are as described below.

- The old bridge is of 5-span simply supported composite girder bridge, each span length 21m, constructed by Australia in 1984. During the Cyclone Namu in 1986, water flow with enormous mud and debris shut the gap between piers and finally one pier and two spans of superstructure on the east bank were washed away (Photo 2.2, Figure 2.4). Furthermore as the westernmost pier inclined toward downstream by 50cm, the remaining superstructure bended, and impassable (Photo 2.3).

Photo 2.2 Two spans missing of the old bridge

Photo 2.3 Superstructure bended to downstream

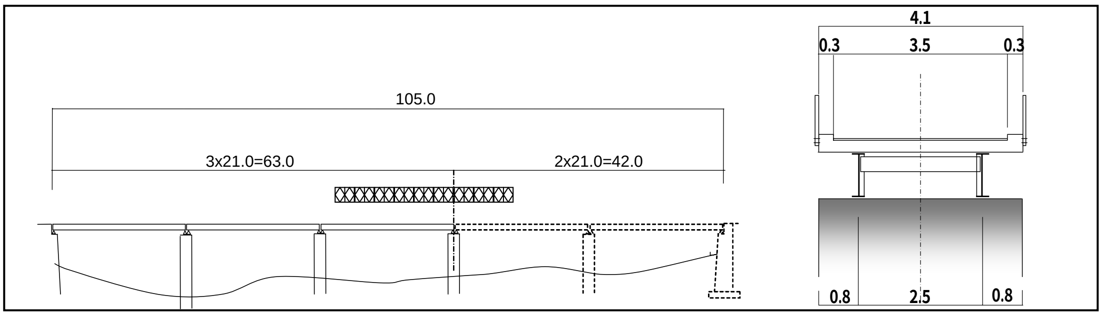


Figure 2.4 The old Ngalimbiu Bridge

- Considering the importance of Ngalimbiu Bridge, the United Kingdom constructed the existing Ngalimbiu Bridge, two-span (each 55m long) truss bridge in 1988.
- In February 2000 during the conflict, a large trailer truck bound for Honiara hit diagonal elements at the upperstream east bank of the existing truss bridge, and the truss bridge fell from the eastern abutment. After placing gravel on the deck of the falling portion and taking some other emergency measures, it is now passable as shown in Figure 2.5 and Photo 2.4.

・ In addition to such natural disasters, it is confirmed that principle truss members above the deck surface such as diagonal and vertical elements have been damaged as shown in Photo 2.5.

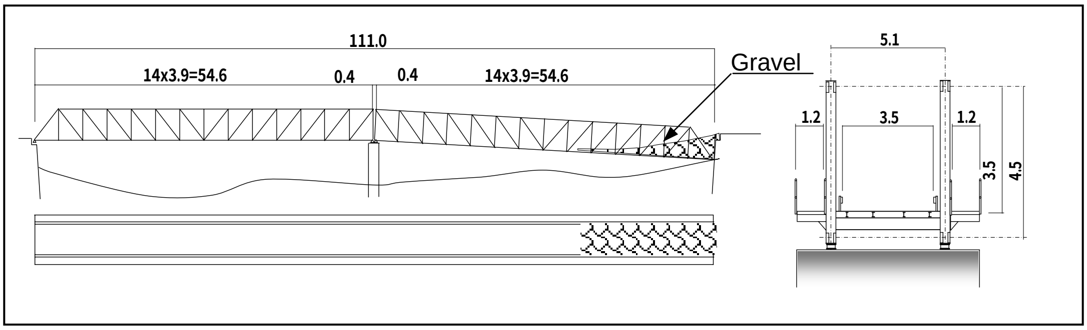


Figure 2.5 The existing Ngalimbiu Bridge

Photo 2.4 Truck passing the existing Ngalimbiu Bridge

Photo 2.5 Vertical member damaged by hit

(2) Particulars of traffic loads

The old Ngalimbiu Bridge was designed taking T33 of NAASRA, National Association of Australian State Road Authority, as the design live load, and the existing bridge applied T44 as the design live load according to Queensland Division Technical Papers.

Tenaru 1 Bridge and Tenaru 2 Bridge are said to be designed by T33 and the bearing capacity to be no more than only about 20 tons according to the study conducted in 2000 by Gold Ridge Mining, user of the bridges.

TL20 design live load of Japanese Bridge Specifications was applied to the design of six bridges along the trunk road. Bending moments at mid-span were calculated for a supposed structure of new Ngalimbiu Bridge by loading TL20, T44 or T33, and compared. Either bending moments by T44 or T33 is less than that by TL20.

Table 2.2 Comparison of bending moments at mid-span by each live load

Live Load	Distributed Load p (t/m)	Line Load P (t)	Bending Moment at Mid-span*2 M (tm)
TL20	4.0 x 0.35=1.40	4.0 x 5.0=20.0	307.5
T44 *1	1.28	15.3	258.8
T33	1.28 x 3/4=0.96	15.3 x 3/4=11.5	194.3

Notes) *1 : T33 assumed to be 3/4 of T44

*2 : Sample taken Ngalimbiu Bridge : 4m wide,Span (L)30m,M=((pL)^2)/8+PL/4

Major companies plan to use heavier trailer truck such that GPOL will utilize 49t trailer, Earth Mover 60t and Gold Ridge 66t, although heavy-duty trailers have run already as shown in the Photo 2.6.

Working stresses under 66t trailer load have been calculated and compared with supposed allowable stresses, based on dimensions of the superstructure elements of Tenaru 1 Bridge and Tenaru 2 Bridge measured at site. The result indicates that the stress in the concrete deck exceeds approximately by 60% and the stress in steel girder by 30%.

Photo 2.6 Heavy trailer truck running on the objective area

(3) Repair/ reinforcement of the existing bridges

1) Tenaru 1 Bridge, Tenaru 2 Bridge

It is necessary to repair/reinforce Tenaru 1 Bridge and Tenaru 2 Bridge against the insufficient capacity, if it is intended to utilize the bridges furthermore. But appropriate countermeasures to repair/reinforce these bridges cannot be found as pointed out in the Study Report issued by Woodward-Clyde mentioned before.

2) Ngalimbiu Bridge

The bridge is passable as of the end of February 2006 due to the emergency repair. But the bridge was repaired aiming only at utilizing the bridge as detour while it is reconstructed, and no reinforcements have been made at all.

(4) Other problems

1) Carriageway width

Lunga Bridge and Alligator Bridge, located between Honiara and the objective bridges, have carriageway with two lanes 3.75m wide, and Metapono Bridge, located eastward from the objective bridges, has one lane 4.0m wide. But the objective bridges, Tenaru 1 Bridge, Tenaru 2 Bridge and Ngalimbiu Bridge, located between those other bridges, have the carriageway 3.5m wide only, and therefore they are left in easily damaged situation during vehicles' passage.

Generally it is necessary to reinforce superstructure, substructure and foundation against increased load intensities in order to widen the superstructure. But on the other hand generally a large-scale work is expected and much cost is required for widening, thus actual work is limited only to few.

As the existing Ngalimbiu Bridge is a so-called deck truss type, where the carriageway is placed between the truss girders on both sides, it is structurally impossible to widen it.

2) Sidewalk

The existing Ngalimbiu Bridge has sidewalks on both sides 1.2m wide. But Tenaru 1 Bridge and Tenaru 2 Bridge have no sidewalk; therefore pedestrians are left in a dangerous situation. Similar problems of reinforcement to those for the carriageway widening will rise to add sidewalk to the bridges.

(5) Conclusions to repair/reinforcement

Issues and judgment on the existing bridges are summarized in Table 2.3.

Table 2.3 Issues on the existing bridges and judgment

Item	Issue			Judgment
	Tenaru 1 Br.	Tenaru 2 Br.	Ngalimbiu Br.	
Width	・As narrow as 3.5m	・As narrow as 3.5m	・As narrow as 3.5m ・Major truss elements damaged due to collision by vehicles	・Slowdown due to narrow carriageway ・Possible to be hit by vehicle further ・Difficult or impossible to widen
Sidewalk	・No sidewalk ・Danger to pedestrian	・No sidewalk ・Danger to pedestrian	・Sidewalks on both sides	・Difficult or impossible to add due to excessive load or structure
Damage	・Corrosion around bearing ・Part of deck missing ・Serious damage on the guardrail	・Corrosion around bearing ・Serious damage on the guardrail	・Collapse of truss bridge on the east bank ・Damage to major components of super structure	・Remedy necessary to have fundamental function

Such countermeasures are required as described below resulting from the judgments above.

1) Tenaru 1 Bridge, Tenaru 2 Bridge

Tenaru 1 Bridge and Tenaru 2 Bridge are to be reconstructed in order to secure safe traffic against the narrow carriageway, damages and insufficient load capacity, and also to equip sidewalk for the pedestrians' safety.

2) Ngalimbiu Bridge

Ngalimbiu Bridge is to be reconstructed in order to ensure traffic flow and address problems such as the narrow carriageway, damage and insufficient load capacity and to install sidewalks to ensure pedestrian safety. By utilizing the present bridge as a detour during construction it will be possible to shorten the construction period and reduce the cost.

2.2.1.1.2 Policy on Cross-section

(1) Number of lanes

The present traffic volume is approximately 500 vehicles per day according to the result of traffic volume survey conducted at the site. One-lane bridge is to be considered, as the traffic will increase only to a limited extent, taking into account the characteristics of the region.

(2) Carriageway width

As the present objective bridges have only 3.5m wide carriageway, vehicles are obliged to slow down when passing them.

On the other hand the six bridges granted by Japan are equipped with 4.0m wide one lane or 7.5m two lane-carriageway to provide smooth traffic.

In order to ensure smooth traffic flow, the planned carriageway is to be one 0.4m lane (Figure 2.6).

(3) Sidewalk

Ngalimbiu Bridge will be planned to be equipped with a sidewalk on one side to secure safety of pedestrians, because the existing bridge has sidewalks and the bridge is planned so long as 120m.

The present Tenaru 1 Bridge and Tenaru 2 Bridge have no sidewalk. Pedestrians are left in a dangerous situation, where habitants from a community adjacent to the site walk over the bridge, and heavy-duty vehicles pass the site increasingly (Photo 2.7).

Photo 2.7 Heavy trailer passing Tenaru 2 Bridge

The objective bridges are planned to have 1.2m wide sidewalk on one side to separate pedestrians from vehicles for the safety, as the bridges by Japanese Grant Aid are equipped with 1.2m wide sidewalk on one side or both sides (Figure 2.6).

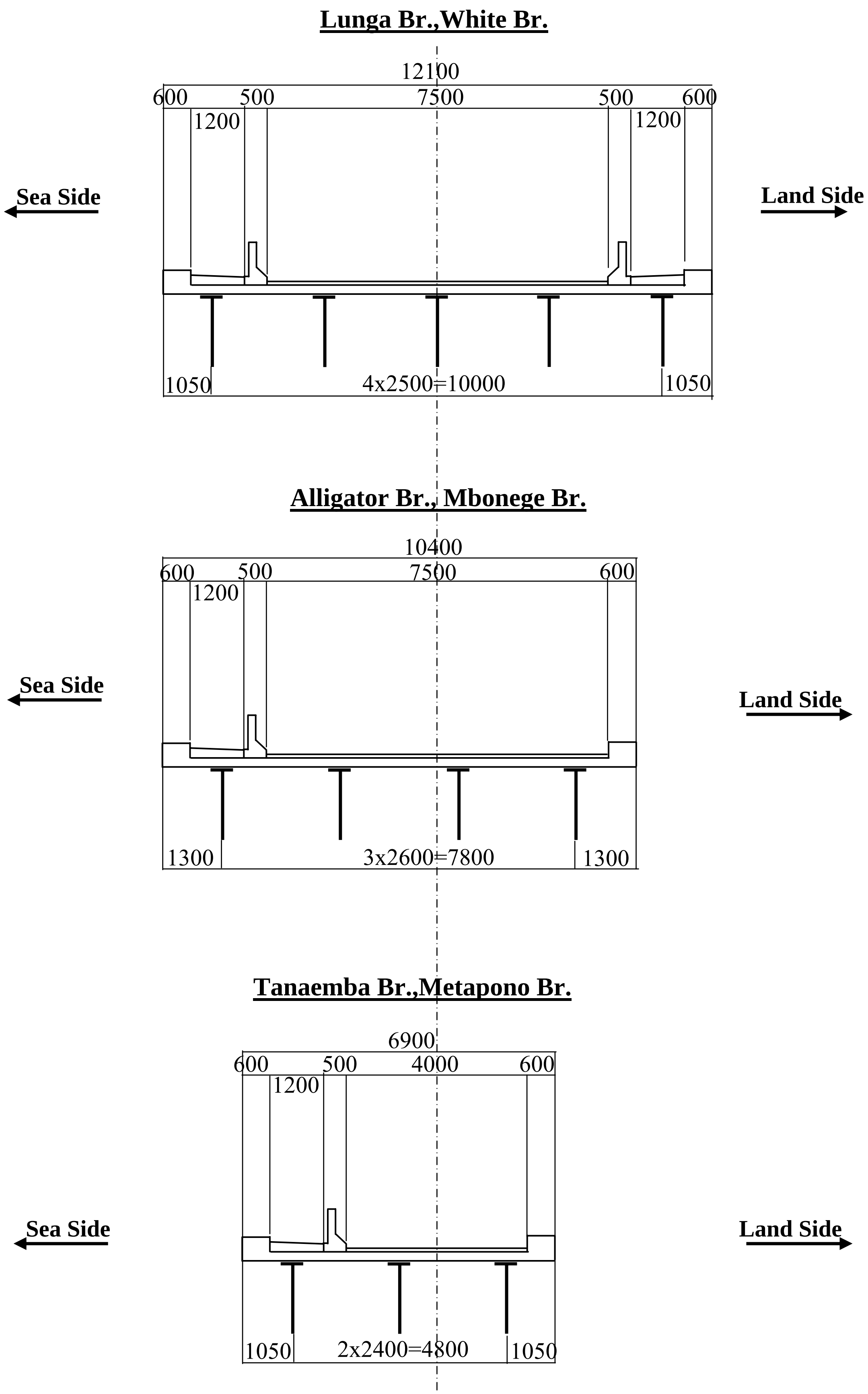


Figure 2.6 Cross-section of Japan's Grant Aid Bridges

2.2.1.1.3 Basic Policy on Design Live Load

Considering the upsizing of vehicles, safety for these bridges will be verified by large-sized trailer truck loads (66t).

In order to ensure safety and the most economical load from traffic of heavier vehicles (66t), the design live load will be TL-20.

2.2.1.1.4 Basic Policy on Selecting Bridge Type

Types of superstructure and substructure are to be selected for the basic design, paying attention to shortening construction period, reduction of construction and maintenance cost

2.2.1.1.5 Basic Policy on Selecting Bridge Material

As there is no steel fabricator in Solomon Islands, the alternatives are to import fabricated steel girders or prepare concrete girders at site.

Steel bridge was adopted taking into account the characteristics of steel bridge for the reasons below:

- As steel structures are fabricated while temporary facilities, foundations and substructures are constructed at site; the total construction period can be remarkably shortened in comparison with concrete bridge where all the works are constructed at site.
- As the fabricated elements are only assembled at site by connecting with high tensile bolts, erection of the superstructure requires only short period.
- Small is a reaction force from the superstructure of steel bridge, it is advantageous for the site where supporting stratum of the ground is deep.
- As the Solomon Island has suffered earthquake so far, steel bridges with light dead load is advantageous from anti-seismic viewpoint.
- As steel elements are lighter in weight compared with those of concrete, neither large lifting machine nor vehicle is required for their transportation and construction.
- As all the major bridges granted by Japan at the same section of the road are of steel structure, it is preferable that materials of the girders are identical in terms of maintenance and operation.

