BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR THE IMPROVEMENT
OF
ROADS AND BRIDGES
IN
THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE

December 2003

Japan International Cooperation Agency

Pacific Consultants International

Nippon Koei Co., Ltd.

PREFACE

In response to a request from the Government of the Democratic Republic of Timor-Leste, the Government of Japan decided to conduct a basic design study on the Project for the Improvement of Roads and Bridges in Timor-Leste and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent Timor-Leste a study team from March 27 to June 24, 2003.

The team held discussions with the officials concerned of the Government of Timor-Leste, 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 Timor-Leste 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 may sincere appreciation to the officials concerned of the Government of Democratic Republic of Timor-Leste for their close cooperation extended to the teams.

December 10, 2003

Kunimitsu Yoshinaga
Vice - President
Japan International Cooperation Agency

December, 2003

Letter of Transmittal

We are pleased to submit to you the basic design study report on the Project for the Improvement of Roads and Bridges in the Democratic Republic of Timor-Leste.

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

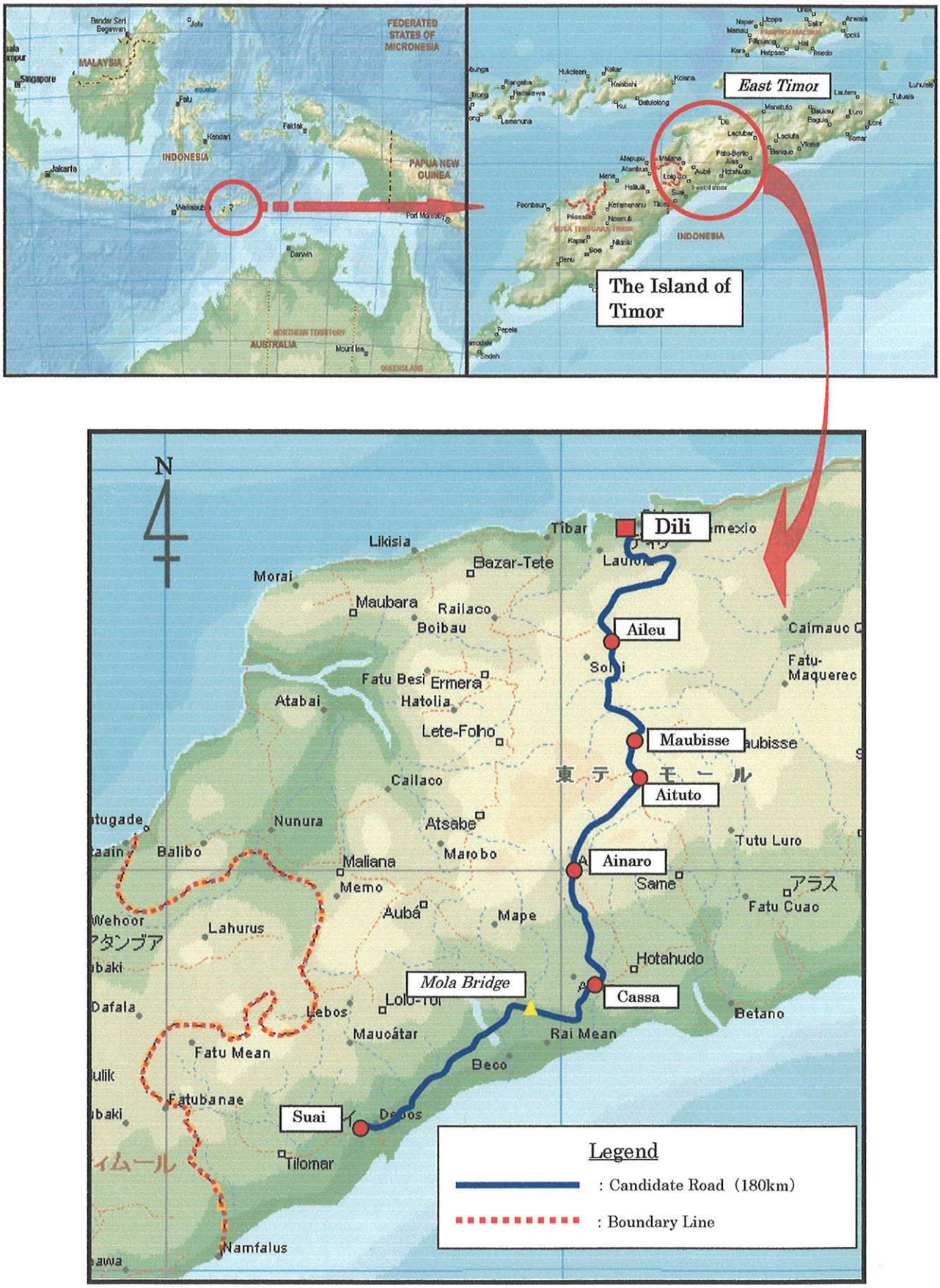
Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

Haruo SAKASHITA
Project manager,

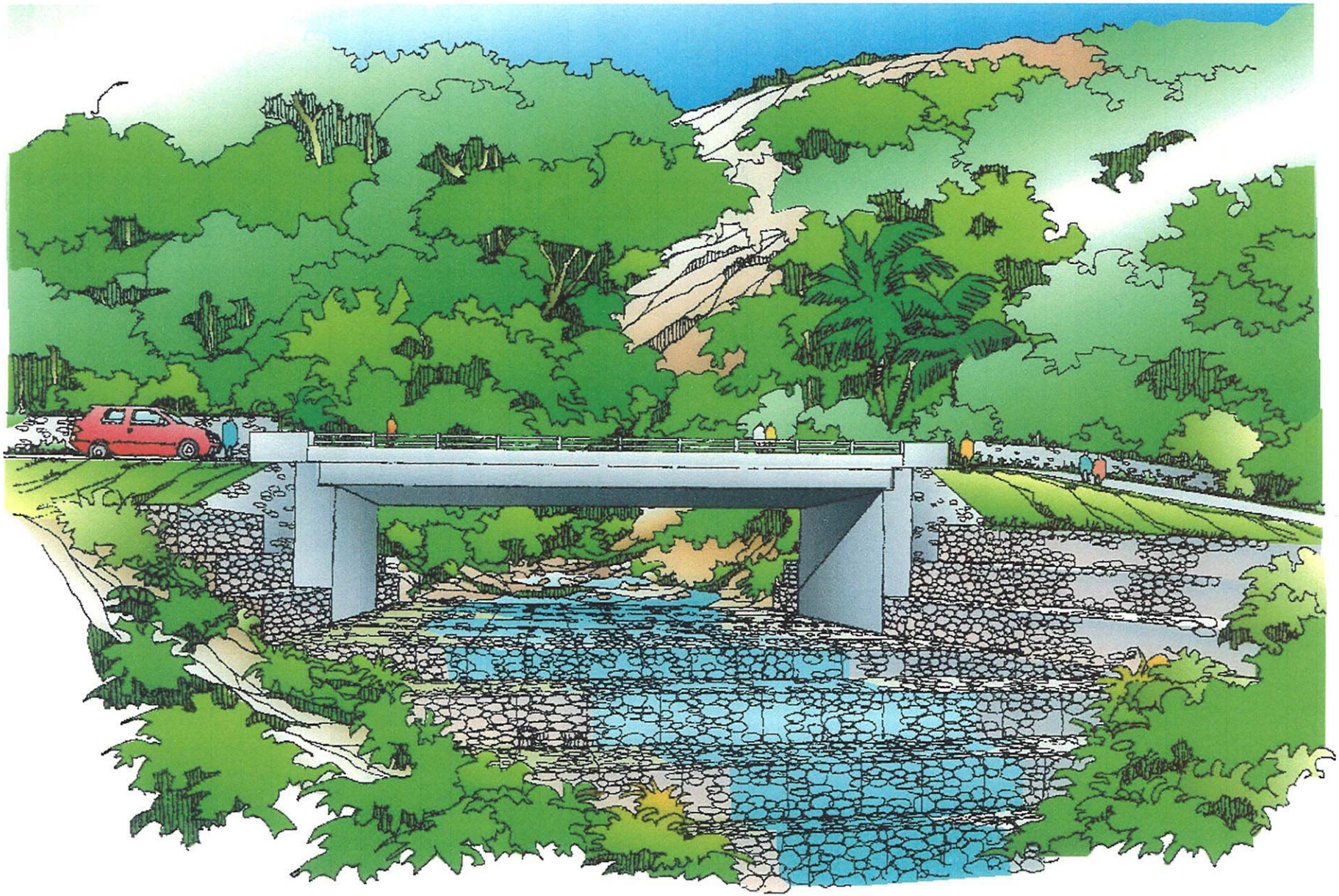
Basic design study team on the
Project for the Improvement of
Roads and Bridges in Timor-Leste

The joint venture between
Pacific Consultants International
and Nippon Koei Co., Ltd.

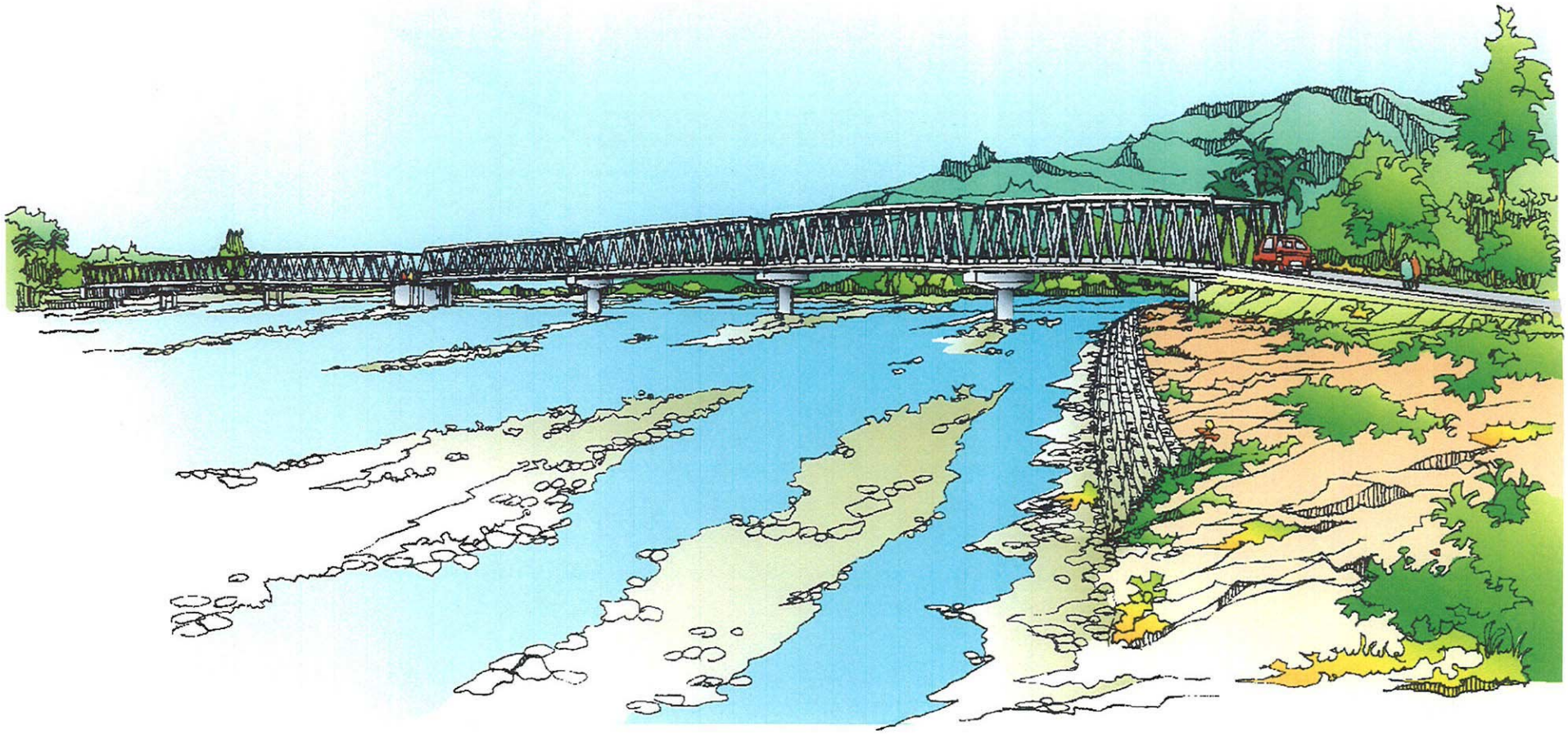


LOCATION MAP

Perspective Image for Improved Road at Aituto



Perspective Image for Improved Bridge at km60.3



Perspective Image for Improved Mola Bridge

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List of Acronyms

ADB	Asian Development Bank
AusAID	Australian Agency for International Development
CAD	Computer-Aided Design
CFET	Consolidation Fund for East Timor
DRBFC	Department of Roads, Bridges and Flood Control
EIA	Environmental Impact Assessment
EIRP	Emergency Infrastructure Rehabilitation Project
EMP	Environmental Management Plan
ETPA	East Timor Public Administration
ETTA	East Timor Transitional Administration
GDP	Gross Domestic Product
GRDP	Gross Regional Domestic Product
JICA	Japan International Cooperation Agency
MTCPW	Ministry of Transport, Communication and Public Works
NGO	Non-Governmental Organization
OD	Origin and Destination
OJT	On-the-Job Training
PDM	Project Design Matrix
PKF	Peacekeeping Force
PKO	Peacekeeping Operations
TFET	Trust Fund for East Timor (World Bank Administered)
UNDP	United Nations Development Programme
UNMISET	United Nations Mission of Support in East Timor
UNOPS	United Nations Office for Project Services
UNTAET	United Nations Transitional Administration in East Timor
USAID	United States Agency for International Development
WB	World Bank

Summary

SUMMARY

70% of infrastructure in Timor-Leste was destroyed due to the civil war and destruction which occurred just after the direct balloting to decide on extension of self-rule, which was conducted by the Indonesian Government in August 1999. Operation & maintenance of infrastructure was discontinued before and after the ballot. Under the control of United Nations Transitional Administration in East Timor (UNTAET), economic conditions improved drastically because of the reconstruction effort aiming for the nation's independence. However, the economic conditions have become worse again after the independence of the Democratic Republic of Timor-Leste in May 2002, due to the big reduction of foreign staff engaged in the aid projects. Under such circumstances, Timor-Leste (one of the less developed countries where the poorest segment of the population reaches 41% on a national level) set a goal of poverty-fighting through economic growth mainly implemented through human resource development, health care, improvement of agricultural productivity, administrative efficiency and infrastructure development.

In view of the conditions mentioned above, the Government of Japan has extended assistance for the following; (1) reconstruction and development (restoration and development of infrastructure, development of agriculture, forestry and fisheries, human resource development, assistance to NGO and assistance to constituent assembly), (2) humanitarian support (financial support, commodity support and physical support), (3) refugee aid efforts, (4) multi-national forces support, and (5) United Nations and PKO support.

Roads of Timor-Leste consists of 1,250 km of National / Main Roads, 1,750 km of District Roads, and 3,000 km of Feeder / Secondary Roads. The Dili-Suai Road, the object of this Project, is an arterial road, which starts at the capital Dili and ends at Suai, a major city for agricultural development in a southern district of the country. The Mola Bridge access road at the section between Cassa and Suai collapsed after a big flood in 2000; therefore, district transportation is passable only during the dry season.

The road has frequently suffered from disasters caused by heavy rainfall of more than 2,500 mm per year on average on steep slopes with loose ground. The section between Aituto and Cassa (especially in the mountainous zone) has been seriously damaged; hence, it is reported that the passability of the road is becoming worse and there is the possibility of road blockage. It is necessary to improve the access portion for the Mola River. In order to improve the above-mentioned roads, the Government of Timor-Leste requested the Government of Japan to rehabilitate the roads & bridges by Grant Aid cooperation.

In response to a Request from the Government of Democratic Republic of Timor-Leste, the Government of Japan decided to conduct a basic design study on the Project for the Improvement of Roads and Bridges and the Japan International Cooperation Agency (JICA) sent to Timor-Leste the basic design study team from 27 March to 18 April 2003 for the 1st study and from13 May to 24 June 2003 for the 2nd study. Site survey was conducted to obtain the data such as existing site conditions, implementation organization and its capability, management and maintenance capability, preceding plans by other donor or recipient countries, and benefit to the regional society, etc.

Further, JICA sent the team to explain and discuss the basic concept of the project from 22 October to 31 October 2003. An agreement was confirmed and reached with those involved in this project.

Evaluation items to select the objective section shall be ① Magnitude of damage, ② Workability, ③ Social impact (such as land acquisition and/or migration), ④ Preceding plan of recipient country and ⑤ Contribution to the regional society. As such, the following four sections are selected to be implemented.

① Road improvement between Aituto and Cassa (50 km)

There are many / more portions of unpaved and damaged roadways in this section than in other sections and failure of slope or shoulder happens frequently. It is difficult for passenger cars to pass on the existing road, which includes steep gradient; therefore, the improvement of this section and the below-mentioned Mola Bridge will be most important for smooth transportation in the whole route between Dili and Suai. Safety facilities are also required in consideration of narrow and curved road alignment in addition to the improvement of pavement, drainage and slope protection.

②Road improvement between Dili and Aileu (43 km)

The asphalt surface (t=5 cm) constructed in the Indonesian era is mostly still functioning and improvement of pavement by overlay is not required. The pothole damage can be restored by patching work. On the other hand, drainage for a total length of 30 km is not installed in this section. It is important to construct side ditches & cross drainpipes to protect pavement from damage by landslide and rainfall. At least 11 locations of slope protection work are also required for improvement of this section.

③Km 60.3 Bridge

The central pier (partition wall) damaged by ground settlement is not functioning. Abutments are also damaged at the downstream side. The existing condition of the bridge is seriously dangerous; therefore reconstruction is required. Right-of-way does not seem to be a problem if the new bridge is constructed at a different location from the existing bridge since there are no private houses or farmland at both upstream and downstream sides.

④Mola Bridge (km 146)

Existing Mola Bridge is located about 9 km upstream of the river mouth where the width of river is about 400 m. The bridge is 180 m in length of truss type and is constructed at left side bank.

As described above, passenger cars can not pass at Mola Bridge because they can not cross the Mola River under the existing conditions. New bridge construction is required as an extension of existing bridge. It is important to select the most suitable design in consideration of cost saving in view of the problems of bridge type, land acquisition and flood possibility (50 years) that must be examined.

Basic design, construction plan and cost estimate were done based on the data collected in this survey regarding ① Road surface condition, ② Topographic and geological survey, ③ Hydrological survey and ④ Soundness survey of existing bridge. Basic concepts of the project and survey result are as described in Table-1.

Table-1 Basic Concept of the Project and Survey Result

Section		Existing Condition	Policy of Improvement
ROAD	Aituto-Cassa (km79-km130)	<Pavement> Many unpaved & damaged sections and cave-ins by land slides from km79 to km110. It is impossible for some passenger cars (sedan type) to pass this section. <Drainage> Side ditches are installed more than the other sections but side ditches & cross pipes are still insufficient in some sections. <Slope> There are many continuous slope failures at mountainside. Valley side is relatively under stable condition but widening by retaining structures are necessary to secure the road width.	Pavement for unpaved area and cave-ins & damaged locations for almost all lines. Overlay for surface is also necessary. Installation of side ditches and cross pipes for about 25 km section. Stone masonry retaining wall for mountainside slope, and gravity type retaining wall & gabion blocks for valley side slope for about 8 km sections.
	Dili-Aileu (km2-km45)	<Pavement> Asphalt pavement constructed in the Indonesia era is almost functioning. Average road width of 4.5 m is kept. <Drainage> Side ditch & cross drainage are not installed for almost all this section. <Slope> Collapsing and dangerous slopes exist. The cave-ins at km40 was restored by JEG (Japan Engineer Group).	Pavement for partial unpaved area and patching for damaged area. Installation of side ditches and cross pipes for about 30 km section. Stone masonry retaining wall for mountainside slope, and gravity type retaining wall & gabion blocks for valley side slope for 11 locations.
BRIDGE	km60.3 Bridge	Serious damage is on the partition wall by ground settlement and scouring. Collapse is possibly expected	There is no land acquisition problem. Bridge beam should be examined carefully about type (RC slab) and location (L=10.5m).
	Mola Bridge (km146)	Driving and crossing in the river is necessary. It is impossible for some passenger cars (sedan type) and people to pass the river when raining.	Land acquisition (right bank), scale of flood, method of construction and cost cutback should be considered for bridge type (4 span steel truss; L=239m).

Construction period of Dili-Cassa Road Rehabilitation is 19.5 months including 2.5 months of detailed design and 17 months of construction, and Mola Bridge Rehabilitation is 19.5 months including 4 months of detailed design and 15.5 months of construction.

Rough estimate of the project cost is 2.267 Billion JPY consisting of 2.265 Billion JPY granted by the Government of Japanese and 2 Million JPY covered by the Government of Timor-Leste.

Execution Agency of the recipient country is Ministry of Transport, Communication and Public Works (MTCPW), and operation & maintenance shall also be done by MTCPW whose capability in implementing, operating / maintaining and taking budgetary steps is considered as appropriate.
By implementing this project, following beneficial effect is expected.

A. Direct impact

Direct benefit population: around 197,000 persons (namely, Dili city: around 120,000 persons, Aileu district: around 32,000 persons and Ainaro district: around 45,000 persons)

i) Aituto - Cassa

Paving road, rehabilitating slope protection and improving drainage will be implemented so that any type of vehicle is able to pass through and road function is recovered by. Simultaneously, reduction of fuel, maintenance cost, time and damage of agricultural commodities are expected.

ii) Dili - Aileu

Traffic condition is to be improved throughout all the year by paving road and improving road drainage. Simultaneously, reduction of fuel, maintenance cost, time and damage of agricultural commodities are expected.

iii) km 60.3 Bridge

Traffic safety is tobe secured by reconstruction of heavily damaged existing bridge.

iv) Mola Bridge

Road function is to be recovered by extending a new bridge over the river so that any type of vehicle and district transportation is possible during rainy season. Simultaneously, reduction of fuel, maintenance cost, time and damage of agricultural commodities are expected. Also, daily life of the region (transportation of daily commodities, commuting, etc.) will improve.

B. Indirect impact

Indirect benefit population: around 787,000 persons (Total population of Timor-Leste of 2001)

i) Activation of agricultural sector

Prompt and efficient distribution of agricultural commodities is secured by smooth road traffic.

ii) Improvement of regional level of life

Access to the market and transportation of daily commodities is facilitated.

iii) Benefit to regional level

Acceleration of economic and industrial development is expected not only in the project area but also in the surrounding area in medium term by rehabilitation of bottleneck sections of roads and bridges.

iv) Benefit to national level

The project contributes to the development of road sector of national development plan.

Achievement Target of the Project

Section	Traffic Volume per Day	Assumed Traffic Volume per Day at Year 2011
Dili～Aileu	500	665
Aileu～Aituto	147	196
Aituto～Ainaro	75	100
Ainaro～Cassa	47	63
	Traffic Volume of bridge per Day	Assumed Traffic Volume per Day at Year 2011
Mola bridge vehicles	63	84
Mola bridge pedestrians	646	756

The Project for the Improvement of Roads and Bridges shall greatly contribute to the social and economic development of Timor-Leste.

It is, therefore, necessary to implement this project by Grant Aid cooperation of the Government of Japan.

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2. Itinerary for 2nd Survey
3. List of Interviewer
4. Minutes of Discussions (M/D)
5. Basic Design Drawing

Chapter1

Background of the Project

Chapter 1 Background of the Project

Timor-Leste has been governed by the United Nations Transitional Administration in East Timor (UNTAET) after the civil war erupted in 1999, and Timor-Leste became independent in May 20, 2002. Timor-Leste is aiming to rebuild its country under the assistance of international community. The Government of Japan has extended assistance to urgently repair damaged roads by urgent grant aid cooperation in view of the importance of infrastructure development. Japanese Engineer Group (PKF by Self-Defense Force) also has extended assistance to urgently repair locations of landslides and erosion of roads to secure this lifeline through PKO.

Dili-Aituto-Suai route (180 km), the object section of Grant Aid cooperation, is an arterial road between capital Dili and Suai, the main southern city for agricultural development. Therefore, Improvement of this route is very important to develop of the distribution network for the "Development of Nation's Land by Market Economy" by National Development Plan. The object road has frequently suffered from disasters caused by heavy rainfall of more than 2,500 mm per year on average on steep slopes with loose ground. The section between Aituto and Cassa (especially in the mountainous zone) has been seriously damaged; hence, it is reported that the passability of the road is becoming worse and there is the possibility of road blockage. The Mola Bridge (bridge length: 180 m), located between Cassa and Suai, on the other hand, collapsed after a heavy flood in 2000; therefore, district transportation is available only during the dry season.

The Government of Timor-Leste requested the Government of Japan to rehabilitate the roads and bridges by Grant Aid cooperation to improve the above-mentioned situation.

Chapter2

Contents of the Project

Chapter 2 Contents of the Project

2-1 Basic Concept of the Project

In Timor-Leste, after the referendum held in August 1999 offering independence or autonomy within Indonesia, disturbance and destruction, and then interruption of maintenance / management occurred. As a result, 70% of infrastructure was destroyed. After that, the provisional government, the United Nations Transitional Administration in East Timor (UNTAET), helped consolidate for an independent country. The economic condition greatly recovered then, but after independence in May 2002 it become worse again due to decrease of foreign investors. In this situation, the Government of Timor-Leste that has poverty of approximately 41% -- one of the poorest countries in the world -- established the policy aimed at poverty reduction by economic development. The development policy includes personnel training (education), insurance, improvement of agricultural productivity, administrative efficiency, infrastructure development, etc. based on "National Development Plan" and/or "Medium-term Expenses Plan". Based on the above mentioned, the Government of Japan is carrying out support the following:

① reconstruction development support (infrastructure reconstruction/development, agriculture/forestry/fisheries development, personnel training, support for NGO etc., support of conventional for promulgation of constitution), ② humanitarian support (financial support, physical support, personal support), ③ refugee aid efforts, ④ multi-nation forces support, ⑤ United Nation PKO support, etc.

Roads of Timor-Leste are divided into National/Main Roads of 1,250 km, District Road with 1,750 km, and Feeder/Secondary Roads with 3,000 km. The Dili – Suai Road is classified as a National/Main Road. The objects for this Grant Aid are an arterial road, which starts at the capital Dili and ends at Suai (a major city for agricultural development in a southern district of the country), and the Mola Bridge access road at the section between Cassa and Suai that collapsed after a big flood in 2000 (therefore, district transportation is only during the dry season).

The road has frequently suffered from disasters caused by heavy rainfall of more than 2,500 mm per year on average on steep slopes with loose ground. The section between Aituto and Cassa (especially in the mountainous zone) has been seriously damaged. Hence, the passability of the road is becoming worse and there is the possibility of road blockage. Also, the Mola Bridge work shall be necessary through length extension, river improvement, etc. In order to improve the above-mentioned conditions, the Government of Timor-Leste requested of the Government of Japan to rehabilitate the roads & bridges by Grant Aid cooperation.

In response to a Request from the Government of Democratic Republic of Timor-Leste, the Government of Japan decided to conduct a basic design study on the Project for the Improvement of Roads and Bridges. JICA carried out the field survey from 27 March to 18 April 2003 for the 1st study and from13 May to 24 June 2003 for the 2nd study. In the field survey, the Study Team carried out the existing site investigation of requested road and data collection such as implementation organization/capacity, operation/management organization, evaluation of priority development plan / other donor countries, social evaluation, etc. Furthermore, JICA sent the Basic Study Team to Timor-Leste to explain the Draft Report for the Basic Design. The authorities concerned of the Government of Timor-Leste agreed through the discussion and confirmed the contents of the Report.

In selection of cooperation project road and bridges, the following basic evaluation criteria were set: ① damaged condition of the existing road, ② construction ability, ③ social impact (possibilities of land acquisition & resettlement by construction), ④ existence of improvement project plan of Timor-Leste, ⑤ contribution to local life. As a result, following four (4) sections were selected for the cooperation project.

(1) Road improvement between Aituto and Cassa (50 km)

There are many more portions of unpaved and damaged roadways in this section than in other sections and failure of slope or shoulder happens frequently. It is difficult for passenger cars to pass on the existing road, which includes steep gradient; therefore, the improvement of this section and the below-mentioned Mola Bridge will be most important for smooth transportation in the whole route between Dili and Suai. Safety facilities are also required in consideration of narrow and curved road alignment in addition to the improvement of pavement, drainage and slope protection.

(2) Road improvement between Dili and Aileu (43 km)

The asphalt surface (t=5 cm) constructed in the Indonesian era is still mostly functioning and improvement of pavement by overlay is not required. The damaged potholes can be restored by patching work. On the other hand, drainage for a total length of 30 km is not installed in this section. It is important to construct side ditches & cross drainpipes to protect pavement from damage by landslide and rainfall. At least 11 locations of slope protection work are also required for improvement of this section.

(3) Km 60.3 Bridge

The central pier (partition wall) damaged by ground settlement is not functioning. Abutments are also damaged at the downstream side. The existing condition of the bridge is seriously dangerous; therefore reconstruction is required. Right-of-way does not seem to be a problem if the new bridge is constructed at a different location from the existing bridge since there are no private houses or farmland at both upstream and downstream sides.

(4) Mola Bridge (km 146)

As described above, passenger cars can not pass at Mola Bridge because they can not cross the Mola River under the existing conditions. New bridge construction is required as an extension of existing bridge. It is important to select the most suitable design in consideration of cost saving in view of the problems of bridge type, land acquisition and flood possibility (50 years) that must be examined.

2-2 Basic Design of the Requested Japanese Assistance

2-2-1 Design Policy

2-2-1-1 Basic Policy

The basic elements of this project outlined below cover: ① object scope (facilities), ② selected site (section), ③ scale of cooperation, etc.

(1) Object scope (facilities):

The object facilities for road improvement by this project are slope protection, drainage structure and pavement. The existing condition of Mola Bridge and km60.3 Bridge will also be improved by this project.

(2) Selected route sections:

① Aituto – Cassa (km79 – km130)
② Dili – Aileu (km2 – km45)
③ km60.3 Bridge
④ Mola Bridge (km146)

(3) Scale of cooperation:

① Aituto – Cassa (km79 – km130)

This section will be improved drastically by installation of drainage and by paving with asphalt concrete for the same thickness of 5 cm to the existing road. The standard road width of 4.5 m will be applied for the design, but sub-standard will also be applied on some sections partially to moderate the standard road width together with the installation of passing places depending on the daily traffic volume. This will avoid the road widening where land acquisition is less possible. The quantity of slope protection, which includes stone masonry retaining wall and gabion wall, will be about 8 km, side ditches will be about 25 km, overlay will be about 28 km and asphalt improvement will be about 23km.

② Dili – Aileu (km2 – km45)

This section is included in the basic design in the scope of cooperation because the section has the heaviest traffic volume in the requested route and also is very near to the capital city of Dili. However, since the recipient side of Timor-Leste is now implementing maintenance in this section, the possibility for implementation of drainage maintenance by the recipient side was confirmed to Timor-Leste. But it was learned that the Dili district road office and Same district road office had annual budgets of only US$ 514,000 and US$ 411,200 respectively. On the other hand, the assumed amount for improvement works of drainage

including cross drainpipe will be about US$ 2.5 million. Therefore, it was decided that pavement restoration for the damaged parts, drainage repair for about 30 km and slope protection work for 11 locations to be included in this section.

③ km60.3 Bridge

As a result of 1st and 2nd site study, invert slab of the box culvert bridge at downstream side was displaced by strong river flow in the rainy season. It is anticipated that the bridge may collapse in the near future, so this km60.3 bridge was included in the basic design in the scope of grant aid.

④ Mola Bridge (km146)

The 50-year probable flood discharge of Mola Bridge basin was computed as 3,510 ton/sec and determined the necessary span length of 37.5 m for the new bridge. This span length suggests that it would be better to use design of simple steel truss bridge in stead of RC bridge or PC bridge in consideration of cost and workability. Regarding the route of new bridge, two routes were examined as candidates: one was a straight route by extension from the existing bridge, and another was a curved route that followed the remaining alignment of embankment in the Mola River. The straight route that usually is applied for cross river bridges, will cause costly land acquisition and migration of residents; hence, application of curved bridge was decided by mutual consent between the donor and the recipient. The official request letters were sent from Timor-Leste side to Japan side on 24 June and 4 September 2003.

2-2-1-2 Policy for Physical Conditions

2-2-1-2-1 Meteorological Condition

The meteorological and hydrological data of Timor Island including project study area was collected from Indonesia since much data for the Timor-Leste was destroyed by fire during the independence struggle. The collected data from Indonesia included daily and monthly rainfall and mean monthly discharge; other meteorological data including temperature, humidity, wind speed/direction and evaporation could not be collected. The collected meteorological data and its period are shown in Figure-2.1. Monthly rainfall record and monthly average discharge record are shown in Table-2.1 and 2.2 respectively. Timor-Leste is located in a tropical region right on the equator, and the weather is clearly divided to rainy and dry seasons by the influence of the monsoon. There is a difference in the period of rainy season. Also, annual rainfall of the northern area on Wetar Strait side and the southern area on Timor Sea side has different rain conditions. The rainy season of northern area with Dili city is 5 months from December to April, and annual rainfall is about 1,000 to 1,500 mm. The rainy season of southern area with Suai and Cassa is 7 months from December to June, and annual rainfall is about 1,500 to 2,000 mm. November is a transition stage to the rainy season from the dry season in both areas. The annual rainfall is about 2,500 mm in the mountain area such as Aituto and Ainaro which is project study area according to the

isohyetal map collected from BMG (Indonesian: **B**adan **M**etereologi dan **G**eofisika, English: Meteorology & Geophysical Agency) in Indonesia as shown in Figure-2.2.

Rainfall

Station Name	Coordinate	Elevation (El.m)	Year	Data Source
Dili (Airport)	E125°34' - S8°34'	4		DOC
Baucau	E125°26' - S8°30'	57		DOC
Komoro	E125°34' - S8°25'	3		DOC
Oe Coussie	E124°23' - S9°12'	2		DOC
Viqueque	E126°22' - S8°52'	46		DOC
Los Palos	E126°58' - S8°35'	-		WB
Tutuala	E127°14' - S8°24'	-		WB

Discharge

Station Name	Coordinate	Catchment Area (km^2)	Year	Data Source
Lonina	E127°06' - S8°33'	406		WB
Atambua	E125°26' - S8°43'	189		WB
Boasabi	E125°18' - S9°10'	1,089		WB
Noilnebu	E124°54' - S9°30'	227		WB
Temef	E124°42' - S9°35'	547		WB

Year: 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99

Remarks ; ▬ : Daily Data ▭ : Monthly Data

Data Source ; DOC : Department of Communications (Indonesia)

WB : World Bank, Report of Hydro-Inventory and Pre-Feasibility Studies (Indonesia)

Figure-2.1 Meteorological Data and Collection Period

Table-2.1 Monthly Rainfall Record (1/3)

Station : Dili Unit : mm

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1977	-	-	-	82	-	-	0	-	-	-	-	-	-
1978	-	-	264	68	63	70	-	25	-	68	72	125	-
1979	-	-	-	65	-	47	0	20	0	5	66	-	-
1980	231	-	98	177	64	40	12	0	1	6	43	247	-
1981	186	74	61	96	113	34	47	5	13	3	196	59	887
1982	182	106	57	70	3	5	1	10	0	0	5	81	520
1983	122	182	109	139	41	40	0	2	0	20	77	82	814
1984	-	-	-	-	-	-	-	-	-	-	-	-	-
1985	-	-	-	-	-	-	-	-	-	-	-	-	-
1986	-	-	-	-	-	-	-	-	-	-	-	-	-
1987	-	-	-	-	-	-	-	-	-	-	-	-	-
1988	-	-	-	-	-	-	-	-	-	-	-	-	-
1989	-	-	-	-	-	-	-	-	-	-	-	-	-
1990	-	-	316	167	86	14	-	-	-	-	-	241	-
1991	24	250	93	302	-	21	-	-	-	-	-	-	-
1992	-	-	-	-	-	-	-	-	-	-	-	-	-
1993	-	-	-	-	-	-	-	-	-	-	-	-	-
1994	-	-	-	-	-	-	-	-	-	-	-	-	-
1995	-	-	-	-	96	-	-	-	-	-	-	-	-
1996	119	207	127	-	-	4	1	10	0	48	81	-	-
1997	-	197	119	-	-	35	0	0	0	0	-	59	-
1998	-	162	-	-	-	81	100	1	8	28	-	-	-
1999	-	-	-	-	-	-	-	-	-	-	-	-	-
Average	144	168	138	130	67	36	18	8	3	20	77	128	935

Data Source : DOC (Department of Communications), Indonesia

Station : Baucau Unit : mm

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1980	200	103	144	33	48	4	0	-	22	-	-	-	-
1981	-	-	-	86	-	30	91	11	2	93	-	-	-
1982	-	-	-	-	-	-	-	-	-	-	-	-	-
1983	-	-	-	-	-	30	0	0	0	-	-	-	-
1984	-	-	-	-	-	-	-	-	-	-	-	-	-
1985	-	-	-	-	-	-	-	-	-	-	-	-	-
1986	-	-	56	-	-	-	-	-	0	4	58	-	-
1987	-	-	-	-	-	-	45	0	0	4	-	-	-
1988	-	-	-	-	-	1	1	2	-	-	-	-	-
1989	-	-	-	-	-	-	-	-	-	-	-	-	-
1990	-	-	-	-	-	-	-	-	-	-	-	-	-
1991	-	-	-	-	-	-	-	-	-	-	-	-	-
1992	-	-	-	-	-	-	0	1	-	-	-	-	-
1993	-	-	-	-	-	-	-	-	-	-	-	-	-
1994	-	-	-	-	-	-	-	0	-	-	2	-	-
1995	-	-	-	-	-	-	-	0	-	-	-	-	-
1996	-	273	68	-	59	6	-	34	4	12	-	437	-
1997	196	141	-	103	-	70	-	-	-	-	-	-	-
1998	-	-	-	-	-	-	-	-	-	34	260	213	-
1999	-	-	-	-	-	-	-	-	-	-	-	-	-
Average	198	173	89	74	53	23	23	6	5	29	107	325	1,105

Data Source : DOC (Department of Communications), Indonesia

Table-2.1 Monthly Rainfall Record (2/3)

Station : Komoro Unit : mm

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1984	-	-	-	-	-	-	-	-	-	-	-	-	-
1985	-	-	-	52	-	-	-	-	-	-	-	-	-
1986	-	-	-	-	-	-	-	-	-	2	-	-	-
1987	-	-	-	13	-	-	-	-	-	-	-	-	-
1988	-	-	-	-	-	-	-	-	-	-	-	-	-
1989	-	-	-	-	-	-	-	-	-	-	-	-	-
1990	-	-	-	-	-	-	-	-	-	-	-	-	-
1991	-	-	-	-	-	-	-	-	-	-	-	-	-
1992	-	-	-	-	-	-	-	-	-	-	-	-	-
1993	-	-	-	-	-	-	-	-	-	-	-	-	-
1994	-	-	-	-	-	-	-	-	-	-	-	-	-
1995	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	-	-	-	-	92	-	-	10	-	-	-	-	-
1997	-	-	-	-	-	-	1	1	0	0	-	-	-
1998	-	-	-	-	72	-	-	-	3	-	-	-	-
1999	-	-	-	-	-	-	-	-	-	-	-	-	-
Average	-	-	-	33	82	-	1	5	1	1	-	-	-

Data Source : DOC (Department of Communications), Indonesia

Station : Viqueque Unit : mm

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1985	-	-	-	-	-	-	-	-	0	-	149	233	-
1986	-	246	477	-	-	302	422	80	-	-	-	104	-
1987	-	-	-	-	-	-	-	-	-	-	-	-	-
1988	-	-	-	-	-	-	-	-	-	-	-	-	-
1989	-	-	-	-	-	-	-	-	-	-	-	-	-
1990	-	-	-	-	-	-	-	-	1	2	-	-	-
1991	219	113	71	187	203	66	13	9	0	0	19	182	1,082
1992	128	292	-	178	280	-	-	-	21	18	38	-	-
1993	-	181	-	-	-	-	86	-	-	0	11	133	-
1994	150	234	-	0	141	91	56	1	0	1	0	101	-
1995	213	252	-	181	329	334	-	-	-	-	-	-	-
1996	-	-	-	-	-	31	65	-	10	24	36	177	-
1997	193	174	67	-	-	170	48	5	0	0	7	244	-
Average	181	213	205	137	238	166	115	24	5	6	37	168	1,493

Data Source : DOC (Department of Communications), Indonesia

Station : Oe Cussie Unit : mm

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1984	-	-	-	-	-	-	-	0	-	-	-	-	-
1985	-	-	-	12	-	-	-	-	-	-	-	-	-
1986	-	-	-	-	-	-	-	-	-	-	40	-	-
1987	-	373	-	18	-	-	-	-	-	-	-	-	-
1988	-	-	-	-	-	-	-	-	-	-	-	-	-
1989	-	-	-	-	-	-	-	-	-	-	-	-	-
1990	-	-	-	-	-	-	-	-	-	-	-	-	-
1991	-	-	-	-	-	-	-	-	-	-	-	-	-
1992	-	-	-	-	-	-	-	-	-	-	-	-	-
1993	-	-	-	-	-	-	-	-	-	-	-	-	-
1994	-	-	-	-	-	-	-	0	0	-	-	117	-
1995	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	75	449	423	55	40	0	0	0	0	4	-	389	-
1997	162	452	104	9	12	16	0	0	0	0	-	-	-
1998	-	105	-	-	-	-	-	0	-	-	-	175	-
1999	-	-	-	-	-	-	-	-	-	-	-	-	-
Average	119	345	263	23	26	8	0	0	0	2	40	227	1,053

Data Source : DOC (Department of Communications), Indonesia

Table-2.1 Monthly Rainfall Record (3/3)