In case of steel bridge, there are two alternatives of steel; weathering (anti-corrosive) steel without any coating on the surface or common steel coated by paint for the maintenance. For the reasons below, the common steel was selected.

- Material and fabrication cost for the weathering steel girder without coating is more than that of the common steel girder with painting.

- It was found that environment against corrosion on steel is considerably good at each site according to the results from the observation of the existing steel bridges.

2.2.1.2 Policy on Natural Conditions

(1) Earthquake

The Solomon Islands suffers earthquake as well as Japan.

The Geological Survey Department, Ministry of Natural Resources is responsible for seismic observation. They experienced thirty-four earthquakes of magnitudes over 5.0 with their epicentres mainly in the south-eastern part of Guadalcanal between 1960 and 1980, and four earthquakes since 1999.

The Bridge Manual of New Zealand is used for calculating the seismic coefficient. The same is applied for the design of Tanabasa Bridge constructed under PCERP. As the bridge is located on the same road as the objective bridges, the seismic coefficient for the Project is also determined based on the Bridge Manual.

(2) Climatic conditions

The Solomon Islands belongs to the tropical climate zone, where dry season is from late May to the beginning of December, and rainy season remains between mid-December and mid-May. Cyclones come around and attack the island during the rainy season. Therefore foundations and substructures are to be constructed during dry season.

Climatic data at Honiara International Airport are shown in the Table 2.4 below.

Table 2.4 Climatic data at Honiara International Airport

Item \ Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total/Average
Precipitation	142	226	185	154	77	104	113	53	64	193	172	152	1,518mm/yr.
No. of Rainy day	15	19	18	15	13	15	15	10	11	15	14	16	176days/yr.
Hours of sunlight	6.2	5.6	6.3	6.4	6.9	6.6	5.6	6.7	6.2	7.1	7.0	5.8	6.4hr./day
Temperature	27	28	28	28	28	28	27	27	28	28	28	28	27.8℃

Source) Precipitation, number of rainy days: from averaging the five year data (2001-2005) by the Climatic Observatory at the Airport
Hours of sunlight, temperature: from Meteorological Service Head Quarter

(3) Hydrology and river engineering

Lunga River is the only river whose hydrological data are observed today in Guadalcanal. In other words, there is no hydrological datum on Ngalimbiu River nor Tenaru River. Thus, the discharge and high water level used for the planning of the bridges were estimated based on the data for Lunga River, hearing from the inhabitants around the sites and reports on the Cyclone Namu

1) Ngalimbiu River

Although the catchment area of Ngalimbiu River is only about two thirds of that of Lunga River, the greatest river in the island, it has characteristics that it flows down from the origin as high as 2,300m above sea level, and there lies a large landslide area at the upperstream.

The worst flood in the past was brought by the Cyclone Namu in May 1986. At first the water level was below the soffit of the old Ngalimbiu Bridge, but dammed up water flew over the deck after logs and debris shut the gap between the piers according to the report by Queensland Division Technical Papers (August 1987). Answers to the hearing conducted to the residents near the site were similar to the above description.

2) Tenaru River

Residents near Tenaru 1 Bridge over Tenaru River said that the water level was below the soffit of the bridge at time of the flood brought by Cyclone Namu.

On the other hand, Tenaru Creek, crossed by Tenaru 2 Bridge, has basically only little flow, and the water level fluctuates only little, affected by water level of Tenaru River. The residents said water level did not fluctuate much even at the time of the Namu. Thus, maintaining the soffit of the existing bridge will be enough for planning the elevation of the new bridge.

Summarized in Table 2.5 are the hydrological data resulted from the studies on Ngalimbiu River and Tenaru River at the bridge sites.

Table 2.5 Hydrological data of Ngalimbiu River and Tenaru River

River Name	Approx. length (km)	Catchment Area (km^2)	Discharge* Q100 (m^3/sec)	H.W.L. (m)
Ngalimbiu River	45	231	1,640	13.6
Tenaru River	28	144	840	5.1

Note) *:Discharge estimated from specific discharge of Lunga River

2.2.1.3 Policy to Social Conditions

(1) Environmental and social considerations

1) Environmental consideration

The environmental situation for the Project was evaluated into “Category B” according to the IEE (Initial Environmental Examination) conducted in collaboration between JICA and the Solomon side, this is because all the required procedures for the land have not yet completed, however the land acquisition procedures are conducted by the Solomon side. Shown in Table 2.6 are possible environmental impacts and the mitigation measures.

Table 2.6 Possible environmental impacts and mitigation measures

Possible impacts	Mitigation measures
Notification of construction and noise	Notices before the construction and using of noise reduction type construction machines
Opportunity of employment to the affected residents	Offering preference of employment as guards, labour
The extent of tainted river water and its duration for Tenaru 1 Bridge	Alternative supply of water for life of habitants (Supply of river water by pump)

2) Social consideration

It must be avoided to relocate the residents for implementing the Project.

- The habitants surrounding Tenaru 1 Bridge and Tenaru 2 Bridge live in state-owned land. They recognize it and agree to relocation, if necessary.
- The land owners of the west bank of Ngalimbiu Bridge have agreed with DID for the acquisition of the customary land. The procedures for the land acquisition is proceeding with the land owners of the east bank. It is expected that the land will be registered as the Government’s land in April 2006. The progress is to be confirmed.

(2) Detecting and removal of unexploded objects

The Solomon Islands is noted as one of the hard-fought battle area during the World War II. It is said that battles happened repeatedly in the Project area. As it is obligated in the Solomon Islands to detect and remove unexploded shells before starting public works, these operations are conducted before the construction at each site.

DID, the implementing agency of the Solomon Islands, will make an application to the Explosive Ordinance Disposal Unit of the Royal Solomon Islands Police Headquarter for the investigating, operating and issuing the certificate of safety.

2.2.2 Basic Plan

2.2.2.1 Applied Standards

As there's no specification for designing highway or bridge, those standards as shown below are applied.

- Specifications for Highway Bridges (Japan)
- Road Structure Ordinance (Japan)
- Ordinance of Structure for River Control Facilities (Japan)
- Bridge Manual (New Zealand)
- AUSTROADS Bridge Design Codes (Australia)

2.2.2.2 Loading

(1) Design live load

Structures are to be designed by TL20 design live load, and verified by 66t trailer truck load.

1) Load by TL20

(For design of deck)

<u>Carriageway</u>

T-load is placed on the carriageway. T-load is loaded in such a manner that an element examined will have the maximum stress, in principle one truck in the longitudinal direction, but as many trucks as possible in the lateral direction.

Table 2.7 Wheel load of T-20

Design load	Total Weight	Weight of front wheel	Weight of rear wheel	Width of front wheel	Width of rear wheel	Length of contact
T20	20.0t	2.0t	8.0t	12.5cm	50cm	20cm

Sidewalk

Pedestrians' load 500kg/m^2 is distributed over the sidewalk.

(For design of girder)

Carriageway

L-load comprising one knife-edge load and distributed load is loaded on the carriageway. L-load is placed in such a manner that an examined element will have the most disadvantageous stress. Intensity of the knife-edge load is 5.0t/m, the distributed load 350kg/ m^2 and pedestrian load 350kg/ m^2.

2) 66t trailer truck load

The safety of the bridge designed by TL20 will be verified later under such conditions that only one trailer truck will be loaded at a time, taking into account the frequency of the trailer truck traffic and economy.

Shown in Figure 2.7 are axis weights and their distances.

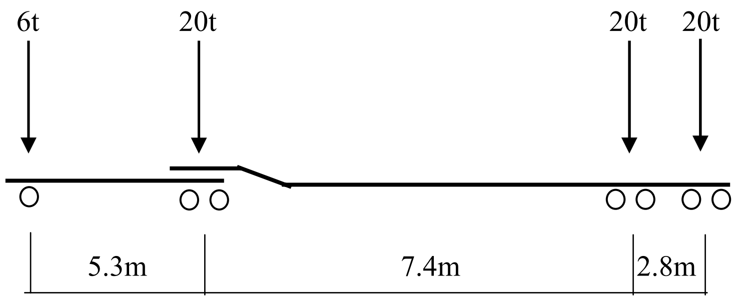


Figure 2.7 Axis weight and their distances of 66t trailer truck

(2) Dead load

Dead loads are calculated using the unit weights in the Table 2.8.

Table 2.8 Unit weights of dead loads

Unit: kgf/m^3

Material	Steel	Reinforced concrete	Concrete	Asphalt pavement
Unit weight	7.85	2.50	2.35	2.30

(3) Horizontal seismic coefficient

Horizontal seismic coefficient will be worked out in accordance with Bridge Manual of New Zealand as below;

Horizontal seismic coefficient = (Basic acceleration) x (Regional coefficient) x
(Risk coefficient) x (Structure characteristic coefficient)
= 0.28 x 1.0 x 1.15 x 0.67 = 0.22

The horizontal seismic coefficient used for the objective bridges calculated is 0.22.

In addition to the verification of working stress under the seismic load, aseismatic connector will be installed at each end of bridge.

(4) Logs and debris load

Let a horizontal force of 820kN act at the top of piers as design load, which corresponds to 3m depth of logs and debris. This horizontal force will not be applied to Tenaru 2 Bridge, as the water flow is negligible.

(5) Public utilities

The six bridges by the Japanese Grant Aid carry load of public utilities weighing 220kgf/m, taking into account future possible utilities such as electric cables, water pipes and so on as design load. The objective bridges will be loaded by the same design load in order to coordinate with other bridges on the same section.

Unit weights of public utilities are shown below.

Public Utilities	Dimension	Unit Weight
Water Pipes	φ260mm	W=160kgf/m
Communication Cables	φ90mm x 2	W=30kgf/m
Power Cables	φ150mm	W=30kgf/m
Total Unit Weight		W=220kgf/m

2.2.2.3 Typical Cross-section

Based on the field study and discussions with the recipient side, the one-lane carriageway (width: 4.0m) will be applied and a sidewalk (on one side) will be installed to ensure pedestrian safety. As shown in Figure 2.8, the same dimensions as the above-mentioned six bridges will be applied to curbs and separators.

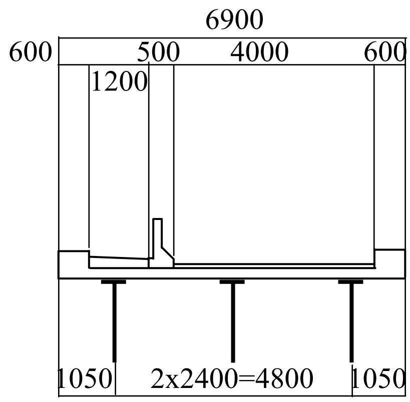


Figure 2.8 Typical cross-section

Sidewalks will be installed on the seaward side of Tenaru 1 and Tenaru 2 bridges, and on the landward side of Ngalimbiu Bridge for the convinience of residents.

2.2.2.4 Bridge Length and Span

In principle, length of reconstructed bridge will not be shorter than that of the existing bridge, so as not to obstruct the water flow by reducing the river section. Also topography of both banks are considered to decide the bridge length.

The length of the existing bridges and that of new ones are compared in the Table 2.9.

Table 2.9 Comparison of new and existing bridges

Length＼Name	Tenaru 1 Br.	Tenaru 2 Br.	Ngalimbiu Br.
Existing	46.0m	24.0m	111.0m (Old bridge:105m)
New	55.0m	25.0m	120.0m

Note) The old Ngalimbiu Bridge is to be demolished before the new bridge construction.

Configuration of spans is arranged based on the bridge length decided above in such a manner that the span will not be less than the minimum required length not obstructing the water flow, and in addition the balance of the main span and side span is structurally reasonable. Finally it must be economical.

(1) Span configuration of Tenaru 1 Bridge

Taking the discharge of Tenaru River as $840m^3/s$, it ranges between 500 and 2000cu. m, then the minimum span for Tenaru 1 Bridge is 20m according to the Japanese Ordinance of Structure for River Control Facilities. Main span length is decided considering the bridge length and number of spans.

(2) Span configuration of Tenaru 2 Bridge

As Tenaru 2 Bridge crosses Tenaru Creek and so the velocity of flow is very low, there's no limitation to the minimum span length. The bridge length is 25m and it will be one span, then the span is 25m long.

(3) Span configuration of Ngalimbiu Bridge

The discharge of Ngalimbiu River is estimated as Q_{100}=1,640 m^3/s according to the record regarding the Cyclone Namu. The span length will become L=28.2m, applying this discharge to the formula specified by the Japanese Ordinance of Structure for River Control Facilities

$$L=20+0.005Q =20+ 0.005 \times 1,640 = 28.2$$

The span is desirable to be longer than 30m taking into account the information through hearings regarding the logs washed away in the past. Furthermore, odd number of spans has been adopted, because in case of even number of spans the central pier would stand so close to the existing pier as to affect adversely the pile foundation of the existing bridge.

Under these conditions, span configuration of Ngalimbiu Bridge was decided like this. The bridge length 120m is divided equally into three spans, that is; 3 x 40= 120m.

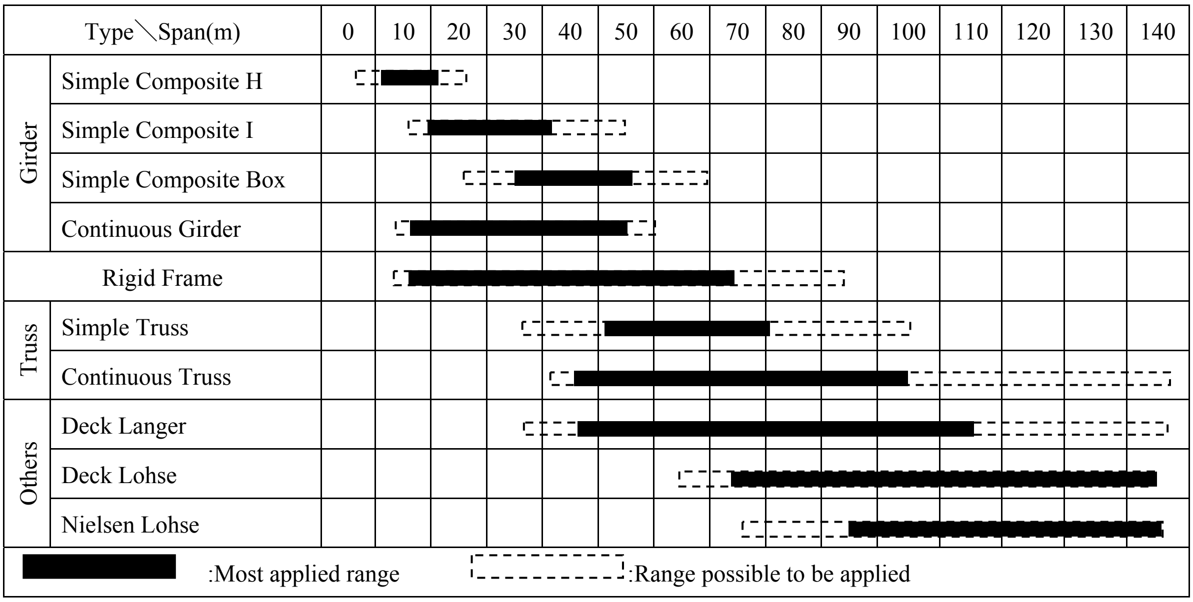
2.2.2.5 Selection of Bridge Type

2.2.2.5.1 Type of Superstructure

All of the three objective bridges are made of steel for the reasons described in 2.2.1.1.

Shown in the Table 2.10 are relations of commonly applicable span length to types of steel superstructure.

Table 2.10 Applicable span of steel bridges

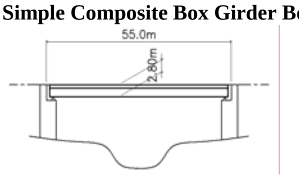
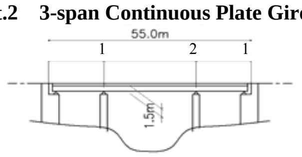
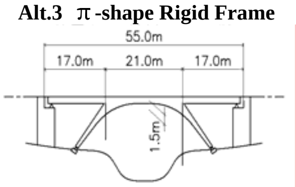


Under the applicable span range, alternatives of superstructure type are compared regarding the economy, constructivity, planned deck height and/or necessity of pier.

(1) Tenaru 1 Bridge

bridge length of 55m can be divided into one to three spans. If the two-span alternative is taken, then the pier stands in the mid-river and therefore odd number of spans is desirable. After examining three types in Table 2.11 considering the applicable span, 3-span continuous non-composite girder was adopted as the superstructure for Tenaru 1 Bridge.

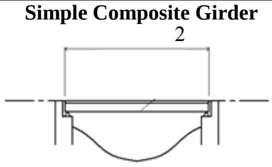
Table 2.11 Comparison of superstructure types for Tenaru 1 Bridge

No. of span	General View	Comments	Evaluation
1	**Alt.1 Simple Composite Box Girder Box** 	・Possible to omit pier. ・High construction cost. ・High girder requires deck level to be elevated. ・Box girder makes construction complicate.	Not good
3	**Alt.2 3-span Continuous Plate Girder** 	・Most commonly adopted type. ・The lowest construction cost. ・Constructed by most common construction method. (Truck crane and temporary supports method.)	Best
3	**Alt.3 π-shape Rigid Frame** 	・Aesthetically the best. ・Steel legs sink during high water. ・Second most costly of three alternatives. ・Complicated construction required.	Good

(2) Tenaru 2 Bridge

For a bridge of only 25m long, the best and most commonly adopted type is a composite girder bridge, and no other competitive type cannot found usually.

Table 2.12 Superstructure types for Tenaru 2 Bridge

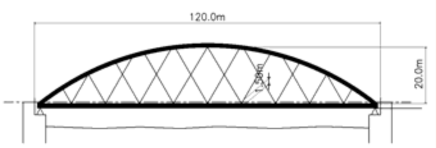
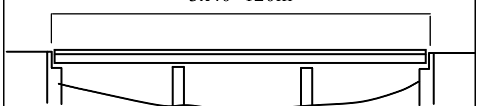
No. of span	General View	Comments	Evaluation
1	**Simple Composite Girder** 	・Most common and cheapest. ・No problem regarding construction found.	Best

(3) Ngalimbiu Bridge

One, two and three span alternatives can be compared for a bridge of 120m long. If the bridge length is equally divided into one, two and three, the spans are 120m, 60m and 40m, but dividing by even numbers is not appropriate as mentioned before, one span and three spans have been compared.

3-span non-composite continuous girder was adopted by the Table 2.13 for Ngalimbiu Bridge.

Table 2.13 Comparison of superstructure types for Ngalimbiu Bridge

No. of span	General View	Comments	Evaluation
1	**Alt.1 Nielsen Lohse** 	・Aesthetically the best. ・Most costly. ・Most complicated erection method, cable erection method, required.	Not good
3	**Alt.2 3-span Non-composite Continuous Box Girder** 3x40=120m 	・Simple appearance matching the environment, similar to other six bridges. ・Each element being heavy, large trailer trucks and cranes necessary for transportation and construction. ・More costly than Alternative 3 plate girder ・No problem in erection by launching method.	Best
3	**Alt.3 3-span Non-composite Continuous Plate Girder** 3x40=120m 	・Most commonly adopted type. ・External appearance similar to box girder. ・Each steel element being light-weighted, thus easily transported and erected. ・Cheapest construction cost. ・No problem in erection by launching method (Same as box girder).	Good

2.2.2.5.2 Substructure

(1) Abutment

For abutment 4.5 to 8m high, a reinforced concrete inverted T abutment is most commonly adopted. Heights of all abutments for the Project are within the range, thus this type is adopted for the abutment of the Project.

(2) Pier

These types of pier such as wall type, rigid frame type and cantilevered oval column type were compared in Table 2.15 regarding structural characteristics, constructivity, river obstruction, effect by logs washed away and economy, and the cantilevered oval column type was adopted.

2.2.2.5.3 Foundation Type

In selecting foundation type, such conditions have been considered as soil conditions, constructivity, availability of construction machine and materials, and pile foundation was adopted for the objective bridge sites.

For Ngalimbiu Bridge, the supporting layer is a little thin but bearing piles can be used. For Tenaru 1 Bridge and Tenaru 2 Bridge, friction type is used as the pile supporting method.

There are two types of piling. One is a driven pile of steel or reinforced concrete, and the other is in-situ pile. They were compared regarding the constructivity, availability of construction machine and economy, and then steel driven pile was adopted (Table 2.14). The adoption of the fabricated steel tube as pile materials will enable shorter procurement period, easy quality control, and also using steel tubes in small diameter will provide wider freedom of selecting pile drivers.

Cost for foundation is a total of material cost, transportation cost and driving cost of steel pile, and also construction cost for the footing. Taking P2 pier of Ngalimbiu Bridge as an example, two diameters of steel tube, ϕ600 and ϕ800, are compared.

Length and thickness of steel tube are same in either case, but required number of piles is different to obtain the expected bearing capacity, i.e. 25 piles of ϕ600 or 20 piles of ϕ800.

The difference of the total cost of material, transportation and driving cost for the two diameters of the piles is only 3%. Dimensions of the footings are 7.5mx7.5m for ϕ600mm and 8.0mx10.0m for ϕ800mm. Concrete volume of the two differs by 43%. Total cost for ϕ600mm pile is less costly, thus ϕ600mm pile was adopted.

Table 2.14 Evaluation of pile diameters

Diameter (mm)	Number of Piles	Pile Length (m)	Plate Thickness (mm)	Dimension of Footing (m)	Evaluation
φ600	5x5=25	27m	9	7.5mx7.5m	Better
φ800	4x5=20	27m	9	8.0mx10.0m	Worse

Table 2.15 Selection of pier type

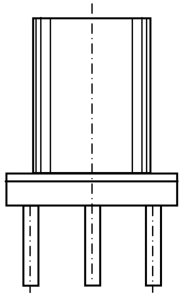
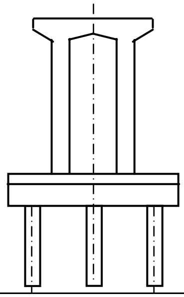
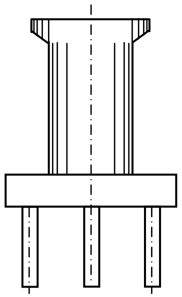
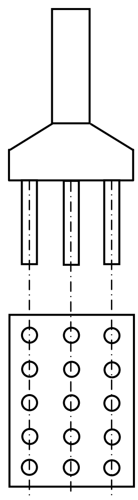
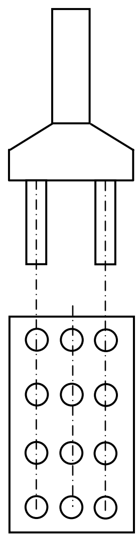
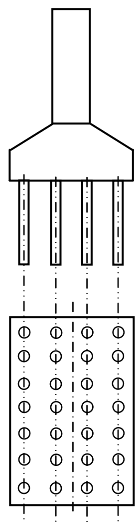
Type		Structural Characteristics	Constructivity	River Obstruction	Economy	Comprehensive Evaluation
Wall		• Common column type with round edges on upperstream and downstream side Good	• No staging required Best	• More river obstruction than that of cantilevered oval column, though not much debris gathered. Good	Good	Good
Rigid Frame		• Appropriate when reduction of pier weight required • Inappropriate for narrow bridge No Good	• Staging required, form work complicated No Good	• Much debris gathered No Good	No Good	No Good
Cantilevered Oval Column		• Reasonable shape; wider beam for bearing seat but small cross-section of column in the river flow Best	• Staging required Good	• Both ends of column shaped round; less debris gathered, less obstruction against river flow. Best	Best	Best

Table 2.16 Comparison of foundation types

	Steel tube pile	In- situ pile	RC pile
General View			
Structural Characteristics	・Applicable up to 60m deep ・Applicable to either bearing pile or friction pile ・Good balance between number of piles and dimension of footing	・Applicable up to 60m deep ・Not applicable to friction pile ・Large diameter (Approx.1.0m) and large footing required	・Generally applicable up to only 15m deep ・Applicable to either bearing pile or friction pile ・Greatest number of piles required
Constructivity	・Easy handling due to the light weight, and less damage ・Easy connection for extension, and good constructivity by welding ・Piles and pile-driver to be imported	・Problems of processing mud and muddy water ・Pile-driver to be imported	・Complicated connection work for extension ・Long construction period due to too many pile number ・Pile-driver to be imported
Economy	Best	Good	No Good
Comprehensive Evaluation	Best	Good	No Good

2.2.2.6 Location of Reconstruction

Such alternative locations for reconstruction as shown below are available for each bridge.

Tenaru 1 Bridge, Tenaru 2 Bridge

① Reconstructed at the existing bridge

② Reconstructed at land side of the existing bridge

③ Reconstructed at sea side of the existing bridge

Ngalimbiu Bridge

① Reconstructed between the existing bridge and the old bridge

② Reconstructed at land side of the old bridge

③ Reconstructed at sea side of the existing bridge

Results of comparing the locations for each bridge are shown in Table 2.17, Table 2.18 and Table 2.19 respectively.

Table 2.17 Comparison of reconstruction location for Tenaru 1 Bridge

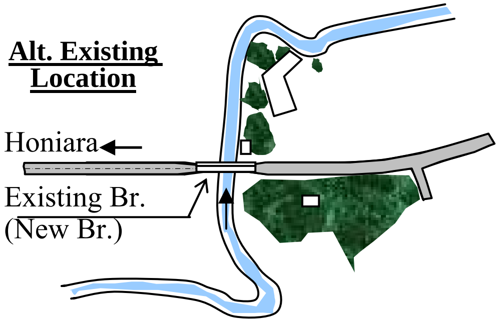
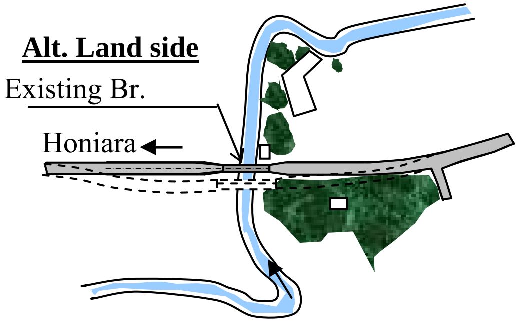
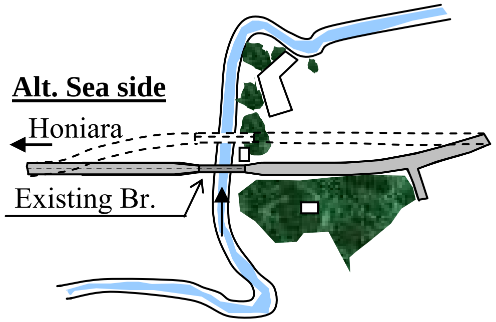
Alternatives	Construction	Cost	Land acquisition	Road alignment & etc.	Evaluation
	・Detour bridge and access necessary during construction. ・Existing bridge necessary to be demolished before construction. ・Not necessary to construct access roads to the new bridge.	・Construction cost for new bridge ・Cost for constructing and demolishing detour bridge and approach ・Most costly of the three alternative	・Temporary use of land for detour bridge and approach (Government land)	・Alignment same as the existing road	No Good
	・Detour bridge not necessary during construction ・Construction of detour bridge and access road	・Cost for new bridge ・Cost for access road	・Compensation for the Government land at land side	・Alignment almost same as the existing road ・Impact to one house	Best
	・Detour bridge not necessary during construction ・Construction of detour bridge and access road	・Cost for new bridge ・Cost for access road	・Compensation for the Government land at sea side	・Alignment worsened ・Close to community on sea side affecting traffic safety and inhabitants ・Old piers remaining necessary to be demolished	Good

Table 2.18 Comparison of reconstruction location for Tenaru 2

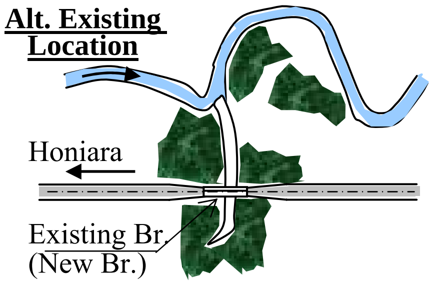
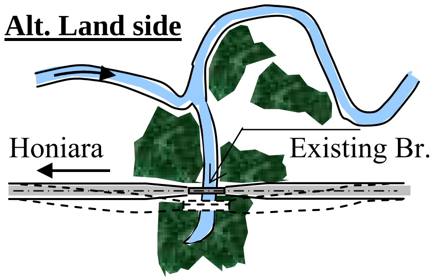
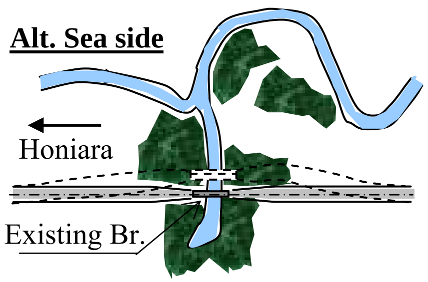
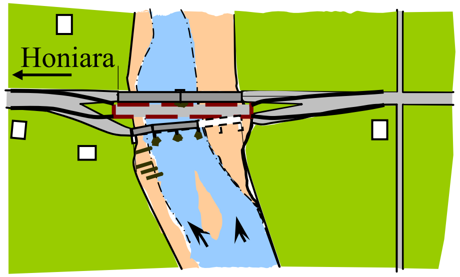
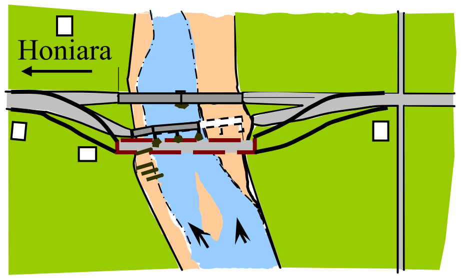
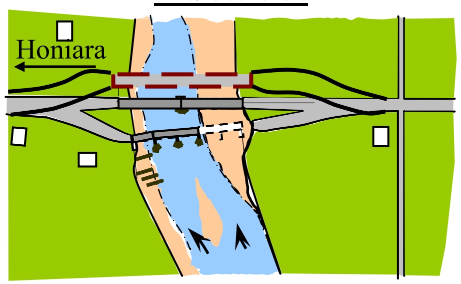
Alternative	Construction	Cost	Land acquisition	Alignment & etc.	Evaluation
	・Detour bridge and access necessary during construction ・Existing bridge necessary to be demolished before construction ・Not necessary to construct access roads to the new bridge	・Construction cost for new bridge ・Cost for constructing and demolishing detour bridge and access road	・Temporary use of land for detour bridge and access (Government land)	・Alignment same as the existing road	No Good
	・Detour bridge not necessary during construction ・Not necessary to construct detour bridge and access road	・Cost for new bridge ・Cost for access road	・Compensation for the Government lad at land side	・Alignment worsened due to curve added ・Cutting down trees required for the approach	Good
	・Detour bridge not necessary during construction ・Not necessary to construct detour bridge and access road	・Cost for new bridge ・Cost for access road	・Compensation for the Government lad at sea side	・Alignment worsened due to curve added ・Vacant land on sea side, advantage due to less cutting down tree	Best