Station : Las Palos Unit : mm

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1953	306	98	65	251	345	90	161	12	4	0	56	258	1,646
1954	172	238	187	275	587	56	79	57	75	43	24	476	2,269
1955	296	224	68	158	499	1,212	561	59	34	114	245	153	3,623
1956	272	143	104	410	87	765	75	274	18	2	4	247	2,401
1957	121	187	109	69	151	95	194	6	2	2	99	408	1,443
1958	282	254	110	205	360	262	59	31	6	23	94	210	1,896
1959	225	207	143	339	481	211	76	19	11	10	4	176	1,902
1960	134	229	254	373	590	82	113	8	7	1	77	195	2,063
1961	190	354	117	205	129	43	22	3	4	45	102	120	1,334
1962	265	317	412	158	297	692	94	30	1	15	217	201	2,699
1963	159	217	341	243	135	49	23	23	0	0	0	122	1,312
1964	230	125	191	160	458	252	35	15	51	154	300	102	2,073
1965	373	109	161	181	175	173	50	0	0	0	0	152	1,374
1966	340	176	142	121	143	281	43	43	0	0	58	218	1,565
1967	251	159	381	157	138	100	43	7	7	1	3	239	1,486
1968	302	161	136	130	571	479	544	28	0	2	2	242	2,597
1969	236	109	170	49	144	202	133	46	2	8	0	379	1,478
1970	145	144	119	236	558	275	81	4	81	49	86	249	2,027
1971	212	30	205	175	310	90	126	12	57	35	216	120	1,588
1972	192	210	415	256	246	157	40	0	4	0	0	191	1,711
1973	270	153	201	271	360	174	114	94	162	36	177	170	2,182
1974	76	235	125	237	161	94	105	8	272	0	245	95	1,653
1975	-	-	-	-	-	-	-	-	-	-	-	-	-
1976	-	-	-	-	-	-	-	-	-	-	-	-	-
1977	-	-	-	-	-	-	-	-	-	-	-	-	-
1978	-	-	-	-	-	-	-	-	-	-	-	-	-
1979	-	-	-	-	-	-	-	-	-	-	-	-	-
1980	-	-	-	-	-	-	-	-	-	-	-	-	-
1981	-	-	-	-	-	-	-	-	-	-	-	-	-
1982	167	228	89	221	72	59	37	38	0	0	57	144	1,112
1983	163	210	174	387	443	491	53	8	1	112	54	329	2,425
1984	231	212	177	372	552	230	54	0	8	17	44	400	2,297
1985	187	278	275	187	299	192	42	5	0	44	150	70	1,729
1986	440	127	133	101	149	368	313	17	4	95	128	196	2,071
1987	234	166	225	93	90	74	113	0	0	30	89	273	1,387
1988	201	250	207	112	59	30	29	78	62	34	127	714	1,903
Average	230	191	187	211	296	251	118	32	30	30	92	236	1,905

Data Source : Report on Hydro-Inventory and Pre-Feasibility Studies, Indonesia

Station : Tutuala Unit : mm

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1957	100	159	268	111	233	130	141	6	0	0	83	212	1,443
1958	177	133	100	180	392	202	69	37	5	24	3	164	1,486
1959	72	222	79	182	551	127	59	16	63	0	0	209	1,580
1960	78	133	202	435	422	65	160	8	0	10	45	249	1,807
1961	384	213	196	260	194	14	25	0	11	11	59	15	1,382
1962	166	240	344	202	324	647	33	70	1	48	164	176	2,415
1963	136	86	137	376	253	28	16	13	0	0	0	36	1,081
1964	197	141	112	268	492	220	60	6	15	99	222	27	1,859
1965	286	139	31	162	154	130	34	1	4	0	13	119	1,073
1966	134	174	244	82	173	399	10	34	0	0	113	140	1,503
1967	352	119	349	296	120	7	24	4	9	2	6	114	1,402
1968	206	54	36	105	418	156	730	12	0	5	7	122	1,851
1969	174	145	194	98	90	50	129	40	3	2	0	262	1,187
1970	152	145	135	157	537	262	93	4	16	12	128	187	1,828
1971	148	32	119	180	390	64	125	9	41	59	60	99	1,326
1972	206	169	114	73	251	102	19	1	5	0	0	164	1,104
1973	276	258	223	322	233	153	39	72	123	16	187	90	1,992
1974	41	225	53	79	198	60	60	7	110	22	293	147	1,295
Average	183	155	163	198	301	156	101	19	23	17	77	141	1,534

Data Source : Report on Hydro-Inventory and Pre-Feasibility Studies, Indonesia

Table-2.2 Monthly Average Discharge Record (1/2)

Station : Lonina

Catchment Area : 406 km^2 Unit : m^3/sec

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1953	-	-	-	-	-	-	-	-	-	6.2	4.0	5.0	-
1954	6.5	9.2	11.8	11.3	14.6	12.6	13.9	14.4	5.8	5.9	5.3	8.3	10.0
1955	9.0	11.0	15.3	11.7	12.1	17.2	21.2	25.7	28.9	14.2	7.0	7.4	15.1
1956	10.1	11.3	9.8	12.6	9.6	14.5	15.8	13.8	18.4	7.1	8.1	5.4	11.4
1957	5.7	7.6	10.3	8.1	8.9	7.3	7.7	7.8	6.6	6.6	4.2	6.8	7.3
1958	8.6	11.9	14.8	12.3	12.2	10.9	11.8	12.1	8.4	4.8	4.7	5.7	9.9
1959	7.3	9.5	11.0	12.1	13.4	12.9	14.9	13.7	7.7	4.9	3.8	4.9	9.7
1960	5.5	7.3	10.5	11.6	15.6	14.7	15.9	14.6	5.8	5.3	4.1	5.3	9.7
1961	6.5	9.9	11.1	11.7	12.3	8.1	8.3	6.0	4.3	4.1	4.4	5.2	7.7
1962	7.5	9.8	12.3	14.0	15.2	18.1	13.2	15.0	15.8	5.3	5.5	6.2	11.5
1963	7.7	11.1	11.7	11.5	12.2	12.2	9.0	6.3	4.5	3.9	3.7	4.2	8.2
1964	5.7	6.6	9.4	10.5	11.2	12.3	11.6	13.4	6.3	5.4	7.0	8.0	9.0
1965	11.7	12.1	10.0	12.7	8.8	9.8	9.2	8.0	6.7	4.2	3.4	4.4	8.4
1966	6.6	7.8	10.8	12.2	9.2	9.6	8.5	8.7	8.6	4.4	4.5	5.2	8.0
1967	6.9	8.8	12.7	12.2	11.2	12.5	8.0	7.1	5.7	4.5	4.2	5.2	8.3
1968	6.9	8.3	11.8	11.4	12.0	13.4	17.0	20.3	16.2	12.7	3.8	5.1	11.6
1969	6.5	7.6	11.2	9.5	7.9	8.8	7.5	8.6	8.1	6.0	4.2	6.1	7.7
1970	6.7	8.5	12.6	9.3	12.0	12.5	14.2	15.5	9.2	5.5	5.0	7.4	9.9
1971	7.8	8.4	10.9	9.5	8.8	10.7	10.3	10.1	6.4	6.1	5.8	6.7	8.5
1972	7.8	10.6	11.1	12.5	13.6	15.0	10.9	9.0	6.3	4.0	3.4	4.8	9.1
1973	6.3	7.6	11.2	12.2	11.7	12.3	12.8	12.2	8.9	7.2	7.8	8.6	9.9
1974	7.0	9.9	9.1	9.0	10.8	9.1	10.0	7.5	7.8	-	-	-	-
Average	7.3	9.3	11.4	11.3	11.6	12.1	12.0	11.9	9.4	6.1	4.9	6.0	9.4

Data Source : Report on Hydro-Inventory and Pre-Feasibility Studies, Indonesia

Station : Atambua

Catchment Area : 189 km^2 Unit : m^3/sec

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1991	14.4	16.8	5.4	2.6	2.7	2.1	2.1	1.7	1.4	1.4	17.7	14.2	6.9
1992	0.5	0.5	0.4	0.4	0.4	0.2	0.1	0.1	0.1	0.1	0.4	0.8	0.3
1993	2.2	2.2	1.5	1.9	0.9	0.8	0.8	0.7	0.3	0.3	0.6	0.9	1.1
Average	5.7	6.5	2.4	1.6	1.3	1.0	1.0	0.8	0.6	0.6	6.2	5.3	2.8

Data Source : Report on Hydro-Inventory and Pre-Feasibility Studies, Indonesia

Station : Boasabi

Catchment Area : 1,089 km^2 Unit : m^3/sec

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1992	6.2	20.8	9.9	8.0	5.4	5.7	6.1	6.3	6.8	6.6	6.5	15.3	8.6
1993	20.2	54.9	28.8	19.2	16.5	15.2	15.2	15.2	14.8	15.7	15.3	24.8	21.3
Average	13.2	37.9	19.4	13.6	11.0	10.5	10.7	10.8	10.8	11.2	10.9	20.1	15.0

Data Source : Report on Hydro-Inventory and Pre-Feasibility Studies, Indonesia

Table-2.2 Monthly Average Discharge Record (2/2)

Station : Noilnebu

Catchment Area : 227 km^2 Unit : m^3/sec

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1980	2.0	2.8	0.7	0.5	0.3	0.3	0.2	19.0	0.2	16.0	0.2	1.8	3.7
1981	1.6	0.7	0.5	0.2	0.1	0.1	0.1	0.1	-	-	0.3	1.4	-
1982	-	-	-	-	-	-	-	-	-	-	-	-	-
1983	-	-	-	-	-	-	-	-	-	-	-	-	-
1984	-	-	-	-	-	-	-	-	-	-	-	-	-
1985	-	-	-	-	-	-	-	-	-	-	-	-	-
1986	-	-	-	-	-	-	-	-	-	-	-	-	-
1987	-	-	-	-	-	-	-	-	-	-	-	-	-
1988	-	-	-	-	-	-	-	-	-	-	-	-	-
1989	-	-	-	-	-	-	-	-	-	-	-	-	-
1990	-	-	-	-	-	-	-	-	-	-	-	-	-
1991	-	-	-	-	-	-	-	-	-	-	-	-	-
1992	3.0	3.1	2.5	1.6	1.6	1.3	1.3	1.3	1.1	1.1	1.6	2.3	1.8
1993	4.2	3.1	1.1	0.8	0.5	0.5	0.0	1.3	1.1	1.1	1.6	2.3	1.5
Average	2.7	2.4	1.2	0.8	0.6	0.6	0.4	5.4	0.8	6.1	0.9	2.0	2.0

Data Source : Report on Hydro-Inventory and Pre-Feasibility Studies, Indonesia

Station : Temef

Catchment Area : 547 km^2 Unit : m^3/sec

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1974	-	-	-	-	6.6	4.6	-	-	-	-	8.6	15.0	-
1975	12.0	15.2	15.3	21.9	17.7	10.4	5.8	3.1	1.5	3.6	9.6	13.3	10.8
1976	19.2	9.6	25.9	8.1	5.3	5.9	2.9	-	2.0	2.2	2.3	8.9	-
1977	17.8	28.9	29.8	7.1	5.2	6.0	3.3	2.2	1.8	2.5	2.5	16.7	10.3
1978	20.6	25.4	17.4	-	-	-	-	-	-	-	-	-	-
1979	-	-	-	-	-	-	-	-	-	-	-	-	-
1980	13.2	17.2	9.0	6.8	6.9	4.7	4.0	2.7	2.0	3.8	3.1	11.7	7.1
1981	-	-	-	-	-	-	-	-	-	-	-	-	-
1982	-	-	-	-	-	-	-	-	-	-	-	-	-
1983	-	-	-	-	-	-	-	-	-	-	-	-	-
1984	-	-	-	-	-	-	-	-	-	-	-	-	-
1985	-	-	-	-	-	-	-	-	-	-	-	-	-
1986	-	-	-	-	-	-	-	-	-	-	-	-	-
1987	-	-	-	-	-	-	-	-	-	-	-	-	-
1988	-	-	-	-	-	-	-	-	-	-	-	-	-
1989	-	-	-	-	-	-	-	-	-	-	-	-	-
1990	-	-	-	-	-	-	-	-	-	-	-	-	-
1991	4.2	16.8	2.3	5.2	1.5	0.5	0.3	0.2	0.2	0.2	1.7	1.2	2.9
1992	11.6	18.5	10.3	10.3	15.3	12.4	4.9	2.7	2.5	2.9	10.1	21.1	10.2
1993	12.7	14.8	8.4	10.9	5.3	8.4	5.8	3.6	2.7	2.1	2.5	5.1	6.9
Average	13.9	18.3	14.8	10.0	8.0	6.6	3.9	2.4	1.8	2.5	5.1	11.6	8.2

Data Source : Report on Hydro-Inventory and Pre-Feasibility Studies, Indonesia

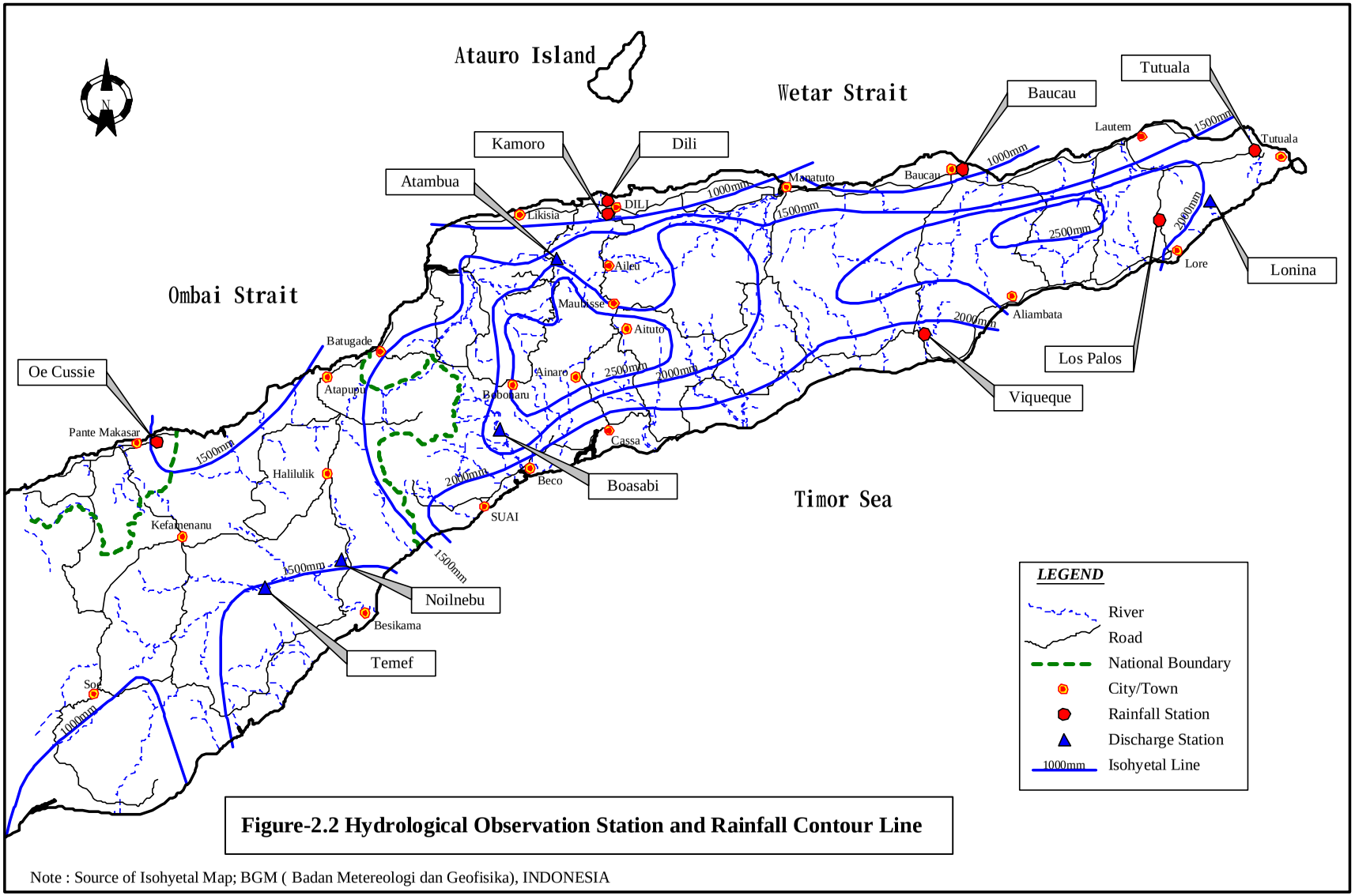


Figure-2.2 Hydrological Observation Station and Rainfall Contour Line

Note : Source of Isohyetal Map; BGM (Badan Metereologi dan Geofisika), INDONESIA

Table-2.3 Monthly Rainfall Record at Dili Observation Station after Interpolation

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1977	-	-	-	82	-	-	0	-	-	-	-	-	-
1978	-	-	264	68	63	70	-	25	-	68	72	125	-
1979	-	-	-	65	-	47	0	20	0	5	66	-	-
1980	231	67	98	177	64	40	12	0	1	6	43	247	986
1981	186	74	61	96	113	34	47	5	13	3	196	59	887
1982	182	106	57	70	3	5	1	10	0	0	5	81	520
1983	122	182	109	139	41	40	0	2	0	20	77	82	814
1984	-	-	112	-	-	-	0	10	-	-	-	-	-
1985	-	-	112	47	-	23	-	-	-	-	-	-	-
1986	-	119	99	140	-	30	-	-	0	3	25	203	-
1987	232	137	227	20	-	13	23	0	0	0	-	238	-
1988	-	-	270	14	-	0	1	3	9	61	153	-	-
1989	56	-	-	-	-	69	27	-	-	-	40	-	-
1990	-	-	316	167	86	14	-	-	-	-	-	241	-
1991	24	250	93	302	-	21	-	-	-	-	-	28	-
1992	-	132	-	-	-	-	0	45	-	-	-	377	-
1993	-	-	-	242	-	-	2	-	-	-	97	-	-
1994	-	-	-	103	18	8	0	0	1	0	7	193	-
1995	-	-	327	-	96	65	0	0	-	-	-	-	-
1996	119	207	127	163	62	4	1	10	0	48	81	303	1,125
1997	198	197	119	67	25	35	0	0	0	0	15	59	713
1998	102	162	281	312	100	81	100	1	8	28	433	68	1,676
1999	-	-	-	295	-	-	-	-	-	-	-	-	-
Average	145	149	167	135	61	33	13	9	3	19	94	165	991

2-2-1-2-2 Hydrological Study

The following hydrological studies were carried out and are described in this chapter:
(1) Rainfall Analysis, (2) Flood Flow Analysis, (3) Low Flow Analysis, (4) Local Scouring of Pier and (5) Necessity of Bank Protection.

(1) Rainfall Analysis

Interpolation of Unavailable Rainfall Data

Much data is unavailable in the rainfall record. The long-term rainfall data is necessary to raise the precision of flood flow analysis. Therefore, the possibility of interpolation of unavailable data was examined by the correlation of monthly rainfall of several rainfall stations. The good correlation of the northern area rainfall stations was confirmed. The correlation coefficient with Dili station and Baucau, Komoro and Oe Cussie stations exceeds 0.8. The existing data of Dili station are the longest record. From the above, Dili station was selected as a representative rainfall station of flood flow analysis and interpolation of unavailable data was carried out using Dili station data. The monthly rainfall at Dili observation station after interpolation is shown in Table-2.3. It is desirable to use Viqueque station located in the same southern area near Mola Bridge; however, the correlation with other stations of Viqueque station is improper, it does not satisfy the long-term rainfall data.

Probable Rainfall

There are 2 bridges as objects in the site study, Mola Bridge located 146 km from Dili and Box Culvert Bridge (km60.3 Bridge) located 60.3 km from Dili. The basin area, total river length and basin average elevation of the Mola Bridge basin are 150.2 km^2, 26.4 km and EL. 600 m respectively. The basin area, total river length and basin average elevation of the km60.3 Bridge basin are 0.39 km^2, 1.34 km and EL. 1,300 m respectively. Catchment area for two rivers are shown in Figure-2.3 & 2.4 respectively. The elevation of Dili station, which is a representative rainfall station, is EL. 4 m. The rainfall compensation for the project study area is necessary because representative rainfall station is different from project study area in elevation and in rainfall intensity. However, high elevation station is not included in the collected data; therefore, the rainfall compensation coefficient was decided from the isohyetal map collected from BMG in Indonesia as shown in Figure-2.2. The annual mean rainfall estimated from isohyetal map is 2,300 mm for Mola Bridge basin and 1,800 mm for km60.3 Bridge basin respectively. The annual mean rainfall of Dili station was 1,000 mm, so rainfall compensation coefficient was estimated as 2.3 at Mola Bridge basin and 1.8 at km60.3 Bridge basin respectively. The probable basin 1-day rainfall of Mola Bridge and km60.3 Bridge basins was calculated by Log Pearson-III and Gumbel methods shown in following formulas. These are popularly applicable in Southeast Asia area. Data of Dili station after interpolation of unavailable rainfall data and rainfall compensation coefficient was also utilized. The result is shown in Table-2.4.

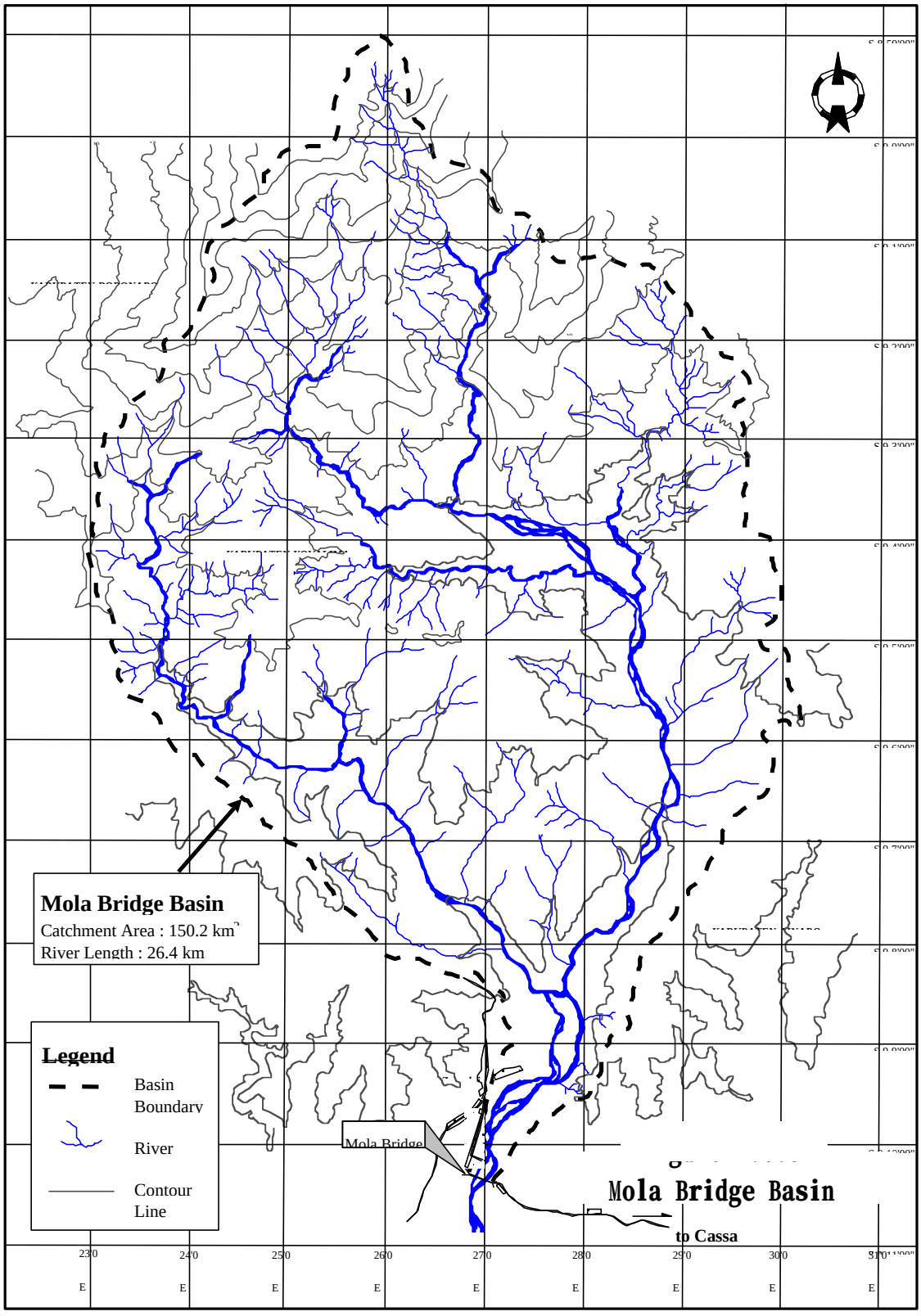


Figure-2.3 Mola River Catchments Area

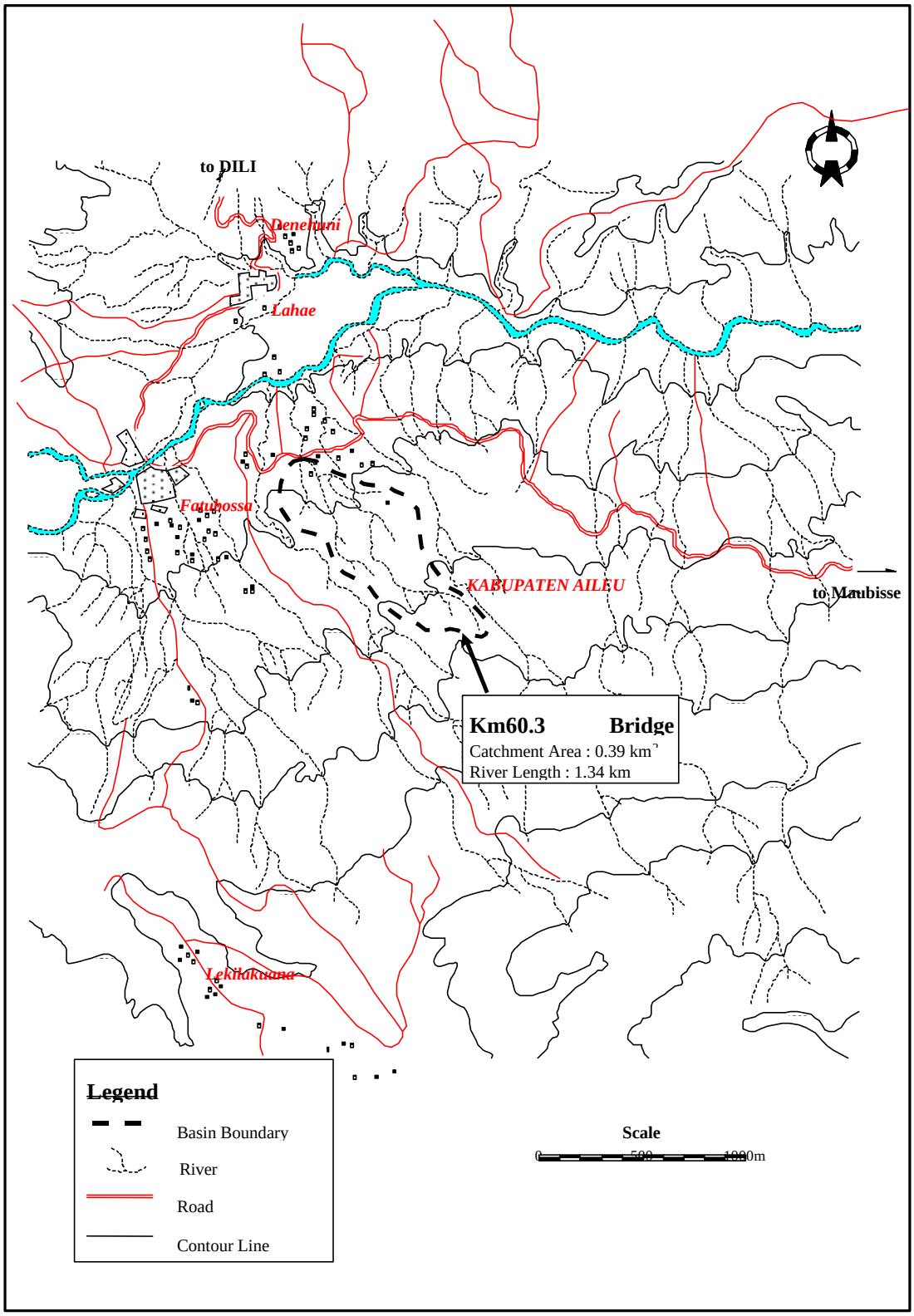


Figure-2.4 km60.3 Bridge River Catchments Area

Log Pearson-III Method

$$f(x) = \frac{1}{|a|\tilde{A}(b)}\left(\frac{y}{a}\right)^{b-1}\exp\left(-\frac{y}{a}\right) \qquad (y \geq 0)$$

$$p \equiv F(x) = \begin{cases} \dfrac{1}{\tilde{A}(b)}\int_0^{y/a} t^{b-1}e^{-t}dt = \dfrac{\tilde{A}(b,y/a)}{\tilde{A}(b)} = P(b,y/a) \\ 1 - \dfrac{1}{\tilde{A}(b)}\int_0^{y/|a|} t^{b-1}e^{-t}dt = 1 - \dfrac{\tilde{A}(b,y/|a|)}{\tilde{A}(b)} = 1 - P(b,y/|a|) \end{cases}$$

a : scale parameter b : form coefficient
$G(\,.\,)$: standard gamma function
$G(\,.\,,\,.\,)$: first-class defective gamma function
$P(\,.\,,\,.\,)$: defective gamma function ratio
p, a, m : constant

Gumbel Method

$$F(x) = exp(-e^{-y})$$

$$y = a(x - x_0)$$

a, x_0 : constant

Table-2.4 Probable Basin 1-day Rainfall

Return Period	Mola Bridge Basin (mm)		km60.3 Bridge Basin (mm)	
	Log Pearson-III	Gumbel	Log Pearson-III	Gumbel
1	112.5	96.7	88.1	75.7
2	203.4	205.3	159.2	160.7
5	259.9	270.2	203.4	211.5
10	297.4	313.2	232.8	245.1
50	380.9	407.8	298.2	319.2
100	417.1	447.8	326.6	350.5
500	503.8	540.2	394.6	422.8
1000	542.8	578.0	425.2	453.9

Comparing the above 2 methods, numerical values for probable basin 1-day rainfall can be recognized since the Gumbel method is bigger than Log Pearson-III method. Thus the design probable basin 1-day rainfall adopted Gumbel method since it will make the design on the side of safety. The design return period for bridge is assumed to be 50 years. Therefore, design probable basin 1-day rainfall in Mola Bridge basin is 407.8 mm/day, and km60.3 Bridge basin is 319.2 mm/day.

Rainfall Intensity

The flood duration is considered as an hourly unit because the basin area of Mola Bridge and km60.3 Bridge basins is so small being 150.2 km^2 and 0.39 km^2, respectively. Therefore, time of flood concentration is rapid. The estimated hourly-rainfall is computed applying rainfall intensity formula by MLIT (Ministry of Land Infrastructure and Transport) in Japan, as shown in the following formula:

Rainfall Intensity Formula

$$I = 0.36 \cdot \frac{5416 \cdot (1 + 0.25 \cdot \log P \cdot t^{0.13})}{(t+19)^{0.82}}$$

I : rainfall intensity (mm/hour)
P : return period (year)
t : time of flood concentration (minutes)

The rainfall intensity formula is a function of return period and time of flood concentration. The return period is 50-year, and time of flood concentration is assumed as 60 minutes in both Mola Bridge and km60.3 Bridge basins. The rainfall intensity was calculated by the above formula as 93.4 mm/hour in both basins. For the rainfall pattern, central concentration pattern was applied, and 50-year probable rainfall is shown in Table-2.5.

Table-2.5 50-year Probable Rainfall

Time (hour)	Mola Bridge Basin (mm)	km60.3 Bridge Basin (mm)
1	19.8	28.7
2	23.3	38.2
3	28.7	61.1
4	38.2	93.4
5	61.1	46.6
6	93.4	32.6
7	46.6	18.6
8	32.6	-
9	25.6	-
10	21.4	-
11	17.2	-
Total	407.8	319.2

(2) Flood Flow Analysis

Design Flood Discharge

Generally, flood flow analysis for estimation of design flood discharge applies Rational Formula method, Unit Hydrograph method, Storage Function method, etc. The applicable condition of Rational Formula method is as shown below.

1) No flood control facilities of upper reaches
2) Basin area is less than 200 km^2
3) Not considering of basin storage
4) No discharge record in the basin

Mola bridge basin satisfies all the above conditions. Besides, much hydrological data is necessary for other flood analysis method; hence, those other methods are inapplicable because of the scant hydrological data of this basin. Therefore, the Rational Formula method as shown below is utilized.

Rational Formula Method

$$Q = \frac{1}{3.6} \cdot C \cdot R \cdot A$$

Q : flood discharge (m^3/sec)
C : runoff coefficient
R : rainfall (mm/hour)
A : catchment area (km^2)

The runoff coefficient was assumed as 0.9 because flood discharge shall be designed on the side of safety and the ground condition is assumed as saturated in the rainy season. The 50-year probable flood discharges of Mola Bridge and km60.3 Bridge basins are 3,510 m^3/sec and 9.1 m^3/sec, respectively. The probable flood peak discharge is shown in Table-2.6 and the probable flood hydrograph shown in Figure-2.5.

Table-2.6 Probable Flood Peak Discharge (m^3/sec)

Return Year	Mola Bridge	km60.3 Bridge
1	2,040	5.3
2	2,300	6.0
5	2,640	6.9
10	2,910	7.5
50	3,510	9.1
100	3,770	9.8
500	4,380	11.4
1000	4,640	12.0

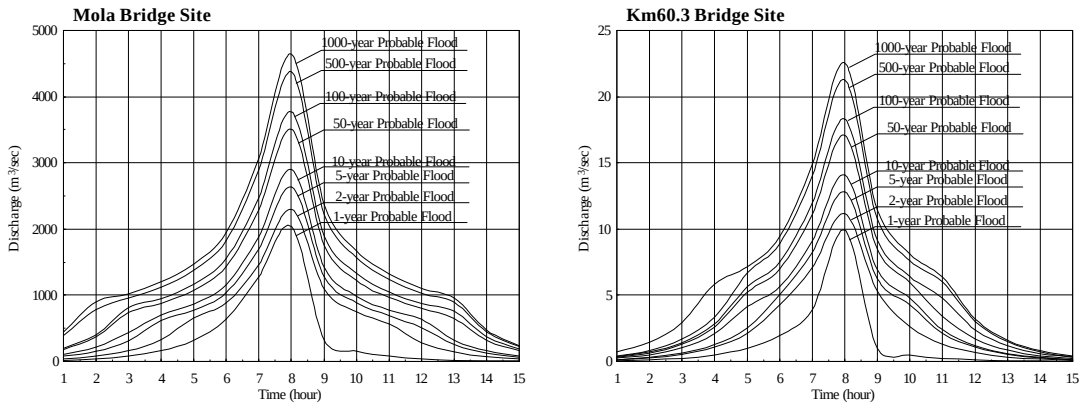


Figure-2.5 Probable Flood Hydrograph

Flood Water Level of Present River Condition

The discharge is converted to water level by Non-Uniform Flow Calculation method, and the calculation result of river flow capacity in the present river condition at the location of Mola Bridge and the km60.3 Bridge is shown in Table-2.7. Plan & cross section at Mola Bridge are shown in Fig.-2.6 & 2.9. The basic formula of Non-Uniform Flow Calculation is shown as follows:

Non-Uniform Flow Calculation

$$H_i = H_{i-1} + \frac{a \cdot Q^2}{2g} \cdot \left[\frac{1}{A_{i-1}^2} - \frac{1}{A_i^2} \right] + \frac{Q^2}{2} \cdot \left[\frac{n_{i-1}^2}{R_{i-1}^{4/3} \cdot A_{i-1}^2} + \frac{n_i^2}{R_{i-1}^{4/3} \cdot A_i^2} \right] \cdot DX$$

H	:	water level (El.m)	g	:	acceleration of gravity (m^3/sec^2)
Q	:	discharge (m^3/sec)	A	:	cross section area of flow (m^2)
DX	:	distance(m)	n	:	Manning's coefficient
R	:	hydraulic radius (m)	a	:	compensating rate of velocity

The possible flood discharge at the Mola Bridge site is over 2,000 m^3/sec as a maximum yearly volume. The flood water level exceeds the height of existing right side dike where many private houses are concentrated as found in Table-2.6. Flood water level also reaches to the crest level of left side dike. The most recent biggest flood occurred in December 2000 according to the flood interview survey around Mola Bridge; the access road by dike was washed away by this flood. Flood water level at Mola Bridge based on the interview is shown in Figure-2.7. The flood water level in December 2000 was El.65.25 m at the right bank (river section MO-450). Year 2000 flood is assumed as equivalent to 20-year probable flood (flood discharge: 3,000 m^3/sec) according to Table-2.6 and 2.7. Besides, 50-year probable flood discharge of Mola Bridge site is 3,510 m^3/sec, and flood water level in the present river condition is El. 63.8 m at the left bank side abutment and El. 65.4 m at the right bank side abutment. The difference of water level between the left and right bank is because the river cross section and existing bridge are not parallel. The flood water level of year 2002 was El. 64.77 m at the left bank according to the flood mark. Year 2002 flood is estimated as equivalent to 2-year probable flood (flood discharge: 2,300 m^3/sec).

On the other hand, 50-year probable flood discharge of the km60.3 Bridge is 9.1 m^3/sec, and flood water level is El. 1205.8 m under the present river condition based on the Non-Uniform Flow Calculation.

Design Flood Water Level

Mola Bridge rehabilitation is part of the applicable scopes in this study, and 5 alternative plans are under consideration. The river water level is assumed to become more than the present river level after construction of Mola Bridge because of the changed river condition by bridge pier. The Non-Uniform Flow Calculation for post-construction was carried out for 5 alternative plans considering 50-year probable flood discharge (3,510 m^3/sec). The result is shown in Table-2.8 comparing with the present condition. The 5 alternative plans developed similar results when present condition and design water level of 50-year probable flood discharge were compared.