Table 2.19 Comparison of reconstruction location for Ngalimbiu Bridge

Alternative	Construction	Cost	Land acquisition	Alignment & etc.	Evaluation
Alt. Between existing and old bridge 	・Temporary repair on the existing bridge ・Demolishing the old bridge ・Using the existing bridge as detour during construction ・Shortest approach road	・Cost for new bridge ・Cost for access road	・Possible to construct within the present obtained land	・Best access alignment	Best
Alt. Land side 	・Temporary repair on the existing bridge ・Demolishing the old bridge ・Using the existing bridge as detour during construction ・Longest approach road	・Cost for new bridge ・Cost for access road	・Required to obtain new land on upperstream side ・Required to obtain long customary land for the access, then much compensation	・Diverting much from the existing access, then the alignment being the worst	No good
Alt. Sea side 	・Temporary repair on the existing bridge ・Demolishing the old bridge ・Using the existing bridge as detour during construction ・Long approach road	・Cost for new bridge ・Cost for access road	・Required to obtain new land on upperstream side ・Required to obtain long customary land for the access, then much compensation	・Better than the Alt. Land side ・Passing close to the community on the west bank ・Consideration required for impact to the inhabitants’	Good

Conclusions

These mentioned were concluded as the location of the new bridges

- Tenaru 1 Bridge : On Land side
- Tenaru 2 Bridge : On Sea side
- Ngalimbiu Bridge : Between the old bridge and existing bridge

2.2.2.7 Proposed Deck Elevation and Access Road

The proposed deck elevation was determined in such a manner that soffit of the new bridge may secure that of the existing bridge as mentioned below.

(1) High water level and proposed deck elevation

1) Tenaru 1 Bridge

The soffit of the new bridge was determined to keep as same as that of the existing bridge, as the safety of the existing soffit was confirmed as the result of the hearing conducted regarding the situation at the time of the Cyclone Namu.

Furthermore, the water level is EL+3.8, resulting from water level-discharge curve taking 840m^3/s as the planned discharge, and is 1.3m lower than the planned water level EL+5.1.

2) Tenaru 2 Bridge

As Tenaru 2 Bridge crosses the creek where water seldom flows, soffit of the new bridge keep same as that of the old bridge.

3) Ngalimbiu Bridge

It is reported by a paper regarding the Cyclone Namu damaging on the worst scale that the soffit of the old bridge was higher than the water level before logs and debris shut the gaps between the piers. The high water level was taken as 13.4m for planning the existing bridge as the result of the hearings and flood marks of that flood. This high water level is to be taken as the planned high water level, but it is modified to 13.6 by the elevation difference between the measured elevation of those days and this time. Finally 1.0m is added as allowance, and soffit of the new bridge is taken as 14.6m.

The proposed deck elevations of Tenaru 1 Bridge and Ngalimbiu Bridge are taken as high water level plus 1m allowance plus structure height. But soffits of the new bridges are taken at least higher than those of the existing bridges as shown in Figure 2.9 and Table 2.20.

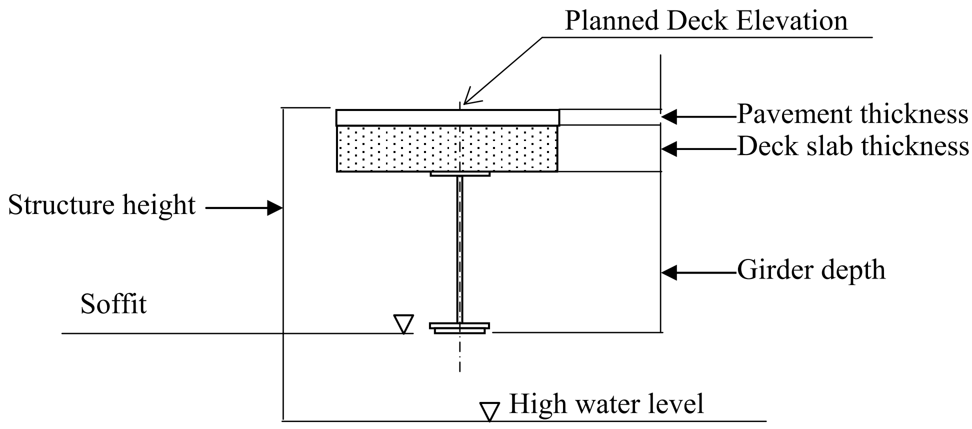


Figure 2.9　Planned deck elevation

Table 2.20　Planned deck elevation,planned high water level and allowance

Item \ Bridge	Tenaru 1 Bridge	Ngalimbiu Bridge
The past highest flood level	EL +3.8m	EL +13.6m
Planned high water level	5.1m	13.6m
Allowance	1.0m	1.0m
Structure height	1.5m	2.5m
Planned deck elevation	6.5m	17.1m

(2)　Access road

Access roads connect a new bridge with the existing road horizontally and vertically. As the topography around the objective bridges are comparatively flat, vertical slopes are made less than 2% and radii of the horizontal curvatures are made less than 200m.

The existing access roads are 7.5m wide, and the new bridge is planned to be 4.0m wide, then the access roads are to be tapered to adjust the width difference.

Typical cross-section of the access road is shown in Figure 2.10, and the lengths of the access roads of each bridge in Table 2.21.

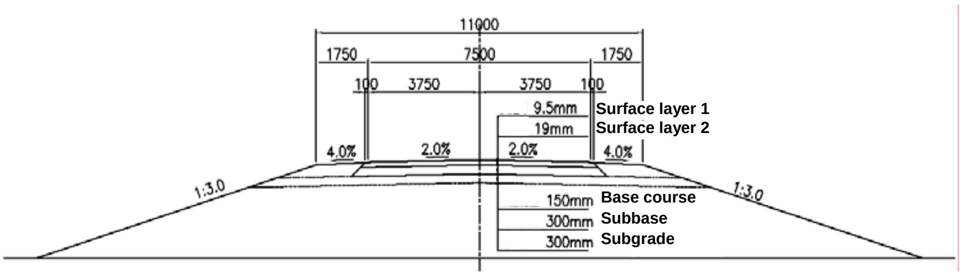


Figure 2.10　Typical cross-section of access road

Table 2.21 Length of access roads

Bridge	Length on the west bank (m)	Length on the east bank(m)
Tenaru 1 Br.	144.60	203.40
Tenaru 2 Br.	190.00	190.00
Ngalimbiu Br.	205.02	174.98

2.2.2.8 Abutment Protection Work

As an abutment is a structure that supports a superstructure, it must be protected where it may be washed away.

Photo 2.8 and 2.9 show the abutment of the old Ngalimbiu Bridge on the west bank, where the steel pipe piles are exposed by scouring and the bearing capacity fell to an extreme extent.

Photo 2.10 shows the existing abutment of Tenaru 1 Bridge protected by wire mats.

Photo 2.8 Abutment of the Old Ngalimbiu Bridge (1)

Photo 2.9 Abutment of the Old Ngalimbiu Bridge (2)

Photo 2.10 Abutment of Tenaru 1 Bridge

And abutments of the six other bridges granted by Japan are also protected well with wire mats.

The abutments of objective bridges are to be protected as well as the other six bridges with wire mats taking into consideration the protection achieved by these bridges.

The length of the protection is decided according to the Japanese Ordinance of Structure for River Control Facilities.

Table 2.22 Lengths of abutment protection and slope

Dimension/Bridge	Tenaru 1 Br.	Tenaru 2 Br.	Ngalimbiu Br.
Upperstream	10 m	-	10 m
Front of abutment	6.9 m	-	6.9 m
Downstream	10 m	-	10 m
Slope	1 : 1.2	-	1 : 1

2.2.3 Basic Design Drawing

General view and general structural view of each bridge are shown on the following pages.

(1) General View (Tenaru 1 Bridge)

(2) General Structural View (Tenaru 1 Bridge)

(3) General View (Tenaru 2 Bridge)

(4) General Structural View (Tenaru 2 Bridge)

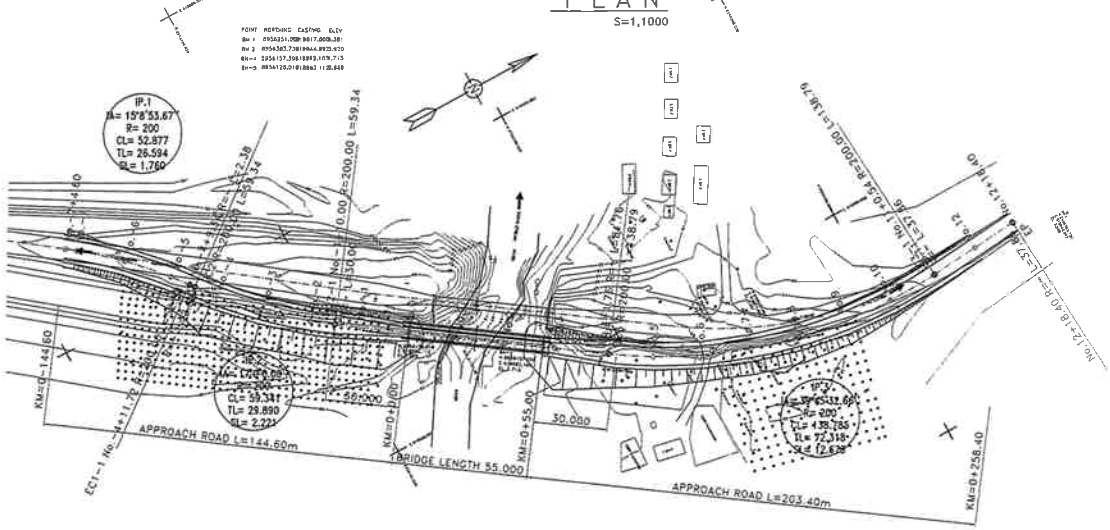
(5) General View (Ngalimbiu Bridge)

(6) General Structural View (Ngalimbiu Bridge)

GENERAL VIEW (TENARU1 BRIDGE)

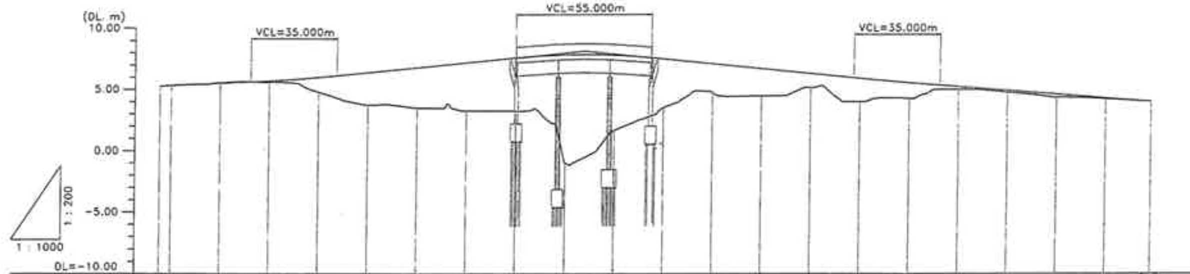
PLAN

S=1,1000



PROFILE

H=1,1000
V=1:200



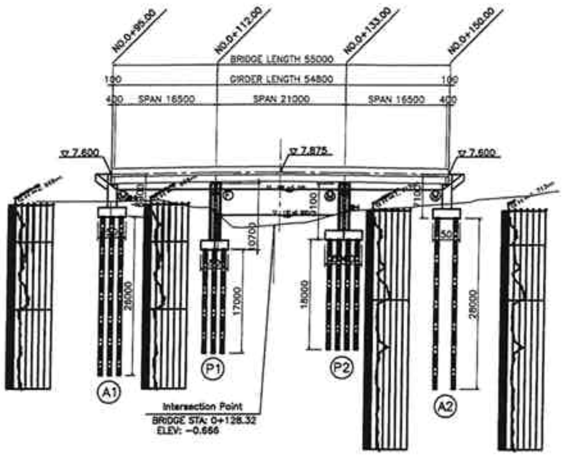
Grade: 5.25 — i=1.00% L=54.60m — 5.80 — i=2.00% L=117.50m — 8.15 — i=2.00% L=127.50m — 5.60 — i=1.54% L=103.40m — 4.00

Station	Proposed Height	Ground Height	Distance (m)	Unit distance (m)
-4.60	5.25	5.3	-144.60	0.00
No.-7	5.30	5.3	-140.00	4.60
No.-6	5.50	5.5	-120.00	20.00
-7.50	5.62	5.6	-107.50	12.50
No.-5	5.71	5.6	-100.00	7.50
-11.72	5.82	5.6	-91.72	8.28
-10.00	5.84	5.5	-90.00	1.72
-9.34	5.85	5.5	-89.34	0.66
No.-4	6.01	4.8	-80.00	9.34
-12.50	6.15	4.3	-72.50	7.50
No.-3	6.40	3.8	-60.00	12.50
No.-2	6.80	3.5	-40.00	20.00
-10.00	7.00	3.5	-30.00	10.00
No.-1	7.20	3.3	-20.00	10.00
No.0	7.60	3.2	0.00	20.00
No.1	7.85	-1.0	20.00	20.00
+7.50	7.87	-0.6	27.50	7.50
No.2	7.82	1.6	40.00	12.50
+15.00	7.60	2.8	55.00	15.00
No.3	7.50	3.5	60.00	5.00
No.4	7.10	4.7	80.00	20.00
+1.76	7.06	4.5	81.76	1.76
No.5	6.70	4.5	100.00	18.24
No.6	6.30	5.1	120.00	20.00
+17.50	5.95	4.8	137.50	17.50
No.7	5.90	4.8	140.00	2.50
+15.00	5.62	4.3	155.00	15.00
No.8	5.53	4.3	160.00	5.00
+12.50	5.33	5.0	172.50	12.50
No.9	5.21	5.0	180.00	7.50
No.10	4.91	4.8	200.00	20.00
No.11	4.60	4.3	220.00	20.00
+0.54	4.59	4.3	220.54	0.54
No.12	4.29	4.2	240.00	19.46
+18.40	4.00	4.0	258.40	18.40

Curvature figure of plan: R=200.00 L=52.88; L=2.38; R=200.00 L=59.34; L=30.00; L=81.76; R=200.00 L=138.79; L=37.86

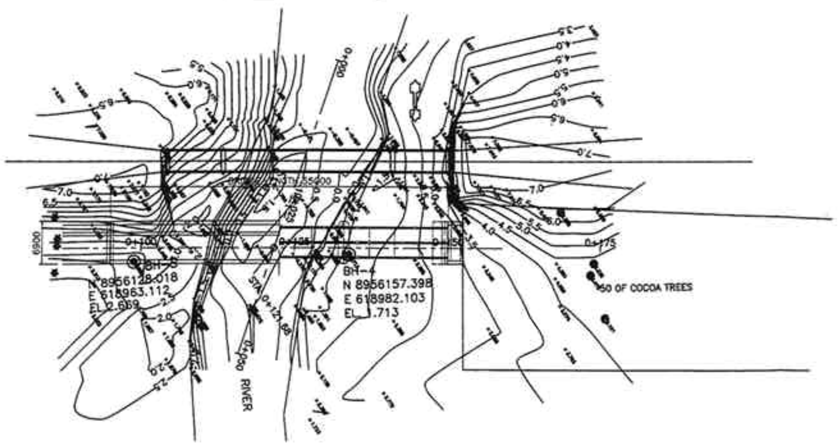
General Structural View (Tenaru 1 Bridge)

SIDE VIEW SCALE=1/400

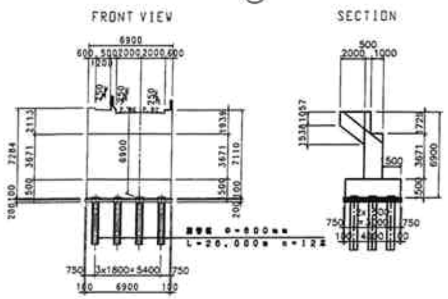


Grade	2.0%		VCL=55m		2.0%
Proposed Height	7.600	7.835	7.875	7.835	7.600
Ground Height					
Distance	95.00	112.00	122.50	133.00	150.00
Station	No.0 +95.00 (A1)	+112.00 (P1)	+122.50	+133.00 (P2)	+150.00 (A2)

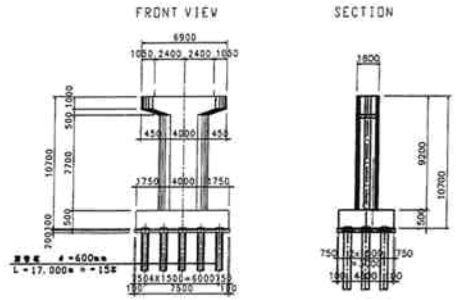
PLAN SCALE=1/400



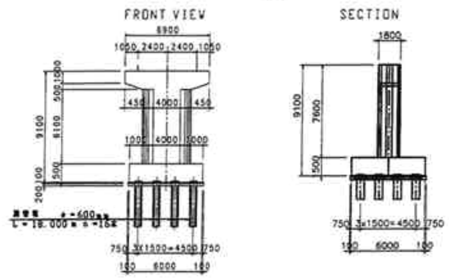
ABUTMENT SCALE=1/200 (A1)



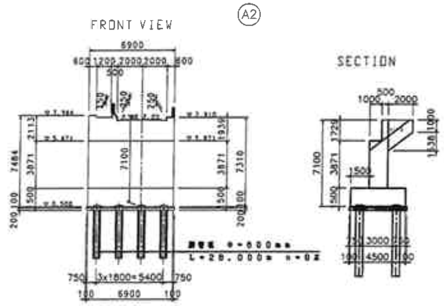
PIER SCALE=1/200 (P1)



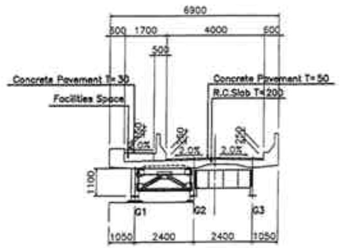
PIER SCALE=1/200 (P2)



ABUTMENT SCALE=1/200 (A2)



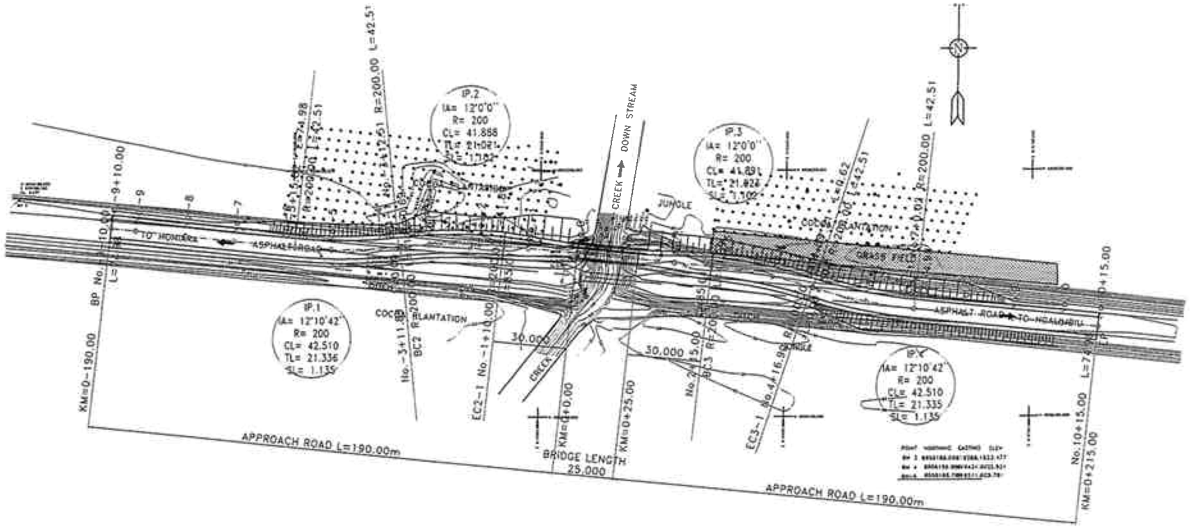
CROSS SECTION SCALE=1/100



GENERAL VIEW (TENARU2 BRIDGE)

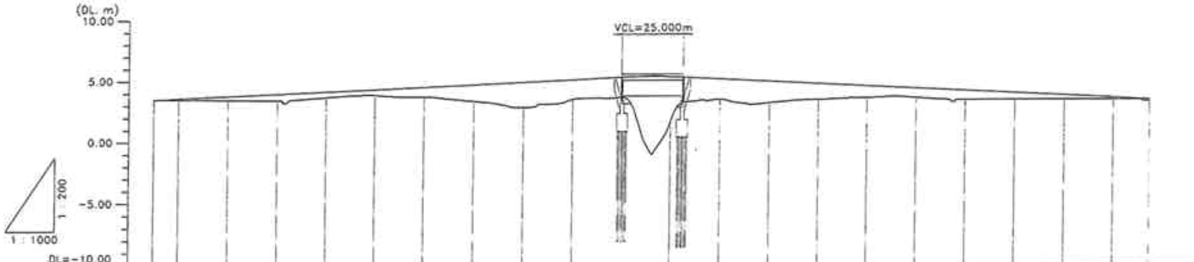
PLAN

S=1,1000



PROFILE

H=1,1000
V=1:200



Station	Distance (m)	Unit distance (m)	Ground Height	Proposed Height
-10.00	-190.00	0.00	3.50	3.50
No.-9	-180.00	10.00	3.50	3.60
No.-8	-160.00	20.00	3.50	3.80
No.-7	-140.00	20.00	3.50	4.00
No.-6	-120.00	20.00	3.75	4.20
-15.02	-115.02	4.98	3.83	4.25
No.-5	-100.00	15.02	3.94	4.40
No.-4	-80.00	20.00	3.81	4.60
-12.51	-72.51	7.49	3.70	4.67
-11.89	-71.89	0.62	3.68	4.68
No.-3	-60.00	11.89	3.45	4.80
No.-2	-40.00	20.00	2.93	5.00
-10.00	-30.00	10.00	3.21	5.10
No.-1	-20.00	10.00	3.60	5.20
No.0	-0.00	20.00	3.74	5.40
+12.50	12.50	12.50	-0.92	5.46
No.1	20.00	7.50	1.74	5.44
+5.00	25.00	5.00	3.34	5.40
No.2	40.00	15.00	3.57	5.25
+15.00	55.00	15.00	3.17	5.10
No.3	60.00	5.00	3.28	5.05
No.4	80.00	20.00	3.54	4.85
+16.90	96.90	16.90	3.67	4.68
+17.52	97.51	0.62	3.67	4.67
No.5	100.00	2.49	3.68	4.65
No.6	120.00	20.00	3.68	4.45
No.7	140.00	20.00	3.50	4.25
+0.03	140.02	0.02	3.50	4.25
No.8	160.00	19.98	3.50	4.05
No.9	180.00	20.00	3.50	3.85
No.10	200.00	20.00	3.50	3.65
+15.00	215.00	15.00	3.39	3.50

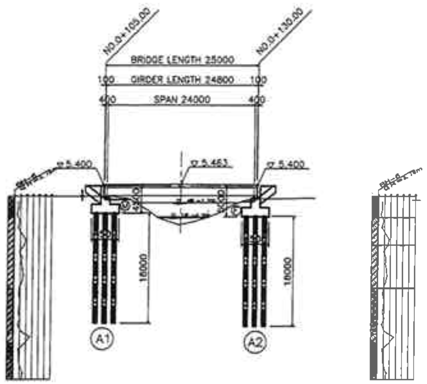
Grade: 3.50 — i=1.00% L=202.50m — 5.52 — i=1.00% L=202.50m — 3.50

Curvature figure of plan:

L=74.98	R=200.00 L=42.51	L=0.62	R=200.00 L=41.89	L=85.01	R=200.00 L=41.89	L=0.62	R=200.00 L=42.51	L=74.98

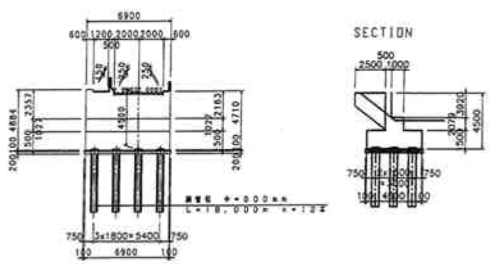
General Structural View (Tenaru 2 Bridge)

SIDE VIEW SCALE=1/400

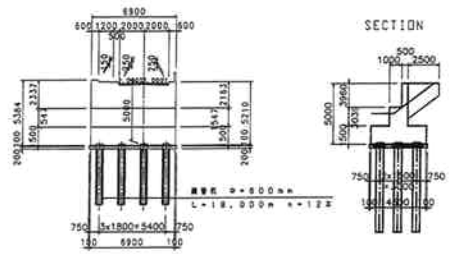


Grade	1.0%	VCL=25m		1.0%
Proposed Height	5.400	5.463	5.400	
Ground Height				
Distance	105.00	117.50	130.00	
Station	No.0 +105.00 (A1)	+117.50	+130.00 (A2)	

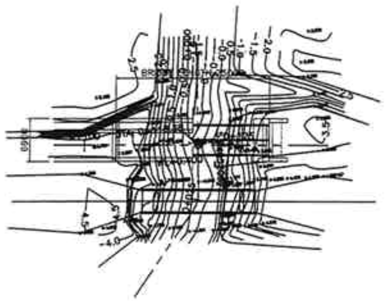
ABUTMENT
SCALE=1/200
(A1)



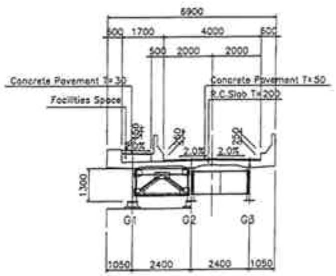
ABUTMENT
SCALE=1/200
(A2)



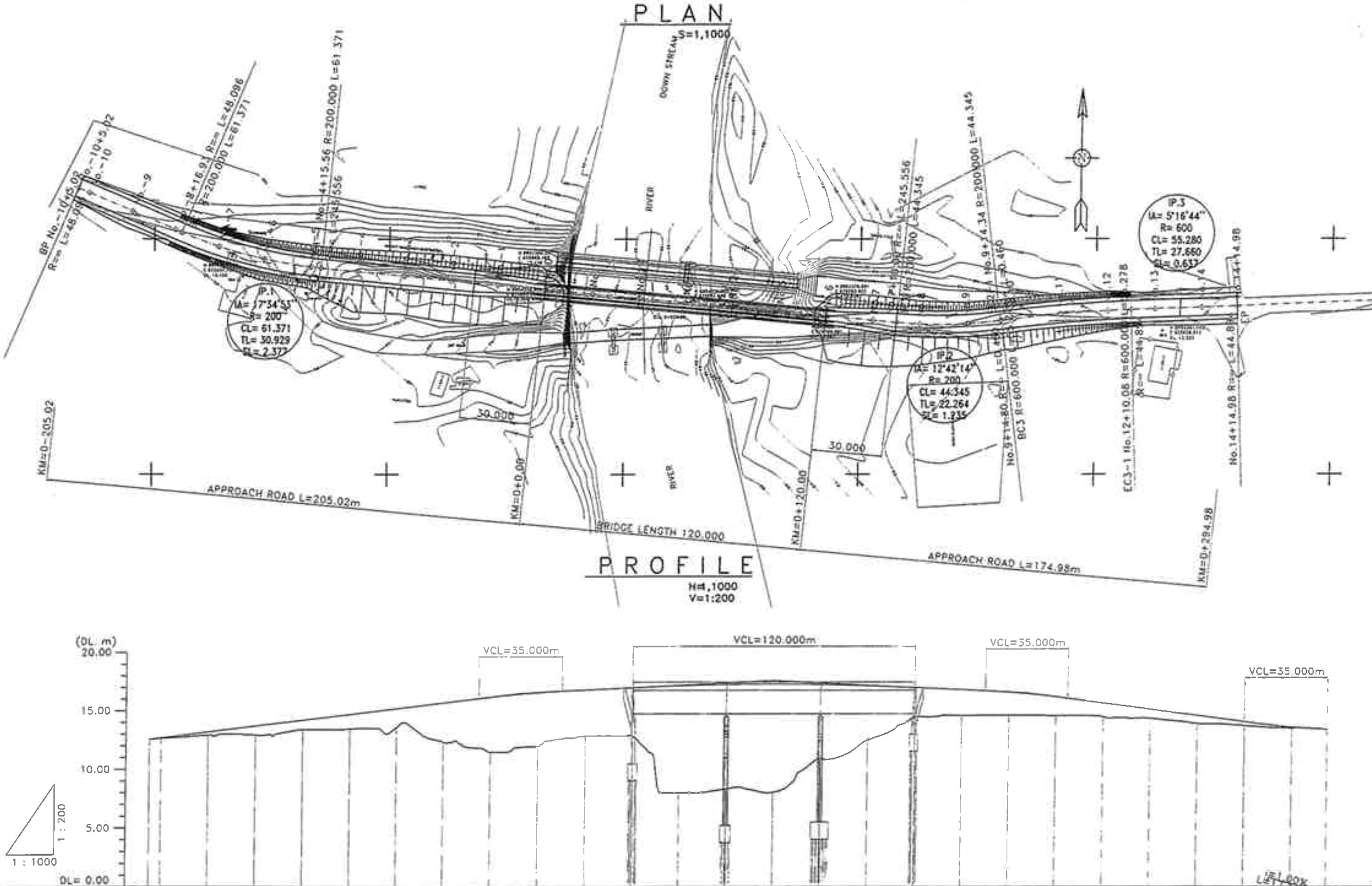
PLAN SCALE=1/400



CROSS SECTION SCALE=1/100



GENERAL VIEW (NGALIMBIU BRIDGE)