Table-2.7 River Flow Capacity

Mola Bridge

Section	Distance	Elevation (El.m)			Discharge (m^3/sec)									
Name	(m)	Riverbed	L. Bank	R. Bank	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900
MO-300	0	59.32	62.89	62.97	62.49	62.58	62.65	62.70	62.74	62.78	62.84	62.88	62.91	63.11
MO-350	50	59.85	64.29	65.23	63.15	63.21	63.28	63.37	63.45	63.53	63.59	63.67	63.74	63.82
MO-400	100	60.83	64.82	65.84	63.88	63.98	64.09	64.16	64.23	64.30	64.39	64.46	64.52	64.59
MO-450	150	62.32	65.45	65.09	64.10	64.20	64.29	64.38	64.51	64.53	64.58	64.64	64.69	64.74
MO-500	200	63.43	66.14	65.50	64.98	65.03	65.10	65.14	65.19	65.24	65.29	65.33	65.38	65.42
MO-550	250	64.21	66.70	66.03	65.83	65.89	65.96	66.02	66.08	66.14	66.20	66.25	66.29	66.33
MO-571	271.57	64.40	67.34	65.78	66.32	66.38	66.44	66.51	66.56	66.62	66.67	66.73	66.78	66.84

Section	Distance	Elevation (El.m)			Discharge (m^3/sec)									
Name	(m)	Riverbed	L. Bank	R. Bank	2000	2100	2200	2300	2400	2500	2600	2700	2800	2900
MO-300	0	59.32	62.89	62.97	63.16	63.22	63.28	63.32	63.36	63.40	63.44	63.48	63.52	63.56
MO-350	50	59.85	64.29	65.23	63.91	63.95	64.04	64.08	64.15	64.19	64.25	64.28	64.34	64.38
MO-400	100	60.83	64.82	65.84	64.63	64.71	64.75	64.82	64.86	64.92	64.97	65.03	65.07	65.12
MO-450	150	62.32	65.45	65.09	64.79	64.83	64.87	64.91	64.95	64.99	65.05	65.10	65.15	65.20
MO-500	200	63.43	66.14	65.50	65.46	65.50	65.54	1.00	65.63	65.66	65.70	65.74	65.78	65.83
MO-550	250	64.21	66.70	66.03	66.38	66.42	66.46	66.50	66.54	66.57	66.61	66.65	66.69	66.72
MO-571	271.57	64.40	67.34	65.78	66.89	66.95	66.99	67.04	67.08	67.13	67.17	67.22	67.26	67.30

Section	Distance	Elevation (El.m)			Discharge (m^3/sec)									
Name	(m)	Riverbed	L. Bank	R. Bank	3000	3500	4000	4500	5000	5500	6000	6500	7000	7500
MO-300	0	59.32	62.89	62.97	63.59	63.76	63.90	64.03	64.16	64.28	64.39	64.49	64.59	64.69
MO-350	50	59.85	64.29	65.23	64.43	64.63	64.83	64.98	65.13	65.25	65.37	65.49	65.61	65.70
MO-400	100	60.83	64.82	65.84	65.16	65.36	65.53	65.67	65.77	65.88	65.99	66.08	66.16	66.24
MO-450	150	62.32	65.45	65.09	65.23	65.42	65.59	65.74	65.88	66.00	66.11	66.21	66.29	66.38
MO-500	200	63.43	66.14	65.50	65.87	66.10	66.29	66.44	66.62	66.79	66.93	67.01	67.17	67.27
MO-550	250	64.21	66.70	66.03	66.76	66.96	67.13	67.30	67.48	67.63	67.77	67.89	68.00	68.10
MO-571	271.57	64.40	67.34	65.78	67.36	67.63	67.86	68.07	68.25	68.38	68.53	68.65	68.75	68.85

km60.3 Bridge

Section	Distance	Elevation (El.m)			Discharge (m^3/sec)							
Name	(m)	Riverbed	L. Bank	R. Bank	5.3	6.0	6.9	7.5	9.1	9.8	11.4	12.0
60-000	0	1197.00	-	-	1197.27	1197.29	1197.31	1197.33	1197.36	1197.38	1197.41	1197.43
60-010	10	1200.00	-	-	1200.37	1200.39	1200.41	1200.43	1200.47	1200.48	1200.51	1200.52
60-020	20	1203.00	-	-	1203.38	1203.41	1203.45	1203.48	1203.54	1203.57	1203.63	1203.66
60-030	30	1205.00	-	-	1205.60	1205.63	1205.67	1205.70	1205.76	1205.78	1205.83	1205.85
60-040	40	1207.00	-	-	1207.23	1207.25	1207.27	1207.28	1207.32	1207.34	1207.37	1207.39
60-050	50	1208.00	-	-	1208.57	1208.62	1208.66	1208.68	1208.76	1208.78	1208.85	1208.87

Table-2.8 Peak of Flood Water Level (EL. m)

	Peek of Flood water Level (EL. m)					
Section	Present	Alternative1	Alternative2	Alternative3	Alternative4	Alternative5
MO-300	63.76	63.57	63.57	63.57	63.57	63.56
MO-350	64.63	64.53	64.53	64.54	64.53	64.52
MO-400	65.36	65.53	65.52	65.54	65.53	65.50
MO-450	65.42	65.71	65.70	65.72	65.71	65.69
MO-500	66.11	66.09	66.09	66.09	66.09	66.09

Notice; Left side bank (Dili side): MO-300, Right side bank (Suai side): MO-450

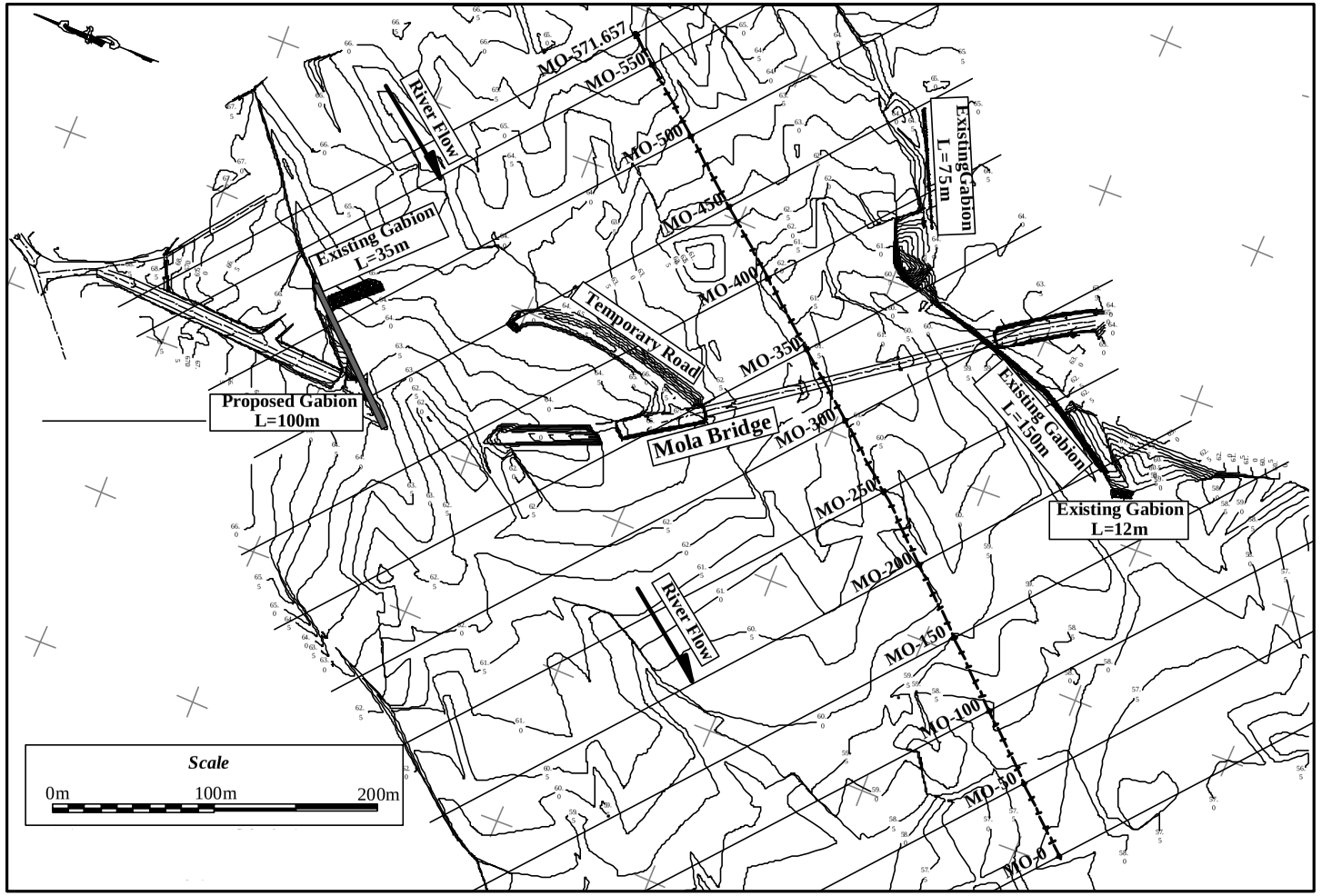


Figure-2.6 Mola Bridge Plan

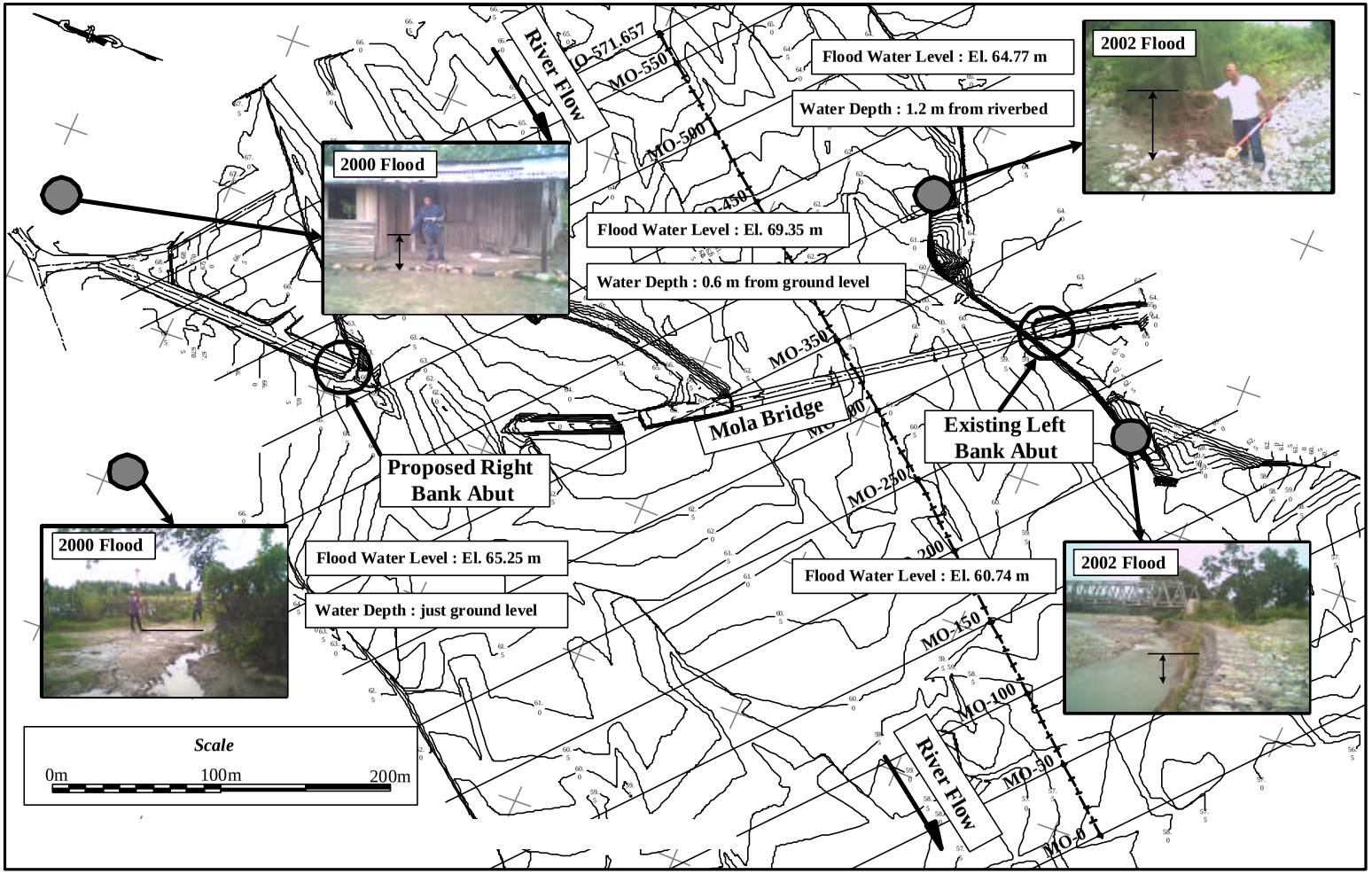


Figure-2.7 Mola Bridge Area Flood Water Level

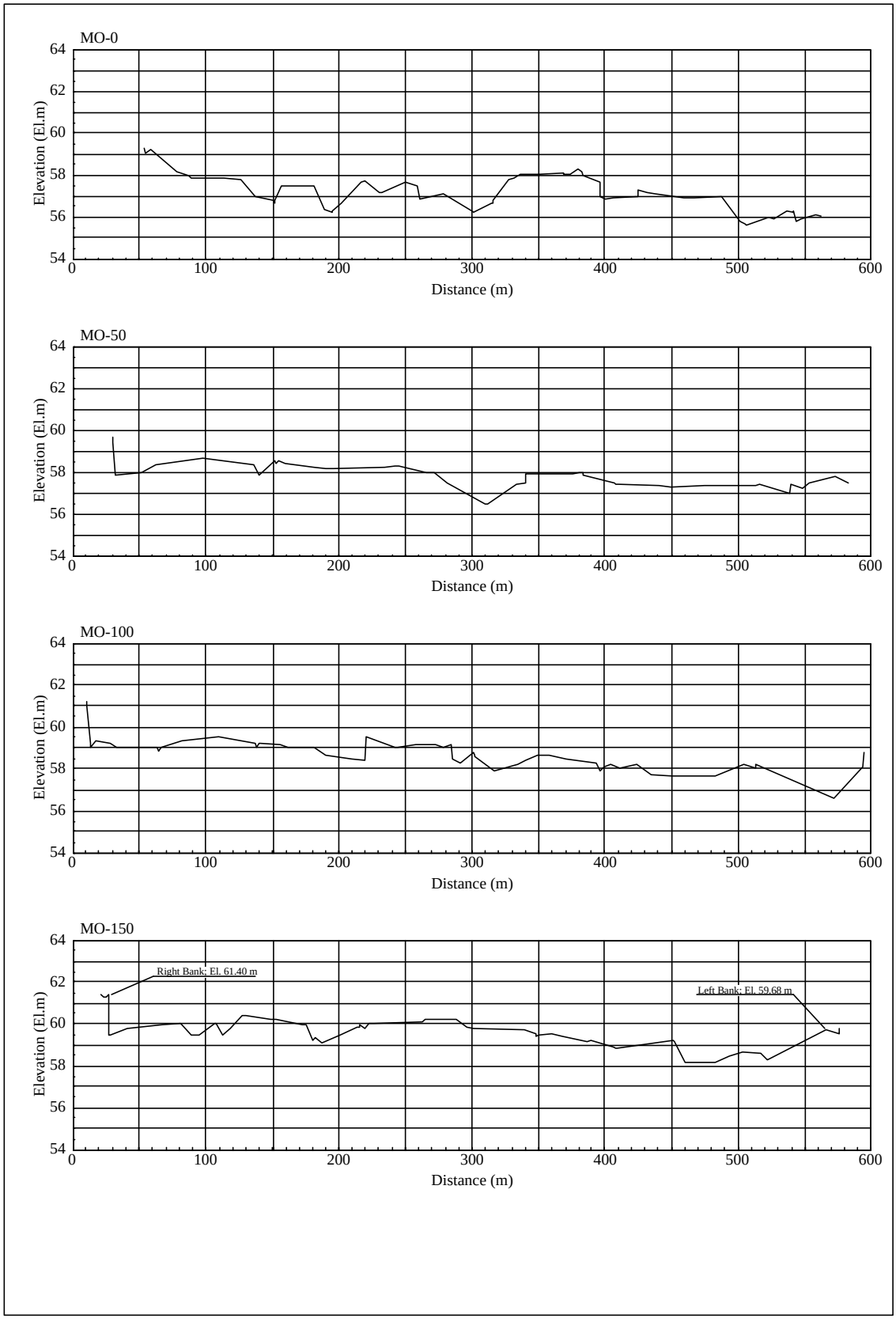


Figure-2.8 Mola Bridge River Cross Section (1/4)

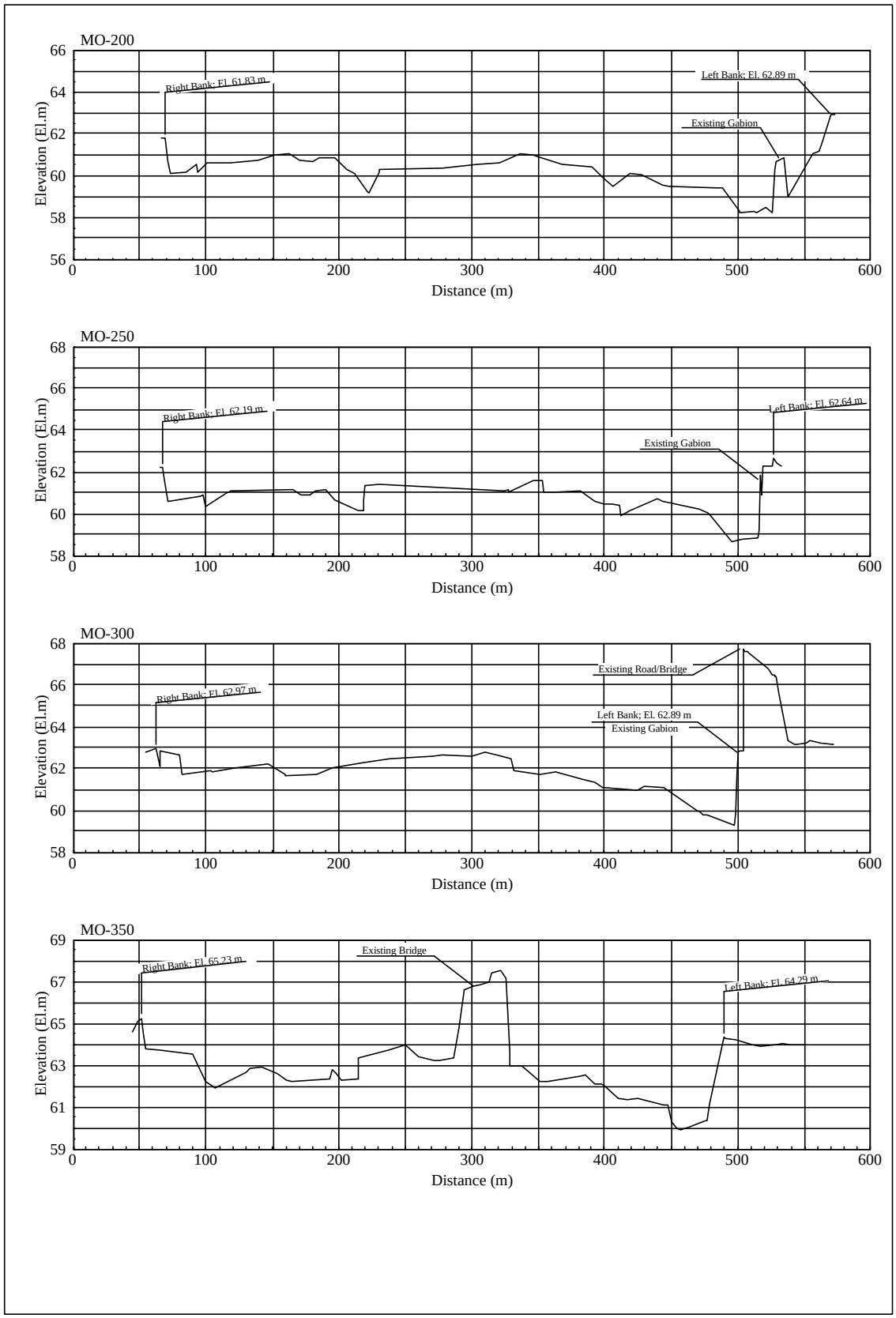


Figure-2.8 Mola Bridge River Cross Section (2/4)

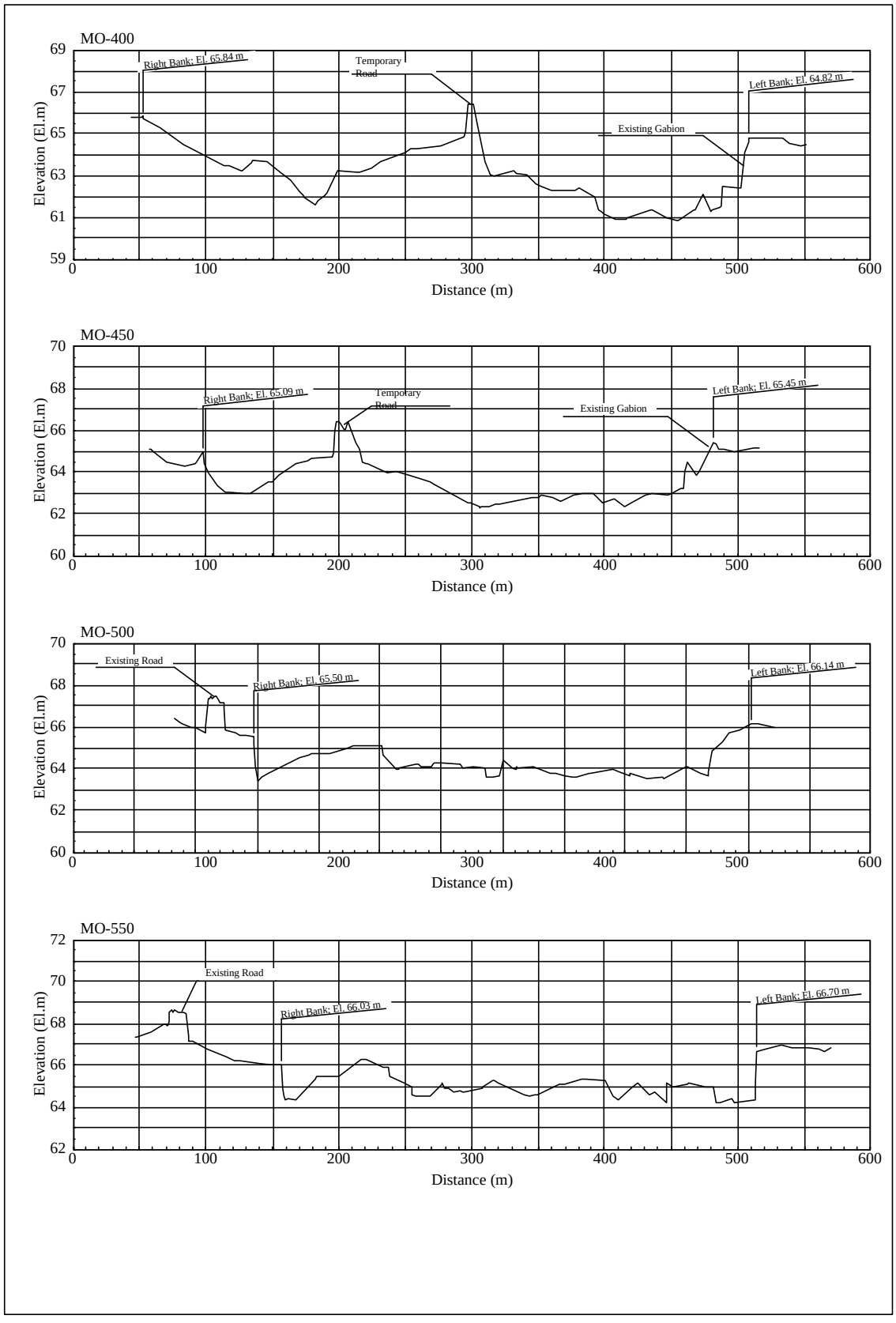


Figure-2.8 Mola Bridge River Cross Section (3/4)

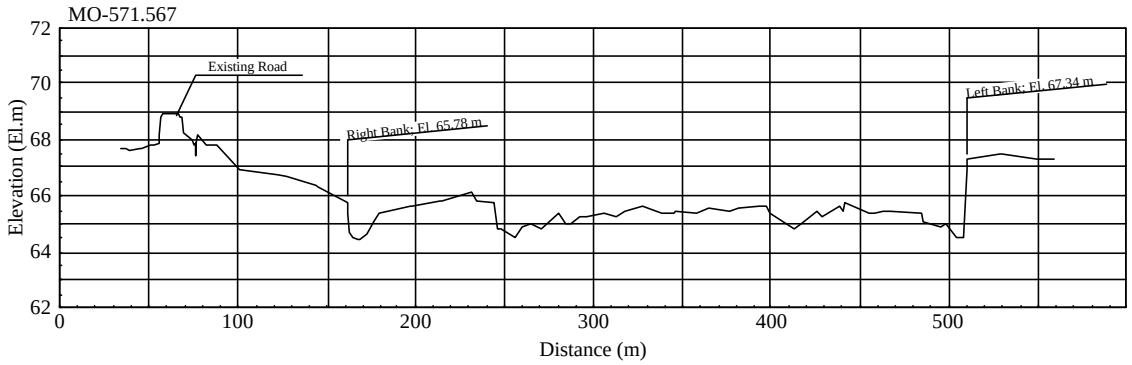


Figure-2.8 Mola Bridge River Cross Section (4/4)

5 alternative plans developed similar results when present condition and design water level of 50-year probable flood discharge were compared as shown in Table-2.8. The flood water level decreased about 20cm at the left bank abutment in section MO-300 and increased about 30 cm at the right bank abutment in section MO-450 respectively from the flood water level of present condition. The water level decrease at the left bank abutment in section MO-300 is because of increase of river flow area. The 80 m length of existing abutment at the river center and access road on remaining dike are obstructing the river flow now, but the access road on dike is planned to be re removed. The water level increase at the right bank abutment in section MO-450 is because of deceleration of flow velocity at the upstream side of pier since surface friction at pier increases by larger hydraulic radius of new bridge pier. The design flood water level is EL.63.6m at the left bank abutment and EL.65.7m at the right bank abutment for all 5 alternative plans.

km60.3 Bridge is another applicable bridge in this study. It will be reconstructed at the downstream side about 2-3 m from the location of present bridge which means that both bridges can be considered as almost same location in hydraulic conditions. River flow condition for km60.3 Bridge is different from Mola Bridge because reconstruction does not increase any obstructing structure in the river. Therefore, 50-year probable flood water level of km60.3 Bridge is EL. 1205.8 m. at section 60-030 as shown in Table-2.5.

(3) Low Flow Analysis

The estimate of low flow discharge in dry season is necessary to select construction machines for Mola Bridge rehabilitation. The hydrological data, however, are scarce in this area, and so it is very hard to decide coefficients and numerical values among the various data for low flow analysis as described in the former clause. Consequently, average and common values or data utilized for analyses in Southeast Asian countries are applied in the low flow analysis assuming that the conditions at Mola area are almost the same as those countries. Tank Model Method (four tanks one column model) is applied as the method of analysis, which is commonly utilized in the area of small river basin less than 500 km^2 in Southeast Asia.

Necessary data for Tank Model are rainfall, evaporation, constant value and parameter of hole size & height for tank model. The rainfall data is computed by multiplication of rainfall value at Viqueque station and rainfall compensation coefficient for 3 years (1991, 1994 and 1997) that consist of complete record. Data at Dili station was used for the flood flow analysis but data at Vequeque station was used for the low flow analysis because the yearly maximum rainfall data is necessary for the flood analysis and also long-term data with no missing points is required for frequency analysis. Viqueque station is located in the southern area the same as Mola Bridge, but it is not selected as representative rainfall station because of having no long-term data. Low flow analysis demands rainfall data through the year. Mola Bridge basin is located in the southern area; therefore, data at Dili station, which is located north area can not express the difference of wet and dry seasons for low flow discharge. Therefore, as a representative rainfall station for low flow analysis, Viqueque station was selected. Rainfall compensation coefficient adopts 1.53 (=2,300 mm/1,500 mm) after the application of isohyetal map using the same method as flood flow analysis. Evaporation is assumed as 3 mm/day for wet season and 4 mm/day for dry season as an average of Southeast Asian area. The constant value for Tank Model is also assumed as an average value of Southeast Asian area as shown in Table-2.9.

Table-2.9 Constant Value for Tank Model

Tank	Infiltrate Hole	Bottom Hole	Height of Bottom Hole	Top Hole Size	Height of Top Hole
Top Tank	0.300	0.100	10.0	0.080	30.0
Second Tank	0.008	0.020	0.0	-	-
Third Tank	0.006	0.003	0.0	-	-
Forth Tank	0.000	0.002	0.0	-	-

Result of Tank Model Analysis is shown in Figure-2.9.

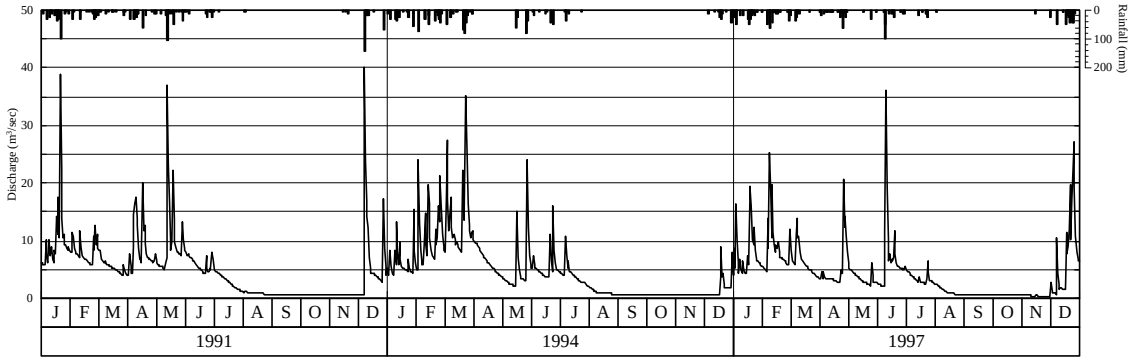


Figure-2.9 Result of Tank Model Analysis

Riverbed stream is estimated as 0.5 m^3/sec for dry season from July to November and maximum discharge is assumed as 5 m^3/sec.

(4) Local Scouring at Bridge Pier

The depth and area of local scouring around the pier were examined for disaster prevention even though the river flow at Mola Bridge is stable. The river flow around the pier is basically divided into the flow toward right & left sides in front of the pier, and vertical down flow along the pier front. The flow divided to right and left becomes a curving flow along the wall surface of pier, and the concentration of local flow occurs at the wall surface of the pier. On the other hand, the down flow in front of the pier collides against the riverbed, and riverbed gravel rolls up a revolving whirlpool. The soil and sand rolled up by whirlpool is carried to the back of the pier by the flow divided right and left. Generally, flow is more concentrated when pier width is thicker if identical hydraulic quantity is same condition. The flow velocity becomes fast and riverbed material around pier front & side is carried away. The maximum scouring depth and scouring area are controlled by characteristic conditions such as size and shape of pier, hydraulic quantity and riverbed material.

Maximum Local Scouring Depth

Many prediction-formulas are proposed for maximum scouring depth around the pier and these formulae have been evaluated and examined. But, each prediction-formula has its own problems, and it must be applied within the application allowance when used because there are many affecting factors for estimation of maximum scouring depth around the pier but all of the factors are not considered in the formula. The dimensionless scouring depth is influenced by some dimension quantities as shown below.

There are some factors that influence the scouring depth around the pier, and maximum scouring depth is expressed by the next formula.

a) Factors (non-influence by piers)

Riverbed slope, water depth, density of water, dynamic viscosity of water, diameter of riverbed material, density of riverbed material and gravitational acceleration

b) Factor of pier

Bridge width, bridge characteristic form and flow direction and crossed axes angle

c) Scouring physics

Maximum scouring depth, scouring area and scouring form

Maximum Scouring Depth-1

$$\frac{Z}{D} = f\left(t_*, \frac{h_0}{d_m}, Re_*, s, \frac{h_0}{D}, \frac{k}{D}\right)$$

Z : maximum scouring depth (m) D : pier diameter (m)
t_* : dimensionless tractive force h_0 : water depth (m)
dm : dean diameter of riverbed material (m)
Re_* : Reynolds number k : bridge characteristic form
s : relative density in hydrospace of riverbed material =(ρs-ρw)/ ρw
ρs : density of riverbed material ρw : density of water

From the 1st factor to the 4th factor of the right term in the above equation, the maximum scouring depth formula is a dimensionless quantity that prescribes the conditions for moving riverbed flow. The influence of *Re** is less than *t** and *h0/ dm*, if compared with it, and *s* can be a constant value of 1.65 if the riverbed is common material. The term of *k*/*D* can be neglected because Mola Bridge will consist of column-type piers. Therefore, relative scouring depth around the column-type pier is controlled by three dimension quantities (*t**, *h0/ dm*, *h0/ D*). The maximum scouring depth formula is expressed as shown below when average flow velocity is applied instead of the riverbed slope.

Maximum Scouring Depth-2

$$\frac{Z}{D} = f1\left(Fr, \frac{h_0}{d_m}, \frac{h_0}{D}\right)$$

Fr : Froude number ($Fr = u_0 / \sqrt{gh_0}$)
u_0 : average flow velocity g : acceleration of gravity

The common input conditions among 5 alternative plans for the bridge plan are: 400 m for river width, 7.24 cm for average riverbed material groin size, 3,510 m^3/sec for design flood discharge and 2.5m for average design flood water depth. The average grain size of riverbed material was decided from representative grain sizes of the material as shown in Photo-2.1. The maximum local scouring depth is shown in Table-2.10. The maximum local scouring depth at the abutment between the existing Mola Bridge and new bridge was computed as 7.5 m

Photo-2.1 Riverbed Material of Mola Bridge

Table-2.10 Maximum Local Scouring Depth

Alternative Plan	Pier Diameter (m)	h_0/D	h_0/d_m	Fr	Z/D	Maximum Scouring Depth (m)
Alt-1	1.5	1.67	34.53	0.71	1.5	2.3
Alt-2	1.5	1.67	34.53	0.71	1.5	2.3
Alt-3	2.0	1.25	34.53	0.71	1.4	2.8
Alt-4	2.4	1.04	34.53	0.71	1.4	3.4
Alt-5	1.5	1.67	34.53	0.71	1.5	2.3

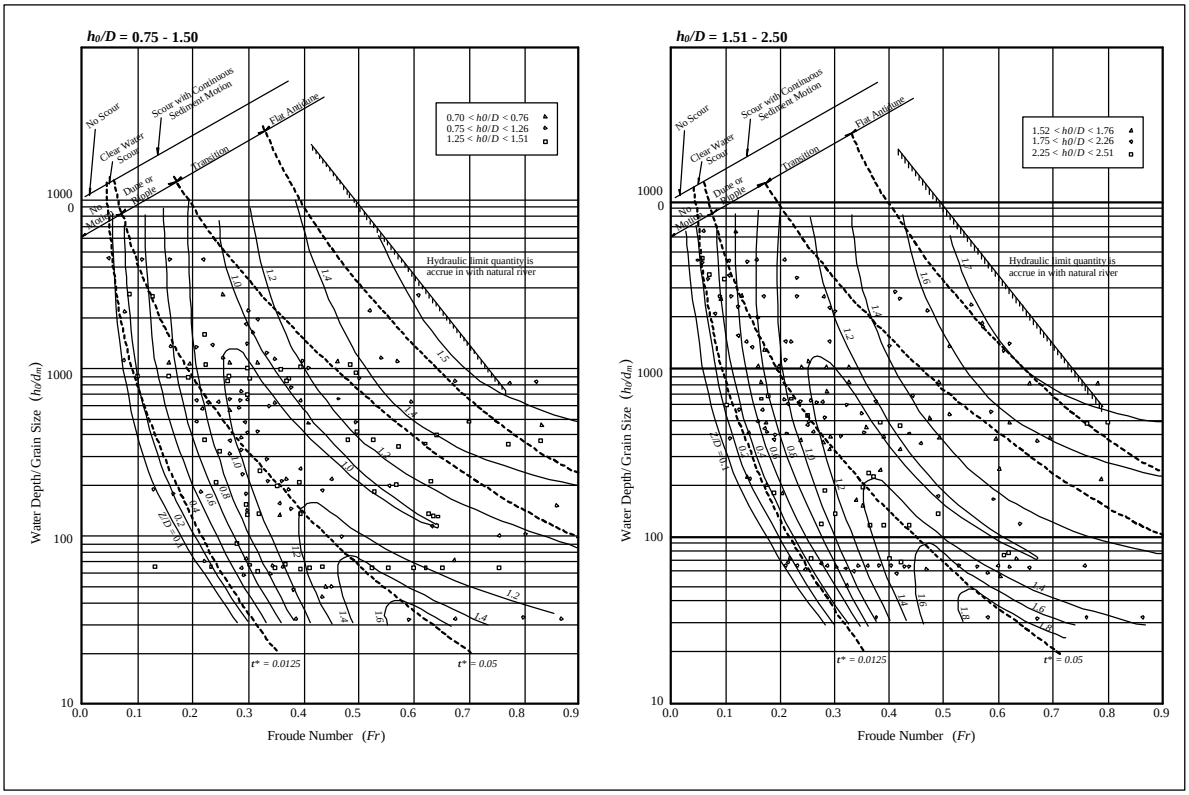


Figure-2.10 Maximum Scouring Assumption

Local Scouring Area

There is a close relation between the local scouring depth and the submerged repose angle of riverbed material regarding the local scouring area around the pier. Generally, the value of repose angle is measured as the natural angle of conical piled mountain when sand is falling from a funnel. The angle of the mountain slope is considered as an angle of dynamic friction since sand particles are stopped little by little during falling on the slope. Figure-2.11 shows the experimental result of relation between repose angle and mean grain size in air and in submerged condition. There is a difference in the upper and lower limit of the experimental values in air and in submerged condition, because the value of static angle of friction, which expresses the beginning of sand particle movement, is bigger than that of dynamic angle of friction. The local scouring area for columnar pier is computed by the following formula:

Local Scouring Area

$X = Z / \tan q$

X : Local Scouring Area (m) Z : Maximum Scouring Depth (m)

q : Repose Angle (degree)

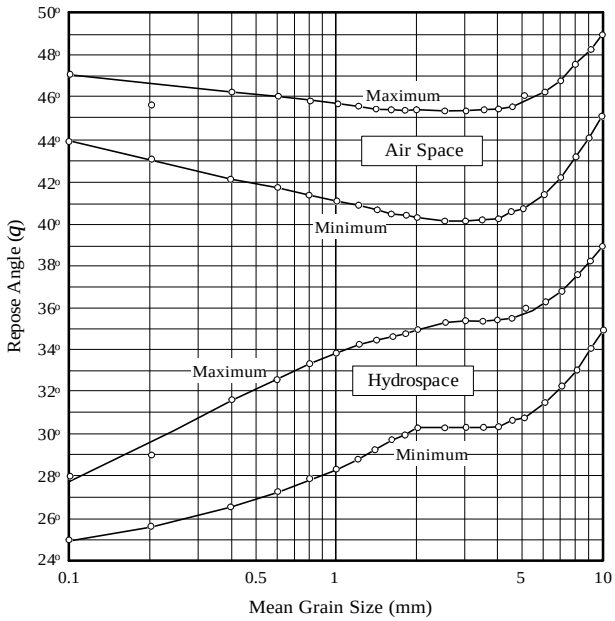


Figure-2.11 Relation of Repose Angle & Mean Grain Size in Air & Submerged Condition

The local scouring area around the pier by 5 alternative plans is shown in Table-2.11.

Table-2.11 Local Scouring Area

Alternative	Maximum Scouring Depth (m)	Repose Angle (degree)	Local Scouring Area (m)
Alt-1	2.3	34.5	3.3
Alt-2	2.3	34.5	3.3
Alt-3	2.8	34.5	4.1
Alt-4	3.4	34.5	4.9
Alt-5	2.3	34.5	3.3

Note) Average submerged repose angle is applied for Repose Angle

The local scouring image of column type pier is shown in Figure-2.12.

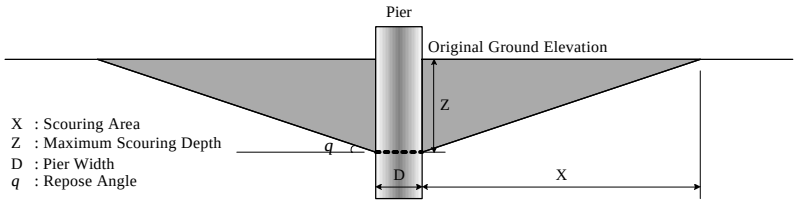


Figure-2.12 Local Scouring Image of Column Type Pier

(5) Necessity for Bank Protection

Protection for riverbank at upstream & downstream sides of Mola Bridge against erosion and protection for piers against scouring are examined as shown below. Present conditions of riverbanks are as follows:

Left Bank (Dili Side)

- Gabion (upstream) : Total length of 150 m from 110 m downstream to 40m upstream
- Gabion(downstream) : Total length of 75 m from 75 m upstream to 150 m upstream
- Riverbank erosion : Riverbank is eroded beyond 150 m upstream side from Mola Bridge, but the progress of erosion is hindered by the riverbank protection at the downstream side.

Right Bank (Suai Side)

- Erosion (upstream) : Riverbank erosion is found at upstream side.
- Gabion (upstream) : Gabion (35 m length and 1.5 m height) perpendicular to river flow in the Mola River at 50 m upstream side from the bridge.
- Riverbank erosion : Riverbank is eroded at downstream side but the progress of erosion is not found and the surrounding condition is stable.

The left bank side of the Mola River is protected by existing gabion and riverbank is not eroded in the present condition. Also, condition of Mola Bridge will be continued; therefore, additional bank protection is not necessary. The right bank side is eroded because low water flow is introduced near and along the riverbank. New gabion similar to the left bank side is necessary at both sides of the stream to protect the newly built abutment. The scale of protection shall be about 100 m (70 m at upstream side and 30 m at downstream side) as shown in Fig-2.6. The height of bank protection will be El.66.5 m at the upstream end and El.65.4 m at the downstream end because height of 1.2 m as the freeboard. The freeboard value of 1.2 m is derived from Japanese Standard, and it should be decided from design flood discharge.

2-2-1-2-3 Topographic Survey

Topographic survey was carried out to grasp route alignment for road improvement, basic data of road facility design, geographical features for bridge rehabilitation and river. This survey used a Total Station System and plan drawings were produced by Auto-Cad system. The method is simultaneously centerline, profile leveling and cross-sectioning surveyed shown in Figure-2.13. Survey point distance is 20m, and the detailed area was applied cross-sectioning survey to grasp the land shape of mountainous and valley side. Standard drawings of route survey are attached as another data.

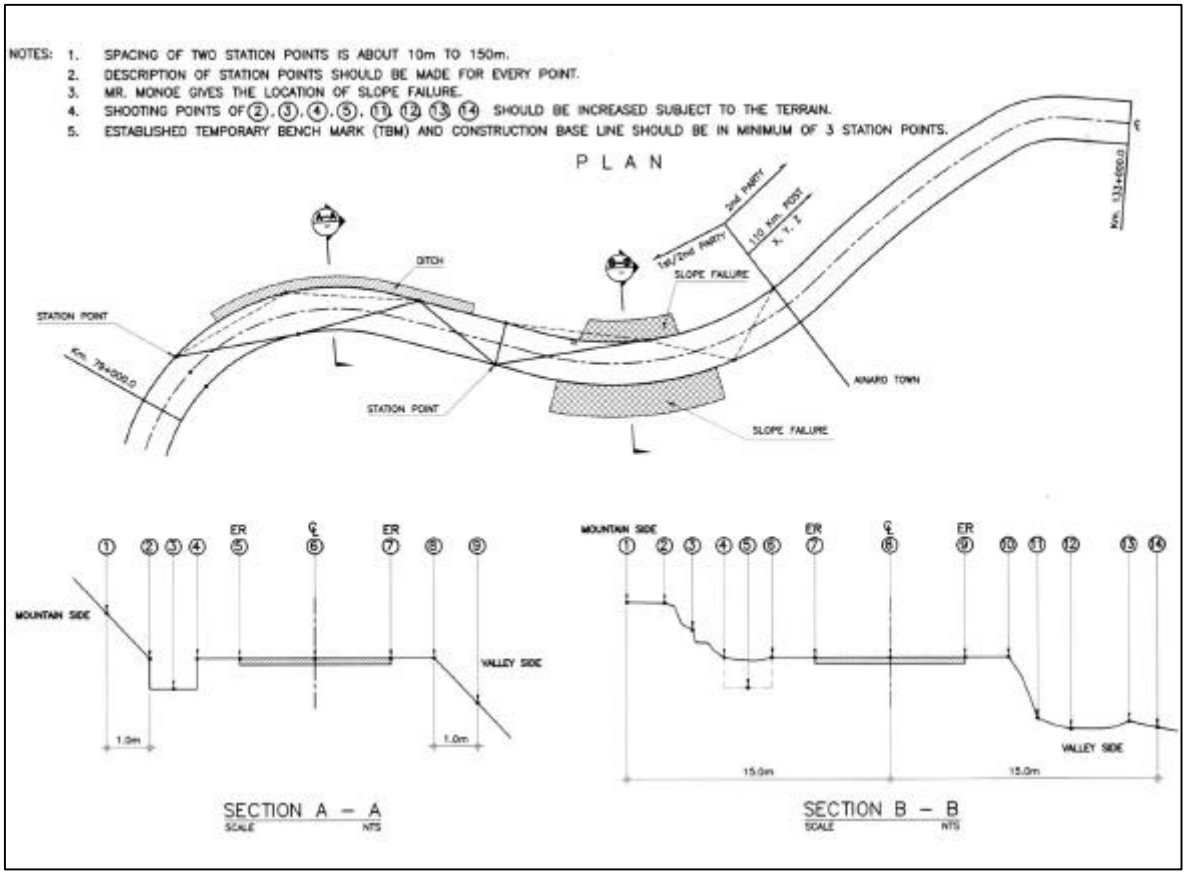


Figure-2.13 Method of Topographic Survey

Plane and vertical survey for bridge, vertical and cross survey for river were conducted at Mola Bridge and km 60.3 Bridge area. Plan drawing for Mola Bridge is attached separately.