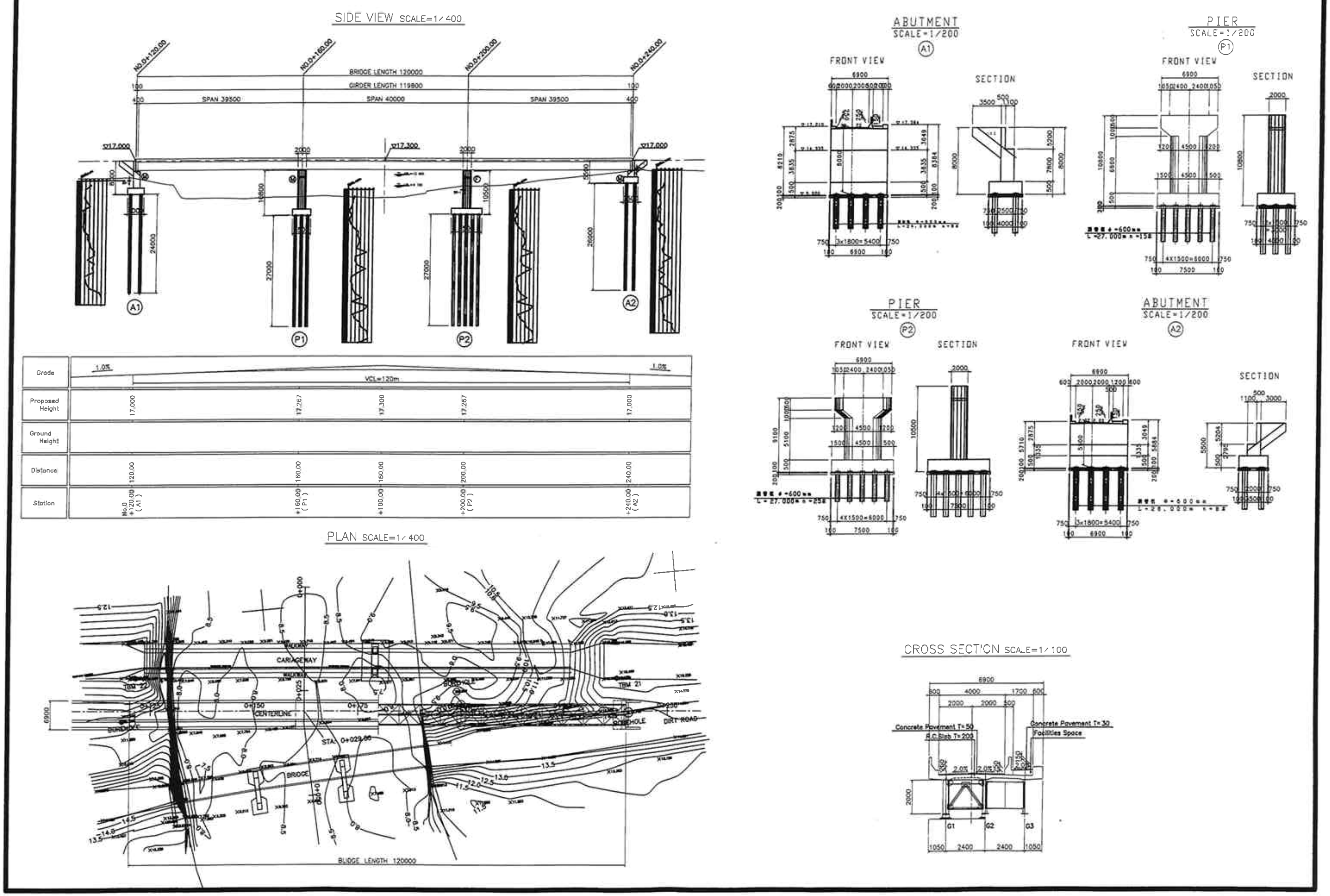
Grade: 12.56 — i=2.52% L=157.52m — 16.53 — i=1.00% L=107.50m — 17.60 — i=1.00% L=107.50m — 16.53 — i=2.72% L=109.98m — 13.53 — i=1.00% — 13.36

ProposedHeight	12.56 12.69	13.19	13.69 13.77	14.20	14.70	15.20 15.32	15.71	16.08 16.20	16.46	16.58	16.70	16.80	17.00	17.17	17.27
GroundHeight	12.6 12.6	12.9	12.9 12.9	13.4	13.5	13.6 13.9	12.3	11.8 11.5	11.5	12.0	12.6	12.9	12.8	8.0	8.3
Distance (m)	-205.02 -200.00	-180.00	-160.00 -156.93	-140.00	-120.00	-100.00 -95.56	-80.00	-65.00 -60.00	-47.50	-40.00	-30.00	-20.00	0.00	20.00	40.00
Unit distance (m)	0.00 5.02	20.00	20.00 3.07	16.93	20.00	20.00 4.44	15.56	15.00 5.00	12.50	7.50	10.00	10.00	20.00	20.00	20.00
Station	-5.02 No.-10	No.-9	No.-8 +16.93	No.-7	No.-6	No.-5 +15.56	No.-4	-5.00 No.-3	-7.50	No.-2	-10.00	No.-1	No.0	No.1	No.2

ProposedHeight	17.30	17.27	17.17	17.00	16.80	16.70	16.58	16.45	16.18 16.05	15.79 15.78 15.64	15.10	14.55	14.28	14.01 14.01	13.61 13.56	13.36
GroundHeight	8.0	10.9	12.5	14.5	14.6	14.6	14.6	14.6	14.6 14.6	14.6 14.6 14.4	14.3	13.9	13.8	13.7 13.7	13.5 13.4	13.4
Distance (m)	60.00	80.00	100.00	120.00	140.00	150.00	160.00	167.50	180.00 185.00	194.34 194.80 200.00	220.00	240.00	250.08	259.98 260.00	277.48 280.00	294.98
Unit distance (m)	20.00	20.00	20.00	20.00	20.00	10.00	10.00	7.50	12.50 5.00	9.34 0.46 5.20	20.00	20.00	10.08	9.89 0.02	17.48 2.52	14.98
Station	No.3	No.4	No.5	No.6	No.7	+10.00	No.8	+7.50	No.9 +5.00	+14.34 +14.80 No.10	No.11	No.12	+10.08	+19.98 No.13	+17.48 No.14	+14.98

Curvature figure of plan: L=48.10 — R=200.00 L=61.37 — L=245.56 — R=200.00 L=44.34 — L=0.46 — R=600.00 L=55.28 — L=44.89

General Structural View (Ngalimbiu Bridge)



2.2.4 Implementation Plan

2.2.4.1 Implementation Policy

In implementing the Project through Japan's Grant Aid Scheme, the following matters are taken into consideration:

- To effectively utilize local engineers, workers, materials and equipment in the Solomon Islands so as to contribute to the creation of employment opportunities, technology transfer, revitalization of the regional economy;
- To establish a close communication system between the Government of the Solomon Islands, the consultant and the contractor for the smooth implementation of the plan;
- To draw up a construction method and construction plan for completing substructure work during the dry season when river levels are low;
- To draw up a practical plan taking into consideration rainfall patterns, the period required for materials and equipment procurement and application of an appropriate construction method, etc.;
- To draw up a construction plan and a field work schedule that will not hinder the present traffic flow or create any inconveniences.

2.2.4.2 Implementation Condition

The following should be given special attention when implementing the plan:

(1) Compliance with Labor Standards

The contractor should present any conflicts with workers and secure safety by observing the present construction-related legislation in the Solomon Islands, respecting appropriate working conditions and customs associated with employment.

(2) Environmental Conservation during the Construction Period

In receiving "a construction permit" prior to the commencement of construction, instruction and supervision should be provided for construction work to ensure that the environmental aspects are taken into account as a prerequisite for the permit.

In particular, in the case of site execution, instruction and supervision should be provided for construction work to ensure that excessive dust and mud resulting from scrap wood disposal, excavated soil disposal, landfill work and paving does not occur.

(3) Necessity of Onsite Communication Means

Since the infrastructure for telephone communications including cellular phones has not yet been developed at the project site, the minimal necessary communications facilities should be taken into consideration for construction supervision and safety control of personnel engaged in construction.

(4) Respect for Local Customs

In drawing up a construction plan, a work schedule that conforms to local religions and customs should be prepared.

(5) Ensuring Road Safety

In order to carry out construction while the present bridges are left open to general traffic under the plan, special consideration should be given and smooth traffic management provided to ensure traffic safety during construction without delay in the process by obtaining the cooperation of the Solomon Islands' police authorities.

(6) Customs Clearance

A construction plan with sufficient time allotted for the required number of days for importation, unloading and customs clearance should be drawn up.

(7) Land Acquisition

It should be confirmed that prior agreements and payments of compensation, etc. will be appropriately implemented.

(8) Work Process Adjustment

Work progress to be taken by the Solomon Islands should be sufficiently confirmed and adjusted.

(9) Search and Removal of Unexploded Bombs

Prior to the execution of work, the Department of Infrastructure and Development (DID) will apply for a survey by the Explosive Ordnance Disposal Unit of the Royal Solomon Islands Police Headquarters. After the said unit completes the field survey, a safety certificate will be issued by the Headquarters. However, if an unexploded bomb is detected during construction work, a request will be made to DID for the said unit to have it disposed of.

2.2.4.3 Scope of Work

In implementing the plan, work to be taken respectively by the Government of Japan and the Government of Solomon Islands is outlined as follows.

(1) Work to be taken by the Japanese Government

1) Construction of Tenaru 1 and 2 Bridges and Ngalimbiu Bridge

- Construction of facilities as per section “2.2 Basic Plan" of this report.
- Engineering work for traffic safety facilities for the above-mentioned construction.
- Creation of temporary facilities (such as site office and laboratory)

2) Procurement of Equipment and Materials

Procurement of construction equipment and materials necessary for bridge construction described in “2.4.6 Procurement Plan”

3) Safety Measures

Safety control and safety measures required for the execution of construction work.

4) Consultation Services

Preparation of a detailed design, tender and contract documents, assistance to the Government of the Solomon Islands for tender proceedings, and construction supervision described in "2.4.4 Consultant Supervision".

(2) Work to be provided by the Government of the Solomon Islands

1) Issuance of Construction Permit

Before starting the construction work, the Ministry of Infrastructure and Development in the Government of Solomon Islands should issue a construction permit for the Project.

2) Customs Clearance and Tax Exemption

The Government of Solomon Islands should provide customs clearance for importation and exportation of construction equipment and materials at the Solomon port and provide tax exemptions.

3) Land Expropriation and Security of Lot

The Government of Solomon Islands should condemn land to construct targeted bridges under the Project and secure a lot for a base camp and concrete plant yard necessary for constructing temporary facilities such as a site office, laboratory and plant, and disposal sites for waste and excavated soil.

4) Others

- Provision of the quarry and borrow pit, etc.
- Issuing of visas, certificates and other privileges to Japanese nationals and other personnel from any third country necessary to the implementation of the Project.
- Exemption of customs duty, taxes and public charges imposed by the Government of the Solomon Islands
- Appointment of counter parts (C/P) and securing of their travel arrangements, expenses, etc.
- Survey of unexploded bombs, issuance of a safety certificate and disposal of unexploded bombs

2.2.4.4 Consultant Supervision

(1) Operating Schedule of Consulting Services

In the case of implementing the Project, the signing of Exchange of Notes (E/N) between both the Government of Japan and the Government of Solomon Islands is dependent on the detailed design and supervision of construction pertaining to the grant aid project. After the conclusion of the E/N, based on a letter of recommendation issued by JICA, the consultant will conclude a consultancy agreement with the Ministry of Infrastructure and Development, which is the implementing agency for the Solomon Islands, in accordance with the scope and procedures of Japan’s grant aid scheme. After the agreement, in the case of going ahead with the detailed design, assistance for tendering procedures and supervision of construction work, major consulting services included in the consultancy agreement are described below:

1) Preparation Stage of Tender Documentation (Detailed Design Stage)

A detailed design of every facility will be drawn up based on the results of the Basic Design Study Report for the purpose of preparing tender documents. Tender documents include the following materials and should be approved by the Department of Infrastructure and Development of the Ministry of Infrastructure and Development.

- Design report
- Drawings

- Tender documents

2) Tender Stage

The Department of Infrastructure and Development of the Ministry of Infrastructure and Development will select a contractor who is a Japanese national through open bidding with the assistance of the consultant. Representatives of the Government of Solomon Islands who participate in the bidding and the construction contract should have the right of approval for the contract and should be capable to judging technical fields. Assistance services of the consultant at the tender stage are listed as follows.

- Announcement of tender
- Pre-qualification
- Bidding and tender evaluation
- Construction contract

3) Construction Supervision Stage

- On receiving verification of the construction contract from the Government of Japan, the Consultant will issue a Notice to Proceed to start construction supervision. In the construction supervision, the consultant should report directly to the Department of Infrastructure and Development of the Ministry of Infrastructure and Development on the progress of construction work; whereas, the consultant should provide solutions and recommendations, etc. on work progress, quality, safety and payments to the contractor. In addition, the consultant should report to the Embassy of Japan in the Solomon Islands and to the Solomon Islands JICA Office when necessary.

- The consultant should conduct a completion inspection one year following the completion of construction supervision. This inspection will be the final responsibility of the consulting services.

(2) Implementation System

The contents of the consultant's consulting services at each stage of the detailed design, construction tender and construction supervision are shown as follows.

1) Preparation of Detailed Design and Tender Documents

A detailed design will be drawn up by a design team established by the chief consultant.

2) Construction Supervision System

The responsibilities of Japanese engineers who will be involved in the construction supervision and the number of personnel are described as follows.

(a) Work Supervision Engineer

A work supervision engineer is responsible for the efficient coordination and implementation of construction work, administration of a resident supervisory engineer and project team leader who are dispatched to the Solomon Islands in order to confirm the onsite supervision system at the start of construction and handing over of facilities to be completed at the time of completion.

(b) Resident Supervisory Engineer

A resident supervisory engineer will be dispatched when construction work is established. The dispatching period will be 13 months from the beginning of construction work to its completion. His major duties are to supervise quality control, schedule control, work progress reports and safety control at the site. Since the total dispatching period is 13 months, temporary visits to Japan should not be taken into account.

(c) Super Structure Engineer

A super structure engineer will be dispatched for a short period of time during the construction of steel beams at the Ngalimbiu Bridge, which requires the most prudence in schedule and safety control of all three bridges.

(d) Piling Work (Foundation) Engineer

A piling work (foundation) engineer will be dispatched for a short period of time during the laying of steel tube piles. Piling of 131 steel tubes into abutments and the piers of the three bridges, quality control for junction welding, schedule control and safety control will also be carried out.

(e) Acceptance Inspection at Supplier (Japan)

A super structure engineer will be dispatched to the plants of manufacturers in order to ensure the quality control of steel beams and to carry out temporary erection inspections. The dispatching period will be 4 days in total (2 days × 2 times).

As described above, the following table shows the personnel plan for consultants in construction supervision planning.

2.2.4.5 Quality Control Plan

As described in “2.4.1 Implementation Policy”, in the case of implementing the Project, engineers in Solomon will be effectively utilized and local workers will be hired. Quality control and schedule control for each work should be therefore taken by Japanese contractors and engineers.

The necessary quality control plan for construction work under the Project is shown in Table 3.25.