Table-2.12 Contents of Topographic Survey

Survey Item	Section	Contents of Survey	Output
Center Line	km2～km45	Interval: 20 m, Length: 43 km	Plan : 1/1,000 Contour Line : 0.5 m
	km79～km130	Interval: 20 m, Length: 51 km	
	km60.3 Bridge	Interval: 20 m, Length: 0.2 km	
	Mola Bridge	Interval: 20 m, Length: 0.5 km	
Vertical Survey	km2～km45	Interval: 20 m, Length: 43 km	Vertical Section : X ; 1/1,000 Y ; 1/200
	km79～km130	Interval: 20 m, Length: 51 km	
	km60.3 Bridge	Interval: 20 m, Length: 0.2 km	
	Mola Bridge	Interval: 20 m, Length: 0.5 km	
Cross Survey	km2～km45	Interval: 20 m, Length: 43 km	Cross Section: 1/200 Interval ; 20 m
	km79～km130	Interval: 20 m, Length: 51 km	
	km60.3 Bridge	Interval: 20 m, Length: 0.2 km	
Plane Survey for Bridge	km60.3Bridge	4 ha	Plan : 1/1,000 Contour Line : 0.5 m
	Mola Bridge	25 ha	
Vertical Survey for River	km60.3 Bridge	Interval: 20 m, Length: 0.6 km	Vertical Section : X ; 1/1,000 Y ; 1/200
	Mola Bridge		
Cross Survey for River	km60.3 Bridge	3 Sections, Width: 400 m	Cross Section: 1/200
	Mola Bridge		

2-2-1-2-4 Geological Investigation

(1) Preface

Geological investigation of road rehabilitation section was carried out for the purpose of understanding of geological conditions for Subgrade and Base/Subbase course materials, slope protection and design and construction of bridge foundations.

The geological investigation was carried out in the following two phases.

1st Field Survey

Regional survey, slope inspection of the project area and preparation for 2nd field survey were carried out.

- Slope inspection sheets
- 2nd Field Survey Plan

2nd Field Survey

Detailed survey was carried out based on the result of 1st field survey.

- Results of geological investigations along the road slopes (landslide, collapse, etc.); 11 sites, 13 holes
- Results of geological investigation for the improvement of the Mola Bridge; 1 site, 3 holes
- Mechanical properties of typical soil in the project area

The Geological survey items are shown in Table-2.13. The following surveys were carried out (see attached Tables-2.14 and 2.15). The locations of the surveys are illustrated in the attached Fig-2.14.

Table-2.13 Items of Geological Investigation

Object	Survey	Quantities
a) Road slopes stability (include improvement of the bridge)	Core drilling Standard penetration test Laboratory tests (water content, specific gravity, grain size, Atterberg limits) Swedish sounding	13 holes 69 nos 31 samples 111 nos
b) Mola Bridge foundation	Core drilling Standard penetration test Laboratory test	3 holes 39 nos 2 samples
c) Base/Subbase course materials	Sampling Laboratory test (CBR test etc.)	2 points 2 samples
d) Subgrade materials	Sampling Laboratory test (CBR test etc.)	4 points 2 samples

Table-2.14 Core Boring Survey List

No.	STA	S	E	Height(m)	Side of Road	Length(m)	soil	rock	Undisturbed sampling	SPT(nos	Moisture content	Particle size	Atterberg limits	Specific gravity	Unconfined compression	Disaster Type
Road Survey (Coordinates were measured by handy GPS)																
1	23.0	8°37.161	125°38.120	1080	Left	6.70	4.50	2.20	1	4	2	2	2	2	0	Embankment failure
2	23.5	8°37.291	125°38.050	1120	Left	7.00	0.50	6.50	1	4	2	2	2	2	0	Collapse
3	40.3	8°41.524	125°32.923	1110	Left	10.00	10.00	0.00	2	6	3	3	3	3	0	Embankment failure
4	60.9	8°47.877	125°33.755	1160	Right	10.78	7.50	3.28	1	7	3	3	3	3	0	Embankment failure (Basement survey for the
5	83.4	8°52.995	125°36.386	1800	Right	9.00	7.00	2.00	2	6	2	2	2	2	0	Embankment failure
6	83.4	8°52.995	125°36.386	1800	Right	9.00	7.50	1.50	1	6	3	3	3	3	0	Embankment failure
7	89.3	8°54.042	125°35.531	1540	Right	7.52	4.50	3.02	2	5	3	3	3	3	1	Embankment failure
8	91.3	8°54.690	125°35.088	1470	Left	7.52	6.00	1.52	1	5	2	2	2	2	1	Embankment failure
9	91.3	8°54.690	125°35.088	1470	Right	7.50	5.00	2.50	2	5	3	3	3	3	1	Embankment failure
10	91.7	8°54.711	125°35.016	1440	Left	9.00	8.00	1.00	1	6	2	2	2	2	0	Embankment failure
11	108.1	8°59.109	125°31.197	925	Left	7.95	4.00	3.95	2	5	2	2	2	2	1	Embankment failure
12	109.6	8°59.504	125°30.824	813	Right	7.50	4.00	3.50	1	5	2	2	2	2	1	landslide
13	109.9	8°59.497	125°30.768	795	Right	7.50	4.00	3.50	2	5	2	2	2	2		landslide
subtotal						106.97	72.5	34.47	19	69	31	31	31	31	5	
Bridge Survey																
14	Mola A1	9°10.290	125°26.998	65.5	Left	13.50	13.50	0.00		8						
15	Mola P	9°10.258	125°26.944	63.75	Left	23.88	16.00	7.88		16						
16	Mola A2	9°10.201	125°26.921	62.85	Right	22.88	15.50	7.38		15	2	2	2	2	0	
subtotal						60.26	45.00	15.26		39	2	2	2	2	0	
Grand total						**167.23**	**117.5**	**49.73**	**19**	**108**	**33**	**33**	**33**	**33**	**5**	

Table-2.15 Swedish Penetration Test List

Serial No.	SWS No.	Quantity	Disaster Type	Geology
1	22+900	3	embankment failure	soil/schist
2	23+750	3	collapse	soil/schist
3	40+500	7	embankment failure	soil/schist
4	42+100	6	collapse	soil/schist
5	60+900	5	Bridge basement	tuff/faracyured zone/schist
6	80+150	3	collapse	soil/schist
7	80+500	3	embankment failure	soil/schist
8	83+400	3	embankment failure	embankment(sliding/steady)
9	85+300	2	embankment failure	embankment(sliding/steady)
10	86+250	3	embankment failure	embankment(sliding/steady)
11	86+900	3	embankment failure	embankment(sliding/steady)
12	88+850	6	collapse/embankmentfailure	talus deposits/embankment/limestone
13	89+250	3	embankment failure	soil/limestone
14	89+300	3	embankment failure	soil/limestone
15	91+300	3	embankment failure	embankment(sliding/steady)
16	91+700	3	embankment failure	embankment(sliding/steady)
17	92+900	3	embankment failure	soil/limestone
18	96+850	4	embankment failure	soil/limestone
19	99+200	2	collapse	soil/detritus
20	99+500	3	collapse	soil/detritus
21	102+100	3	embankment failure	embankment(sliding/steady)
22	105+200	3	embankment failure	landslide
23	106+010	2	embankment failure	landslide
24	106+600	3	embankment failure	embankment(sliding/steady)
25	108+100	3	embankment failure	embankment(sliding/steady)
26	109+550	3	landslide	soil/fractured zone
27	109+900	3	landslide	soil/fractured zone
28	116+600	2	embankment failure	soil/terrace deposits
29	128+200	3	embankment failure	embankment(sliding/steady)
30	128+700	5	embankment failure	embankment(sliding/steady)
31	130+100	5	embankment failure	embankment(sliding/steady)
32	130+300	5	embankment failure	embankment(sliding/steady)
total		111		

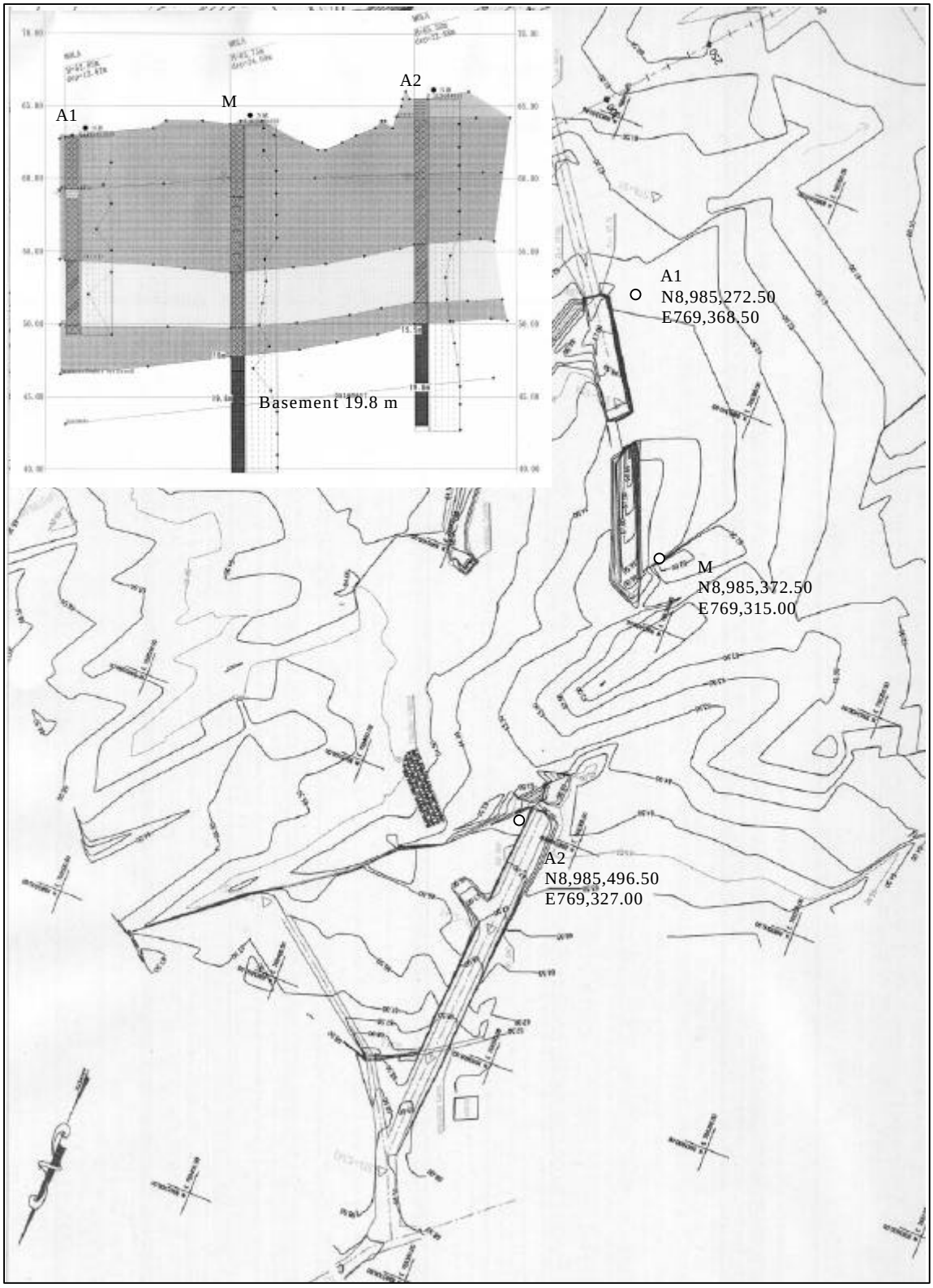


Figure-2.14 Mola Bridge Boring Survey Location Map

(2) Topography and Geology

The project area is underlain by the following rocks. Schematic profile of the area is shown below.

① Dili-Maubisse

Schist rocks of the Permian age, easily weathered and flaked, distributed from Dili to Maubisse. The project road rise meandering and steep slopes from Dili until km20, while from km20 to Maubisse the road lies on hills of gentle slopes.

② Mountain range that runs Timor Leste from east to west-Ainaro

Limestone of Paleozoic-Mesozoic age, fresh and hard, distributed in the mountain range. The limestone forms escarpments and steep valleys.

③ Ainaro-Cassa

Alternations of mudstone and sandstone (not exactly known, but a portion of it is Tertiary age), soft and fragile, distributed from Ainaro to Cassa. Four different level terraces are widely distributed in this area. Thick terrace deposits, very dense sand and gravels, cover the route. The road runs through the flat terrace.

④ Cassa-Suai

Quaternary river and alluvial fan deposits, soft and loose, cover Cassa-Suai area. The road runs through the boundary of mountains and plain area. After heavy rain, drainage ditches along road frequently overflow. The Mola Bridge is located on the top fan of Mola River.

Photo-2.2 Distant view of Mola Bridge

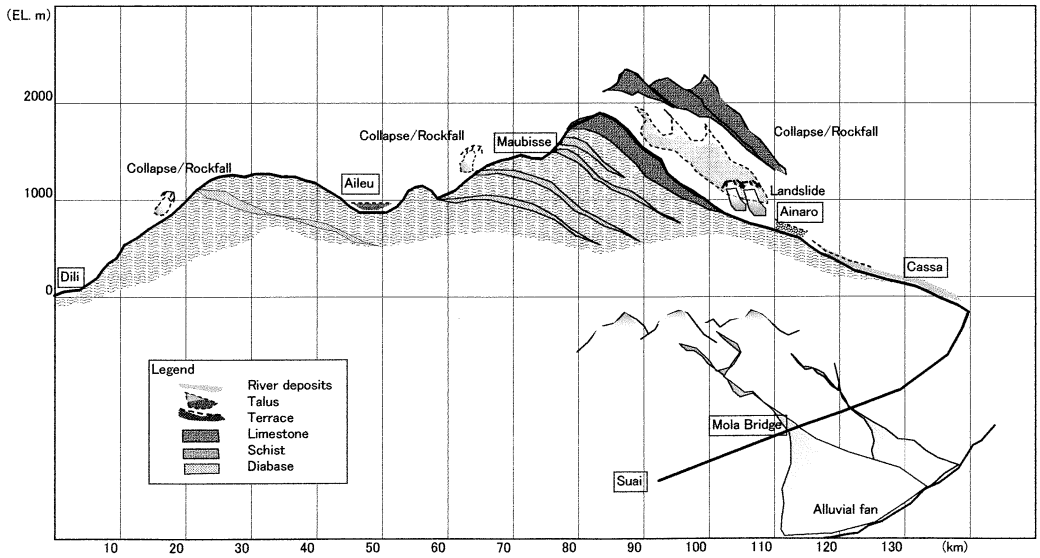


Figure-2.15 Schematic Profile from Dili to Suai

(3) Lithology

A. Schist Rocks

Schist rocks widely are distributed from Dili to Maubisse.

The character of schist rock is as follows:

- Easily weathered and flaked
- Joint spacing ranging 1 to 10 cm
- Schistosity (mica) is well developed
- Schistosity plane mainly dips southwestward although there are miner folds
- Many miner faults are observed along the cut of road
- Diabase layers are intercalated.

(The picture shows the dip of the foliation.)

Photo-2.3 Weathered Schist Rocks (km24.6)

Schist rocks generally are easy to collapse and slide. Many collapsed slopes are observed along the cut of the project road due to high weathering. South-facing slopes tend to slide easily compared with north-facing ones due to schistosity dipping southward. Diabase causes rock mass failures and large rock falls, because its joint spacing is relatively wide (ranging from 30 to 100 cm).

Diabase (km23.9)

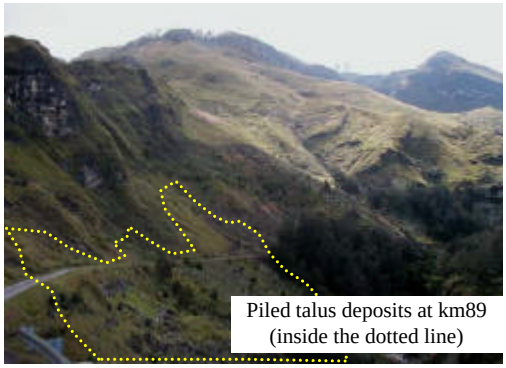
Photo-2.4 Diabase

B. Limestone

Limestone, forming escarpments, is distributed from the mountain ridge to southern slope. The character of limestone is as follows:

- Hard with assumed unconfined compression strength ranging 60 to100 MPa
- Joint spacing ranging 20 to 30 cm, expect massive limestone from km95 to km97
- Bedding planes of limestone frequently show different dip (chevron fold).

Many rock mass failures and rock falls due to weathering are observed along the project road. Residual soil of about 1 m thick and thin talus deposits of 1 to 2 m thick cover limestone on the ridge and on the steep valley respectively, where groundwater level is generally shallow, and causes collapse of the cut of road and embankment failure.



Piled talus deposits at km89 (inside the dotted line)

Limestone Outcrops;km94.7

Photo-2.5 Accumulation of Limestone and Outcrops

Massive limestone, forming escarpment of approximate 100 m high, from km95 to km97, has a potential of rock mass failure. Boulders of about 5 m in diameter, which are remnants of rock mass failure, were observed at 96 km.

C. Alternation of mudstone and sandstone

Although alternation of mudstone and sandstone, soft and fragile, causes collapse, few outcrops are exposed along cut of the road.

D. Detritus

Pleistocene detritus cover gentle slopes beneath limestone escapement distributed along the Belulic River, located on approximate 200 m higher than riverbed from km92 to km103. The character of detritus is as follows:

Photo-2.6 Pleistocene Detritus

- Mainly composed of angular gravel of less than 10 cm (max 2 -10 m) in diameter
- Consisted of limestone fragments with gravel ratio ranging from 50 to 70%
- Well consolidated (N values are assumed to be 10 to 20). Detritus forms stable steep (50 degrees-60 degrees) slopes of 5 m to 7 m high, although included gravels sometimes fall on the road.

E. Terrace deposits

Four level terraces: high terrace (170 - 200 m higher than riverbed), middle terrace (approximate 100 m high), low terrace1 (20 - 30 m high) and low terrace2 (5 - 10 m high), are distributed from Ainaro to the bridge of km120. The character of terrace deposits is as follows:

Photo-2.7 Terrace Deposits

- Mainly composed of rounded gravels of Less than 20 cm (max 1 m) n diameter, while sub-rounded to sub-angular gravels in high terrace
- Including gravels of limestone, diabase and sandstone etc,
- Gravel ratio ranging from 50% to 70%,
- Well consolidated (N values are assumed to be 10 to 20.),
- Low ground water level.

Few points of disturbed subgrade were observed.

F. Talus deposits

From Dili to Maubisse, where schist rocks are distributed, many of fragments of the talus deposits were broken into gravels of less than 10 cm in diameter due to weathering. Almost talus deposits along the road cut were 1 to 2 m thick except landslide area. At mountain valleys the deposits sometimes attains 5 m thick.

From Maubisse to Ainaro, where limestone is distributed, thick talus deposits are distributed. The deposits include boulders of 5 - 6 m (maximum 15 m) in diameter.

G. Landslide

At Maubisse, low activity and few deformations on the road surface are observed.

Landslide areas were illustrated in attached geological maps by field surveys and topographical inspection (1:25,000 in scale).

Photo-2.8 Landslide

H. Fractured zone

Fault line at km64

Three fracture zones range 20 - 100 m and one fracture zone of approximate 300 m is distributed at km60 - km68, and km109 - km110 respectively.

Many collapsed slopes and landslides were observed in the vicinity of the faults.

Photo-2.9 Fractured zone

(3) Road Survey

The boring investigation is summarized below. Swedish sounding was carried out at collapse points shown in Table-2.16.

Table-2.16 Boring Investigation Result

No	STA (km)	Object	Result
1	23.0	Collapse	0-4.5 m Soil, 4.5 m-rock(schist, CLL/CLH class)
2	23.5	Embankment failure	0-0.5 m Talus deposits, 0.5 m- rock(schist CLL class)
3	40.3	Embankment failure	0-0.4 m embankment material, 0.4-4.5 m soil, 4.5m- rock (schist CLL class)
4	60.5	Bridge foundation	0-1.0 m talus deposits, 1.0-6.0 m soil, 6.0-7.5 m solid soil, 7.5m- foundation of the bridge(schist CLH class)
5	83.4	Embankment failure	0-7.0 m embankment material, 7.0 m- rock(limestone CLH class)
6	83.4	ditto	0-7.5 m embankment material, 7.5 m- rock(limestone CLH class)
7	89.3	Embankment failure	0-4.5 m talus deposits,4.5m- rock(limestone CLH class)
8	91.3	Embankment failure, collapse	0-6.0 m talus deposits, 6.0 m- rock(limestone CLH class)
9	91.3	Embankment failure, collapse	0-2.0 m talus deposits, 2.0-5.0 m diabase D class, 5.0 m- rock(limestone CLH class)
10	91.7	Embankment failure, collapse	0-7.0 m talus deposits, 7.0m- rock(diabase, limestone CLL/CLH class)
11	107.0	Landslide	0-4.0 m mass, 4.0 m- rock(fractured)
12	108.3	Landslide	0-4.0 m mass, 4.0 m- rock(limestone)
13	108.5	Landslide	0-4.0 m mass, 4.0 m- rock(limestone)
14	Mola A1	Bridge foundation	0-13.5 m sand/gravel
15	Mola P	Bridge foundation	0-16 m sand/gravel, 16 m- tuff, 19.8m- N value of more than 50
16	Mola A2	Bridge foundation	0-15.5 m sand/gravel, 15.5 m- tuff, 19.8m- N value of more than 50

(4) Geo-technical assessment

In this study the soil and rock in the project area are classified into the following three classes based on rock facies and N values. Rock classifications are on the basis of criteria developed by CRIEP (Tanaka, 1964) as follows. See attached boring logs and Swedish penetration test data sheets (see attached boring logs and Swedish penetration test data sheets).

D class: Clayey and sandy materials with soft rock fragments

CL class: Soft rock by weathering (CL class was further divided into CLL and CLH class based on N values.)

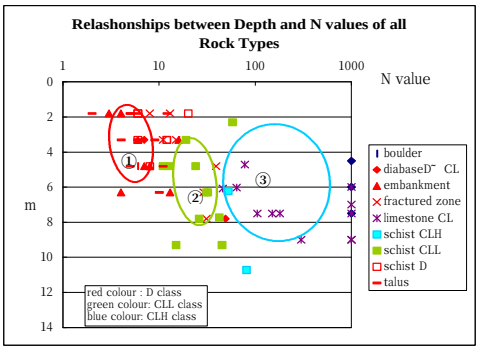


Figure-2.16 Geological Conditions, N-value and Distinction

① Collapsing materials, residual soil, completely weathered rock, fractured zone (D class);

N value: 5 - 7 (wide variations)

Standard penetration tests were not carried out at the just point of sliding plane. According to Swedish sounding data of the sliding plane, N values were estimated to be less than 3.

② Highly weathered rock (CLL), embankment (stable); N value: 15 - 20

③ Slightly weathered rock (CLH class); N value: more than 50

In general, since sandy soil of N values of more than 20 or cohesive soil of more than 10 - 15 are suitable in bearing capacity for concrete retaining wall, layer ③ will be adequate. Layer ② will be also a foundation, after geotechnical inspection for each wall.

Gabions or mortar masonry retaining walls of less than 3 meters high do not need to rest on rock foundation because of their required bearing capacity. However they are expected to rest on layer ② or ③, because many uneven settlement points of the existing gabions in the project area were observed according to site inspection.

Each Stratum Test Result became as below.

Table-2.17 Geological Investigation Result (Average Value)

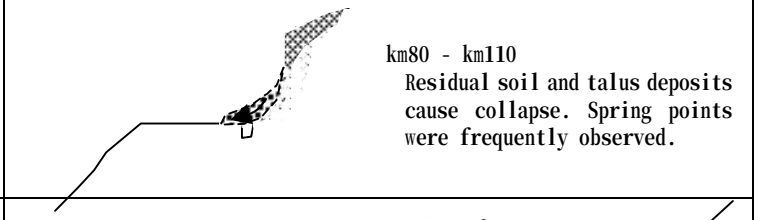
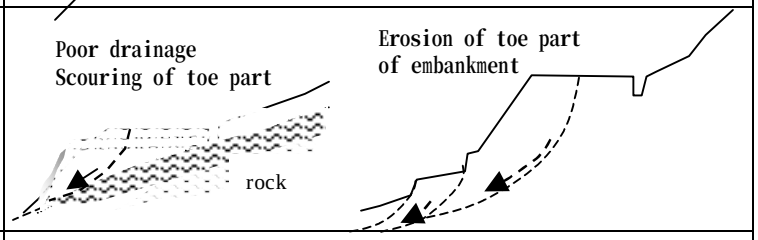
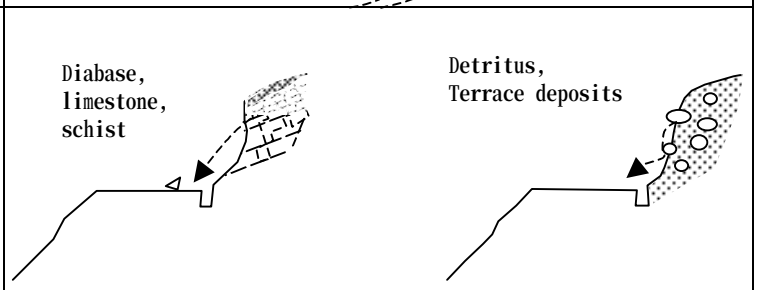
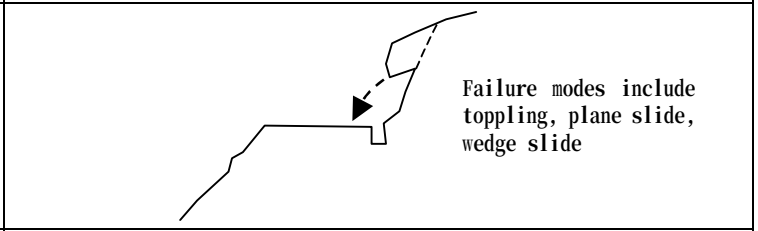
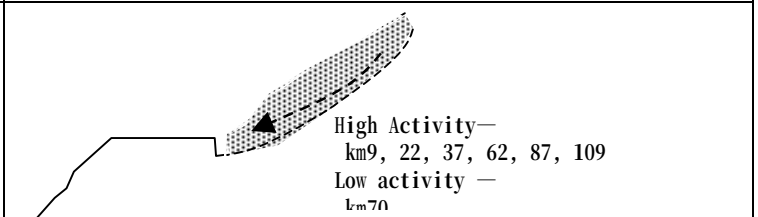
Geology	N-value(Boring)	N-value estimated by Swedish sounding (Sws)
①layer (collapse and embankment failure materials)*		
Soil, talus deposits, completely weathered rock (D class)	7.8（29）, standard deviation 4.1	5.1
Embankment failure	—	4.7
Fractured zone (D class)	10.5（2）	4.9
Sliding plane		Less than 3
②layer (weathered zone/ stable unconsolidated deposits)		
Detritus (Pleistocene)	—	19.2
Terrace deposits	—	13.5
Schist rock (CLL class)	28.3（12）, standard deviation 14.2	14
Embankment (stable)	—	27
Fractured zone (CLL class)	33（3）	14.2
③layer (foundation)		
Schist rock (CLH class)	66.4（2）	More than 50
Limestone (CLH class)	More than 46 （Not penetrated at 5 sites in 13）	More than 50

Note: Figure in parenthesis shows quantities of penetration tests.

(5) Disaster type

Disasters in the project area are classified into three types shown below.

Table-2.18 Type of Slope Failure

Type	Schematic Illustration
Collapse Collapsing materials are residual soils, completely weathered or well jointed rocks. 1-2 m thick Size is generally less than 500 m^3.	
Embankment failure Slope failure in embankment Slump or collapse of slope and settlement of road surface	
Rock fall General rock fall size of is as follows. Dili-Maubisse Schist less than 10cm. Diabase (intercalated in schist) 20-50 cm Maubisse-Cassa Limestone 20-50 cm Detritus/Terrace 10-30 cm	
Rock mass failure General rock mass size is as follows. Dili-Maubisse Diabase 2-5 m^3 Maubisse-Ainaro Limestone 5m^3-more than 100m^3	
Landslide Materials are clayey soils and highly weathered rock.	
Others ① km60(bridge) left bank Fractured zone causes collapse. ② km84 - km109 Mud flow from small valleys. ③ km120 - Cassa Overflow at side ditches and flood by strong rain damage road base course.	

(6) Geology and Disaster type of the project area

Geology and disaster type are summarized in the following table.

Table-2.19 Geology and Disaster Type of the Project Area

No	Distance from Dili (km)	Distance (km)	Topography	Geology	Disaster type
1	0 (Dili) - 20	0 - 2	**Alluvial Plain**	**Recent river deposits**: Sand and gravel, loose	-
		2 - 20	**Mountains** Steep slope	**Schist**: The rock mass is somewhat softened by weathering. km2 – km15 relatively fresh km15 - km20 highly weathered	Collapse, rock fall and embankment failure
2	20 - 46(Aileu) - 60	20 - 43	**Hills** Gentle slope	**Schist**: The rock mass is soften by weathering, partly soil.	Collapse, rock fall, embankment failure. km23 - km29 relatively large scale collapse km30 - km43 collapse (2-3 m high) Embankment failure, settlement of road surface (km23 - km25 etc.)
		43 - 51	**Basin** Flat-gentle slope	**Resent river deposits**: Sand and gravel, loose **Terrace deposits**: Sand and gravel, dense	-
		51 - 60	**Hills** Gentle slope	**Schist**: The rock mass is somewhat softened by weathering.	Collapse, rock fall, embankment failure and settlement of road surface
3	60 - 71(Maubisse) - 83 (divide) - 84 (Aituto)	60 - 69	**Hills** Gentle slope	**Schist**: The rock mass is softened by weathering, partly soil. Partly fractured. 66-68 km Boulders of limestone are scattered.	Collapse, rock fall, embankment failure and settlement of road surface
		69 - 82	**Hills-Mountains**	**Schist**: The rock mass is somewhat softened by weathering. This formation contains much intercalated diabase block.	Collapse, rock fall, The landslide at Maubisse was observed not to be active..
		82 - 84	Mountains-Hills(divide)	**Limestone**: Fresh and hard, crack spacing 20-30 cm.	Collapse, rock fall km83 large embankment failure
4	84 - 109 (Ainaro) - 125	84 - 109	Mountains Steep slope	**Limestone**: Fresh and hard, crack spacing 20-30 cm. km94 - 99, massive and hard. **Detritus(Pleistocene)**: Very stiff soil matrix, include fragments of limestone.	Collapse, rock fall, debris flow km89 and km91 large embankment failure km109 landslide
		109 - 116	High terrace	**Terrace deposits**: Sand and gravel, extremely dense.	km114 - km116 Collapse
		116 - 125	Middle-Low terrace	**Terrace deposits**: Sand and gravel, dense	Drainage ditch's overflow Flood Partly settlement of road surface.
5	125 - 130 (Cassa) - 146 (MoLa Bridge) - 170	125 - 170	Boundary hills and alluvial plain	**Recent river deposits**: Sand and gravel, loose Mola Bridge is located on the alluvial fan of the Mola River. The fan sediments, somewhat dense, contain gravel of 20 - 30 cm in diameter.	Drainage ditch's overflow Flood Partly settlement of road surface
6	170 - 180(Suai)	170 - 180	Alluvial plain	**Recent river deposits**: Sand and gravel, loose.	Drainage ditche's overflow Flood Partly settlement of road surface

(7) Mola Bridge Foundation

The Mola Bridge is located on the top of alluvial fan of the Mola River. The riverbed is approximate 750 m wide. The broad alluvial plain spreads on the downstream of the Mola Bridge. The tuff layer 20 m below the surface is suitable for the foundation of the Mola Bridge. The geology and geotechnical assessment of the Mola Bridge site is as follows;

Depth	Geology
0 -10 m	Silty gravel with sand, 2 - 3 cm (average), 20 - 30 cm (maximum), Gravel ratio ranges 50 - 70 %, N values range 20 - 30 (average), dense, 5 - 10 m Silty and gravel ratio less than 50 %
10 -14 m	Sandy silt with gravel to Gravelly silt, Gravel ratio ranges 30 - 50 %, N value is approximate 10, moderately loose, This layer thins toward the right side gradually.
14 -16 m	Silty gravel with sand, 2 - 3 cm (average), 20 - 30 cm (maximum) N value is approximate 30, dense.
16 m-	Tuff This layer shows the feature of very stiff gravely clay because it has fractured, 16 - 17 m highly weathered, moderately loose (N value is 12)
20 m-	N value is more than 50. This layer is suitable for foundation of the Mola Bridge.

Boring core sample of the foundation of the Mola Bridge

Photo-2.10 Core Sample

(8) Laboratory Test

Locations of the laboratory test for base/subbase course materials and subgrade materials as below.

Table-2.20 Original Location Sampling and Geological Condition

No.	STA/ Side*	South latitude/ East longitude	Elevation	Object	Geology
A1-A2	120.0/ Right	9°3.596/ 125°31.385	298m	Base course materials	A1: km120 riverbed A2: Quarry at Dili
S1	39.7/ Left	8°41.285/ 125°32.846	1160m	Subgrade materials	Highly weathered schist, no groundwater
S1	39.7/ Left	8°41.285/ 125°32.846	1160m	ditto	Ditto
S2	83.1/ Left	8°52.799/ 125°36.128	1300m	ditto	Subgrade material, no groundwater
S3	91.9/	8°54.970/ 125°34.688	1360m	ditto	Subgrade materials, relatively flat gravels, no groundwater
S4	99.1/ Right	8°56.367/ 125°32.548	994m	ditto	Detritus, no groundwater.
S5	113.8/ Right	9°1.692/ 125°30.292	617m	ditto	Soil (Terrace deposits), no groundwater
S6	126.5/ Right	9°6.548/ 125°32.031	172m	ditto	Recent river deposits, groundwater was observed.

Note: Side of right or left is fixed from Dili side. Coordinates were measured by handy GPS.

1) Base/Subbase course materials

The sample of km120 riverbed is mainly composed of limestone. Its quality is suitable for the base course materials. The sample of the quarry at Dili is also suitable although some sample of fine aggregates slightly exceed the standard. Because the quarry at Dili varies by samples, quality checking will be required.

Table-2.21 Mechanical Properties of Base/Subbase Course Materials

Location	Absorption (%)		Bulk density (coarse) (g/cm^3)	Soundness Test (%)	Los Angels Abrasion test 400 revolutions (%)
	Coarse	fine			
km120 Riverbed	0.58～0.72		2.67～2.68	2.72	20.51～28.27
Quarry at Dili	1.14～1.93	2.30～3.36	2.58～2.95	2.69～3.06	18.3～30.29
Standard value*	3.0 and under	3.0 and under	2.45 and over	12 and under	35 and under

*) Standard values are from JIS-A5001.

Design CBR values are estimated as shown below.

Table-2.22 Design CBR Values

Location	CBR (average) ①	Standard deviation ②	CBR (①－②)	Design CBR
km120 Riverbed	56.9	15.9	41.0	20
Quarry at Dili	28.4	21.9	6.5	6

2) Subgrade materials

The results of CBR test were shown below.

Table-2.23 Result of CBR Test

Location	12 blows		26 blows		55 blows	
	0.1 in	0.2 in	0.1 in	0.2 in	0.1 in	0.2 in
S1	21.89	27.15	22.65	30.20	39.42	44.72
S2**	13.44	11.47	7.41	14.38	17.86	19.31
S3	12.78	15.83	20.91	19.60	22.22	20.47
S4		9.206		6.33		10.7
S5	10.42	20.33	25.70	27.44	34.63	34.56
S6	17.30	12.27	20.47	16.12	31.58	26.57

**) Sample S2 is adjusted as zero point

Modified CBR values were estimated below.

Table 2.24 Modified CBR values

Location	Optimum Moisture Content (%)	Dry density max (g/cm^3)	CBR (%)	
			Dry density max 90%	Dry density max 95%
S1	15.323	1.833	28.4	33.9
S2	13.435	1.794	4.7*	9.9*
S3	12.778	1.859	14.5*	17.7*
S4	7.368	2.219	9.6*	10.1*
S5	10.420	1.949	24	29.8
S6	17.302	1.639	16.6*	20.8*

Note: S2, S3, S4 and S6 are used as reference, because blow numbers of the test are different from JIS standard.

2-2-1-3 Policy for Socioeconomic Condition

Timor-Leste, after his independence in May 20, 2002, has strengthened the nation-building effort under the assistance of international community, but state finance mostly depends upon foreign donors. 90% of fiscal expenditure in 2002 was financed by such donors.

Timor-Leste has 13 prefectures and a national population of 787,000 as affected population (Table-2.25). Among the total population of 884,000 in 1998, 85% people were regional residents before the civil commotion erupted. Following this civil commotion triggered by disruption of the direct balloting, around 50% of the nation was forced to migrated. Refugees returned after calming down of commotion and population rebounded up to 787,000 in 2001. Roads in this study (180 km) start from Dili and reach Suai after passing through 3 prefectures (Aileu, Ainaro, Cova Lima) where population is 246,628 (Table-2.25).

Main industry, on the other hand, in Timor-Leste is agriculture and fishery, including coffee cultivation, which is the only export commodity in this country, and in which three fourth of total population is involved in this industry. However, agricultural products reached only 26.5% of the GNP in 2001 and low productivity in agricultural sector is the cause of poverty. 30% of households are under the poverty line which is almost 2 times that of Indonesia. Therefore this country cannot maintain self-sufficiency and still rely on import of rice, flour, maize and sugar.

Table-2.25 Population in Each Prefecture (after Survey in Early 2001)

		Population (persons)			Population density	Number of
		Females	Males	Total	(persons per km2)	households
01	Aileu	15,615	16,211	31,827	44	6,780
02	Ainaro	22,410	22,682	45,093	56	9,683
03	Baucau	50,721	50,796	101,517	68	23,490
04	Bobonaro	35,079	34,853	69,932	51	15,431
05	Cova Lima	24,178	25,056	49,234	40	10,788
06	Dili	57,080	63,394	120,474	324	19,944
07	Ermera	43,630	44,785	88,415	119	18,112
08	Liquica	22,461	23,114	45,575	83	9,374
09	Lautem	26,739	26,727	53,467	31	12,713
10	Manufahi	18,774	19,842	38,616	29	7,591
11	Manatuto	17,652	17,793	35,446	21	8,136
12	Oecussi	23,307	21,735	45,042	55	11,355
13	Viqueque	31,289	31,415	62,704	35	14,038
East Timor		388,935	398,405	787,340	54	167,435

Source : The 2001 Survey of Sucos by ETTA, ADB, UNDP in Oct. 2001

The drop of GDP to US$ 391 million in 2002 from US$ 402 million in 2001 corresponds to drop of GDP to US$467 per capita in 2002 from US$ 494 per capita in 2001 (see Table-2.26).

Timor-Leste is one of the poorest nations in Southeast Asia and has serious problems of analphabet, dystrophia, tuberculosis etc. Therefore, enhancing transportation and distribution of goods by this project is vital to improve the economy and develop this country.

Table-2.26 GNP and GDP of Timor-Leste

	1999	2000	2001	2002(Expected)
GNP	US$ 270 Million	US$ 326 Million	US$ 402 Million	US$ 391 Million
GDP	270	321	389	368
Petro. Revenue	0	5	13	23
GDP per capita	-	-	US$ 494 Million	US$ 467 Million

Source : Data provided by the Timor Leste authorities; and IMF staff estimates.

The major food crops for Timor-Leste are corn, rice, cassava, and sweet potato. These 4 crops account for 68% of agricultural products (see Table-2-27). Consumption for principal foods is 270 kg per year. The production of major food crops increased by 3% for rice, 7% for cassava and 300% for sweet potato comparing 1992 and 2002, meanwhile, decreased by 27% for corn. The total products of crops increased only by 1% comparing 1992 and 2002. Ainaro prefecture produces 15% of total production of coffee bean and Aileu prefecture produces 1%. 16.6% of total crops are produced in Ainaro, Dili, Aileu and Cova Lima prefectures. 21% of crop production of rice & corn is produced in Ainaro, Aileu and Cova Lima prefectures.

Table-2.27 Crop Production (1992 & 2002) and Yield in Timor-Leste

Crops	Production(ton)		Percent (%)	Area (Ha)	Percent (%)	Yield (ton/Ha)
	1992	2002				
Goro Rice	56,300	3,552	1	3,417	1	1.04
Lowland Rice		54,304	17	35,318	7	2.54
Maize (Corn)	94,000	68,959	22	121,335	23	0.57
Cassave	51,500	55,349	18	91,067	17	0.61
Coffee Cherries	-	26,944	9	88,823	17	0.30
Coffee Dry Bean	-	14,984	5	28,981	5	0.52
Sweet Potato	10,400	31,663	10	67,137	13	0.47
Taro	-	13,500	4	28,912	5	0.47
Banana	-	19,371	6	17,892	3	1.07
Other	-	25,527	8	45,211	9	-
Total	-	313,651	100	528,093	100	-

Timorese draw their primary income from agriculture (94%), fishery (1%) and others (4%). They draw their secondary income from agriculture (8%), fishery (11%) and others (66%). The average daily wage for common labor is US$3.10.

2-2-1-4 Policy for Construction Condition and Procurement Condition

(1) Transportation Route for Material and Equipment

The shortest route from Dili port to Ainaro town, as the construction base, is the route through Maubisse at a distance of 110 km; however, the route crosses beyond the mountain of 1,800 m height with narrow road width and sharp curves. There is an alternative route from Dili port to Ainaro town that goes along north coast near the border by West Timor, going inland through Maliana town, Zumalai town and Mola Bridge. This route is a roundabout way with a total distance of 244 km, but crossing mountains of lower 700 – 800 m height and gentler bends that will allow 20-ton trailer trucks to pass easier. The trailer trucks cannot pass on the way toward Ainaro that is planned to be a construction base in the project, because the road width between km83 and km110 is as narrow as 3.5 – 5.0 m and several bends are composed of small radius of curvature of less than 10 m; thus, only 4-ton truck as a maximum vehicle can pass the route. Ordinary material and equipment will be transported through this route by 4-ton truck, but it will become possible if potholes etc. in the existing road are restored before transportation of material and equipment.

Large-scale equipment and large quantity material will be transported from Dili through Liquica, Batugade, Maliana, Bobonaro, Zumalai and Mola Bridge by 20-ton trailer truck. This route does not include bends with small radius of curvature but some slopes are steep with a gradient of more than 10% and are also composed of several caves.

Temporary access road including corrugated metal pipes should be installed for Mola Bridge rehabilitation before use for transportation by trailer trucks because there are soft ground points in the riverbed and right bank side of the Mola River.

Another route option is from Dili port through marine transportation toward eastern sea route to Suai town; however, the southern coast is shallow and normal cargo ships cannot come alongside the coast. Landing Craft Tank (LCT) type ship may be possible to land and to unload cargo, but even LCT ship needs a simple temporary jetty and also the unloading work is limited to a few hours a day during high tide. It will be impracticable to use this route since navigation is impossible due to strong winds from January to April. Equipment was selected so that transportation of equipment would be possible by 20-ton trailer truck; thus, land transportation is planned for construction. The route of land transportation is shown in Figure-2.17.

Table-2.28 Related Information for Each Route

Transportation	Route Length	Highest EL.	Vehicle	Type of Cargo
Dili-Maubisse-Ainaro	110 km	1,800 m	4-ton Dump Truck	Common Material and Common Equipment
Dili-Maliana-Ainaro	244 km	800 m	20-tonTrailer Truck	Large Quantity Material, Large Scaled Equipment

(2) Diversion under Construction

A. Mola Bridge

Vehicles are now crossing Mola River using the existing truss bridge of 180 m at left bank side within the Mola River of 400 m width and crossing riverbed of Mola river. Temporary diversion is required when the Mola Bridge is rehabilitated because the existing bridge will be closed for construction of new abutment at Dili side. Temporary diversion by soil dike with corrugated metal pipes (D=1800) and with surface protection by sandbags, will be installed at 20–30 m upstream side of the bridge since the river water flow will be extremely decreased in the dry season. Meanwhile, the river water flow will suddenly increase in the rainy season and the temporary diversion may possibly collapse, so the temporary diversion will be relocated by restoration of existing dike as before.

B. Diversion between km83-km110

The road of this section passes mountainous district and there are many narrow parts where road width is 3.5-5.0 m. Therefore, pavement construction closing one side traffic is impractical and construction method with full-scale road closure should be considered. A plan of full-scale road closure for each time zone is examined so as not to obstruct the regular service (4 times in the daytime) of public bus considering the existing traffic volume of less than 100 per day, as shown in Figure-2.18 and Table-2.29.

This traffic control plan has been preliminary approved by Mr. J. B. F. Alves, the State Secretary, and Mr. Jose Piedade, the Director General, of MTCPW. Passing places will be necessary for construction machines such as asphalt finisher or macadam roller, etc., in order to conduct traffic control during the pavement construction. The passing places with the size of 20 m length and 2 m width with the interval of about 500 m will be installed if necessary to meet the traffic demand of mid-size truck (4-ton) in the future.

C. Other Sections

Pavement construction closing one side traffic is possible except for km83 – km110 section because the pavement width is 4.5 m and shoulder width is 1.0 m in other sections. Flagmen will be placed adequately for safety purposes and traffic for general & private vehicles will be regularly secured.

Figure-2.17 Transportation Route for Material and Equipment

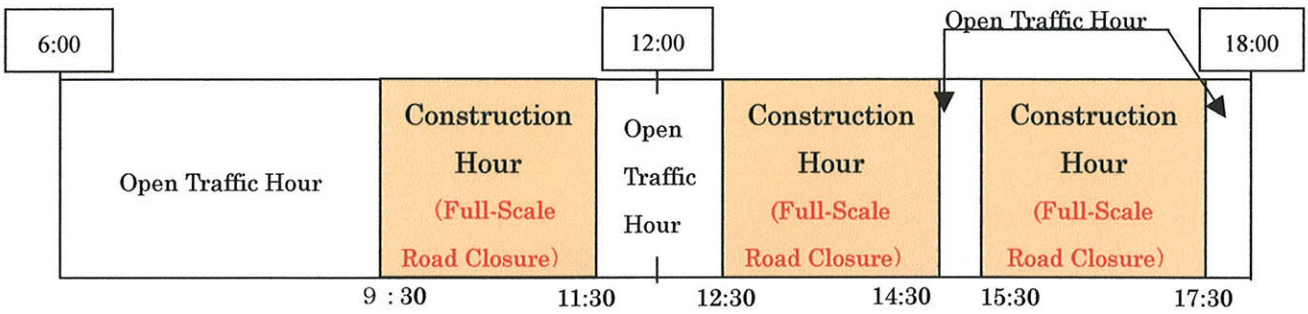


Figure-2.18 Time Zone for Full-Scale Road Closure

Table-2.29 Traffic Control Plan for Full-Scale Road Closure

Time Schedule for Full-Scale Road Closure						
Start of Closure		End of Closure	Duration	Open Traffic Hour		
			9 hrs 30 min	0:00	~	9:30
9:30	~	11:30	2 hours			
			1 hour	11:30	~	12:30
12:30	~	14:30	2 hours			
			1 hour	14:30	~	15:30
15:30	~	17:30	2 hours			
			6 hrs 30 min	17:30	~	24:00

(3) Policy for Procurement

A. Material Situation

All manufactured products are imported into Timor-Leste because there is no manufacturing factory in the country. Ordinary construction materials are imported from Indonesia, Australia and Singapore, and they are sold in Timor-Leste even though the quantity is small. There is no precedent where construction was obstructed by lack of material. Meanwhile, special materials such as steel pipe pile, superstructure material for bridge, plant facilities, testing equipment and so on, do not have a local dealer in Timor-Leste and hence should be imported from Indonesia or Japan.

B. Situation of Construction Equipment and Facilities

As for the equipment situation in Timor-Leste, almost all of the ordinary construction equipment are available by leasing since there is a great demand of construction equipment for many urgent rehabilitation projects by UNTAET.

The purchase situation of construction equipment, however, is still at a quite expensive level, even now, since the demand of rehabilitation projects after the conflict raised the market price of imported equipment before starting of lease business. Prices of personnel expenses and groceries are more expensive in Timor-Leste than neighboring Indonesia, being influenced by a steep rise in prices for foreigners or local UN staff wage after the implementation of social rehabilitation initiated by UNTAET. Considering the above-mentioned conditions, it is not probable that the high price for lease equipment is going down in the short term.

It is possible to purchase construction equipment or plant facilities in Indonesia; however, it will be basically more expensive than in Japan because they are imported first. Special material such as plant facilities or testing equipment will be imported from Japan. However, in case of special equipment like a piling machine, which will be used during a short period of 2-3 months, purchase from Indonesia, even with higher lease fee, shall be chosen because of no regular cargo ship service and unrealistic transportation cost by charter ship.

C. Workers Condition

The unemployment rate exceeds 70% in the city area of Timor-Leste, and workers are in oversupply condition. However, jobs which needed special knowledge and technology were mostly occupied by Indonesians before the conflict, so there are still very few numbers of local engineers or skilled technical workers in the country. Engineers or skilled technical workers mostly are Australian and Filipino in the rehabilitation projects under UN. Meanwhile, the Indonesian people are frightened by the afterimage of conflict and they hesitate to work in Timor-Leste, so it is very hard to find the Indonesian engineers or technical skilled workers working in the construction site.

Most workers are unemployed and are suffering from hardship of life, but they are not willing to work on holidays, even short-term labors or car drivers. It is a local custom to employ site workers from the neighboring community because local sectionalism is very strong. Therefore, residents do not need to be anxious about being dismissed, and they are not willing to work hard or improve productivity; hence, their productivity becomes very poor.

It is necessary to abolish such a custom of sectionalism in the community to make the people have more spirit of competition but it will be very hard to put into practice. Thus, it is more desirable to encourage residents to increase technical skill with improvement of their employment conditions by training, education and raising the level for local engineers & skilled technical workers.

2-2-1-5 Policy for Application of Local Contractors

There are about 10 companies, which can receive contract orders of public works and possess more than one engineer, in Timor-Leste. All of them are capitalized in Australia or Singapore and none of them is a 100% capitalized in Timor-Leste. There are 4 Japanese contractors undertaking contracts in Timor-Leste, as of June 2003: Tobishima, Dai Nippon, Toa and Wakachiku Corporations. Road, irrigation and port facility construction are major contracts in Timor-Leste until now, and none of bridge construction has been ordered after the conflict. Pavement, drainage (stone pitching ditch), slope protection (gabion block and stone masonry retaining wall), small concrete structure and embankment are the typical classifications of implemented works.

Each company has an office in Dili city and its concrete plant, crushing plant and asphalt plant are also placed only in Dili city. Material suppliers and equipment lease companies are also concentrated in Dili city. Construction in rural area, 200–300 km as the furthest case, is implemented by running a site office and temporary facilities on site with a base in Dili city.

2-2-1-6 Policy for Operation & Maintenance by Implementation Organization

(1) Implementation Organization of Recipient Country

Execution agency to implement this project is Ministry of Transportation, Communication and Public Works (MTCPW) and its organization is shown in Figure-2.19. Three sections, power & water, public works and transport & communication, are arranged under the minister, vice minister and secretary state in MTCPW (see Figure-2.19). Public works, roads/bridges & flood protection, and equipment & asset management sections are arranged within the public works department. Plan and design, disaster prevention, operation and maintenance and administration sections and their staffs are arranged within the department of roads, bridges and flood control (DRBFC). Equipment & asset management section was newly arranged to utilize the remaining assets of PKF.

(2) Budget of Recipient Country

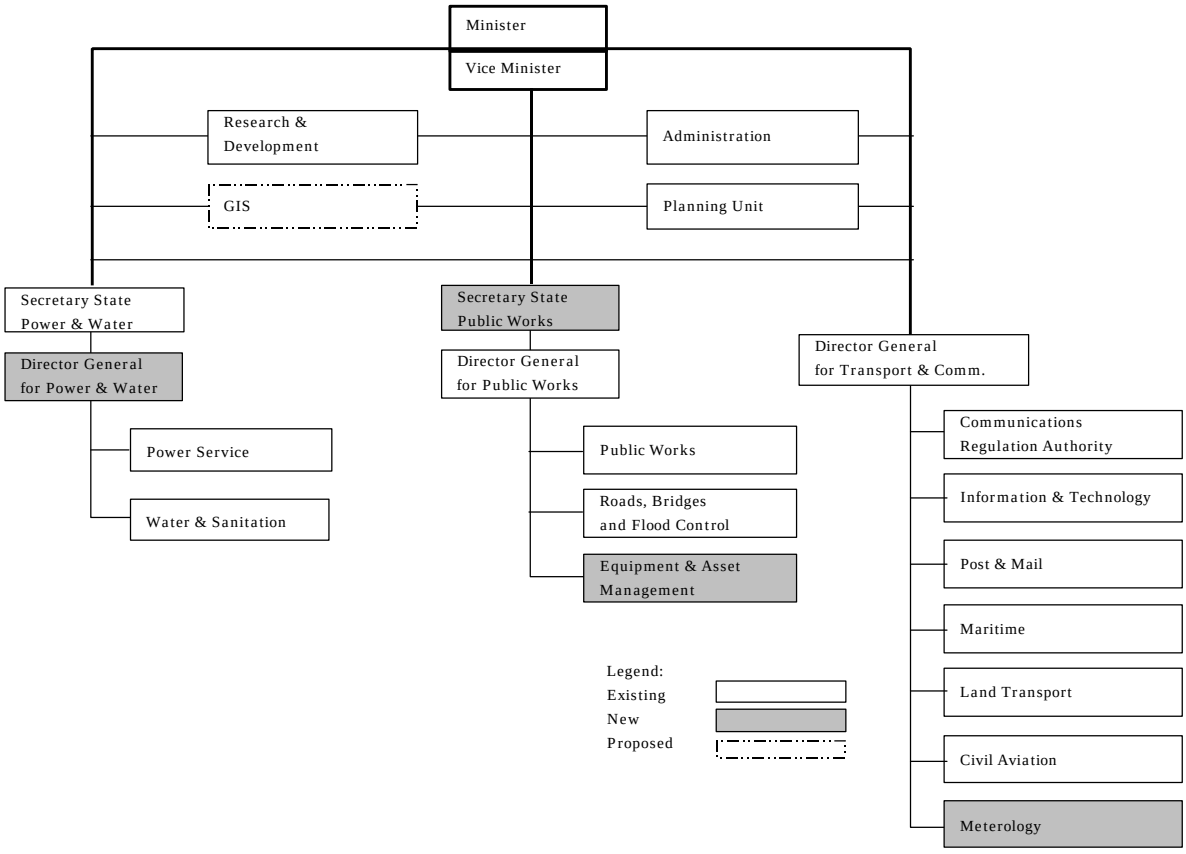
Budget of MTCPW, Public Works Department and DRBFC is as shown in Table-2.30. Budged of Timor-Leste is closely tied up with National Development Plan formulated in May 2002 and is given the priority to education, health care and nutrition improvement sectors. Budget for personal expense, operating expense and project cost (CFET) is US$ 11.199 million and 15% of state budget. Among the budget of MTCPW, 49% is allocated to Public Works Department. 43% of Public Works Department budget is allocated to DBRFC.

Table-2.30 Budget for Road Maintenance and Operation

		Y2001	%	Y2002	%	Y2003	%	Y2004	%	Y2005	%	Total 02-05
A	National Budget	3,817		74,282		80,050		92,921		102,412		349,561
B	MTCPW (B/A)	12,018	22	11,199	15	10,634	13	10,408	11	7,600	7	39,841
C	Public Works Department(C/B)	4,762	40	5,467	49	5,467	51	5,490	53	5,986	79	22,412
D	DBRFC (D/C)	2,288	48	2,351	43	2,543	47	2,769	50	3,018	50	10,682

Unit : 1,000US$

ORGANIZATION CHART OF MINISTRY OF TRANSPORT, COMMUNICAITON & PUBLIC WORKS



Note:
a] Administrative function of Facilities Unit under Directorate of Administration
b] Administrative function of Government Transport under Directorate of Equipment

ORGANIZATION CHART OF THE DIRECTORATE OF PUBLIC WORKS

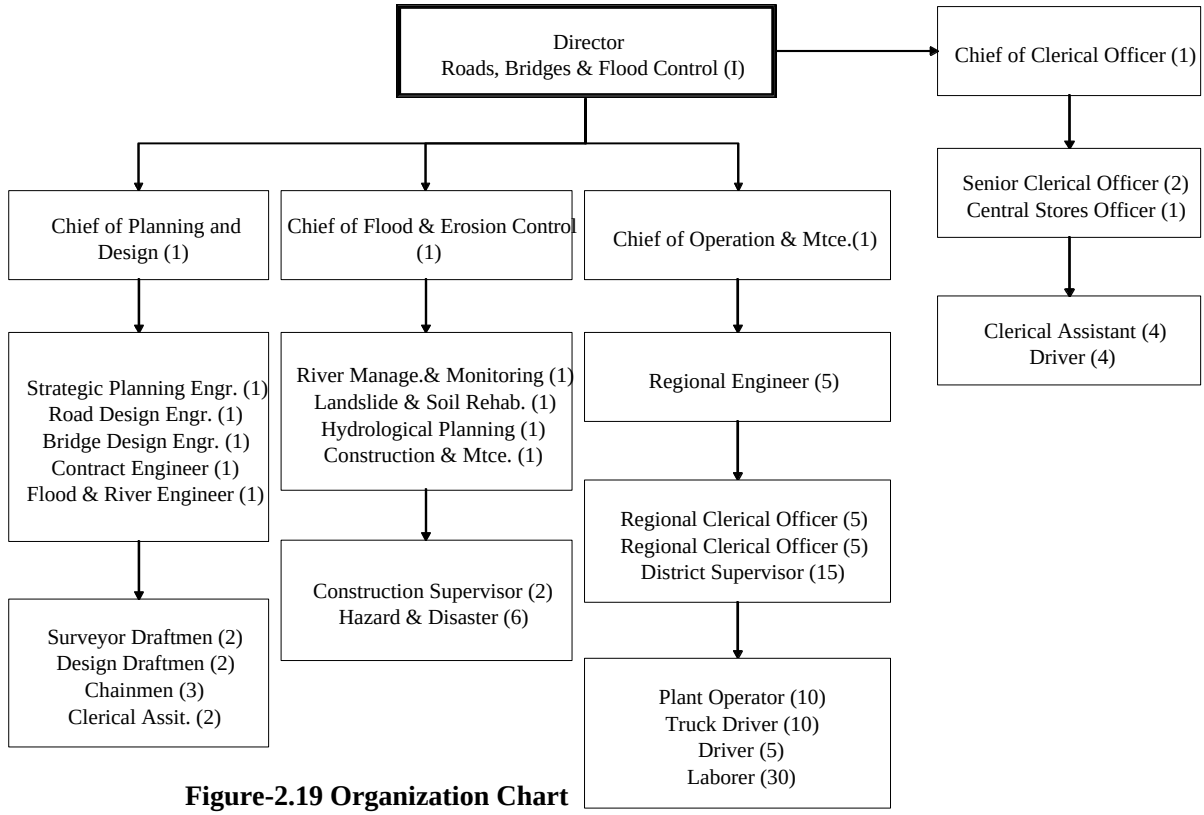


Figure-2.19 Organization Chart

2-2-1-7 Policy for Improvement Grade for Facilities

Grade of improvement for the objects of roads and bridges are summarized as shown in Table-2.31 hereunder.

Table-2.31 Summary of Improvement Grade

Section		Existing Condition	Policy of Improvement
ROAD	Aituto - Cassa (km79 - km130)	<Pavement> Many unpaved & damaged sections and cave-ins by landslides from km79 to km110. It is impossible for some passenger cars (sedan type) to pass this section <Drainage> More side ditches are installed than the other sections but side ditch & cross pipe are still insufficient in some sections. <Slope> There are many continuous slope failures at mountainside. Valley side is relatively under stable condition but widening by retaining structures are necessary to secure the road width.	Pavement for unpaved area and cave-ins & damaged locations for almost all lines. Overlay for surface is also necessary. Installation of side ditches and cross pipes for about 25 km section. Stone masonry retaining wall for mountainside slope, and gabion blocks for valley side slope for about 8 km sections.
	Dili - Aileu (km2 - km45)	<Pavement> Asphalt pavement constructed in Indonesia era is still almost functioning. Average road width of 4.5 m is kept. <Drainage> Side ditch & cross drainage are not installed for almost all this section. <Slope> Collapsing and dangerous slopes exist. The cave-ins at km40 was restored by JEG.	Pavement for partial unpaved area and patching for damaged area. Installation of side ditches and cross pipes for about 30 km section. Stone masonry retaining wall for mountainside slope, and gabion blocks for valley side slope for 11 locations.
BRIDGE	km60.3 Bridge	Serious damage is on the partition wall by ground settlement and scouring. Collapse is possibly expected.	There is no land acquisition problem. Bridge beam should be examined carefully about type (RC slab) and location (L=10.5m).
	Mola Bridge (km146)	Driving and crossing in the river is necessary. It is impossible for some passenger cars (sedan type) and people to pass the river when raining.	Land acquisition (right bank), scale of flood, method of construction and cost cutback should be considered for bridge type (4 span steel truss; L=239 m).

2-2-1-8 Policy for Method of Construction, Procurement and Construction Period

(1) Workable Ratio and Countermeasure for Rainy Season

Climate in Timor-Leste is classified into the dry season from July to November and the rainy season from December to June. Rain is very seldom in the dry season and rivers are dried up; thus, it becomes very difficult to obtain industrial water on site. Meanwhile, it rains heavily more than 200 mm per day or 50 mm per hour several times every year. Because of its steep topography and short river length, rivers swell suddenly and mudflow & slope failure occur in various districts. Earthwork that produces unstable cut surface and/or foundation work for bridge pier should not be implemented during the rainy season. Countermeasures should be taken into account for rainfall if works are conducted through unavoidable circumstances in rainy season.

Workable days ratio should be examined considering divisions of rainy and dry seasons when preparing schedules. The workable days ratio is computed separately for mountainous districts and Mola Bridge because rainfall characteristics are different among Dili side (north area), mountainous districts and Mola side (southern area).

(2) Planning for Site Office and Plant Base

Site office and plant bases are assumed as shown below considering the optimum conditions for transport distance and environmental problems.

	Site Area	Proprietor	Location
① Ainaro Road Office	8,000 m2	Ainaro Pref.	km110
② Asphalt Plant	7,500 m2	Ainaro Pref.	km111
③ Crushing Plant	8,000 m2	Cova Lima Pref.	km120
④ Concrete Plant	2,500 m2	Cova Lima Pref.	km146
⑤ Mola Bridge Office	2,500 m2	Cova Lima Pref.	km146

Telephone is available only in Suai and Baucau cities, besides Dili city. Only 60 areas are electrified in the country; moreover, electric power supply is mostly limited only for 5 or 6 hours at night. Cave-ins and faulting because of pavement damage and insufficient road maintenance obstruct passenger cars. Huge intensity of rainfall in rainy season and defective installation of drainage produces failures on slope & road shoulder at each heavy rain.

Many bridges are destroyed and little bridges are installed on rivers. Vehicles cross rivers passing on the riverbed in the dry season because most rivers dry up at that time. Meanwhile, rivers swell by small rainfall in the rainy season and this makes traffic impassable. It is more frequently seen in the southern districts where road maintenance is scarce. Existing condition of lifeline in Timor-Leste is very poor except in Dili City. Road maintenance for transportation route at an early stage, industrial water to secure for preparation of site office & plant, and arrangement of power plant are necessary for implementation of rehabilitation project. Communication tools are also required in rural site area like a satellite phone or receiving apparatus for satellite broadcasting because of no telephone utility.

(3) Countermeasure for Narrow Working Condition (km83 – km110)

Project road from km83 to km110 was developed on steep hill by cutting & embankment and the effective road width is so narrow that the minimum is 3.5 m. However, road widening will not be implemented basically in the project. Therefore, transportation vehicles mainly will be 4-ton trucks because of the limitation of road width even though the work efficiency will be lowered. For the design of earthwork, borrow & disposal of material will be decreased as much as possible since borrow pits & disposal area cannot be found in this section. Where road surface is caved-in or road shoulder is eroded, these places are usually restored by replacement with selected material together with installation of drainage.

However, the method of construction by compaction of soil bags, being filled by selected soil used for subgrade and roadbed, will be applied for rehabilitation of the project road because of the special circumstances. The method will not need long transportation of soil material and it will create employment for residents because of manual construction. Passing places will be arranged if necessary at the minimum interval of 500 m for the purpose of traffic control under construction and smooth crossing for future traffic.

(4) Method of Construction with Consideration of Employment Creation

The unemployment rate exceeds 70% for city area at present in Timor-Leste. It is a serious social problem and the most important subject for the government of Timor-Leste. It is no exaggeration to say that the residents around the project road are expecting the project to hire them and to give them cash income. In consideration of the above social condition, labor-intensive method of construction will be introduced in the project.

Supposed Method of Construction by Labor-Intensive Mehod

①Gabion Block	Frequently applied slope protection method in Timor-Leste and the construction is possible by local residents.
②Stone Pitching (Riprap)	Side ditch is constructed by stone pitching instead of concrete U-ditch. Retaining wall is also constructed by stone masonry. It is also frequently applied in Timor-Leste.
③Soil Bag Method	Soil bag method is applied for backfill of gabion block, slope protection for access road in the river and treatment of poor subsoil. This method is simple work; packing soil in the bag, laying out and compacting the bag. Construction is possible by local residents.

(5) Length of Project and Transportation of Material

The project section widely ranges from Dili city to km150 and the rehabilitation work is concentrated on the Ainaro section between km80 and km130, and Mola bridge at km146. The project work is so distinctive that any material and equipment including imported products should be transported from Dili for about 100 km because material suppliers & lease companies are concentrated on Dili city in Timor-Leste then transportation cost becomes extremely high. Sections & length for transportation will be readjusted in order to estimate the project amount correctly and efficiently.

(6) Cement on the Market in Timor-Leste

Cement on the market in Timor-Leste is produced at Kupang, located at the West End of Timor island, and the product type is portland pozzolan cement. The strength is less than products in Surabaya or Jakarta but the price is inexpensive. Kupan cement costs US$ 70.00/ton; on the other hand, Surabaya cement costs US$ 150.00/ton.

Kupan cement is used in the construction of school buildings for the department of technology, national university of Timor-Leste, and the required strength of 25 N/mm2 is obtained even though the unit quantity of cement increases. The project for improvement of road & bridge will also adopt the economy Kupan cement and the actual result in the construction of school building for the university will be applied for the estimation of cement quantity.

	Unit Cement Weight	Water Cement Ratio	Design Strength (Trial Mix)
Design of Mix Proportion	400 kg	46%	25 N/mm2

Comparison of unit price per 1 cubic meter (cement only)

- Surabaya Cement: 0.27 x $150.00/ton = US$40.50

- Kupan Cement: 0.40 x $70.00/ton = US$28.00

Therefore, reduction of US$12.50 per 1 cubic meter of concrete will be possible.

2-2-1-9 Others (Traffic Volume Survey)

Traffic volume survey was conducted to find the existing traffic volume and to compare the result with the preliminary result (in the 1st study) at Aileu (km40), Aituto (km84) and Ainaro (km115). Vehicle type and OD (origin & destination) survey for 24hr on June 2 & 3 was conducted hourly at Aileu. Vehicle type and OD survey for 12hr on 16th April and 3rd June was conducted hourly at Aituto and Ainaro. OD and cargo contents were surveyed to vehicle drivers through interview from 9:00 to 15:00 on June 3rd at Aituto in the presence of policeman of Maubisse police station. The result of 12hr traffic survey was converted to 24hr traffic volume by the ratio of 24hr / 12hr traffic volume survey result at Aileu;(453/368).

Table-2.32 Daily Traffic Volume Result for Preliminary (1st) and Full-Scale (2nd) Survey

Route	Survey	Bike	Car, Bus, 4WD	Big Truck (>4ton)	Total (Nos./day)
Aileu (km50) –	1st	52	138	9	199
Aituto (km84)	2nd	54	72	34	160
Aituto (km84) –	1st	27	71	4	102
Ainaro (km115)	2nd	35	42	20	97
Ainaro (km115) –	1st	17	30	17	64
Cassa (km130)	2nd	26	48	11	85
Aituto (km84) –	1st	25	67	5	97
Same	2nd	19	30	20	69
Dili – Aileu	1st	177	176	100	453

Source: JICA Study Team

Traffic volume for pedestrian and vehicle also was surveyed at Mola Bridge for verification of public interest after the completion of the project as shown below;

Table-2.33 Traffic Volume Survey Result at Mola Bridge

Direction	Vehicle	Pedestrian
From Ainaro to Suai	23	274
From Suai to Ainaro	40	372
Total	63	646

Surveyed; 23 June 2003 from 6:30 to 16:00 for 2 directions hourly

2-2-2 Basic Plan (Construction Plan)

2-2-2-1 Total Plan

Rough estimation for each work item (road, km60.3 bridge, Mola Bridge) in the project is shown in Table-2.34.

Table-2.34 Rough Estimation of Quantity

Road Rehabilitation

Item / Section	Pavement				Drainage		Slope Protection	
	Base Course (m^2)	Subbase (m^2)	Overlay (m^2)	Surface (m^2)	Side Ditch (m)	Cross Pipe (Nos.)	Stone P.R.Wall (H=2m) (m^2)	Gabion Block (m^3)
Dili – Aileu (2km - 45km)	24,667	11,092	-	21,223	32,504	85	-	1,065
Aituto – Ainaro (79km–110km)	77,015	12,690	49,692	44,530	13,590	86	11,370	1,870
Ainaro - Cassa (110km-130km)	44,310	2,820	35,148	25,620	10,440	61	2,115	2,270
Total	145,992	26,602	84,840	91,373	56,534	232	14,028	5,205

Bridge Rehabilitation at km60.3

km60.3 Bridge		Unit	A1 Abutment	A2 Abutment	Total	Remarks
Superstructure	Slab Concrete	(m3)	17.3		17.3	T=50mm
	Re-Bar Weight	(kg)	3,800.0		3,800.0	
	Asphalt Pavement	(m2)	79.0		79.0	
Substructure	Concrete	(m3)	104.0	98.1	202.8	
	Re-Bar Weight	(kg)	5,762.0	5,399.0	11,162.0	
Foundation	Steel H-shape Pile	(m)	72.0	72.0	144.0	H400x400x13x21 SS400

Mola Bridge Rough Estimation Quantity

Superstructure	Unit	A1～P1	P1～P2	P2～P3	P3～A2	Total
Slab Concrete σ ck=24N/mm²	m³	101	121	121	98	441
Slab Re-Bar Weight	Kg	15,368	18,419	18,419	18,419	70,625
Girder Weight	Kg	145,508	189,858	189,858	189,858	714,787
Shoe	Nos.	4	4	4	4	16

Substructure	Unit	A1	P1	P2	P3	A2	Total
Concrete σ ck=24N/mm²	m³	621	215	233	224	227	1,520
Re-Bar Weight	Kg	41,356	17,207	18,457	18,026	12,485	107,531

Foundation	Unit	A1	P1	P2	P3	A2	Total
Steel Pipe Pile (L=16.5m, Dia=50cm)	Nos.	72	16	16	16	20	140

(1) Road Section km79 – km130

Section km79 – km130 ranges from Lauhili to Cassa for 51 km as shown in Figure-2.20.

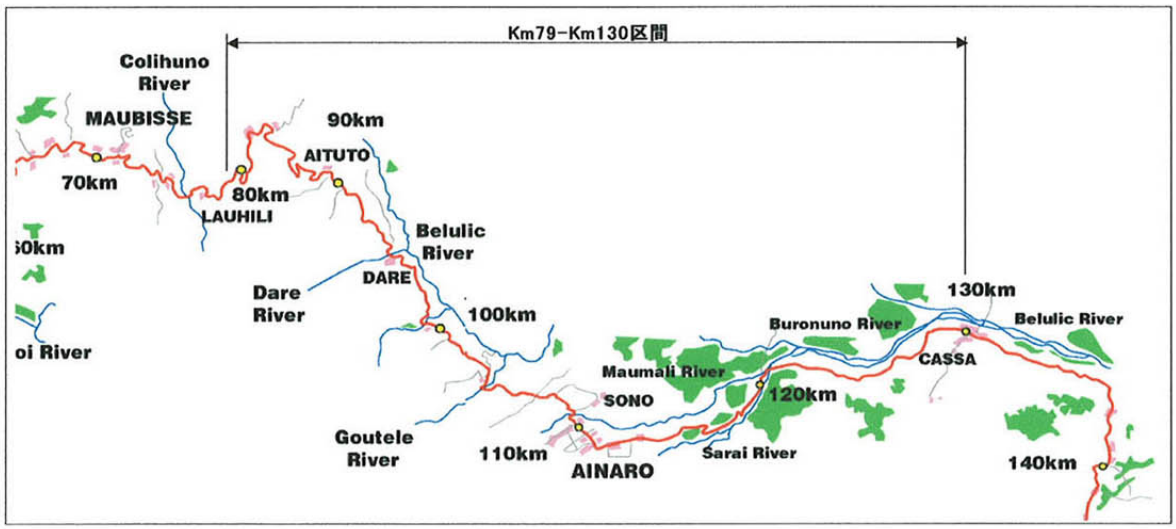


Figure-2.20 Location Map for Section km79 – km130

This section includes the most damaged area from km79 (Aituto) to km110 (Ainaro) in the project road for about 30km, also includes unpaved section and landslide locations. Summary of road conditions for this section is shown in Table-2.35.

Photo-2.11 Landslide(Valley) at km83+500

Photo-2.12 Landslide (Mountain) at km109+800

Table-2.35 Summary of Road Conditions for Section km79 – km130

Item		Road Conditions
Pavement	Surface Overlay	94,080 ㎡ (54.2%)
	Asphalt Pavement	68,085 ㎡ (39.8%)
	Unevenness	10,360 ㎡ (6.0%)
Road Width	Average Pavement Width	3.77 m
	Minimum Pavement Width	3.10 m
	Average Effective Width	5.62 m
	Minimum Effective Width	3.50 m
Drainage (Side Ditch)	Total Length	29,630 m
	Ratio of Installation	59.30%
	Average Width at Top	0.65 m
Drainage (Cross Pipe)	Total Numbers	99
	Installation Interval	505 m
	Fraction Defective	33.30%
Slope	Length of Slope Failure	4,380 m
	Ratio of Slope Failure	8.80%

(2) Road Section km2 – km45

Section km2 – km45 ranges from the outskirts of Dili city to Aileu town for 43 km as shown in Figure-2.21.

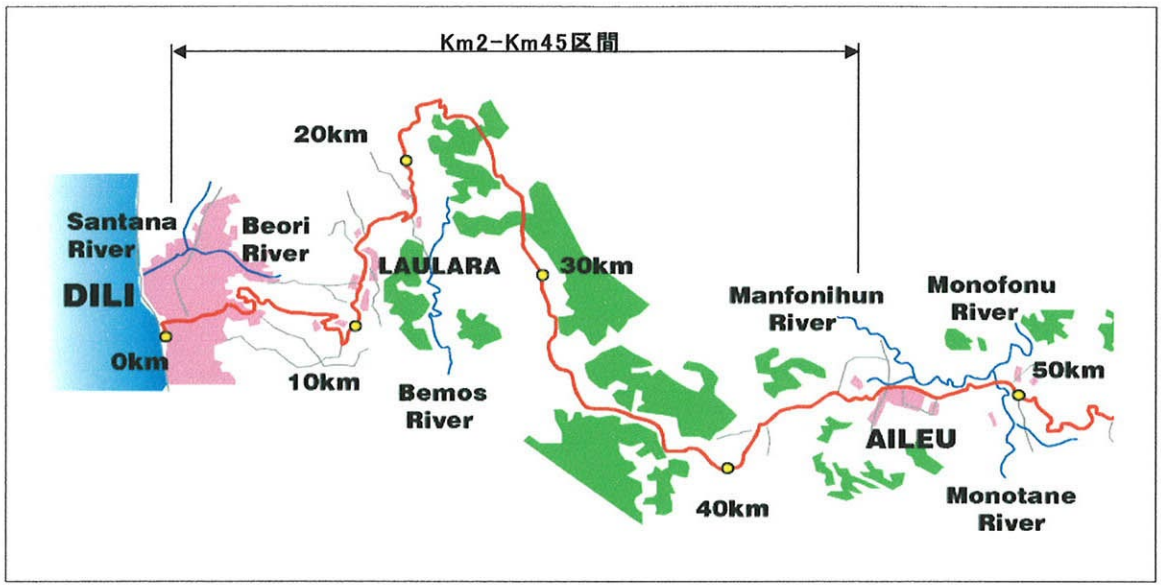


Figure-2.21 Location Map for Section km2 – km45

This section includes locations of partial damaged pavement and unevenness of road surface because of erosion of backfill or failure of valley side slope, but the section mostly is maintained in relatively good condition. A large-scale slope failure was found at km40, with huge cave-in and erosion of almost half width of the road. This failure was completely rehabilitated from May to July 2003 by Japanese Engineering Group.

Photo-2.13 Slope Failure at km40+500 and Situation of Restoration by Japanese PKF

Table-2.36 Summary of Road Conditions for Section km2 – km45

Item		Road Conditions
Pavement	Asphalt Pavement	10,536 ㎡ (5.4%)
	Unevenness	10,055 ㎡ (5.2%)
Road Width	Average Pavement Width	4.57 m
	Minimum Pavement Width	3.30 m
	Average Effective Width	6.55 m
	Minimum Effective Width	5.20 m
Drainage (Side Ditch)	Total Length	16,600 m
	Ratio of Installation	38.50%
	Average Width at Top	0.72 m
Drainage (Cross Pipe)	Total Numbers	179
	Installation Interval	240 m
	Fraction Defective	29.95%
Slope	Length of Slope Failure	1,172 m
	Ratio of Slope Failure	2.73%

(3) Total Planning for Bridge (Design Criteria)

The Indonesian bridge design standard, July 2003, is referred to for bridge width, seismic load, wind load and temperature change and the other conditions conformed to USA standard or Japanese standard.

1) Bridge width: Class B (Overall Width=7.0m, Carriage Way=6.0m, Curb=0.5m x 2)

2) Live load: AASHTO HS20-44 x 125 %

3) Seismic load: H = Kh x W, Kh = C x F x I x M

where,

- H: Horizontal seismic load
- W: Dead load
- Kh: Horizontal Seismic Coefficient
- C: Base seismic coefficient by place, soil and natural frequency
- F: Structure factor = 1
- I: Important factor = 1
- M: Material factor = 1

4) Wind load 1 KN/m^2

5) Temperature change ±15℃

6) Unit weight of material

Structural steel	77 KN/m^3
Reinforced concrete	24.5 KN/m^3
Plain concrete	23 KN/m^3
Asphalt concrete	22.5 KN/m^3

7) Material strength

Minimum yield point of structural steel;

SM400 (t<40 mm)	235 N/mm^2
SM490Y(t<40 mm)	355 N/mm^2
SR235	235 N/mm^2
SD345 345 -	440 N/mm^2
SKK400	235 N/mm^2

Design strength of concrete;

Reinforced concrete	23.5 N/mm^2
Plain concrete	17.5 N/mm^2

2-2-2-2 Facility Design

(1) Road Design

1) Standard for Road Design

The island of Timor is mountainous and slopes are very steep, and largely covered with basalt-rich colluvial talus. The annual precipitation of mountainous region in Timor island ranges roughly from 2,000 to 2,500 mm. The most fundamental facilities of the project road are standard road width and pavement thickness. The route of project road passes mountainous region where the precipitation is high; hence, slope protection is essential. Drainage is also an important facility to prevent the road from slope failure and/or pavement damage. The road width basically is decided with consideration of topography, design vehicle speed, traffic volume and importance of road. The existing road was designed based on the design standard in Indonesian era. The design vehicle speed will be decided excluding hairpin bends with consideration of result for inventory study and limitation of investment for improvement. The design standard for road in Indonesia is shown in Table-2.37. Since the route of project road passes through a mountainous region, it is adequate to decide the design speed as 20–30 km/hr as shown in Table-2.37 because of low traffic volume per day.

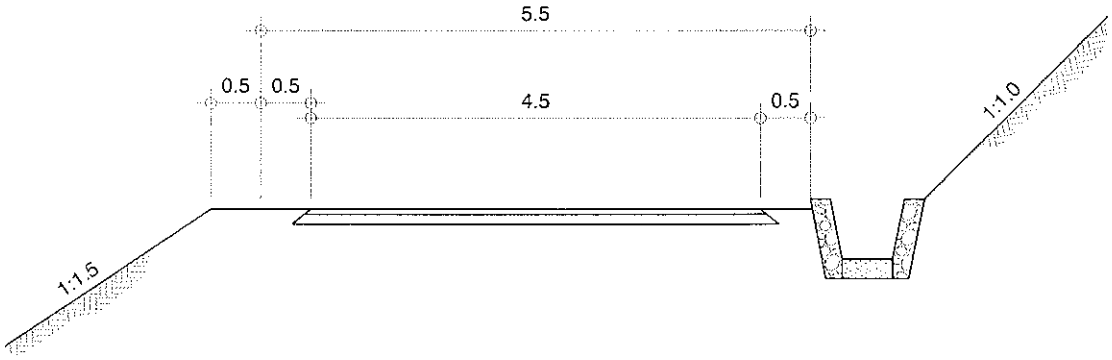
Table-2.37 Design Standard for Road in Indonesia

Traffic Volume (Vehicles per day)	Terrain	Flat to Rolling		Hilly		Mountainous	
		Desirable	Minimum	Desirable	Minimum	Desirable	Minimum
> 500	Design Speed	80	50	60	40	40	30
	Pavement Width	5.5	4.5	5.5	4.5	5.5	4.5
	Shoulder Width	2.0	1.5	1.5	1.25	1.5	1.25
500 - 201	Design Speed	60	40	40	30	30	30
	Pavement Width	5.0	3.5	5.0	3.5	5.0	3.5
	Shoulder Width	1.5	1.25	1.25	1.0	1.0	1.0
200 - 50	Design Speed	60	40	40	30	30	30
	Pavement Width	4.5	3.5	4.5	3.5	4.5	3.5
	Shoulder Width	1.5	1.0	1.0	1.0	1.0	1.0
< 50	Design Speed	50	30	30	30	25	20
	Pavement Width	4.5	3.0	4.5	3.0	4.5	3
	Shoulder Width	1.0	0.75	1.0	0.75	0.75	0.75

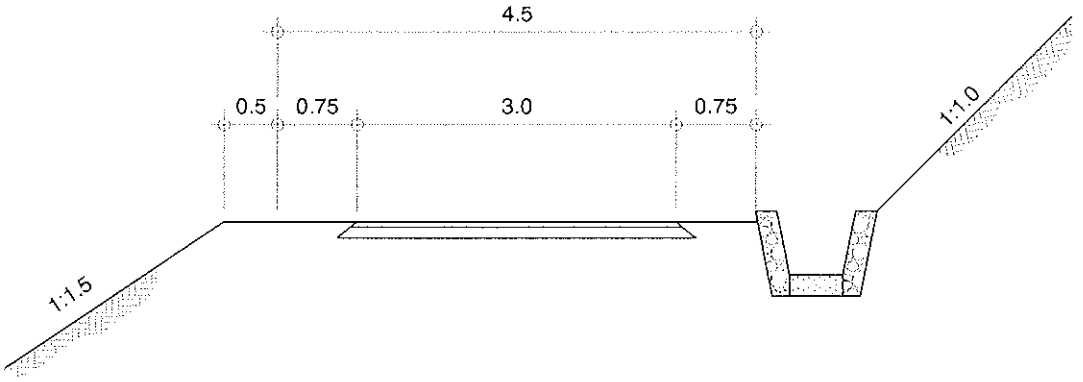
Source: Report on Roads in East Timor TA 3401-ETM, July 1990.