Table 2.23 List of Major Quality Control Items

Description			Test method	Examination frequency
Base / Sub-base	Combination (mixed) material		Liquid limit / Plasticity limit	For each mix
			Sieve test	
			Strength test for aggregates	
			Density test for aggregates	
	Laying		Maximum drying density (compaction test)	Once / day
Prime coat Asphalt emulsion	Material	Bitumen materials	Certificate of quality	For each material
			Temperature at the time of keeping / spreading	For each delivery
Asphalt	Material	Bitumen materials	Certificate of quality, Ingredient analysis list	For each material
		Aggregate	Sieve test	For each mix, Once / month
			Water absorption rate	For each material
			Strength test for aggregate	
Concrete	Material	Cement	Certificate of quality, Physics / chemical test result	For each material
		Water	Ingredient test result	
		Additive agent	Certificate of quality, Ingredient analysis list	
		Fine aggregate	Absolute dry specific gravity	
			Sieve test	
			Silt mixture rate for clay and silt material	
		Course aggregate	Absolute dry specific gravity	
			Grain size distribution (Mixture)	
	Cement mix	Test piece	Compressive strength test	For each mix
	Foundation		Slump (concrete)	For each materials
			Air content	
			Temperature	
	Strength		Compressive strength test (7th day, 28th day)	For each foundation
Reinforcement bar	Material		Certificate of quality, Tension strength test result	For each lot unit
Steel tube	Material		Certificate of quality	For each lot unit
Bearing shoe	Material		Certificate of quality	For each lot unit
Others			Various tests	If necessary

2.2.4.6 Procurement Plan

(1) Procurement Plan

In principle, materials required for civil work that are available in the Solomon Islands will be locally procured.

However, if the quality is inferior or if it is difficult to obtain the required quantity within a prescribed period due to insufficient supplies, such materials will be procured from Japan.

In particular, fabricated steel materials, which are major materials under the Project, will be procured from Japan for reliability of procurement during the short construction period, extremely accurate processing techniques and convenience of regular marine transportation service.

Table 2.24 Procurement of Major Construction Materials

Material	Solomon Islands	Japan	Reason
Cement	○		Imported product, but local acquisition is possible.
Aggregate (sand / gravel)	○		High quality materials are available.
Wood (plywood / squared lumber / log)	○		Processed products are imported, but local acquisition is possible.
Reinforcement bar	○		Imported product, but local acquisition is possible.
Steel tube / steel sheet pile		○	Quality and reliability of supply
Bridge accessories (shoes / expansion joints)		○	Same as above
Steel handrail		○	Same as above
Steel materials (Scaffolding / forms) for temporary construction		○	Same as above
Bitumen materials		○	Same as above
Fuel / oil	○		It is import goods, but local acquisition is possible.
Bent materials		○	Quality and stability of supply

It is possible collect and procured aggregates from local rivers. However, securing the volume collected is difficult due to flooding. Therefore collection and procurement should not only take into consideration the place of collection of aggregates, etc. but also a temporary storage site.

(2) Procurement of Construction Machinery

When medium and large-scale construction projects are implemented in the Solomon Islands, necessary construction machinery is procured from neighboring countries since most of the construction work is road construction. Therefore, machinery for road construction such as dump trucks and road graders are locally available. However, there are no truck cranes or crawler cranes which are utilized for bridge construction.

In addition, there are no companies with plants capable of producing and supplying the necessary amount of ready mixed-concrete (100m^3 per day) in the Solomon Islands, so concrete will be procured from a Japan plant.

Most machinery available from third countries located close to the Solomon Islands was comprehensively judged following a comparison of items shown in Table 3.27. In particular, in order to complete construction work within the limited schedule, assuming normal operation of construction machinery or at the plant, in the case of leasing machinery, taking into consideration the maintenance of general machinery, the capacity to procure spare parts and cost, etc. in a country where a leasing company is located, procurement from Japan was judged to be the most favorable.

Table 2.25 Comparison of Procurement Sources in Third Countries

Items / Sources	Rental	Maintenance	Transportation Cost	Transportation Period	Availability of Spare Parts	Overall Judgment
Australia	×	△	○	○	△	×
New Zealand	×	△	○	○	△	×
Indonesia	○	×	○	△	×	×
Papua New Guinea	○	×	○	○	×	×
Thailand	○	×	△	△	×	×
Singapore	△	△	△	△	×	×
Philippines	○	×	△	△	×	×

Note: higher cost = × / same class = △ / lower cost = ○, compared with Japan
In need of supply short term = ○ long term = ×, quality Good = ○ / quality bad = ×

As described earlier, a procurement plan for major construction machinery in the Project is shown in Table 3.28.

Table 3.26 Procurement Sources for Major Construction Machinery

No.	Construction Machine	Specifications	Solomon Islands	Japan
1	Backhoe	Crawler type, $0.45m^3$		○
2	Bulldozer	15t class		○
3	Dump truck	10t	○	
4	Truck mixer	$3.0 – 3.2m^3$		○
5	Clamshell	Oil pressure rope type, $0.8m^3$		○
6	Raftelene Crane	Oil pressure expansion, 20t		○
7	Tip spreader	Tele-tailgate type, $0.25m^3$		○
8	Sprinkler truck	5,500-6,500 litter	○	
9	Freight truck	Six ton products		○
10	Trailer / truck	Semi-trailer type, 35t	○	
11	Road roller	10-12t	○	
12	Vibration roller	Embarkation type, Combined 3- 4t		○
13	Truck crane	Oil pressure expansion 4.9t		○
14	Concrete pump car	Boom type, 90- $110m^3/h$		○
15	Wheel loader	Normal, heaped volume $2.1m^3$		○
16	Tire roller	8-20t		○
17	Crawler crane	Oil pressure drive 50- 55t		○
18	Crawler pile driver	Oil pressure type, lamb weight 6.4- 8.0t		○
19	Vibro-pile driver	Electricity-type 90kw		○
20	Motorized grader	Blade 3.1m wide		○
21	Concrete plant	Self-loading hopper $1.0m^3$		○
22	Air compressor	Movable, $7.5m^3/min$		○
23	Generator *	Diesel drive 45kVA		○
24	Motor pump *	Diameter 150mm, head 15m		○

Note) * Loading / Transportable by freight truck

(3) Material and Machinery Transportation Plan

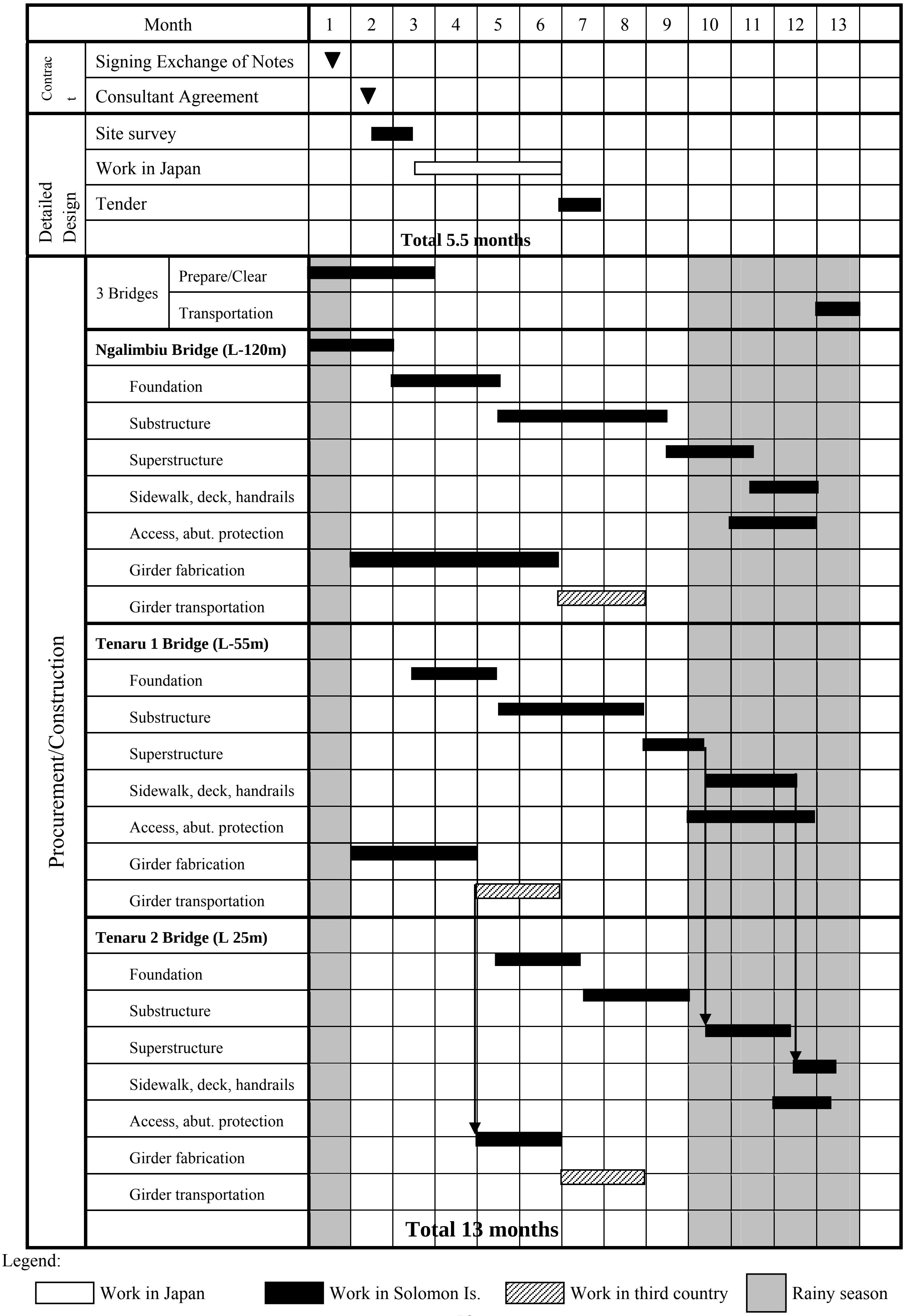
Two moths will be required for packaging, shipping, marine transportation, unloading, customs clearance and inland transportation of materials and machinery from Japan. A process plan should be drawn up in due consideration of this period.

Item	Transport path	Period
Packaging and shipping	Factory to Japanese seaport	0.4 months
Marine transportation	Japanese seaport to Honiara port on Guadalcanal Island	1.3 months
Unloading and Customs clearance	Honiara port	0.2 months
Overland transport	Honiara port to base camp or each site	0.1 months
	Total	2.0 months

2.2.4.7 Implementation Schedule

The implementation schedule for each bridge is shown in the following table.

Table 3.27 Implementation Schedule (Draft)



2.3 Obligations of the Recipient Country

2.3.1 Common Items of Japan's Grant Aid Scheme

Although general work to be undertaken by the Solomon Islands is confirmed in the Record of Discussion (R/D) and the Minutes of Discussions (M/M), the contents are described as follows.

- To secure land required for project implementation such as construction yards and to level such land, etc.
- To complete utilities such as electricity, water supply and drainage system up to the land.
- To secure prompt unloading of materials and construction machinery to be purchased under the grant aid project at the port of disembarkation and to bear expenses.
- To exempt Japanese nationals from custom duties, internal taxes and other public charges arising in the recipient country with respect to the supply of products and services under verified contracts.
- To permit Japanese nationals and construction-related parties in third countries who may be required in connection with the supply of products and services under verified contracts entry into the recipient country and stay therein in the performance of their work.
- To properly and effectively utilize and maintain the targeted bridges for project implementation.
- To post counterpart engineers.
- To coordinate and resolve any problems that might occur with third parties or local residents at the project sites.

2.3.2 Specific Project Items

Specific items to be undertaken by the Solomon Islands are described as follows.

Ngalimbiu Bridge is scheduled to be newly built between the old bridge (steel girder bridge) and the existing bridge (truss bridge). The present condition and relationship between bridges and their usage are demonstrated below.

In addition, following the construction of the new bridge, only one heavy trailer truck (66t) will be permitted to cross over it at a time. Although several vehicles are unable to cross over Tenrau 1 and Tenaru 2 Bridges simultaneously, special attention will be given to Ngalimbiu Bridge. A sign for flow regulation, etc. will therefore be installed.

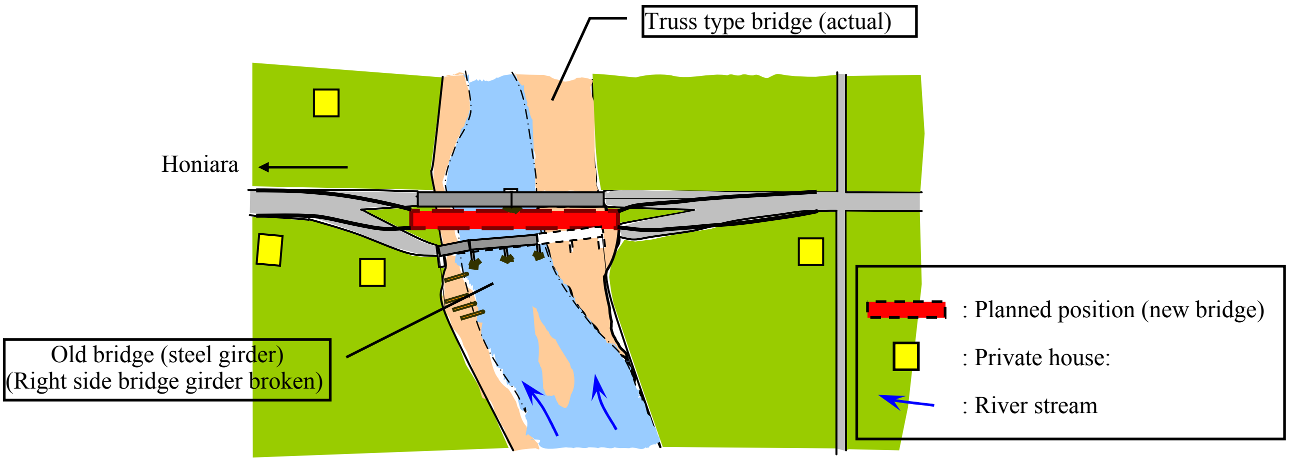


Figure 2.11 Actual Condition of Ngalimbiu Bridge

Table 2.28 Present Condition of Old and Existing Bridges, Usage and Measures

Bridge	Actual condition and usage at the time of new bridge construction	Measures taken by the Solomon side
Old bridge	• The bridge girders on the right bank were washed away. • It is located upstream and is obstructing the new bridge construction.	• Removal prior to new bridge construction
Existing bridge	• Buckling / falling off of floor slab in the vicinity of the right bank side abutment, and damage to primary materials • Will be utilized as a detour during new bridge construction	• Repair • Removal following new bridge completion

The Solomon side has agreed to remove the old bridge and repair the existing bridge prior to construction of the new bridge. In fact, they began to repair the existing bridge in January 2006.

2.3.3 Obligations of the Recipient Country

In addition to the construction work, the recipient country will be responsible for the following.

- The relevant authority on the Solomon side (Explosive Ordnance Disposal Unit of the Royal Solomon Islands Police Headquarters) should search for and remove unexploded bombs within the targeted sites prior to construction and issue a safety certificate.
- With respect to Ngalimbiu Bridge listed under the Project, both the abutments from the old bridge located upstream and the embankment on the right bank should be removed.
- Immediately after signing the Exchange of Notes (E/N), the Ministry of Infrastructure and Development should take the initiative to carry out a briefing session on the Project by gathering local residents or their representatives along the project sites.

- Since frequent disruptions in traffic flow are anticipated due to construction work, the public should be thoroughly informed of such inconveniences during the construction of the three bridges via the media such as radio, etc.