2) Typical Cross Section for Road

The standard cross sections are shown in Figure-2.22 as below.



Typical Cross Section for Dili - Aituto



Typical Cross Section for Aituto - Cassa

Figure-2.22 Typical Cross Sections for Road

(2) Pavement Design

1) Pavement Design Criteria and Traffic Volume

The thickness of pavement is determined by the traffic volume of heavy vehicle, value of CBR, and pavement material. The existing traffic volume of heavy vehicles is shown in Table-2.38 based on survey in the 1st field study and ADB report. The assumed traffic volume of heavy vehicles in 2011 (5 years later after the improvement) is forecast to be 1.5 times the present number. Hence, the assumed traffic volume of heavy vehicles would be 6-38 per day, and the category of pavement structure shall be "Type-L traffic: less than 100 per day" in the classification of "Pavement Manual" by Japan Road Association. The asphalt thickness shall be determined by the measured value of CBR for subgrade.

Table-2.38 Category of Pavement Structure for Traffic Volume of Heavy Vehicle

Section	Traffic Volume per Day	Traffic Volume of Heavy Vehicle	Assumed Traffic Volume at Year 2011	Category of Pavement
Dili～Aileu(*)	500	25	38	Type-L
Aileu～Aituto	147	9	14	Type-L
Aituto～Ainaro	75	4	6	Type-L
Ainaro～Cassa	47	17	26	Type-L

* ; Dili～Aileu: Based on the predicted volume by ADB Report

2) CBR Value for Each Section

Values of CBR_m for km79 – km130 section are as shown below;

Table-2.39 CBR Values for Existing Road Condition

Location	km83.1	km91.9	km99.1
CBRm	17.9	22.2	5.45

Average CBR_m : 15.2

Standard deviation $(\sigma n-1)$: 8.7

Sectional CBR : 15.2 - 8.7 = 6.5

3) Design CBR

Design CBR value is decided as 6 in the following Table-2.40.

Table-2.40 Design CBR

Sectional CBR	Design CBR
(More than 2 less than 3)	(2)
More than 3 less than 4	3
More than 4 less than 6	4
More than 6 less than 8	6
More than 8 less than 12	8
More than 12 less than 20	12
More than 20	20

Source: Guideline for Pavement Design & Construction (Japan Highway Association)

4) TA Method with Consideration of Reliability

The certainty for durability not to fail by fatigue all through the design life is considered as the design reliability. The relation between the reliability and traffic volume prescribed in the "Guide for Design of Pavement Structures" by AASHTO, 1986, is shown below.

Table-2.41 Reliability and Converted Traffic Volume

Reliability	50%	75%	90%
Definition	50% of fatigue failures occur after the duration exceeding design life	75% of fatigue failures occur after the duration exceeding design life	90% of fatigue failures occur after the duration exceeding design life
Converted Traffic Volume	Equal	Double	Treble
Duration for Fatigue Failure	Pavement will not yield fatigue failure before the duration of design life if the operation condition is same as the design.	Pavement will not yield fatigue failure before the duration of design life even if operation condition changes slightly from the design and/or pavement will not yield fatigue failure even slightly after the duration of design life if the operation condition is same as the design.	Pavement will not yield fatigue failure before the duration of design life even if operation condition is different from design and/or pavement will not yield fatigue failure even after the duration of design life if operation condition is same as the design.

According to the table, the reliability can be 90% if design traffic volume is increased to three times even though the actual reliability is 50%, and the reliability can be increased to 75% if the traffic volume is doubled. The relation between design CBR and TA is shown in Table-2.42. The design cross section by TA method with consideration of reliability is shown in Table-2.43 and Figure-2.6.

$T_A = 3.07 \times N \times 0.16 / CBR \times 0.3$

(Corresponding to the reliability of 50%)

where,

TA : Required equivalent converted thickness

N : Fatigue failure wheel number; 30,000

(Pavement design traffic volume = 100/day, direction)

CBR : Design CBR (=12)

Table-2.42 Required Equivalent Converted Thickness TA

Reliability \ Design CBR	3	4	6	8	12	20
50%	12	11	10	9	8	7
75%	13	12	11	10	9	8
90%	15	14	12	11	10	9

Table-2.43 Pavement Cross Section

Reliability	Surface+Base	Upper Subbase	Lower Subbase	TA	Total Thickness
50%	5	10	10	11.0	25
75%	5	10	10	11.0	25
90%	5	10	10	11.0	25

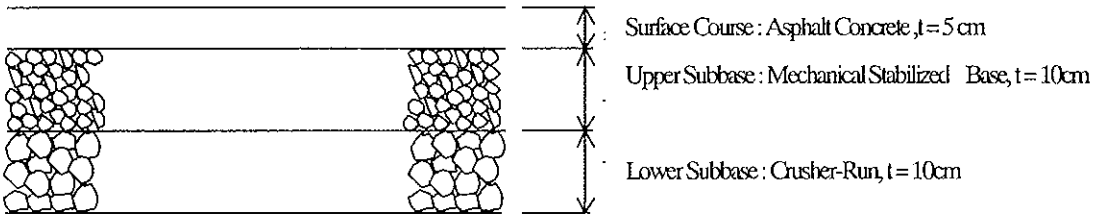


Figure-2.23 Pavement Section by TA Design Method

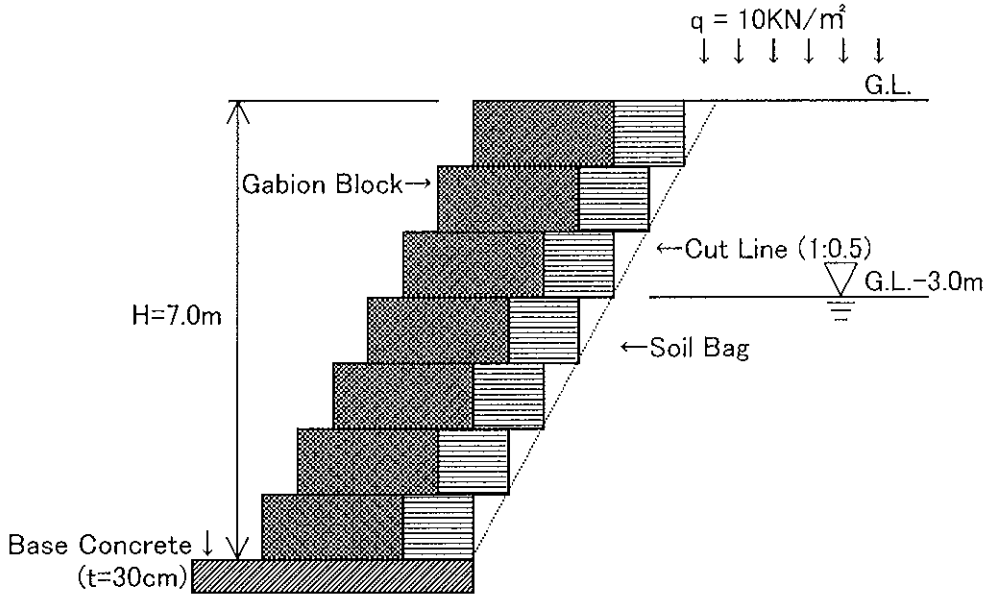
(3) Design of Gabion Block

A. Design Condition

Gabion block is designed assuming a virtual retaining wall.

1) Dimensions for Sectional Examination

- Base ; Spread foundation by plain concrete (t = 30 cm)
- Backfilling ; Soil bags are laid behind the gabion block to prevent from runoff of backfill and settlement of ground surface
- Gradient ; 1 : 0.5
- Design height ; H = 7.0 m (Max.)



2) Design Load

- Unit weight of backfill ; $\gamma = 20$ KN/m^3
- Submerged unit weight of backfill ; $\gamma' = 10$ KN/m^3
- Angle of internal friction of backfill ; $\phi = 35^\circ$
- Unit weight of gabion block ; Wg = 20 KN/m^3
- Earth pressure ; by trial wedge method
- Surcharge (traffic load) ; q = 10 KN/m²
- Raise of ground water in rainy season ; Maximum GWL = G.L. − 3 m

3) Stability of Foundation

i) Normal condition (traffic load considered)

- Allowable bearing capacity ; qa=200 KN/m²
- Safety factor for sliding ; Fs=1.5
- Stability against overturning ; e <B/6, where,

e : distance from centroid of foundation to loading point

B : width of foundation

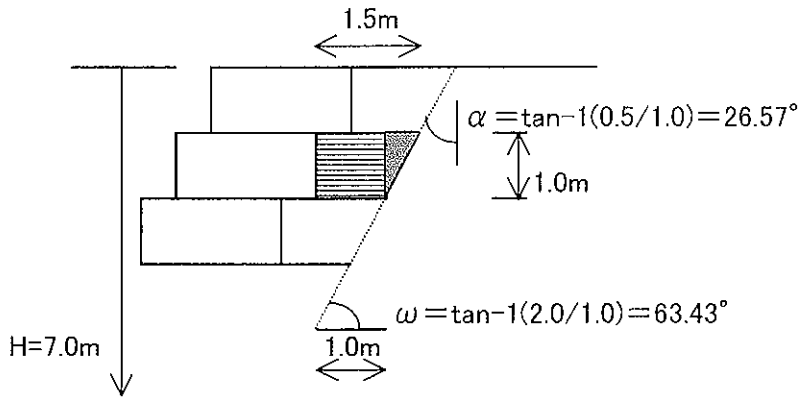
ii) Abnormal condition (raise of ground water by rainfall)

- Allowable bearing capacity ; qa=300 KN/m²
- Safety factor for sliding ; Fs=1.2
- Stability against overturning ; e <B/3

B. Computation of Earth Pressure

1) Earth Pressure on Cut Slope

Friction angle on failure surface is taken as $\delta' = \phi$.



Weight of sliding soil mass Ws is computed as follows:

Ws= 7 ×(1.0+1.5)×1.0/2×20.0=175KN/m

Normal active earth pressure Pa is computed as follows:

$Pa = Ws \cdot \sin(\omega - \delta') / \cos(\omega - \delta' - \delta - \alpha)$

Where, $\omega = 63.43°$ 、 $\delta' = \phi = 35°$ 、 $\delta = 2/3\,\phi = 23.33°$ 、 $-\alpha = 26.57°$

$Pa = 175 \times \sin(63.43° - 35°) / \cos(63.43° - 35° - 23.33° + 26.57°)$

$= 175 \times 0.476 / 0.851 = 97.9$ KN/m

$Pha = Pa \cdot \cos(\delta + \alpha) = 97.9 \times \cos(23.33° - 26.57°) = 97.7$ KN/m

$Pva = Pa \cdot \sin(\delta + \alpha) = 97.9 \times \sin(-3.24°) = -5.5$ KN/m

Earth pressure by surcharge load:

$Ka = 2\,Pa / \gamma H^2 = 2 \times 97.9 / 20 \times 7.0^2 = 0.20$

$Pal = q \cdot Ka \cdot H = 10 \times 0.20 \times 7.0 = 14.0$ KN/m

$Phla = Pal \cdot \cos(-3.24) = 14 \times 0.998 = 14.0$ KN/m

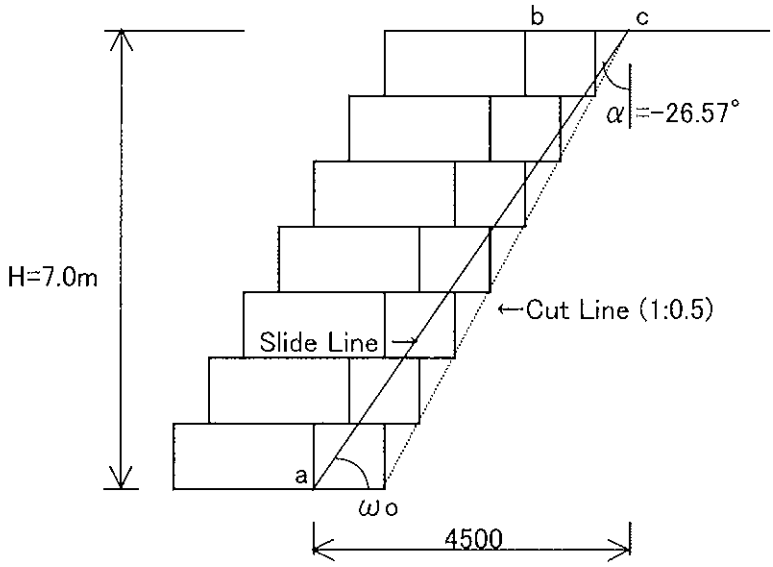
$Pvla = Pal \cdot \sin(-3.24) = 14 \times (-0.056) = -0.8$ KN/m

Resultant force at regular condition:

$Ph = Pha + Phl = 97.7 + 14.0 = 111.7$ KN/m

$Pv = Pva + Pvl = -5.5 - 0.8 = -6.3$ KN/m

2) Earth Pressure on Backfill Slope



Coefficient of earth pressure is computed by sliding angle of ωo assuming that a sliding line occurs within the soil bags as line a-c as shown above.

$\tan \omega o = 7.0/4.5$

$\omega o = \tan^{-1}(7.0/4.5) = 57.26^\circ$

$Ka = \sin(\omega - \phi)/\cos(\omega - 5/3\,\phi - \alpha) \cdot (\cot \omega + \tan \alpha)$

$= \sin(57.26^\circ - 35^\circ)/\cos(57.26^\circ - 5/3 \times 35^\circ + 26.57^\circ)$

$\times (\cot 57.26^\circ + \tan(-26.57^\circ))$

$= 0.3788/0.9026 \times (0.6430 - 0.5)$

$= 0.060$

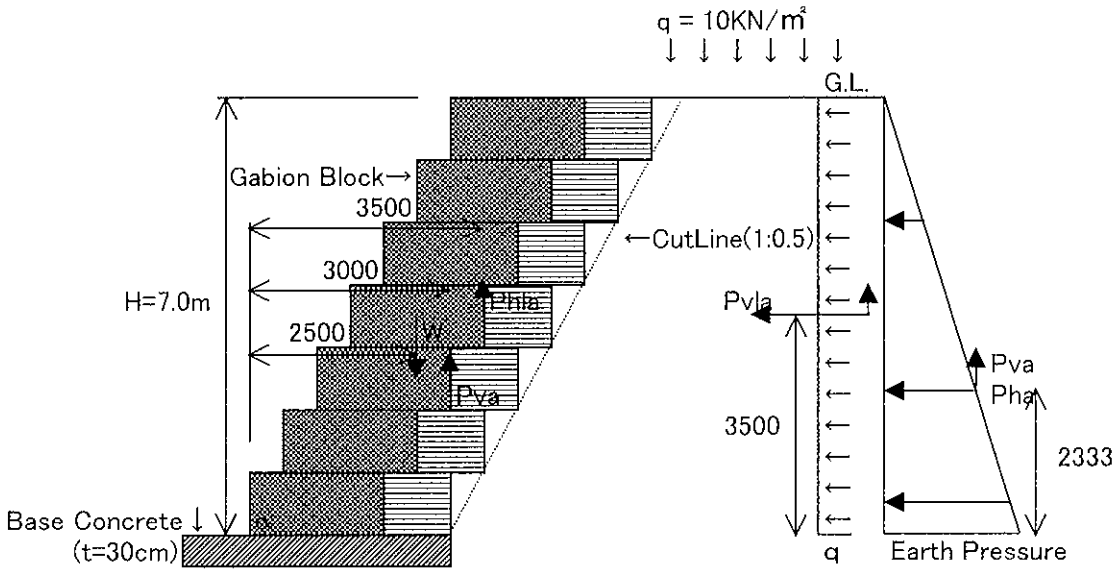
Pha＝1/2· γ Ka·H²cos(δ + α)＝1/2·20×0.060×7.02×cos(-3.24)＝29.35 KN/m

Pva＝1/2· γ Ka·H²sin(δ + α)＝1/2·20×0.060×7.02×sin(-3.24)＝-1.66 KN/m

3) Design Earth Pressure

Comparing the earth pressure of cut slope and backfill slope, the coefficient of earth pressure for backfill slope of 0.06 is less than that for cut slope of 0.20. Therefore, the earth pressure of cut slope is applied as design earth pressure.

C. Setting-out for Center of Gravity for Self Weight of Gabion Block



The position of center of gravity for gabion block is decided by its shape, gradient of 1:0.5 and 7 blocks; it is located at the position of 2.5 m from O point (0,0).

D. Stability Analysis

1) Stability in Normal Condition (Low Ground Water and Surcharge)

i) Computation of Overtuning Moment

Σ Ma＝Wg×2.50－Pha×2.333－Phla×3.50－Pva×3.0－Pvla×3.50

＝(20×1.0×2.0×7)×2.50－97.7×2.333－14.0×3.50－5.5×3.0－0.8×3.5

＝403.8 KN.m/m

ii) Weight calculation

$\Sigma Va = Wg - Pva - Pvla = 20 \times 1.0 \times 2.0 \times 7 - 5.5 - 0.8 = 273.7$ KN/m

iii) Position of resultant force

$Xa = \Sigma Ma / \Sigma Va = 403.8/273.7 = 1.475$ m

iv) Stability against overturning

$e a = Ba/2 - Xa = 2.0/2 - 1.475 = -0.475$ m

$Ba/6 = 2.0/6 = 0.33$m

$e a = -0.475$m $< Ba/6 = 0.33$m-----o.k.

$< | Ba/3 | = 0.67$ m ----- o.k.

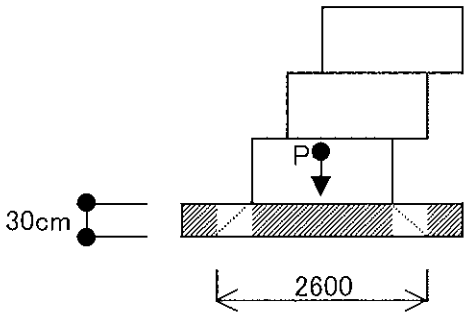
v) Bearing Stability

The reaction force of ground is calculated by the following equation because the location of loading is out of core in the base:

$q \max = 2 \Sigma V / 3 d = 2 \times 273.7 / 3 \times (1.0-0.475) = 347.5$ KN/m²

$> q a = 200$ KN/m²-----N.G.

Then, the base ground below the bottom block is replaced by concrete (t=30 cm) and the bearing stability is recomputed using the increased base width.



vi) Recalculation for stability against overturning

$e a' = Ba'/2 - Xa = 2.6/2 - 1.475 = -0.175$ m

$Ba'/6 = 2.6/6 = 0.433$m

$e a' = -0.175$m $< Ba'/6 = 0.433$ m ----- o.k.

vii) Recalculation for stability against bearing

The reaction force of ground is calculated by the following equation because the location of loading is within a core in the base:

$q = \Sigma Va / Ba' \cdot (1 \pm 6e/B) = 273.7/2.60 \times (1 \pm 6 \times 0.175/2.60)$

$= 147.8$ KN/m², 62.8 KN/m² $<$ $q a = 200$ KN/m² ----- o.k.

viii) Stability against sliding

Resistance force at base of bottom block Hu:

$Hu = cA' + V \tan \phi b$

Now that the base ground is supposed as sandy soil, c=0 and $\phi b = 0.6$.

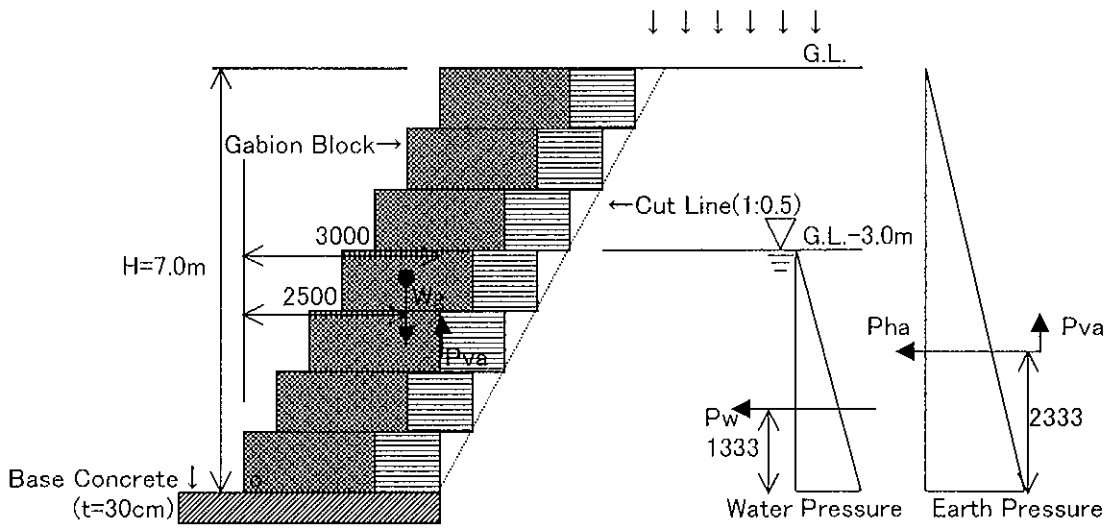
$Hu = 273.7 \times 0.6 = 164.2$ KN/m

Horizontal force $H = Ph = 111.7$ KN/m

$Fs = Hu/H = 164.2/111.7 = 1.47 \fallingdotseq 1.5$ ----- o.k.

1) Stability in Abnormal Condition (High Ground Water Level)

The case for raised ground water level by rainfall in the rainy season is examined even though the gabion block is a permeable retaining wall structure.



Weight of sliding soil mass Ws':

$Ws' = 1/2 \cdot (1.0+1.5) \times 1.0 \times 20 \times 3 + 1/2 \cdot (1.0+1.5) \times 1.0 \times 10 \times 4 = 125$ KN/m

Active earth pressure in the abnormal raining condition Pa':

$Pa' = Ws' \cdot \sin(\omega - \delta') / \cos(\omega - \delta' - \delta - \alpha) = 125 \times 0.476 / 0.851 = 69.9$ KN/m

$Pha' = Pa' \cdot \cos(\delta + \alpha) = 69.9 \times \cos(-3.24) = 69.8$ KN/m

$Pva' = Pa' \cdot \sin(\delta + \alpha) = 69.9 \times \sin(-3.24) = -4.0$ KN/m

Ground water pressure Pw:

$Pw = 1/2 \cdot 10 \times 4.0^2 = 80$ KN

i) Computation of overturning moment

$\Sigma Ma' = Wg \times 2.50 - Pha' \times 2.333 - Pva' \times 3.0 - Pw \times 1.33$

$= (20 \times 1.0 \times 2.0 \times 7) \times 2.50 - 69.8 \times 2.33 - 4.0 \times 3.0 - 80 \times 1.33$

$= 418.9$ KN/m

ii) Weight calculation

$\Sigma Va' = Wg - Pva' = 280 - 4.0 = 276$ KN/m

iii) Position of resultant force

$Xa' = \Sigma Ma' / \Sigma Va' = 418.9/276 = 1.518$ m

iv) Stability against overturning

$e a' = Ba'/2 - Xa' = 2.6/2 - 1.518 = -0.218$ m

$Ba'/6 = 2.6/6 = 0.433$ m $>$ $e a' = -0.218$ m ----- o.k.

v) Stability against bearing

$q' = \Sigma V'a / Ba' \cdot (1 \pm 6 e a'/Ba') = 276/2.6 \times (1 \pm 6 \times 0.218/2.60)$

$= 159.55$ KN/m², 52.75 KN/m² $<$ $q a' = 300$ KN/m² ----- o.k.

vi) Stability against sliding

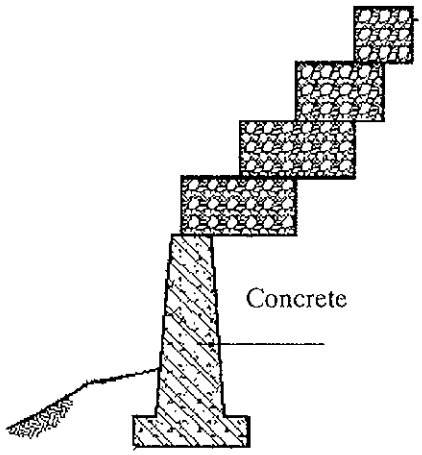
Resistance force at base of bottom block Hu:

$Hu' = V \tan \phi b = 276 \times 0.6 = 165.6$ KN/m

Horizontal force $H' = Pha' = 69.8$ KN/m

$Fs' = Hu'/H' = 165.6/69.8 = 2.37$ $>$ 1.2 ----- o.k.

E. Design of Cross Section



Outline for Design & Construction

①Gabion Block Standard Size : 2m × 1m × 1m

②Laying of Gabion Block : Long side (2m) is arranged toward road side, top 2 layers can be perpendicular.

③Max. height of Gabion : 7 steps, 7 m as maximum.

④Gradient of Gabion : Adjust to surrounding ground, apply 1:0.5 or 1:1 or combination of two gradients.

⑤Total Gabion height to be limited within 7m utilizing gravity type r-wall when whole height exceeds 7m.

⑥Many weep holes(4 Nos./m²) to be installed for r-wall

⑦Spread footing shall be base concrete (t=30cm).

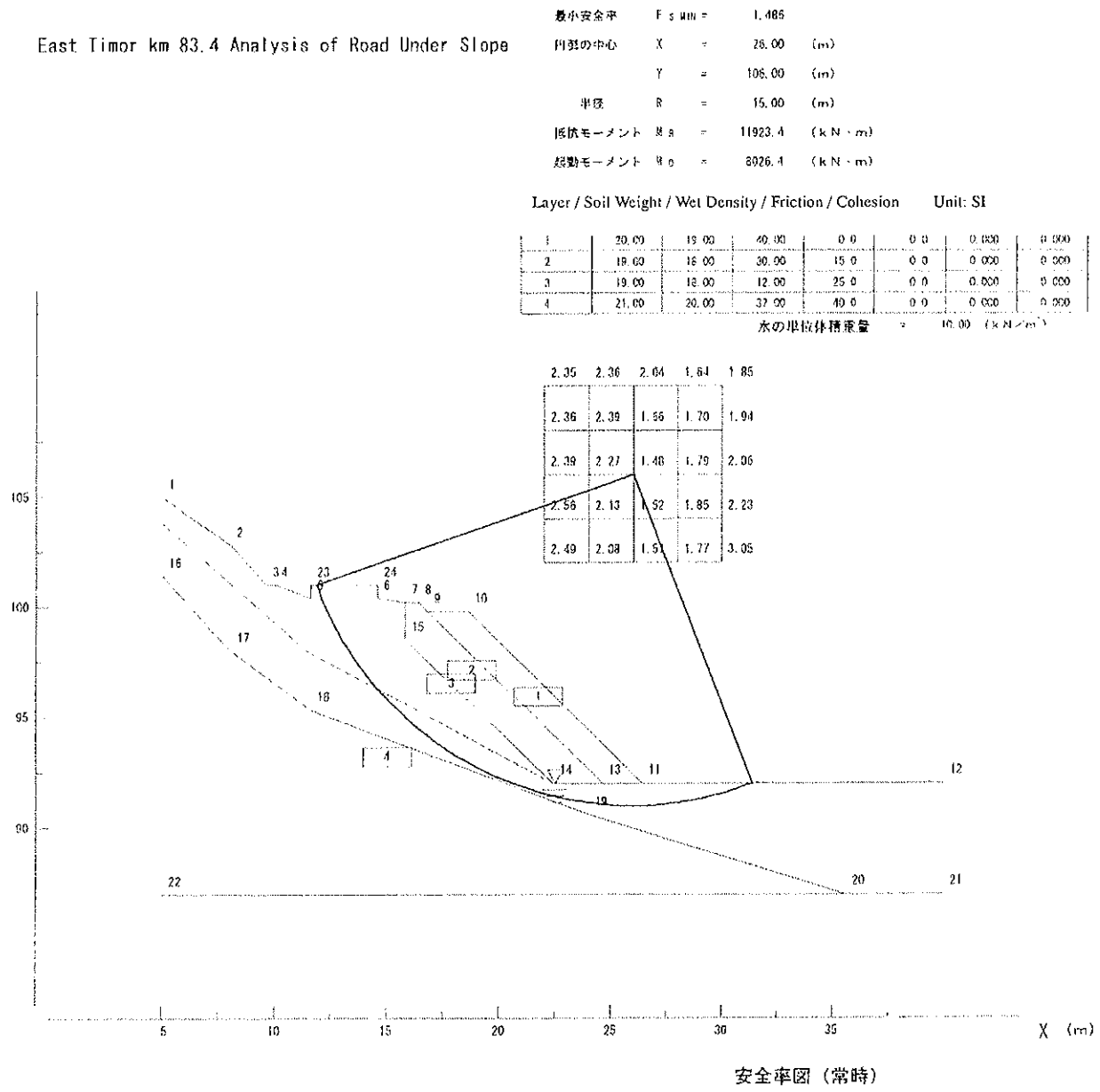
⑧Base ground shall be confirmed to be rigid enough.

F. Slope Stability Analysis

Stability analysis for slope protection at km83.4

- Result of topographic survey was applied and maximum height of 7 m was examined.
- Sliding circle was confirmed by the results of topo-survey, boring and sounding, and the ground water line is assumed considering the drain function of soil bags.
- Sliding soil mass is defined as shown below;

Saturated soil weight:	19 KN/m^3, Wet soil weight: 18 KN/m^3
Cohesion:	25 KN/m^2 (referred to the result of grain-size test)
Angle of internal friction	12 degrees (based on existing safety factor of 1.0)



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(4) Design of Drainage (Side Ditch)

A. Design Conditions

1) Area of Basin

A candidate point for the maximum basin is selected between km80 and km130 as the largest rainfall section among the project road, and considering the topographic and river drainage influence. As a result of examination, the point at km97+500 as the maximum basin of 0.18 km^2 is chosen for the design.

2) Rainfall Intensity

Rainfall intensity is computed using the rainfall intensity formula by former ministry of construction, and assuming the duration of local downpour as 2 hours and the probability of rainfall return period as 3 years.

$I = 0.36 \times 5.416 \times (1+0.25 \log P \times t^{0.13})/(t+19)^{0.82} = 41.7$ mm/hr

3) Coefficient of Discharge

The coefficient of discharge, when return period is small (3 years), is about 0.30 – 0.70 for gravel road and 0.70 – 0.95 for paved road, value of 0.70 is applied as the coefficient.

B. Calculation of Discharge Volume by Rainfall

Discharge volume $Q(m^3/s)$ is calculated using the Rational formula:

$Q = (1/3.6 \times 10^6) \times C \times I \times a$

Where, C : Coefficient of discharge = 0.70

I : Rainfall intensity = 41.7 mm/hr

A : Area of catchment area = 0.18×10^6 m^2

$Q = (1/3.6 \times 10^6) \times 0.70 \times 41.7 \times 0.18 \times 10^6 = 1.46$ m^3/sec

C. Calculation of Sectional Area for Discharge

The cross section of stone pitching ditch is assumed as 0.7 x 0.7m.

The cross sectional area A and the hydraulic mean depth R:

$A = 0.7 \times 0.7 = 0.49$ m^2

$R = (0.7 \times 0.7)/(3 \times 0.7) = 0.233$

Velocity of flow V is calculated using Manning's formula. Coefficient n of roughness for stone pitching is assumed as 0.02 and gradient of water flow as 3%.

$V = (1/n) \times R^{(2/3)} \times I^{(1/2)} = (1/0.02) \times 0.233^{(2/3)} \times 0.03^{(1/2)} = 3.28$ m/sec

Discharge capacity Qc for side ditch:

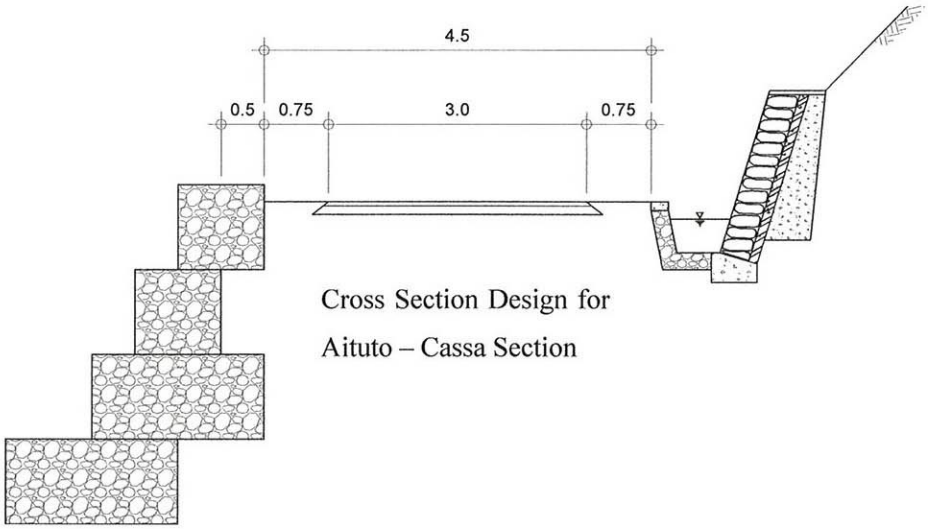
$Qc = V \times A = 3.28 \times 0.49 = 1.61 m^3$/sec

$> Q = 1.46 m^3$/sec ----- o.k.

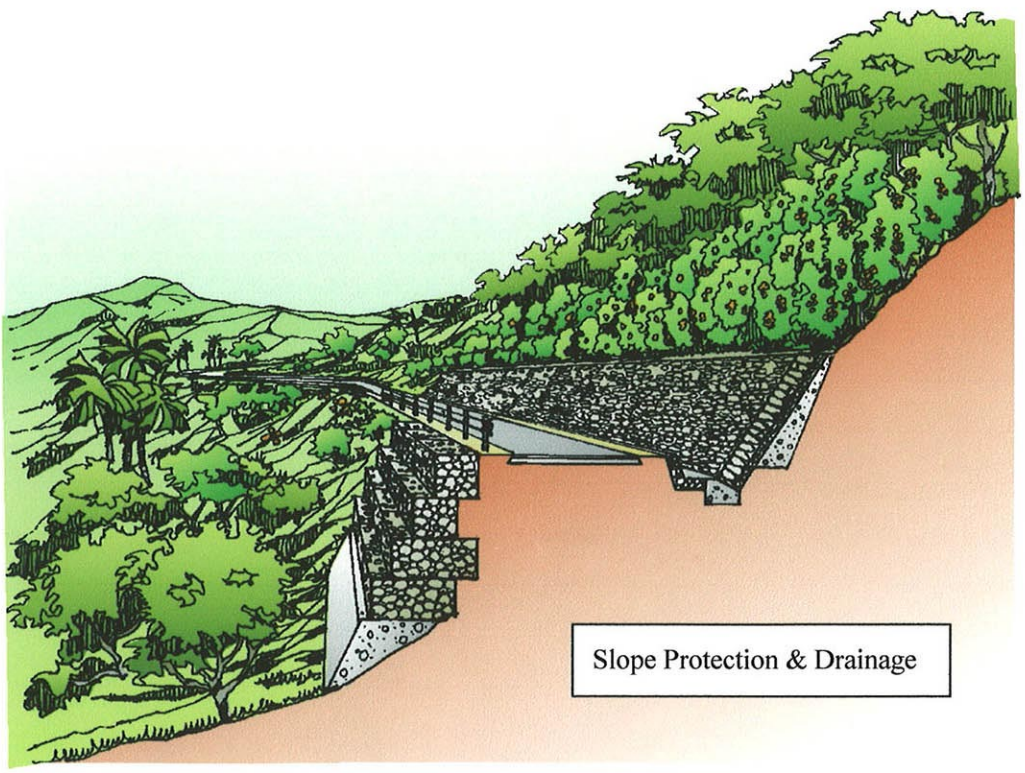
Discharge capacity is more than discharge by rainfall.

D. Slope Protection and Drainage

Since the annual precipitation of mountainous region in the project road ranges between roughly 2,000 to 2,500 mm, the protection measure for the road is quite important because of steepness of fragile slope. Gabion block, stone masonry retaining wall, concrete retaining wall are necessary as a slope protection. Stone masonry retaining wall at mountainside is 3 m height from base bottom, and the wall constitutes a side of ditch wall to maintain the road width at some sections. The ditch sectional area is locally 0.5 m^2 as maximum and the general section is 0.4 m^2.



Cross Section Design for
Aituto – Cassa Section



Slope Protection & Drainage

Location of Maximum Area of Basin

(5) Basic Design of Mola Bridge

Mola River is about 400 m wide. Existing bridge at left bank side of the river is shown in Photo-2.14. The 180 m long and 3 spans steel truss bridge was erected on 1996 by Indonesian government. The lacking portion about 240 m of the bridge at right bank side of the river is examined below.

1) Minimum Span Length

Minimum span length is determined by design flood discharge.

$L=20+0.005xQ$

Where, L: Minimum span length (m)

Q: Design flood discharge =3,510 m^3/sec

$L=20+0.005x3.510=37.6$ m

The minimum span length is estimated as 37.6 m by the formula shown above to cope with the floating debris such as long and big logs.

2) Selection of Abutment Location

The new abutment at left river side is proposed to keep its parapet face at 10 m from the existing right abutment because it is very hard to change the existing right abutment as a new pier since the detail condition of existing abutment is not clear. The right bank side abutment is proposed to arrange at the location 10 m from revetment line.

3) Selection of Route, Number of Span and Bridge Type

2 routes are considered for bridge building. One is the curved line along existing dike with a radius of curvature of 300 m. Another is the straight line by extension of existing bridge. Number of span can be 5 spans or 4 considering the minimum span length. Setting angle of pier beam can be arranged as parallel to flow or 90 degrees to road alignment. Span length of bridge will be 43.5 or 61 m because of 37.6 m of minimum span length. Reinforced concrete T type girder and prestressed concrete I type girder cannot be selected because span length is too long. Prestressed concrete box girder can not be selected because of difficulty for staging method within the river. Therefore, bridge type should be steel bridge. The comparison table for proposed types of Mola Bridge is shown in Table-2.44.

①Alternative 1: Curved bridge, 5 spans, parallel to river stream, steel plate & box girder

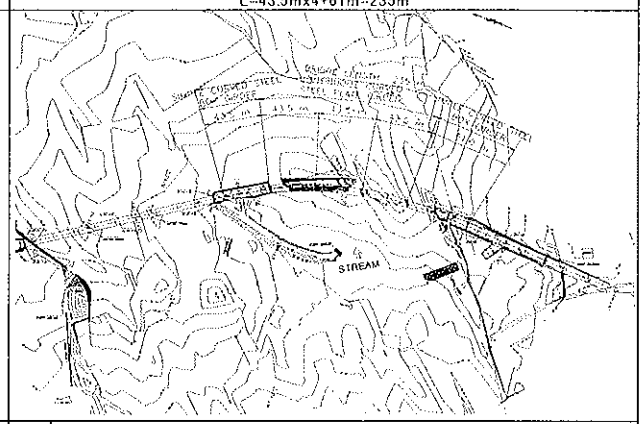
②Alternative 2: Curved bridge, 4 spans, parallel to river stream, steel box girder

③Alternative 3: Curved bridge, 5 spans, not parallel to river stream, steel plate & box girder

④Alternative 4: Curved bridge, 4 spans, not parallel to river stream, steel truss

⑤Alternative 5: Straight bridge, 4 spans, parallel to river stream, steel truss

Table-2.44 Comparison Table of Proposed Type of Mola Bridge (1)

Alternative No.				Alternative ①	
Alignment (Rout				Curved Bridge of upper stream side	
Bridge Type				3 Span Continuous Curved Steel Plate Girder + Simple Steel Box Girder x 2 Span	
Number of Spar				5-Span	
Angle of Bearing				Parallel for Stream	
Bridge Length				L=43.5mx4+61m=235m	
Profile					
Evaluation items	Construction Cost (Ratio)		60	52.2	1.15
	Construction Period		3	1	19
	Structure Aspect	Super-structure	2	1	inferior to Alt. 2 & Alt. 3 due to skew 38 degree at abutment A2.
		Sub-structure	2	2	superior to Alt.3 & Alt.4 due to 2-column,because location of column and bearing is the same .
	Construction execution	Super-structure	2	1	pre-twisting method or jack up & down method will be required due to skew. inferior to Alt. 3, Alt.4, Alt.5.
		Sub-structure	2	2	superior to Alt.4.
	Blocking Ratio		2	2	(1.5x2+12.0+1.5x4)/400.0x100=5.3%
	Land Acquisition		25	25	not need for change of residence and land acquisition of field
	Maintenance		2	2	maintenance-free due to using atmospheric corrosion resistant steel for near seashore
Recommendation			100	88.2	

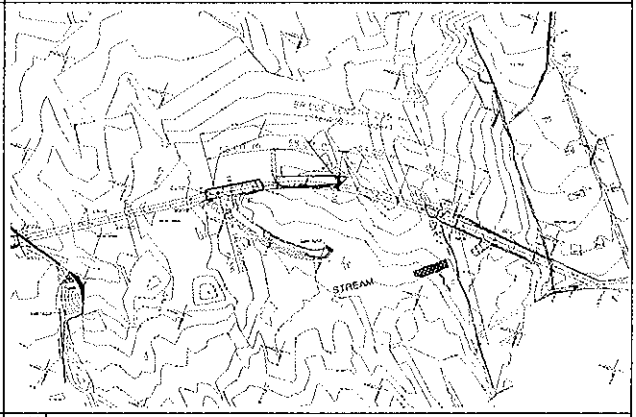
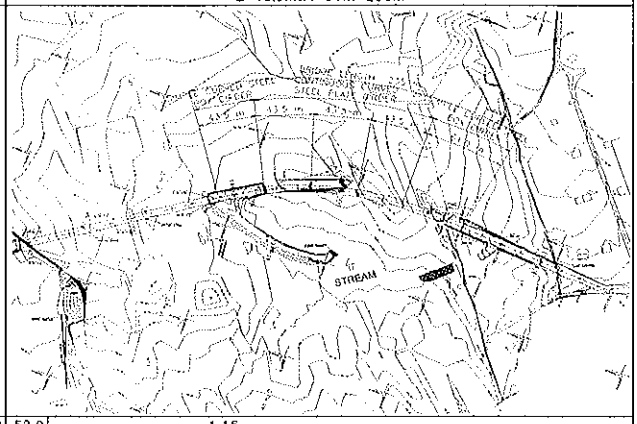
Alternative No.				Alternative ②	
Alignment (Rout				Curved Bridge of upper stream side	
Bridge Type				4 Span Continuous Curved Steel Box Girder	
Number of Spar				4- Span	
Angle of Bearing				Parallel for Stream	
Bridge Length				L=58.0mx3+61m=235m	
Profile					
Evaluation items	Construction Cost (Ratio)		60	48	1.25
	Construction Period		3	1	19
	Structure Aspect	Super-structure	2	2	superior to Alt.1 & Alt.3 due to box girdrer with tortional strength.
		Sub-structure	2	2	superior to Alt.3 & Alt.4 due to 2-column,because location of column and bearing is the same .
	Construction execution	Super-structure	2	1	large capacity of truck crane will be required due to box girder. inferior to Alt. 3, Alt.4, Alt.5.
		Sub-structure	2	2	superior to Alt.4.
	Blocking Ratio		2	2	(1.5x2+12.0+1.5x3)/400.0x100=4.9%
	Land Acquisition		25	25	not need for change of residence and land acquisition of field
	Maintenance		2	2	maintenance-free due to using atmospheric corrosion resistant steel for near seashore
Recommendation			100	85	

Table-2.44 Comparison Table of Proposed Type of Mola Bridge (2)

Alternative No.				Alternative ③	
Alignment (Rout				Curved Bridge of upper stream side	
Bridge Type				3 Span Continuous Knuckled Steel Plate Girder + Simple Steel Box Girder x 2 Span	
Number of Spar				5-Span	
Angle of Bearing				Non-Parallel for Stream	
Bridge Length				L=43.5mx4+61m=235m	
Profile					
Evaluation items	Construction Cost (Ratio)		60	52.2	1.15
	Construction Period		3	1	19
	Structure Aspect	Super-structure	2	2	inferior to Alt. 2, but superior to Alt. 1.
		Sub-structure	2	1	inferior to Alt. 1,Alt.2,Alt.5 due to 1-column.
	Construction execution	Super-structure	2	2	superior to Alt.1& Alt.2.
		Sub-structure	2	2	superior to Alt.4.
	Blocking Ratio		2	2	(1.5x2+12.0+2.0x4)/400.0x100=5.8%
	Land Acquisition		25	25	not need for change of residence and land acquisition of field
	Maintenance		2	2	maintenance-free due to using atmospheric corrosion resistant steel for near seashore
Recommendation			100	89.2	

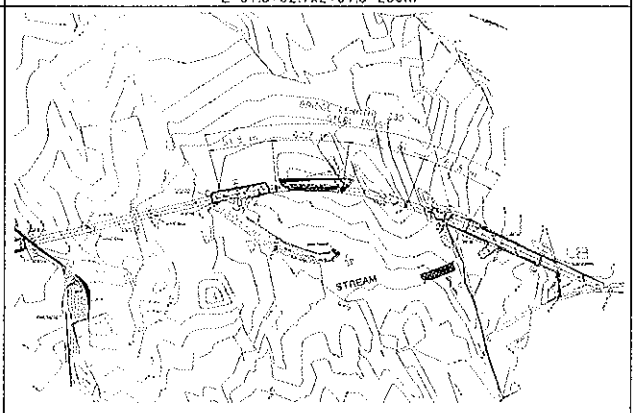
Alternative No.				Alternative ④	
Alignment (Rout				Curved Bridge of upper stream side	
Bridge Type				Simple Steel Truss	
Number of Spar				4-Span	
Angle of Bearing				Non-Parallel for Stream	
Bridge Length				L=51.8+62.7x2+61.8=239m	
Profile					
Evaluation items	Construction Cost (Ratio)		60	57.1	1.05
	Construction Period		3	3	17
	Structure Aspect	Super-structure	2	2	plan of truss is rectangle due to using Indonesian standard truss. inferior to Alt. 5, but superior to Alt.1,Alt.2 & Alt.3.
		Sub-structure	2	1	inferior to Alt. 1,Alt.2,Alt.5 due to 1-column.
	Construction execution	Super-structure	2	2	superior to Alt.1, Alt.2 & Alt.3 due to small capacity of truck crane.
		Sub-structure	2	1	inferior to Alt.1,Alt.2,Alt.3 & Alt.5 due to wide area for pier beam supporting.
	Blocking Ratio		2	2	(1.5x2+12.0+2.4x3)/400.0x100=5.6%
	Land Acquisition		25	25	not need for change of residence and land acquisition of field
	Maintenance		2	2	maintenance-free due to coat with zinc
Recommendation			100	95	recommended mainly from Land Acquisition.

Table-2.44 Comparison Table of Proposed Type of Mola Bridge (3)

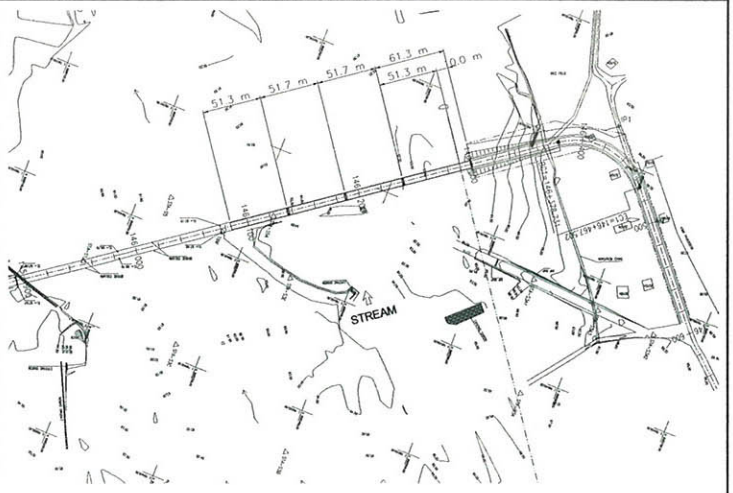
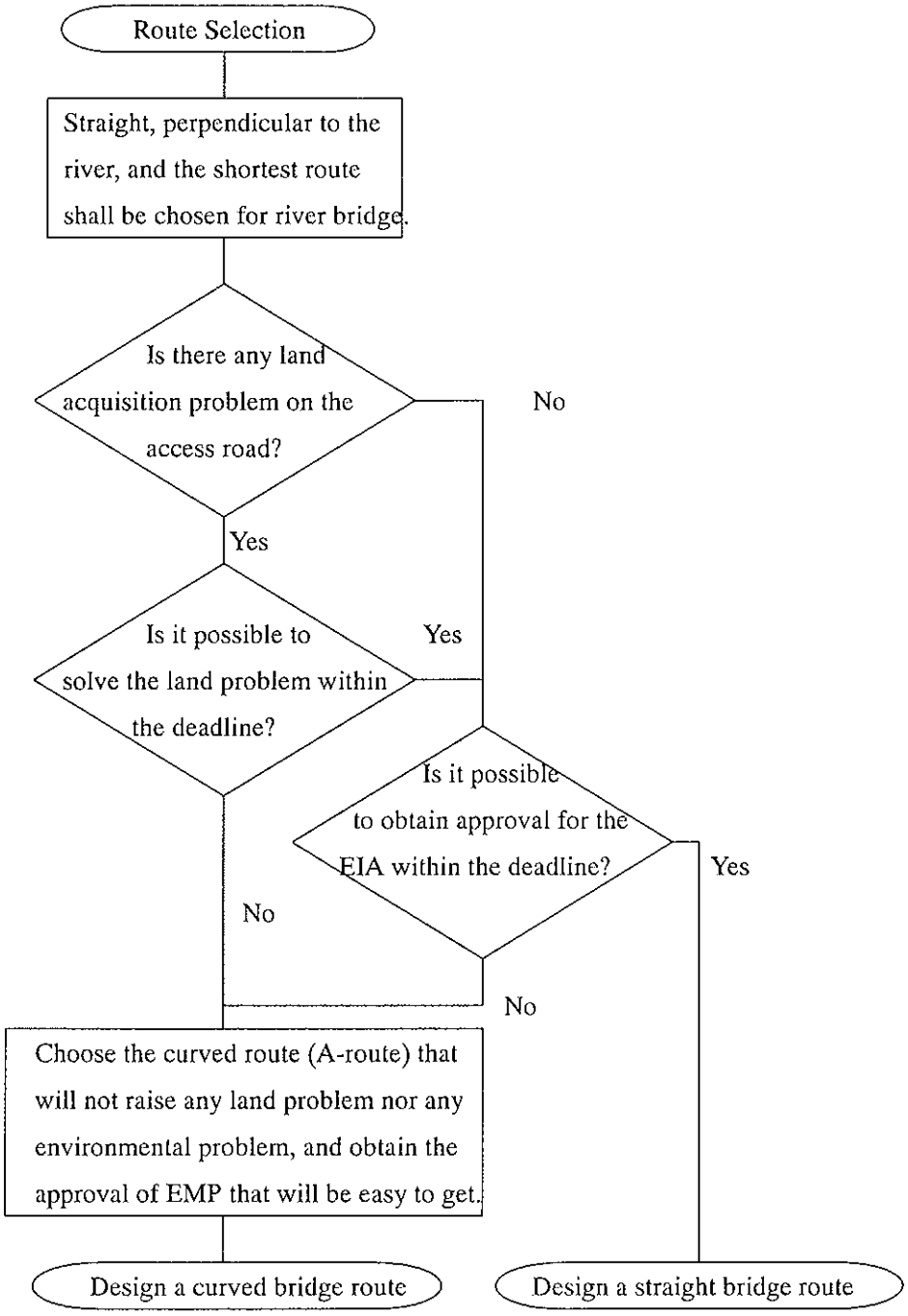
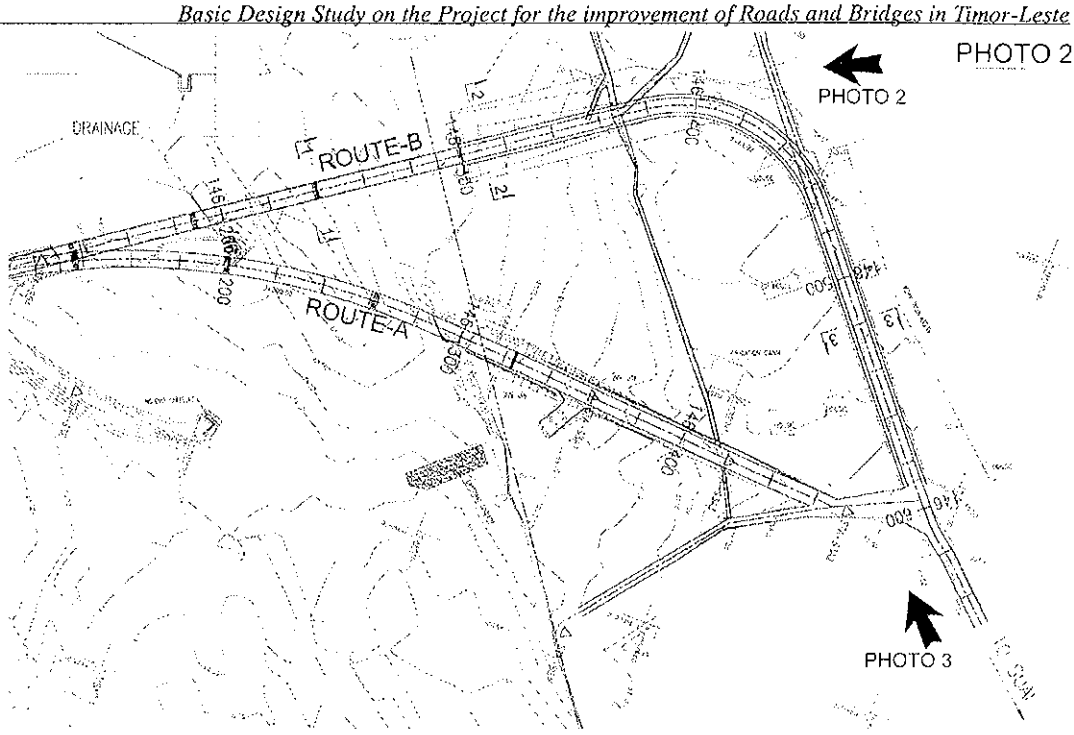
Alternative No.			Alternative ⑤		
Alignment (Rout			Straight Bridge of down stream side		
Bridge Type			Simple Steel Truss		
Number of Spar			4-Span		
Angle of Bearin			Parallel for Stream		
Bridge Length			L=51.3+51.7x2+61.3=216m		
Profile					
Evaluation items	Construction Cost (Ratio)		60	60	1.00
	Construction Period		3	3	17
	Structure Aspect	Super-structure	2	2	superior to Alt.1, Alt.2, Alt.3 & Alt.4 due to straight of alignment.
		Sub-structure	2	2	superior to Alt.3 & Alt.4 due to 2-column,because location of column and bearing is the same .
	Construction execution	Super-structure	2	2	superior to Alt.1, Alt.2 & Alt.3 due to small capacity of truck crane.
		Sub-structure	2	2	superior to Alt.4.
	Blocking Ratio		2	2	(1.5x2+12.0+1.5x3)/400.0x100=4.9%
	Land Acquisition		25	10	need for change of residence and land acquisition of field
	Maintenance		2	2	maintenance-free due to coat with zinc
Recommendation			100	85	

Photo-2.14 Mola Bridge Existing Condition

On the selection of bridge type alternatives, span lengths for the bridge longitudinal axis of 5-Span-Bridge alternative satisfied to required standard span length with 37.6m, are 43.5m, 61.0m, therefore RC girder type and PC-I girder type are not applicable. Though PC Box girder type is applicable the length, that is not applied because fixed-staging method (which is required for construction method of this type) is prohibited in the river area. Thus, only steel girder bridge can be adopted for this bridge type. And about the route, 2 (two) routes, one for alternative ①~④ of curved bridge and another for alternative ⑤ of straight bridge, are considered (refer to the flow chart below).





It is common for a river-crossing bridge to choose the route that will be the shortest, straight, perpendicular or almost perpendicular alignment. It is also usual to choose the straight route from the point of view of economic, structural, construction easiness, cost and technical reasons. However, the existing access portion of the bridge was constructed by the curved route within the river. It is assumed that there was some strong reason or other how the curved route was chosen instead of the straight route by execution of land acquisition in the Indonesian era. The residents requested, when the study team interviewed, to issue the land certificate, to provide alternative land, to grant compensation and to support their agricultural activity (to provide young plants) on condition that they agree to change of residence. It may be possible for Timor-Leste to cope with the request if it can be resolved by money; however, it may be a long term and/or impossible to settle regarding the alternative land because it is not certain that the land is accepted by the residents. On the other hand, the director of land & property in the ministry of justice gave notice to MTCPW that the ministry could not issue the land certificate because of disorder through the conflict. It is, therefore, necessary to select the curved route which will not cause the change of residence nor land acquisition at this moment in time.

The straight route, however, may become possible to choose if the land problem is solved before the phase of detailed design and if Timor-Leste side obtains the approval for EIA before the deadline since the implementation of improvement for Mola Bridge will be commenced after the road rehabilitation. Because the above-mentioned matters are unclear at present, the curved A-route will be selected to implement the basic design since there is not any land problem and it is certain that the approval for EMP is obtained with easier procedures before the deadline.

Based on the aforementioned policy, the alternative plan (4) is selected as the best suited bridge type as per the comparison in Table-2.44.

4) Selection of Substructure Type

Two columns type is selected for pier of Alt.1, Alt.2, and Alt.5 considering the parallel direction of pier beam to the river stream. On the other hand, one column type is selected for pier of Alt.3 and Alt.4 because it is non-parallel to the stream. Reverse T type is selected for abutment because the height of abutment is high, 9 m.

5) Selection of Foundation Type

The bearing stratum for foundation is tuff layer with class CL and 20 m deep. RC and PC piles are not selected for the foundation because large cobble with the diameter of 15 cm was found. Steel pipe pile is selected because the foundation of existing bridge is steel pipe pile. It will reduce the danger of hitting cobbles if steel pile is driven below the bottom of footing.

6) Selection of Type for Revetment and Riverbed Protection

Gabion blocks are installed along the left bank for 225 m in front of the existing abutment as the revetment. Gabion blocks will be installed along the right bank for 170 m toward the upstream and 30 m toward the downstream as the revetment for 200 m. The elevation of revetment top is determined as to be 1.2 m higher than the flood level. The half-cylindrical retaining wall is constructed between the existing right abutment and the proposed new left abutment. Then the form of plan for new abutment-pier will be oval. Soil bag method will be selected in order to prevent the backfill from outflow. Riverbed also will be protected by gabion blocks but ground still for pier will not be installed because of shallow scouring depth.

(6) Basic Design of Km60.3 Bridge

km60.3 Bridge is located between Aileu and Maubisse. The bridge span length is 10.5 m. The structural member of existing bridge is seriously damaged and it is necessary to reconstruct the bridge. The policy of basic design for km60.3 Bridge is mentioned below.

1) Design Criteria of Hydrology

Design criteria of hydrology are as follows:

Design flood discharge	: 9.1 m^3/sec
Design flood level	: 1205.8 m
Design riverbed	: 1205.0 m
Design flood depth	: 0.8 m
Elevation of existing bridge	: 1209 m
Soffit of superstructure	: 1208.5 m
Under-clearance for riverbed	: 3.5 m
Under-clearance for DFL	: 2.7 m (safe)
Under-clearance for rebound of small boulder	: 1.5 m (safe)
Under-clearance for rebound of large boulder	: 1.0 m (safe)

Many boulder stones are driven in the river during and after the strong rainfall. The diameter of boulders is between 0.5 and 2.5 m. Rebounding height of small boulder is about 2 m by Japanese technical data. The under-clearance for boulder rebounding is 1.5 m. Huge boulder stones are assumed not to rebound but to slide down or roll down, so the under-clearance for large boulder of 1 m is safe. Soffit of proposed superstructure is the same to that of existing superstructure.

2) Selection of Abutment Location

A. Condition of Existing Abutment

Existing bridge, approach road and river conditions are shown in Figure-2.24. Existing bridge shown in photos No. 1 & 2 is near the turning point of reversed curve. Length of existing bridge is 10.5 m and the number of span is two. Type of superstructure is reinforced concrete slab. Type of abutment and pier is Stone masonry with concrete. It can be understood in photos No. 3 & 4 that abutments and pier were damaged mainly due to scouring and settlement. Abutment of left bank at upstream side is shown in photo No. 6. It can be seen that the abutment and backfill are scoured with exposed width of about 2 m and exposed height of about 3m because the river stream is curved to left bank and debris flows. Dotted lines in Figure-2.25 show design flood water level. The line shows the flow that curves to left at upper stream of bridge.

B. Foundation of Existing Bridge

Weathered mudstone of class CL is selected for bearing layer after the result of geological survey in the site study. It is 6 m deep from riverbed. Soil near the riverbed is clay mixed with gravel and its N value is less than 10. There is little possibility for application of spread foundation for the existing abutment and high possibility of timber piles.

Abutment and pier with timber piles subsided because stone masonry structure was not constructed as a perfect composition of stone and concrete.

C. Location of New Abutments

The location of abutment A1 at left bank is proposed to setback of 2.5 m away from the existing left abutment because the stream is curved to left. The location of abutment A2 at right bank is proposed to be forward to river for 2.5 m away from the existing right abutment due to keep away from remaining timber pile.

Thus, the proposed bridge length is decided to be 10.5 m.

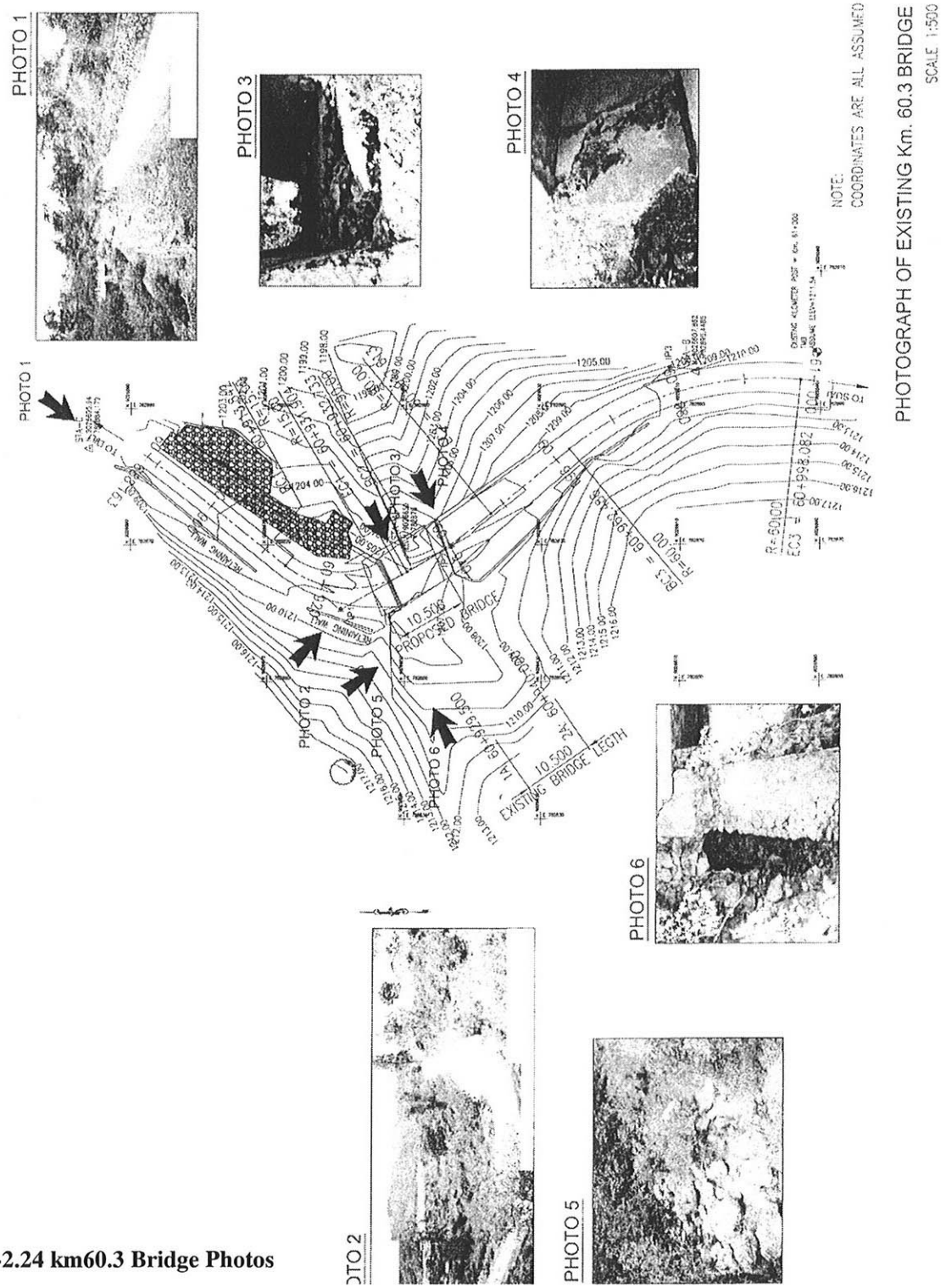


Figure-2.24 km60.3 Bridge Photos

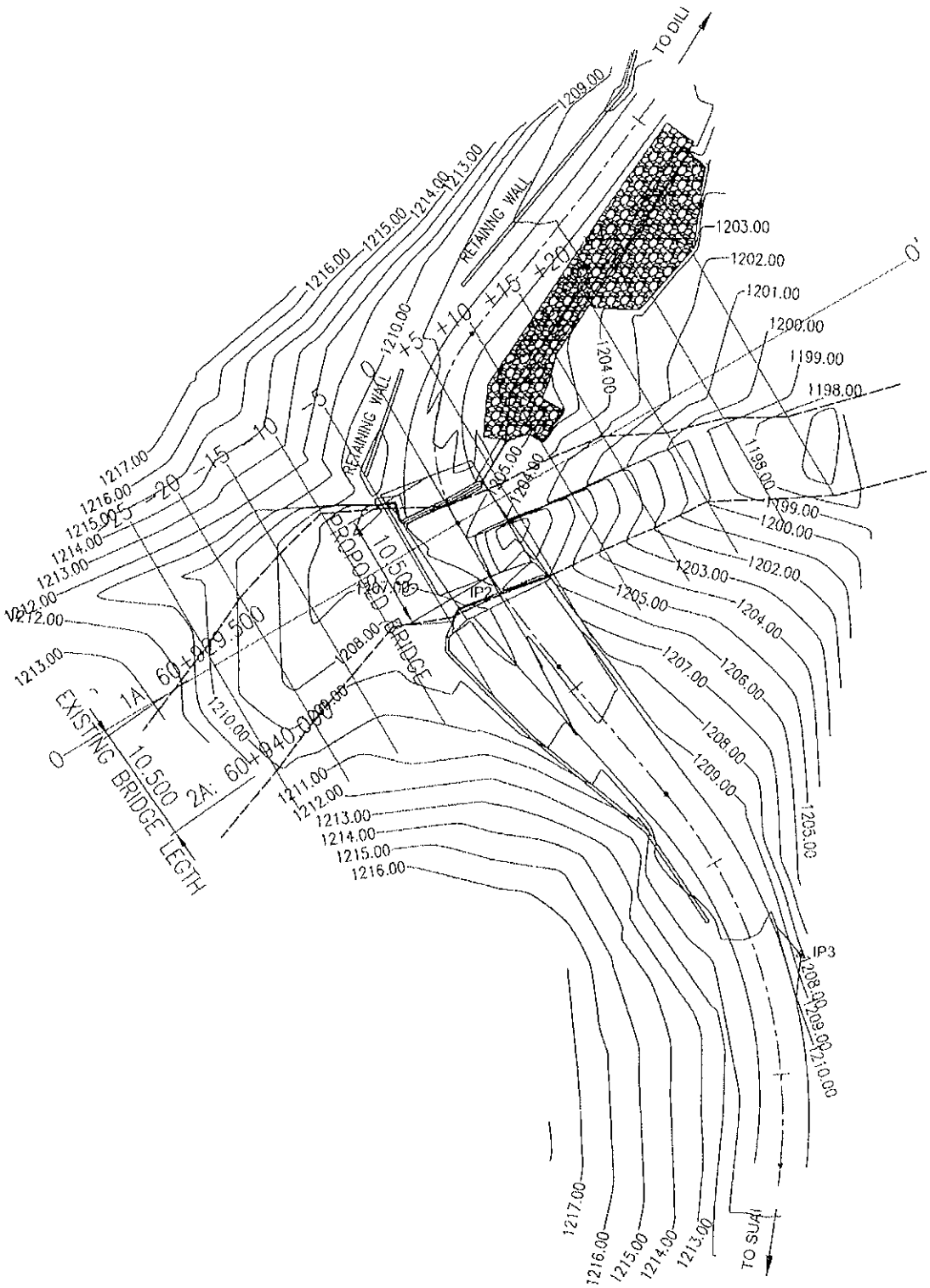
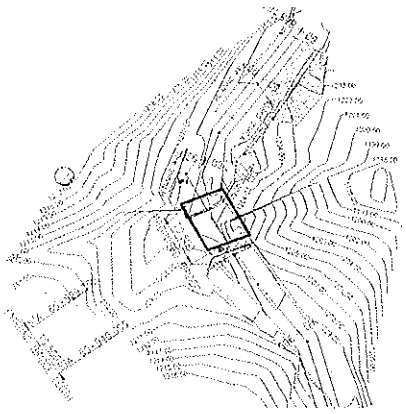
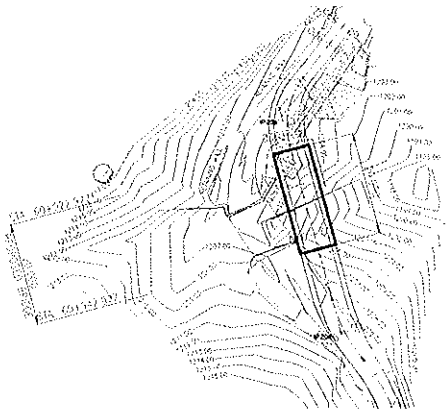


Figure-2.25 km60.3 Bridge Location Plan

Table-2.45 km60.3 Bridge Comparison Table for Bridge Type

Alternative No				Route A	
Route ルート				Route of Existing Road	
Bridge Type 形式				Simple Reinforced Concrete Slab	
Bridge Length 橋長				10.5m	
Profile					
Evaluation items	Construction Cost (Ratio)		60	60	1.00
	Construction Period		3	3	9
	Structure Aspect	Super-structure	2	2	good. skew 80 degree.
		Sub-structure	2	2	good. reversed T type abutment + steel H pile
	Construction execution	Super-structure	2	1	reinforced concrete slab by staging
		Sub-structure	2	2	detour will be located in upper stream side of existing bridge.
	Alignment		2	2	minimum radius is 15 m.
	Land Acquisition		25	25	not need for change of residence and land acquisition of field.
	Maintenance		2	2	maintenance -free
Recommendation			100	99	recommended mainly due to demolishing major damaged existing bridge earlier than Route B and low construction cost
Alternative No				Route B	
Route ルート				Route of Down Stream Side	
Bridge Type 形式				Simple Steel Plate Girder	
Bridge Length 橋長				20m	
Profile					
Evaluation items	Construction Cost (Ratio)		60	38.7	1.55
	Construction Period		3	3	9
	Structure Aspect	Super-structure	2	2	good skew 90 degree.
		Sub-structure	2	2	good. reversed T type abutment + steel H pile
	Construction execution	Super-structure	2	2	good. erection by truck crane.
		Sub-structure	2	2	detour will be located in existing road.
	Alignment		2	2	minimum radius is 15 m.
	Land Acquisition		25	25	not need for change of residence and land acquisition of field.
	Maintenance		2	2	maintenance -free if atmospheric corrosion resistant steel will be used.
Recommendation			100	78.7	

3) Selection of Route, Number of Span and Bridge Type

A. Selection of Route

There are 2 routes to be considered: one is the same alignment to the existing road, another is located on the downstream side of existing bridge. Detour of the former route is on upstream side of the existing bridge. The latter is on the existing bridge & road. Number of spans for new bridge is one span to avoid collision by rolling boulder stones from upstream in the river during the rainy season. The comparison of the two alternatives is shown in Table-2.45.

Alternative 1: Existing road route, bridge length of 10.5 m, reinforced concrete slab

Alternative 2: Downstream side route, bridge length 20 m, steel plate girder

Alternative 1 is selected, because major damaged existing bridge can be demolished earlier than Alternative 2, and the construction cost is lower than Alternative 2.

B. Number of Span

Number of spans is one because many boulders will collide at the upstream side in the rainy season if there is a pier under the beam.

C. Selection of Bridge Type

Box culvert type bridge is not recommended for the following reasons.

1) Boulders collide with the internal wall at the upstream side in the rainy season.

2) Maintenance work to remove the piled boulders is more difficult than beam type bridge.

3) Safety is not enough to remove the invert slab during the temporary open cut condition.

Reinforced concrete slab bridge of Alternative 1 is selected as shown in Table-2.46 also because of lower construction cost.

Table-2.46 Comparison of Proposed Type of km60.3 Bridge

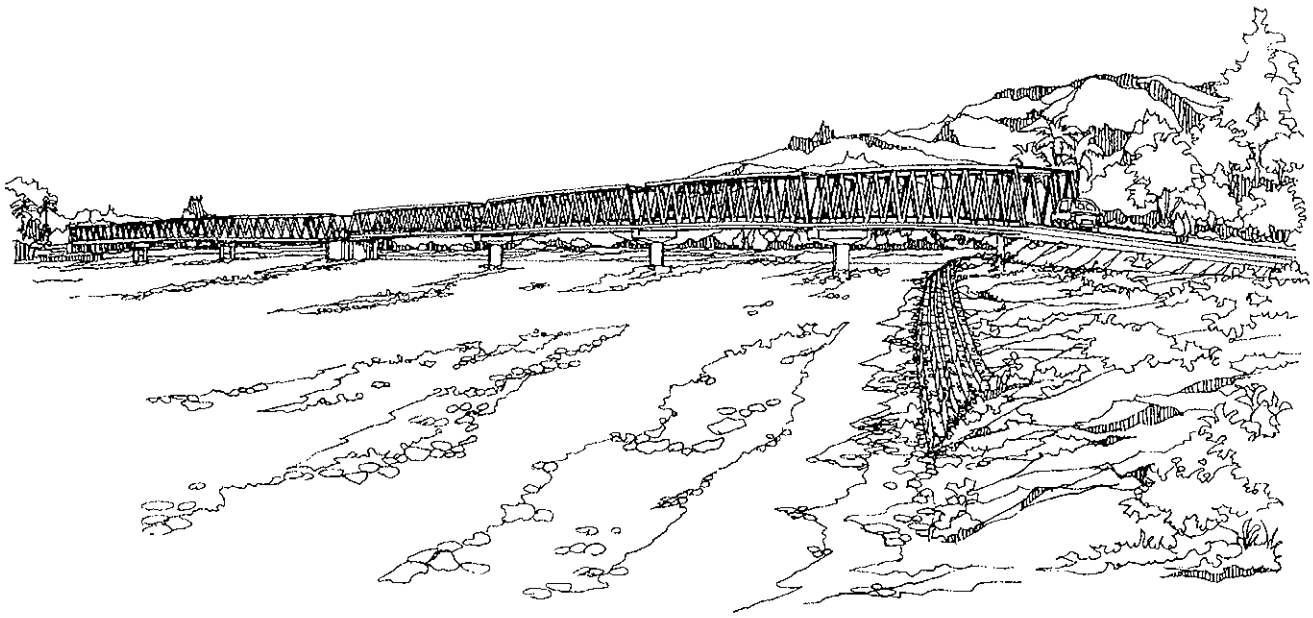
				Alternative 1: Reinforced Concrete Slab		Alternative 2: Steel Plate Girder	
Evaluation items	Construction Cost(ratio)		60	60	1.00	56.6	1.06
	Construction Period		3	3	9	3	9
	Structure Aspect	Super-structure	2	2	reinforced concrete slab by staging	2	steel plate girder with reinforced concrete slab
		Sub-structure	2	2	reversed T type abutment + steel H pile	2	reversed T type abutment + steel H pile
	Construction Execution	Super-structure	2	1	constructed at dry season due to staging method	2	constructed at all season due to erection by truck crane
		Sub-structure	2	2	detour will be located in upper stream side of exi	2	detour will be located in upper stream side of existing road
	Blocking Ratio		2	2	good without pier	2	good without pier
	Land Acquisition		25	2	not need for change of residence and land acquisition of field	2	not need for change of residence and land acquisition of field
	Maintenance		2	2	need for regular inspection and demolishing for boulder stones	1	need for regular inspection and demolishing for boulder stones need for repainting for normal steel material
Recommendation			100	76	recommended mainly due to low construction cost	72.6	

4) Selection of Substructure and Foundation

The bearing stratum for foundation is mudstone layer with class CL and 10 m deep. The elevation of bearing layer is EL. 1,199 m for abutment A1 and A2. The height of abutment is about 11 m when spread-footing type is selected. Because the reversed T-type abutment with spread foundation is not suitable for inclined bearing layer at mountainous construction site, pile foundation is selected for new abutment. Steel H-shape pile is selected because reinforced concrete pile cannot be embedded for weathered mud stone without damage of pile toe, and also because the construction cost is lower than that of steel pipe pile.

2-2-3 Basic Design Drawing

Basic design drawing for road and bridge improvement is attached separately.



2-2-4 Implementation Plan

2-2-4-1 Implementation Policy

(1) Road Work

The following items are examined for implementation of road rehabilitation work.

1) Rainy Season

This project includes the rehabilitation of mountainous road of about 95 km and bridge reconstruction, and the construction period is 17 months extending over 2 fiscal years. Difficulties are anticipated for implementation of rehabilitation works in rainy season from early December, usually to late June. Hence, it is important to utilize the dry season to conduct the work and to complete the project within the time.

2) Topography at km60.3 Bridge Site

The island of Timor is mountainous by the east-west range and rivers are short from the source to the coast with steep gradient. Therefore, water level in the river rises suddenly but for short time once rain falls, and the river flows quickly except the coastal area. The location of km60.3 is also characterized as the same, even though the river size is small. Hence, construction of substructure basically should be scheduled to be completed within the dry season. The countermeasures like a method by soil bags and temporary dikes against the swelling should be taken into account if the construction extends into the rainy season.

3) Securing of Public Traffic

Public traffic should be secured during the implementation of both road and bridge rehabilitation. Third-party vehicles are passing beside the roadwork site because of difficulty to maintain the detour. Thus, the method of construction should be drawn up considering the security of third-party & laborers, securing of third-party vehicle traffic and securing of work place for construction equipment. Publicity activities and cooperation with residents are important to notify the road closure if total traffic control is implemented because of narrow road width, surrounding topography and other inevitable reasons.

The time schedule for total traffic control plan is shown in section 2-2-1-4 in this report.

(2) Mola Bridge Work

The following items are examined for implementation of Mola bridge rehabilitation work.

1) Weather Conditions and Construction Period

This project includes the construction of 4-span truss bridge (L=240m) and the construction period is 15.5 months extending over 2 fiscal years. Difficulties are anticipated for implementation of rehabilitation works in rainy season from early December, usually, to late June. Hence, it is important to utilize the dry season to conduct the work and to complete the project within the time.

2) Existing Conditions at Bridge Location

The Mola River is short from the source to the coast and the river gradient is steep. Therefore, water level in the river raises suddenly but only for a short time once the rain falls, and the river flows quickly except in the coastal area. Hence, the construction of substructure should be completed within the dry season of 1st fiscal year. The countermeasures such as a method by soil bags and temporary dikes against the swelling should be taken into account for the sudden increase of water level in the river during the rainy season. High enough temporary yards should be prepared so that construction equipment would not be submerged nor carried away by river flow in the rainy season. Also, the temporary yards should be large enough to stock the construction materials near the site before rainy season.

3) Securing of Public Traffic

Public traffic should be secured during the implementation of both road and bridge rehabilitation. The new abutment will be constructed behind the existing abutment because the new bridge will be constructed as an extension of existing bridge. The existing bridge will be closed under construction period, so third-party vehicles will pass via the temporary road which is installed on the riverbed with corrugated metal pipe to allow river flow. Also, a detour should be prepared beyond the existing bridge on the riverbed avoiding the location of new bridge construction. River water crossing the detour also should be controlled using cross pipes by corrugated metal pipes.

4) Others

Publicity activities and cooperation are important to notify residents about the bridge rehabilitation work.

2-2-4-2 Implementation Conditions (Land Acquisition)

(1) Laws and regulations

The legal framework on land ownership has not yet been established in Timor-Leste, nor official procedure/regulations for land acquisition, expropriation, compensation, etc. for implementing public works. Moreover, basic data such as cadastral maps and land registers are missing. Thus, the rights for land use or occupancy is not secured legally, and land use/occupancy is customarily done through agricultural activities, etc. This means that the issues of land acquisition or expropriation need to be coped with in every particular project or case.

(2) Issues to be considered

The outcomes are summarized hereinafter based on the discussion with MTCPW and Division of Land and Property of Ministry of Justice, and based on meetings with local authorities and local people. Major issues to be considered on land acquisition are presented below.

1) Different processes are applied in Timor-Leste for land acquisition between the case of private land (non-governmental land) and that of governmental land. In case private land is to be acquired, the evacuation date will be settled considering the harvest season of agricultural products, and in addition, aid for land loss will be provided to the affected household by the government. On the other hand, in case governmental land is used or occupied land by local people is to be acquired, no aid for loss will be provided although the harvest season will be considered for determination of the evacuation date. However, MTCPW (Road, Bridge and Flood Control) has little experience on application of a compensation approach for clearing perennial crops such as coffee trees along the road for widening. It is considered to be necessary to employ the same process as above for implementation of the Project since the coffee cultivation is often observed along the Project road in spite of the fact that the land of 10 m width of both road sides is under governmental management.
2) Project implementation will cause the clearance of coffee trees or other agricultural crops for land acquisition (evacuation of governmental land), although the expected magnitude is considerably small. In order to realize a smooth process toward agreement of land acquisition with land users/occupants and evacuation/transference of land, it is desirable to consider ways to produce a direct benefit such as provision of employment opportunity to the local people, since MTCPW has experienced only a few similar cases of land acquisition. As required, the priority of employment for the Project-related works should be given to the households whose agricultural activities will be affected by the Project implementation. The following summarizes the results of meeting with Administrators and Deputy administrators of Districts/Sub-districts and local people along the target sections/sites of the Project road. Necessary considerations are also presented hereinafter.
    a. All of Administrators and Deputy administrators understand that the areas within 10 m width from the boundary of right-of-way are governmental land. However the local people do not have enough understanding of it, and so agricultural use by local people is occasionally observed along the Project road, such as coffee planting and cultivation of maize, cassava, etc. In order to obtain acceptance from land users/occupants along the road on widening work and land acquisition/evacuation, it is essential for MTCPW to provide enough opportunities for consultation with local people and communities through the local authorities.

b. There is a possibility that the local people might assert ownership in spite of unused land such as barren or bush land, exclusive of the case that land is recognized definitely as governmental. Thus, even if unused land is to be acquired, it is necessary for MTCPW to confirm the status of land occupancy through local authorities, and to consult with local communities as required.

c. Since local authorities have limited experiences on land acquisition, consultation with local people and communities is to be carried out under the close cooperation between local authorities and central ministries including MTCPW. Thus, a committee composed of central ministries and local authorities has an important role to reach a mutual understanding and acceptance on land acquisition/evacuation with local people.

d. It is necessary to provide enough explanation of the plan and design of the Project to local authorities so that Administrators can discuss and arrange the local issues properly with local people/communities. Based on the outcomes of this Basic Design study, MTCPW should present the plan and design of the Project to local authorities through the committee to be established.

e. The local authorities and communities raised an issue that laborers for construction work be employed as much as possible from the villages near the site. This request is to be considered before and during construction stage.

f. The following shows the issues on the specific section/site basis.