2.4 Project Operation Plan

For the targeted three bridges, both super structures will be built using steel girders and the substructures will be made of reinforced concrete. This type of bridge will be generally maintained as follows.

(1) Annual Maintenance

- Inspection and repair of bridge surface: By checking the condition of the bridge surface pavement, cracks, etc. will be repaired.
- Inspection and cleaning of drainage system: By checking the drainage system of the carriageway (catch pits and drainpipes), any sediment will be removed and cleaned.
- Inspection and cleaning of expansion joints: Any clogs of mud or stones in the gaps between expansion joints will be removed and cleaned if necessary.
- Weeding, etc. of slope face along access roads: Slope faces will be weeded and cleaned at least once a year.

(2) Maintenance Every Five (5) Years

- Repair of drainage system: Any damage of catch pits or drainpipes will be repaired.
- Repair of expansion joints: Any minor damage to expansion joints will be repaired.
- Inspection and cleaning of shoes: Shoes under the girders will be inspected and cleaned.

(3) Maintenance Every Fifteen (15) Years

- Recoating: Any rust on steel plating will be removed and repainted.

2.5 Estimated Project Cost

2.5.1 Estimated Project Cost for Requested Japanese Assistance

The total cost of the Project to be implemented in accordance with the Japanese grant aid scheme is shown in Table 3.32. As mentioned earlier, the breakdown of expenses for both sides based on the Scope of Work (S/W) between Japan and the Solomon Islands is shown in the following table based on the estimated conditions stated as follows.

The estimated project cost is tentative and may be reviewed by the Government of Japan in when deciding on the implementation of the grant aid project. In other words, the cost does not reflect limited assistance in accordance with the Exchange of Notes (E/N).

(1) Expenses to be taken by Japan

Estimated Project Cost : Approximately ¥913 million

Table 3.29 Estimated Project Cost (to be taken by the Japanese side)

(Unit: million yen)

Description			Estimated Project Cost
Facilities	Bridge work	Substructure work Superstructure work Abutment protection work Access road work	833
Detailed design and work supervision			80
Total			913

(2) Expenses to be taken by the Solomon Islands

Prior to implementing the construction work, the cost and expenses for land expropriation at the project sites, removal of the old bridge at the Ngalimbiu Bridge, repair of the existing bridge for detours during the construction and promotion of customs clearance with respect to importation of materials and construction machinery. Expenses for removal of the exiting bridge after the completion of the new bridge will also be included.

Table 3.30 Estimated Project Cost (to be taken by the Solomon Islands)

(Unit: Solomon dollars)

Description	Amount
Construction cost (removal of Ngalimbiu Bridge, repair and removal of existing bridge)	1,700,000
Land expropriation cost (both sides of bridges, construction yards)	380,000
Total	2,080,000

(3) Estimated Conditions

1) Exchange rate

1.00US$ = ¥116.29 (as of June 2006)

2) Construction period

Detailed design and tendering : 5.5 months
Construction period : 13 months

3) Other

The Project will be implemented in accordance with the grant aid scheme of the Government of Japan.

The above-mentioned exchange rate will be reviewed by the Government of Japan.

2.5.2 Operation and Maintenance Cost

Major maintenance for the new bridge and various utilities on access roads to be included under the Project include daily inspections, periodical inspections every 5 years and every 15 years as shown in Table 3.35. The amount of maintenance is judged to be approximately 0.5 to 1.4% 5.6 of the actual maintenance cost for roads and bridges at 5.6 million Solomon dollars between 2002 and 2004 (shown in double-plate in Table 3.34), which is judged to be fully feasible for maintenance.

The Department of Infrastructure and Development has maintained 6 bridges built under the grant aid scheme (10 to 15 years have elapsed). Since the 6 bridges are functioning adequately, the technical capability to maintain bridges similar to the above-mentioned 6 bridges or lower bridges in the Project exists.

Table 3.31 Budget of the Ministry of Infrastructure and Development

(Unit: million Solomon dollars)

<table>
<tr><th>Item</th><th>FY2002</th><th>FY2003</th><th>FY2004 年</th><th>FY2005</th></tr>
<tr><td>Government budget
( )indicates overseas financial support</td><td>432.5
(108.7)</td><td>579.9
(205.4)</td><td>710.9
(210.0)</td><td>1,128.9
(578.9)</td></tr>
<tr><td>MID budget</td><td>43.6</td><td>16.9</td><td>35.4</td><td>75.0</td></tr>
<tr><td rowspan="2">Maintenance results on roads and bridges
(2005 indicates budget)</td><td>6.5</td><td>5.4</td><td>4.9</td><td rowspan="2">26.4</td></tr>
<tr><td colspan="3">Average of 3 years = 5.6 million Solomon dollars</td></tr>
<tr><td>Ratio of maintenance cost for roads and bridges in the MID budget</td><td>14.9%</td><td>32.0%</td><td>13.8%</td><td>35.2%</td></tr>
</table>

Source: Ministry of Infrastructure and Development

Table 3.32 Major Maintenance items and Cost

Form of Maintenance	Executive Time	Object	Contents	Amount (SI$)	Amount (Japanese yen)
Daily	Annual	Bridge surface	Check/ repair	13,800	207,000
		Drainage facilities	Check/ cleaning	600	9,000
		Expansion joint	Check/ cleaning	400	6,000
		Access road (surface, slope)	Check/ repair	12,000	180,000
	Total required annual maintenance cost			26,800	402,000
Regularly	Five years	Drainage facilities	Repair	1,500	23,000
		Expansion joints	Repair	2,000	30,000
		Shoes	Check/ cleaning	3,000	45,000
	Total required maintenance cost every five years			6,500	98,000
	15 years	Steel plate	Repair/ Repaint	80,000	1,200,000
	Total required maintenance cost every 15 years			80,000	1,200,000

2.6 Notes on Implementing Japanese Requested Assistance

The ownership of land and incidental trees, soil and stones in the Solomon Islands is complex in accordance with common law. It is therefore important to carefully select locations for felling associated with surveying and construction, borrow pits, disposal for excess sand and soil, quarrying of materials for roadbeds and concrete in close collaboration with the DID and to take appropriate measures.

CHAPTER 3

PROJECT EVALUATION AND RECOMMENDATIONS

CHAPTER 3 PROJECT EVALUATION AND RECOMMENDATIONS

3.1 Project Effects

Safe trunk transportation lines connecting the eastern part of Guadalcanal Island and Honiara, the capital, will be secured through the reconstruction of bridges at the project sites which is expected to benefit approximately 60,000 residents in Honiara and neighbouring areas.

(1) Direct Effects

(i) Safe and Smooth Traffic Flow on Bridges

It will be possible to ensure not only safe passage of large vehicles due to an increase in bearing capacity, but also safety for pedestrians and smooth traffic flow of vehicles through separate carriageways and sidewalks.

(ii) Reinforcement and Stabilization of Transport Capacity

By increasing the present allowable live load from 20 to 66 tons, it will be possible to transport more passengers and cargo in a stable and efficient manner.

(2) Indirect Effects

(i) Contribution to Rehabilitation of Social and Economic Activities through the Restoration of Key Industries (Palm Oil and Gold Mining Industries)

The safe and smooth transportation of palm trees from plantations to processing plants and processed palm oil from plants to Port Honiara, and transportation between Honiara and gold mines will contribute to the restoration of social and economic activities.

(ii) Improvement in Accessibility to Social Services such as Medical and Educational Institutions and Markets

The smooth passage of vehicles and pedestrians will facilitate access by local residents to medical and educational facilities and markets, etc.

3.2 Recommendations

Under the Project, bridges will be reconstructed in accordance with the Japanese grant aid scheme. In addition to the Project, although trunk roads and bridges in the eastern region are presently being developed through the on-going Post Conflict Emergency Rehabilitation Project (PCERP) financed by the Asian Development Bank (ADB), the Department of Infrastructure and Development, which will be the implementing agency, should inspect and maintain all trunk roads periodically and systematically in order to ensure road functions.

In addition, although the allowable live load of the targeted bridges will be increased to 66 tons through the implementation of the Project, this is based on the assumption that only one 66-ton trailer truck will be on the same bridge at any given time. It is therefore necessary to properly inform bridge users and ensure that they observe it by installing traffic signs at the entrance to the bridges following their completion.

APPENDIX

Appendix 1 Study Team Members List

(1) Basic Design Study

Assignment	Current Position	Name
Team Leader	Director, First Project Management Group, Grant Aid Management Department, JICA	Kunihiro Yamauchi
Chief Consultant／Bridge Planning	Construction Project Consultants, Inc.	Yoichi Higaki
Bridge Design	Construction Project Consultants, Inc.	Jiro Koyama
Natural Conditions Survey (Topography & Geology)	Construction Project Consultants, Inc.	Kazuharu Koishikawa
Construction & Procurement Planning／Cost Estimation	Construction Project Consultants, Inc.	Yasuhiro Okubo

(2) Explanation of Final Draft Report

Assignment	Current Position	Name
Vice Team Leader	First Project Management Group, Grant Aid Management Department, JICA	Ken Imai
Chief Consultant／Bridge Planning	Construction Project Consultants, Inc.	Yoichi Higaki
Bridge Design	Construction Project Consultants, Inc.	Jiro Koyama

Appendix 2 Study Schedule

(1) Basic Design Study

No.	Month Day	Travel	Stay	Activities	Remarks
1	Nov. 23 Wed.	Tokyo －	In transit	Moving day	Only members of Mr. Higaki, Mr. Koyama, Mr. Okubo
2	24 Thu.	Honiara	Honiara	Courtesy call to Embassy of Japan and JICA	
3	25 Fri.		Honiara	Meeting with DID and、Department of National Planning and Aid Coordination	
4	26 Sat.		Honiara	Field survey／meeting with DID	
5	27 Sun.		Honiara	Sorting of materials	
6	28 Mon.		Honiara	Field survey／visit Department of Agriculture and Lands	
7	29 Tue.		Honiara	Field survey／meeting with DID	
8	30 Wed.		Honiara	Field survey／visit to Meteorological Service Head Quarters	
9	Dec. 1 Thu.		Honiara	Meeting with DID／visit to gold mining company	Arrival of Mr. Koishikawa at Honiara
10	2 Fri.		Honiara	Field survey／meeting with DID	
11	3 Sat.		Honiara	Field survey／collection of materials	
12	4 Sun.		Honiara	Sorting of materials, internal meeting	
13	5 Mon.		Honiara	Field survey／visit to lumber company	
14	6 Tue.		Honiara	Field survey／visit to Division of Water Resources	
15	7 Wed.		Honiara	Field survey／visit to Meteorological Service Head Quarters	
16	8 Thu.		Honiara	Field survey／visit to Environment and Conservation Division	
17	9 Fri.		Honiara	Meeting with DID／field survey	
18	10 Sat.		Honiara	Field survey／Sorting of materials	
19	11 Sun.		Honiara	Sorting of materials	
20	12 Mon.		Honiara	Field survey／visit to Division of Water Resources	
21	13 Tue.		Honiara	Courtesy call to Embassy of Japan Meeting with JICA office JICA	Arrival of Leader Yamauchi at Honiara
22	14 Wed.		Honiara	Meeting with DID／on-the-spot study	
23	15 Thu.		Honiara	Signing the M/M with DID & Department of National Planning and Aid Coordination Report to Embassy & JICA office	
24	16 Fri.		Honiara	Field survey／visit to Royal Solomon Islands Police Headquarters (related to unexploded bombs)	Departure of Leader Yamauchi from Honiara
25	17 Sat.		Honiara	Field survey、topographical survey, geotechnical investigation	
26	18 Sun.		Honiara	Sorting of materials, topographical survey, geotechnical investigation	
27	19 Mon.		Honiara	Topographical survey, geotechnical investigation, visit to Royal Solomon Islands Police Headquarters	
28	20 Tue.		Honiara	Topographical survey, geotechnical investigation, visit to Royal Solomon Islands Police Headquarters	
29	21 Wed.		Honiara	Field survey、Topographical survey, geotechnical investigation	
30	22 Thu.		Honiara	Meeting with DID Report to Embassy, JICA office, Department of National Planning and Aid Coordination	
31	23 Fri.	Honiara －Tokyo	Honiara	departure from Honiara, arrival at Tokyo	Only members Mr. Higaki, Mr. Koyama, Mr. Okubo
32	24 Sat.		Honiara	Topographical survey, geotechnical investigation	
33	25 Sun.		Honiara	Topographical survey, geotechnical investigation	
34	26 Mon.		Honiara	Topographical survey、geotechnical investigation	
35	27 Tue.	Honiara	Honiara	Departure from Honiara	Only Mr. Koishikawa
36	28 Wed.	－Tokyo	In transit	Moving day	

(2) Explanation of Draft Final Report

No.	Month	Day		Travel	Stay	Activities	Remarks
1	May	19	Fri.	Tokyo －	In transit	Moving day	Mr. Higaki, Mr. Koyama
2		20	Sat.	Honiara	Honiara	Field survey	
3		21	Sun.		Honiara	Sorting of materials	
4		22	Mon.		Honiara	Meeting with DID	
5		23	Tue.		Honiara	Meeting with DID	Arrival of Vice Leader Imai at Honiara
6		24	Wed.		Honiara	Field survey／Meeting with DID	
7		25	Thu.		Honiara	Field survey／Meeting with DID	
8		26	Fri.		Honiara	Signing the M/M Report to Embassy, JICA office	Departure of Vice Leader Imai from Honiara
9		27	Sat.	Honiara	Honiara	Field survey	
10		28	Sun.	－Tokyo	In transit	Moving day	

Appendix 3 List of Party Concerned in Solomon

Department of Infrastructure and Development

Mr. Hon Alfred Sasako	:	Minister
Mr. John Ta'aru	:	Permanent Secretary
Mr. Moses Virivolomo	:	Director Transport, Policy and Planning Unit
Mr. Francis Nori	:	Director of Civil Engineering
Mr. Ambrose Kirei	:	Chief Civil Engineer

Department of National Planning and Aid Coordination

Ms. Jane Waetara	:	Permanent Secretary
Mr. Evans Tuhagenga	:	Acting Permanent Secretary
Mr. Kazuyoshi Ogawa	:	Aid Advisor

Division of Water Resources

Mr. Michael Maehaka	:	Senior Hydrologist

Environment and Conservation Division

Mr. Joe Horokou	:	Deputy Director

Guadalcanal Plains Palm Oil Limited

Mr. Harry Brock	:	Project Manager
Mr. Richard Bedford	:	Director of Tetere Mill Division

Meteorological Service Head Quarters

Mr. Lloyd Tahani	:	Senior Meteorological Officer
Mr. Isach	:	Senior Meteorological Officer

Australian Solomon Gold Ltd.,

Mr. Keith Nibusen	:	Administration Manager

Ministry of Agriculture and Lands
Department of Lands and Surveys

Mr. Alfred Soaki	:	Commissioner of Lands

Explosive Ordinance Disposal Unit of Royal Solomon Islands Police Service Headquarters

Mr. Rex Waiwori	:	Ordinance Commander
Mr. Dennis Sweeny	:	Advisor

Embassy of Japan

Mr. Katuhiko Kubo	:	Ambassador
Ms. Izumi Iwaoka	:	Researcher/Adviser

JICA Solomon Islands Office

Mr. Hiromi Fujita	:	Resident represantative
Ms. Yoko Asano	:	Project Formulation Advisor
Mr. Yoshinobu Takishita	:	Coordinator of JOCV Program