Ainaro area (79~132km and culvert bridge at 60km station)

- Based on meetings with the officials of local authorities, the acceptance and agreement from local people and communities can basically be obtained without any difficulties on land evacuation including clearance of coffee trees. However, there might be a possibility that some complaints or disagreement would be raised, and it would be important that a committee be established handle these issues.
- In case that the agricultural land would be used temporarily for construction works, it is considered to be able to get acceptance from land users/occupants by means of consultation with stakeholders through local authorities. However, there are governmental lands in and around Ainaro town which were the sites of demolished Ainaro District office and market. These lands are available as candidates for camp site and asphalt plant yard.
- According to the local officials, the acceptance from local communities will be obtained without any difficulties on collection of gravels and aggregates from the river located at 121 km station as well as installation of plant and temporary yard nearby.

- Based on meetings with local people, it is expected that the understanding and acceptance with local communities can be obtained with regard to clearance of coffee trees and land evacuation due to the widening works, through proper consultation.

Aileu Area (2～45km)

- Although local officials understand that the areas within 10 m width from the boundary of right-of-way are the governmental lands, they repeatedly stressed that it would be indispensable to have an enough consultation with local people/communities in order to realize agreement on clearance of coffee trees or evacuation of agriculture-used lands for widening works.
- Based on meetings with local officials and people, non-aided land acquisition can be hardly realized, and some compensation will be claimed from the local people.
- Therefore, in order to achieve a smooth process of land acquisition, it is important for MTCPW to provide enough backup and close cooperation with local authorities. The committee has an important role in this regard.

Zumalai Area (Mola Bridge)

- An administrator of the local authority hopes to design a plan on rehabilitation of Mola bridge with minimum requirement of land acquisition and resettlement, since he expects to face many difficulties to settle the issues on land acquisition and resettlement.
- Many concerns and requests as prerequisite conditions for acceptance and agreement on land acquisition and resettlement were raised from the local people through the interview survey. The above expectation of the administrator is considered to be derived from such mentality and perception of the local people.
- Thus, in order to achieve a smooth process of commencement of the construction and a successful completion of Mola bridge rehabilitation, it is essential to pay attention to avoid or minimize the risk and obstacles to be encountered due to the site-specific circumstances. In this regard, it is proposed to have planning of design of Mola bridge rehabilitation which follows the existing alignment, considering the issues of land acquisition and resettlement in this area.

2-2-4-3 Scope of Works

Major undertakings to be taken by each government are as shown below.

A. To be covered by Japan (Grant Aid)

1. To construct the camp, yard and parking lot
2. To construct roads within the site
3. To construct the buildings
4. To provide facilities for the distribution of electricity by drop wiring and internal wiring within the site, and the main circuit breaker and transformer
5. Provide the water supply system within the site (receiving and elevated tanks)
6. Provide the drainage system (for toilet sewer, ordinary waste, storm drainage and others) within the site
7. Provide the main distribution frame/panel (MDF) and extension after the frame/panel
8. Provide project equipment
9. Arrange marine (air) transportation of the products from Japan to Timor-Leste
10. Arrange internal transportation from the port of disembarkation to the project site

B. To be covered by Timor-Leste

1. To secure land on schedule
2. To clear, level and reclaim the site when needed
3. To construct gates and fences in and around the site
4. To construct roads outside the site
5. Provide distributing line for electricity to the site
6. Provide city water distribution main to the site
7. Provide city drainage main (for storm, sewer and others to the site)
8. Provide telephone trunk line to the MDF of the building
9. Provide general furniture
10. To bear the advising commission of Authorization to Pay and payment commission to the Japanese bank for banking services based upon the Banking Arrangement
11. Arrange tax exemption, custom clearance of the products at the port of disembarkation
12. To accord Japanese nationals, whose service may be required in connection with the supply of the products and the services under the verified contracts, such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work
13. To maintain and use properly and effectively the facilities contracted and equipment provided under the Grant
14. To bear all the expenses, other than those to be borne by the Grant, necessary for construction of the facilities as well as for the transportation and installation of the equipment

2-2-4-4 Consultant Supervision

(1) Preparation for Method of Construction and Work Schedules

The Contractor should submit his method of construction and preparation schedules to the Consultant immediately after the Notice to Proceed because he needs to get the approval from the Consultant. Review should carefully examine the rainy season, holidays and working conditions in Timor-Leste. The work schedule should be prepared in consideration of procurement of material & equipment from Japan and the third countries not influenced by delay.

(2) Organization of Project Office

a) Arrangement of Project Office and Organization

The project covers a wide range of road section from km2 – km46 and km79 – km130 with 130 km length. Also, a communication system is not working within the project site. Therefore, 2 project offices will be arranged for the following purpose: Aileu liaison office at km46 will relay information from each site to Tokyo & Jakarta, coordinate with MTCPW, JICA Dili office, Japanese embassy, and purchase material & equipment in Dili city. Road office at km110 will supervise overall matters in the project.

b) Personnel Planning

Staff in central office and road office will supervise the construction. Central office will manage liaison activity, gathering information, procure workers, machinery and material.

(3) Mobilization

a) Clearing and Grubbing

Clearing and grubbing will be conducted prior to the commencement for temporary yard. The produced waste will be disposed at the specified place.

b) Survey to Commence the Work

After clearing and grubbing completed, survey for location of road, section at bridge construction, temporary yard and project office will be conducted. Boundary of project site, referring points and boundary for rented ground are also to be confirmed by survey.

c) Temporary Yard and Outpost

Temporary yard and outpost will be arranged because of long distance of project road. They will be prepared at the location km25 and km110 in Ainaro. Material & equipment yard and working yard also will be arranged for the bridgework at km60.3.

d) Construction of Temporary Facilities

Each temporary yard will have a site office with meeting rooms, penthouse (work shop), warehouse, cement storehouse, lavatory, shower room, resting room, lodging house and guard house. Temporary yard for steel pipe pile, beam member and bridge accessories, stockyard and parking lot will also be prepared. Asphalt plant will be arranged near the road office but the crushing plant will be arranged at km120 near the quarry.

(4) Safety Precautions

a) Safety Precautions for Workers

The chief engineer at each site will conduct safety education and direction of safety to workers during the construction period. Safety education and safety patrol on site will be conducted for all workers once a month. Security guide and watchman will be arranged for earthwork by heavy equipment. A signalman will be arranged for bridgework by crane. Crane will be operated after arranging sufficient extension of out-riggers to prevent falling down.

b) Safety Precautions for Third-Party

Both road rehabilitation and bridgework will be implemented maintaining safety first for third-parties because third-party vehicles are passing under construction for rehabilitation and bridgework. Barricades, plastic cones and other safety signboard will be prepared. Publicity activities and cooperation with residents will be done to keep good communication.

(5) Electricity and Water Supply Plan

a) Electricity Plan

Electric generators (under 100KVA) will be prepared for long distance road rehabilitation work (50 km). Electric generators (about 100 KVA) also will be prepared for the bridgework at km60.3 because of lack of electric power supply. Electric power will be supplied also by generators at each temporary yard

b) Water Supply Plan

Industrial water will be mostly used for concrete mixture, rolling compaction for subbase course and cleaning & curing for concrete slab. Industrial water for concrete mixture and cleaning & curing will be obtained from neighboring rivers. Water for offices will be obtained from deep wells.

(6) Technical Management Plan

a) Quality Control

Quality control for asphalt and concrete will be conducted at a laboratory arranged in the temporary yard. Laboratory test for soil also will be conducted there.

b) Workmanship

Workmanship for road rehabilitation work will be controlled by width & thickness of subbase & base course. Road structures such as side ditch, retaining wall and gabion block, on the other hand, will be supervised by measuring or photographs for shape of excavation and final condition of structures. Workmanship for km60.3 bridge will be controlled by length of pile driving, size & dimensions of each substructure, spacing of supports, driving force for bolts, camber for beams, formation level for expansion joint and each dimension for superstructures.

(7) Management Plan for Construction Equipment and Material

Dili central office will manage the procurement for construction equipment and materials. Daily management for conveyed equipment & materials would be conducted on site. Imported equipment & material especially bridge superstructure should be carefully managed. Temporary yard with security guard must be arranged for equipment and materials.

2-2-4-5 Quality Control Plan

Site engineer of each work item will conduct quality control and the detail will be reported to the project manager as a site representative. The project manager should report the result of quality control to the Consultant together with the data record. Each work item specified in the design drawing should be constructed following the specification. The Consultant will inspect the each work item and the result will be recorded. Quality control will be conducted based on the contracted specifications. It will be mainly conducted by civil engineers (local or expatriate) or laboratory technician (local). Construction progress and schedule control will be managed by local or expatriate civil engineers and whole project will be managed by the project manager in Dili through the Japanese engineer at each site office.

2-2-4-6 Procurement Plan

(1) Worker

1) Condition of Procurement for Engineer and Labor in Timor-Leste

Conflict with Indonesia has just come to an end in Timor-Leste. Indonesian engineers or technician who were working in Timor-Leste have returned to Indonesia, so that not only engineers but skilled labors also are insufficient. Many engineers who are engaged in the construction work aided by other countries are Australian or Filipino. On the other hand, jobless rate in cities is more than 70% for common labor; this means an oversupply of labor.

2) Laws and Regulations about Employment in Timor-Leste

The project will be implemented in conformity to the following labor regulation made in May 2002; ***-Regulation No.2002/5 on the Establishment of a Labor Code for East Timor***

3) Wage system

Engineers and managerial positions are mostly paid monthly but common workers are paid by daily or weekly base. Meanwhile, there is not any large enterprise for a model; therefore, the system has not yet been established in Timor-Leste. The actual situation in the country should be taken into consideration.

4) Taxation System

The related tax for the project is the income tax for local employees. The tax is imposed from income at source and the rates are shown below.

Income (Month)	Income (Daily Base)	Tax Rate
Less than $ 550	Less than $ 22	10%
US $ 551 or More	US$22 or More	30%

(2) Equipment and Material

1) Material Condition

It was confirmed that most materials used in the rehabilitation were available to purchase in Timor-Leste after the 2nd site study. However, any mass consumable materials must be imported from Indonesia, Australia or Singapore. Steel pipe pile for foundation of bridges at km60.3 and Mola, and steel beam materials & accessories (high-tension bolt, key, pipe, handrail, expansion joint and so on) will be imported from Indonesia. The reason of import from Indonesia is: low-priced steel material, certain date of delivery, possible precise assembly by high quality materials and so forth.

2) Equipment Condition

It was also confirmed that most equipment used in the rehabilitation was available to purchase in Timor-Leste after the 2nd site study. Lease is available for most equipment but the charge is quite high so procurement from Japan or third-countries must be considered for comparison. Special equipment for bridge erection, plant, scaffolding member, bolt connection should also be imported from Japan or third-countries.

2-2-4-7 Soft Component

Implementation of soft component was requested by Timor-Leste. The purpose of soft component is to improve the skill for road operation & maintenance together with capacity building when staff of MTCPW conduct road operation & maintenance for routine, periodic and incidental management, and when residents are engaged in the community maintenance. Road operation & maintenance is now under the control of MTCPW, and its organization is shown in Figure-2.1. JICA is planning to assist MTCPW applying technical transfer by Japanese specialist. Hence, the assistance is out of the scope of this project, a sample component is shown as below (amount is rough estimate).

No	Component Item	FY2 9	10	11	12	FY3 1	2	3	4	5	6	7	8	9	10	11	12	FY4 1	2	Remarks	Expense (Venue,Train,Material)
1	Consultation for Maintenance Manual & Seminar										■									0.7 Months	
2	Manual for Routine, Periodic, Incidental Maintenance											■	■	■						Domestic Work (2.3 Months)	
3	Seminar for Routine,Periodic, Incidental Mainten.													■						Open 3 Venues for Staff of MTCPW and Sub-District Offices	$4,590(Seminar①) $2,484(Training①)
4	Manual for Community Based Maintenance														■					0.7 Months	
5	Seminar for Community Based Maintenance															■	■			Open at 5 Sub-District Offices (1 Week at 1 Place)	$7,650(Seminar②) $4,140(Training②)

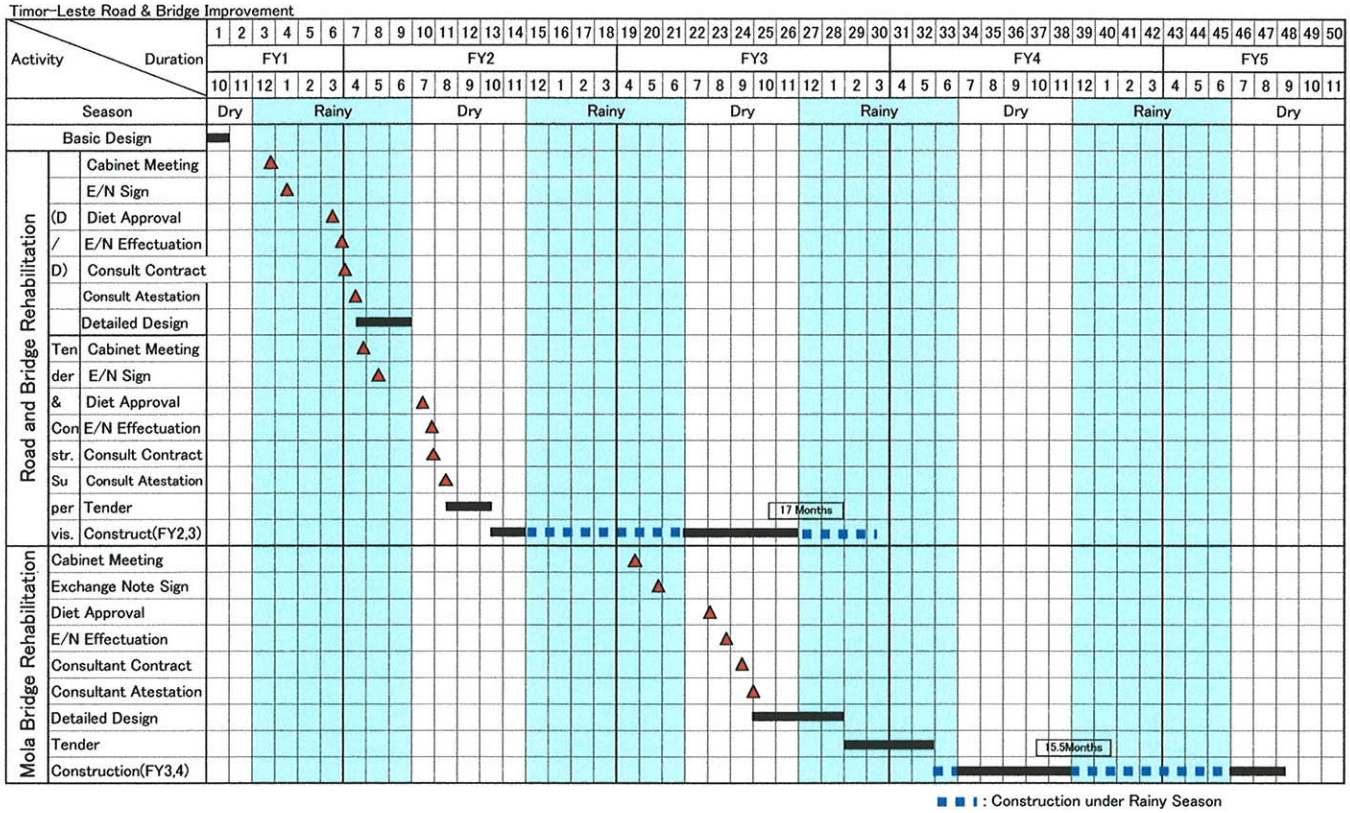
Schedule for the Consultants

	FY2 9	10	11	12	FY3 1	2	3	4	5	6	7	8	9	10	11	12	FY4 1	2
Capacity Building for Road Engineer										■	■	■	■	■	■	■		

Cost for Seminar : $12,240
Cost for Training : $6,624
Total Cost : $18,864
(Excluding Engineer's Cost)

Total Amount for Soft Component: ¥18,257,000
(Including Seminar & Training Cost ¥2,264,000)

2-2-4-8 Implementation Schedule



2-3 Obligations of Recipient Country

2-3-1 Land Acquisition for the Project

(1) Process

Land acquisition for the Project is to be carried out by Timor-Leste side through the following process:

- A committee is to be established, which is composed of central ministries (MTCPW, Division of Land and Property of Ministry of Justice, and Ministry of Agriculture, Forestry and Fishery as required) and local authorities concerned (Districts and Sub-districts), based on the result of the Basic Design Study. A basic agreement is to be realized among the committee members by the end of November, 2003.
- Individual agreements are to be realized with land users/occupants by the end of June, 2004.

(2) Proposed direction for land acquisition and compensation

The following shows a proposed direction for land acquisition and compensation due to the Project implementation as well as for estimate of compensation cost, based on the outcomes of the chapter 2-3-3 and meeting with MTCPW, Division of Land and Property and local authorities.

1) Even in case that additional right-of-way is required due to widening works of the Project road or embankment work at right bank of Mola bridge, the land loss will not be compensated since the required areas for widening/embankment will be within 10 m width from the existing ROW, meaning governmental lands.

2) However, the following consideration is to be paid when land lots under agricultural use are to be acquired.

- Clearance of perennial cash crops such as coffee planting due to the Project implementation is to be compensated since: i) cost for maintenance and caring have been invested so far, and ii) expected benefit in future will be damaged.
- Regarding clearance of annual crops such as cassava and maize, the date to be evacuated from land users/occupants is to be set up considering the harvest seasons. In this case, no compensation will be provided because loss/damages are not expected.

3) It is planned to pay attention to the design through work cross section and installation of passing places, etc., in order to avoid damage to the existing house structures. Thus, land acquisition of residential lots due to the Project implementation will not occur, and compensation will not be required.

4) Cost necessary for temporary land use (land rent) for the construction work is to be estimated, in case non-governmental land will be proposed for the construction yard, such as the area for plant installation accompanied with material collection near the 120 km-station river and the area for temporary road at km60.3 bridge.

2-3-2 Environmental Approval Necessary for the Project Implementation

Environmental approval for the Project implementation is to be obtained by Timor-Leste, with the following process:

- Considering that the related laws and regulations including EIA process have not yet been established, the official procedure for obtaining the environmental approval is to be based on Guideline No. 1 and No. 6 issued by Ministry of Development and Environment (MoDE).
- The Project is composed of rehabilitation and improvement of the existing roads and bridges, not composed of any section of new road construction. In addition, the Project road will not pass through sensitive areas such as a protected or designated area. Thus, the Project is to be classified as a [Category B] project according to the guidelines.
- An environmental screening and preparation of an environmental management plan for the Project are to be done by MTCPW based on the result of the Basic Design Study, and are to be submitted to MoDE. After reviewing by MoDE, the environmental approval is to be obtained by the end of November, 2003.

Opportunities for meeting and discussion between MTCPW and MoDE are to be realized properly in the above procedure, in order to obtain the environmental approval promptly and smoothly.

2-3-3 Cost for Obligations for Recipient Country

The cost which should be covered by Timor-Leste is estimated below, including cost of compensation for clearance of coffee trees due to land acquisition for the Project.

Item	Estimated Cost	
Cost of compensation for clearance of coffee planting due to land acquisition	US$ 16,100	(1.9 mil. JPY)
Cost of temporary land use (land rent) for construction yard and road	US$ 2,500	(0.3 mil. JPY)
Cost for obtaining of environmental approval and environmental monitoring	US$ 1,900	(0.2 mil. JPY)
Total	**US$ 20,500**	**(2.4 mil. JPY)**

2-4 Project Operation Plan

2-4-1 Allocation of Section, Operation & Maintenance by Sub-District Office

Operation and maintenance of facilities improved by the Grant are undertakings by the recipient side. The project road section will be operated and maintained by 3 public works offices among the 5 offices in Timor-Leste as shown by sub-district office in Table-2.47.

Table-2.47 Allocation of Section for Dili – Aituto – Suai Road

Sub-District Office	Road Section	Road Length	Prefecture to Pass
Dili	km0.0 - km14.7	14.7 km	Dili
Same	km14.7 - km165.0	150.3 km	Aileu, Ainaro
Maliana	km165.0 - km180.0	15.0 km	Cova Lima

Operation & maintenance cost for 5 sub-district offices is shown in Table-2.48 below. The average cost of operation & maintenance for 1 km of national road is ¥138,000 (US$1.00=120 yen). It is quite low compared with that in Indonesia (average ¥300,000/km). It is almost same level with Philippines (average ¥150,000/km) without consideration of prior investment for road rehabilitation before the implementation of operation & maintenance by Philippines.

Table-2.48 Cost of Operation & Maintenance for Each Sub-District Office and Road Length

Sub-District Office	National Road	Provincial Road	Secondary Road	Total (US$)
Dili	359,800	102,800	51,400	514,000
Same	287,840	82,240	41,120	411,200
Maliana	287,840	82,240	41,120	411,200
Baucau	359,800	102,800	51,400	514,000
Oecussi	143,920	41,120	20,560	205,600
Total	1,439,200	411,200	205,6000	2,056,000
Road Length	1,250 km	1,750 km	3,000 km	6,000 km
Cost/km	US$ 1,151/km	US$ 235/km	US$ 69/km	US$ 343/km

The existing budget for operation & maintenance is enough to maintain the Dili - Suai road since the maintenance cost for the project road will be reduced after the rehabilitation by the basic design for the improvement of roads and bridges. The problem is how much rehabilitation can be conducted through out Timor-Leste and how complete the system for operation & maintenance can be organized. The equipment list for rehabilitation in sub-district office is shown in Table-2.49.

Table-2.49 Equipment List for Rehabilitation in Sub-District Office (Unit: Nos.)

	Name of Equipment	Type	Dili	Same	Maliana
1	Pick-Up Truck	Mitsubishi 4WD; Double Cab.	1	1	1
2	Dump Truck	Mitsubishi Canter: 4 ton	3	2	2
3	Small Roller	Hand Roller	2	1	1
4	Concrete Mixer	Manual Type	3	3	3
5	Compactor	VPH70, BS 500 Rammer	4	4	4
6	Water Pump	HD 3.7	2	2	2
7	Motorbike	YAMAHA 175cc, HONDA	4	3	3
8	Vibrator	HD 3.7 FWP 40/60	2	2	2
9	Re-Bar Cutter	BTS 1035	1	1	1

Types of rehabilitation equipment for Baucau and Oecussi offices are almost the same as the other offices in the above table except the number of equipment.

The equipment in the table is suitable for routine maintenance but not for periodic or incidental maintenance which requires more suitable equipment.

However, it is not a good policy that MTCPW prepares for the maintenance system at its own expense to consider cost-effect; it is better to introduce the maintenance system by referring to other countries' systems in Southeast Asia. This means that the initial investment for equipment, material and personnel expenses should be decreased as low as possible and contracts with private companies should be ordered for maintenance work as much as possible. This method has been proposed in studies by JICA, UNOPS and ADB as summarized in the following table.

Table-2.50 Form of Maintenance Works

	Contents of Maintenance Work	Force Account*	Contract
Inspection & Patrol		○	
Routine Maintenance	Grass Cutting for Road Shoulder & Slope, Ditch Cleaning, Repair Gabion and Potholes	○ (Community Base)	
Periodic Maintenance	Slope Protection, Pavement, Bridge and Overlay Repair		○
Incidental Maintenance	Slope Protection, Pavement, Bridge	○	○

* Time and materials basis

The Department of Equipment and Asset Management was established within MTCPW in April 2003 to put the remaining construction equipment by JEG to practical use. The list for the remaining equipment is shown in the following table.

Table-2.51 List of Remaining Equipment by JEG (Partial)

Vehicle	Jeep	6	Equipment	Excavator	1
	Cargo Truck (light)	1		Excavator (13 Ton)	1
	Cargo Truck (Medium)	1		Excavator (wheel)	1
	Motor Bicycle	1		Truck Crane	1
	Ambulance	1		Bulldozer (D2)	2
				Bulldozer (D4)	1
				Bulldozer (D6)	1
				Bucket Loader	1
				Truck Carrier with Crane	2
				Roller	1
				Concrete Mixer	1
				Crusher Plant	1
				Transporter	3
				Grader	1
Total		10	Total		18

The organization, operation and ordering system should be reexamined in consideration of the existing & future remaining equipment in each sub-district office for road operation & maintenance.

2-4-2 Organization

Three sections, power & water, public works and transport & communication, are arranged under the minister, vice minister and secretary state in MTCPW (see Figure-2.19). Public works, roads/bridges & flood protection, and equipment & asset management sections are arranged within the public works department. Sub-district offices, which are engaged in the maintenance work, are arranged under the public works section.

2-4-3 Regulations and Usage

The existing regulations quoting Indonesian laws and new regulations are now in preparation expecting approval by Diet within a few months. Roads are classified into national (main) roads of 1,250 km, district roads of 1,750 km, and feeder (secondary) roads of 3,000 km. Public works department is engaged in the maintenance work based on budget regulations, but it is limited only for national road, main road, and partial routine maintenance for provincial road.

Sub-district offices conduct routine road maintenance by CBM (Community Base Maintenance), PC (Private Contract) and Depot contracts. CBM is implemented with procurement of work force from the surrounding communities mainly for road cleaning, grass cutting and ditch cleaning, and by the assignment contract based on the work volume.

The above-mentioned CBM contract system is suited to custom in Timor-Leste such that the work in a community must be conducted by the workforce within the community, and it is functioning to a limited extent.

PC is a type of contract system that orders to private contractors. Sub-district offices can contract by their own authority if the contract amount is less than US$1,000. Approval of central office is required if the amount is more than US$1,000.

Depot is a type of contract system that orders to a community group with supply of material and small equipment.

The work extent is different among each sub-district office. For example, Maliana sub-district office recognizes that national road and provincial road should be covered by it; on the other hand, Same sub-district office recognizes that only national road should be covered by it.

2-5 Rough Cost Estimate for the Project

2-5-1 Rough Cost Estimate for the Grant Project

The total amount of the project for implementation is about US$ 18.94 million. The cost covered by each side (Japan and Timor-Leste) is estimated as below based on the following estimation conditions. This cost estimate is just provisional, not final and would be further examined by the Government of Japan for the approval of the Grant.

(1) Cost Covered by Japanese Side

Classification	Road Rehabilitation	Mola Bridge	Total
(1) Construction	JPY 1,438 Million	JPY 621 Million	JPY 2,059 Million
(2) Consulting Service	JPY 125 Million	JPY 81 Million	JPY 206 Million
Total	JPY 1,563 Million	JPY 702 Million	JPY 2,265 Million

(2) Cost Covered by Timor-Leste

The cost covered by Timor-Leste is estimated as follows, including cost of compensation for clearance of coffee trees due to land acquisition for the Project.

Item	Estimated Cost	
Cost of compensation for clearance of coffee planting due to land acquisition	US$ 16,100	(1.9 mil. JPY)
Cost of temporary land use (land rent) for construction yard and road	US$ 2,500	(0.3 mil. JPY)
Cost for obtaining of environmental approval and environmental monitoring	US$ 1,900	(0.2 mil. JPY)
Total	**US$ 20,500**	**(2.4 mil. JPY)**

(3) Condition of Estimation

① Time of Estimation : October, 2003

② Exchange Rate : 1US$ = 119.68 Yen

③ Construction Period : Project is implemented for 2 terms: Detailed Design and Construction periods are shown in the work schedule.

④ Others : The project will be implemented based on the system of grant aid by Japanese government.

2-5-2 Cost for Operation and Maintenance

The operation & maintenance cost for the improved roads & bridges in the project is estimated as shown below.

A. Maintenance Cost for Roads

Maintenance cost for national road in Timor-Leste (refer to Table-2.48) is US$1,151/km/year (Year2002), and estimated in the national budget. However, the maintenance cost (US$1,151) is not enough because the rehabilitation for the national road with 1,250km length is incomplete. Therefore, immediate work is expected. After completion of the road rehabilitation between Dili and Cassa by this project, operation & maintenance cost will be reduced, and become US$857. Thus, the budget for this road section will be secured.

- Future maintenance cost after the project : US$ 840/km/yr (Based on the ratio*)
- Maintenance cost for Dili – Cassa road : US $840×100 km=US$ 84,000/yr

*): average maintenance cost for paving road (databank for World Bank) multiplied by cost for slope protection and drainage maintenance (30%).

B. Maintenance Cost for Mola Bridge

Unit: thousand yen

Classification	Frequency	Inspection Point	Maintenance Work	Expense
Maintenance for bridge	1 time/yr	Drainage	Cleaning of drain pipe Photos & records for damage	62
		Steel handrail	Photos & records for damage	
		Support	Cleaning around supports Photos & records for damage	
Maintenance for revetment	1 time/yr (after flood)	Gabion revetment Gabion riverbed	Check of scouring and settlement	31
Restoration for revetment	1 time/5yrs (if necessary)	Gabion revetment Gabion riverbed	Restoration of damaged part	520
Restoration for bridge				0
Total (10yrs)				1,970
Average annual maintenance cost				197

US$ 1,650/yr/ Mola Bridge

Remarks:

Bridge maintenance cost	; Engineer (¥8,000) × 2 man/day=	¥16,000
	; Technician (¥2,000) ×10 man/day=	¥20,000
	; Accommodation (¥1,000) ×6man/day=	¥6,000
	; Vehicle (¥10,000)×2days=	¥20,000
	; Total=	¥62,000
Maintenance for revetment	; Half of bridge maintenance=	¥31,000
Restoration for revetment	; 1,300 yen/m^3×4,000m^3×10%=	¥520,000
Restoration for bridge	; Painting is not necessary because of galvanized steel	

C. Maintenance Cost for Roads and Bridge

Based on the above A and B (improved length: 100km)

Maintenance Cost for Roads and Bridge = US$84,000 + US$1,650 = US$85,650

Thus, annually average maintenance cost for roads and bridge is; US$857 /km

2-6 Environmental Issues

(1) Environmental Evaluation of the Project and Issues to be considered

1) Laws and Regulations

The current situation of fundamental framework of legislation related to environment in Timor-Leste is described below.

- Draft Pollution Control Law: The draft law aims at control of pollutants in air quality, water quality and soil, as well as management of solid waste, which would be discharged into the ambient environment due to the industrial activities. It secures the environmental control and management of industrial activities on the basis of license or permission system. The related regulations have not yet been prepared, such as the type and scale of industrial activities to be controlled, standard values of effluents, etc.
- Draft Environment Impact Assessment Legislation Law: The draft law obligates the project proponents to conduct EIA for implementation of development projects. The related regulations will be prepared, such as the type and scale of the development project on which the EIA is to be conducted, official process, scopes to be studied, items and contents to be included in EIA statement, etc.
- The legislation for natural environment conservation or protected areas has not yet been prepared. UNTEAT Regulation No.19/2000 is the currently effective ordinance for natural environment in Timor-Leste, which stipulates the management of protected areas.
- The environmental administration in Timor-Leste is executed based on eight guidelines issued by Ministry of Development and Environment (MoDE) in 2001, in addition to the UNTEAT ordinance.

  Guideline No.1: Environmental Requirements for Development Proposals (mentioned in the next section)
  Guideline No.2: Mechanized Sand and Gravel Extraction from Rivers and Borrow Pits
  Guideline No.3: Small Landfill Siting Guidelines
  Guideline No.4: Interim Tibar Landfill Operation Guidelines
  Guideline No.5: Prescribed Activities for Pollution Control (no effectuation)
  Guideline No.6: Environmental Screening (mentioned in the next section)
  Guideline No.7: Storage of Fuel and Oil
  Guideline No.8: Ambient Noise from Stationary Sources

Among the above, guidelines Nos.1, 2 and 6 are to be referred for implementation of the Project. Guideline No.2 stipulates the restrictions on activities related to sand/gravel extraction in and around the river areas, including prohibition of installing a stock yard within the river area, prohibition of watercourse change causing a probable bank erosion, boundary identification and notice of area for extraction, etc.

(2) Environmental Impact Assessment (EIA) System

- The proposed project is classified under three categories according to its own type and scale: namely, [Category A] project on which EIA is essential, [Category B] project on which an environmental management plan (EMP) is necessary, and [Category C] project on which no environmental approval is needed. However, in case that the project site is located in or around the sensitive areas such as a protected area on which a special consideration should be paid, the proposed project is classified as [Category A] project regardless of its type or scale.
- The overall process for obtaining the environmental approval are: i) to identify the category of the project through environmental screening by the proponent, ii) to submit the screening result to MoDE, iii) to prepare EIA or EMP statement and submit it to MoDE after the proponent meets the acceptance from MoDE on the screening result, and iv) to obtain the environmental approval after MoDE review the EIA/EMP statement.
- [Category A] project necessitats conducting a full-scale EIA, and holding a public hearing/consultation. On the other hand, regarding [Category B] project, EMP statement is to be prepared including the environmental impact prediction, environmental mitigation measures and monitoring plan. It is unnecessary for [Category B] project to hold the public hearing/consultation.

(3) Environmental evaluation on the Project

Environmental evaluation on the Project was carried out based on the JICA Environmental Consideration Guideline (Road sector), and the results are presented below:

i) Screening (Selection of target components to be evaluated)

Among all the sections of 180 km requested by Timor-Leste, the following sections and sites were selected as the targets necessary for the environmental examination and evaluation. Other sections/sites were screened out for further examination because no construction work was planned.

- Dili-Aileu section (km2~km45)
- Aituto-Cassa section (km79~km132)
- Mola bridge
- Double cell box culvert bridge at km60.3 (km60.3 bridge)

The environmental examination below was conducted considering the construction works, temporary land use for stock yards, etc. during the construction stage, and probable change of traffic volume after completion of the Project.

ii) Result of Environmental Evaluation

The environmental items for examination were set up based on the JICA guideline, including nine (9) elements on social environment, eight (8) elements on natural environment, and eight (8) elements on environmental pollution. The examination was conducted on each section/site selected in the screening step, in due consideration on the current condition of environment in the Project area and the characteristics of the Project activities. The results are shown in the Table-2.52.

Since i) the Project is mainly composed of the improvement or rehabilitation works of the existing roads and bridges, and ii) there are no sensitive areas along the Project roads necessary for paying special attention from the environmental viewpoint, the environmental impacts are expected to be small or negligible in general. However, adequate consideration is to be given on the following issues because a certain magnitude of impact may occur.

a.Dili-Aileu section: It is not expected to bring about the large scale acquisition of land including agricultural use due to the Project implementation. However, agricultural land use can be observed in some lots for cultivation of annual crops (maize, cassava, etc.) and coffee planting; thus, there is a possibility to partially clear the agricultural crops along the section due to widening works for installation of side ditch or slope protection.

b. Aituto-Cassa section: In same manner as the above, there is a possibility to partially clear the agricultural crops including coffee planting along the section, due to installation of side ditch, etc.

c.Mola bridge: It is not expected to bring about the large scale acquisition of land including agricultural use due to the Project implementation, since the plan for rehabilitation of the bridge is to follow the alignment of the existing road. However, embankment work with longitudinal length of 50 m is planned in order to meet the elevation of the existing road from the right-bank abutment of Mola bridge, and the agricultural land use for annual crop production can be observed partially along the existing alignment. It may be necessary to acquire a few lots of the agricultural area along the embankment-worked section for the Project implementation, although the area to be acquired is very limited.

The above issues will not cause serious impacts on the regional economic activities. However, due consideration should be given to the households whose agricultural activities in the lots along the target sections/sites of the Project will be affected due to land acquisition/evacuation. As mentioned in the chapter 2-3-3, it is proposed to compensate the clearance of coffee planting due to widening works, and to set the date for evacuation of the lots along the target sections/sites considering the harvest season of agricultural crops.

iii) Other issues

The following is to be considered for avoidance of causing environmental impacts.

- It is inevitable to stop traffic when pavement work is done at a site with narrow width. Thus it is proposed to develop a work construction plan for reducing inconvenience to traffic.
- The appropriate management should be done in order to avoid deterioration to health and sanitary conditions at the construction camp sites.
- The dust (coarse particulate) will be generated in the heating and drying process of aggregate in the asphalt plant to be constructed in the suburb of Ainaro. Therefore, it is necessary to take a countermeasure such as installation of dust-collecting equipment at the vent to remove the dust.
- The stones and rocks are being quarrying out from the existing slope of the Project road, especially some spots of Aituto-Cassa section, by local people who expect a requirement of gabion materials for future construction works. Such uncontrolled quarrying will cause a probable erosion or slope failure. Therefore, it is necessary to cope with this issue adequately; for example, to restrict the local people to quarry through the control of the local authorities.
- It can be observed that the local people use the river at upstream and downstream of Mola bridge for bathing, washing and irrigation intake. Therefore, due consideration is to be given during construction stage to keep the current channel and watercourse of the river through such measures as: i) installation of corrugated steel pipes to temporary river-crossing road, and ii) preparation of work plan on construction schedule as well as on design of channel diversion for construction in order to minimize an impact on river use due to coffering the current watercourse and stream.
- It is planned to collect the asphalt aggregate and other construction materials in Sarai river located at km121 nearby within Aituto-Cassa section. It can be observed that the local people use the river at the downstream (up to Cassa) for bathing and washing. Therefore, due consideration is to be given on extraction work for collecting materials in order to reduce turbid water inflow into the river through such measures as equipping temporary earth dyke encircling the extraction spot.

In addition, it is preferable to take into account the following issues for the Project implementation, although the following is not identified in JICA guideline as an environmental item to be evaluated.

- Temporary markers and traffic controllers are to be arranged in order to reduce the traffic hindrance in a section under construction.
- It can be occasionally observed in mountainous area that the PVC pipes are installed by local people along the Project road in order to use water from springs or small streams for domestic purpose. It may be necessary to take a measure such as temporary work in case that the water use of local people would be impeded by the Project implementation.
- The main pipes for water distribution equipped for public water supply system in Ainaro town are buried along the Project road of km109 ~ km113. It is necessary to pay attention in order to avoid damage to their function due to the construction works.

Table-2.52 (1) Result of Environmental Evaluation (Social Environment)

Environmental Item	Evaluation	Basis for Evaluation
1 Resettlement	C	Dili – Aileu; There are Dili urban district at 0-3 km station of the Project road and a few small-scale villages scattered along the road. However, resettlement will not occur due to the Project implementation, since it is planned to pay attention to the design through worked-out cross section and installation of passing places, etc., in order not to damage the existing house structure. Besides, construction yard or camp is not planned in the section.
	C	Aituto – Cassa; There are relatively big towns such as Ainaro (110km station of the Project road) and Cassa (130km station of the Project road) and there are also a few small-scale villages scattered along the road. However, resettlement will not occur due to the Project implementation, since it is planned to pay attention to the design through worked-out cross section and installation of passing places, etc., in order not to damage the existing house structure. Since construction yard and camp are planned to be established at the sites of the previous office building and market which are within the public lands in the suburbs of Ainaro, resettlement will not occur.
	C	Mola Bridge; Resettlement will not occur, since the plan of rehabilitating the bridge follows the existing alignment. And installation of construction road, yard, and camp will not bring about the resettlement.
	C	60Km Bridge; Some houses are scattered around the site. However, resettlement will not occur since the rehabilitation plan follows the existing alignment. And installation of construction yard will not bring about the resettlement.
2 Economical Activity, Land Acquisition	B	Dili – Aileu; Large scale acquisition of land including agricultural use will not occur, and then there will be no impact on the local economy. However, agricultural use can be observed in some lots along the section for cultivation of annual crops (maize, cassava, etc.) and cash crops (coffee planting, etc.), thus there is a possibility to partially clear these agricultural crops due to widening works for installation of side ditch. Besides, construction yard or camp is not planned in the section.
	B	Aituto – Cassa; Large scale acquisition of land including agricultural use will not occur, and then there will be no impact on the local economy. . However, agricultural use can be observed in some lots along the section for cultivation of annual crops (maize, cassava, etc.) and cash crops (coffee planting, etc.), thus there is a possibility to partially clear these agricultural crops due to widening works for installation of side ditch. Besides, land acquisition (temporary use) will not occur during construction stage, since i) construction yard and camp are planned to be established at the sites of the previous office building and market which are within the public land in the suburbs of Ainaro, and ii) the improvement of Dili – Maliana - Zumalai road is limited to grading of road surface for the heavy vehicles passing for construction.
	B	Mola Bridge; Large scale acquisition of land including agricultural use will not occur, and then there will be no impact on the local economy. However, an embankment work with longitudinal length of 50 m is planned in order to meet the elevation of the existing road from the right-bank abutment of Mola bridge. It may be necessary to acquire a few lots of the agricultural area along the embankment-worked section, although the area to be acquired is much limited. Besides, land acquisition (temporary use) will not occur during construction stage, since i) the construction yard and camp, etc. are planned on the wasteland of the left bank (governmental land), and ii) the improvement of Dili – Maliana - Zumalai road is limited to grading of road surface for the heavy vehicles passing for construction.
	C	60Km Bridge; Since the rehabilitation plan follows the existing alignment, there expects no land acquisition. However, some lots under agricultural use are scattered around the site. Thus, land acquisition (temporary use) might occur during construction stage in case that stock yard, etc. would be prepared nearby.
3 Traffic, Facility for life	C	All target sections/sites; There is no serious impact on the present local traffic system and on the sensitive facilities such as schools and hospitals along the Project road. However, it is necessary to prepare a worked-out construction plan to avoid the all-day traffic stop for pavement works.
4 Split of community	C	All target sections/sites; Split of local community is not expected.
5 Cultural/historical heritage	C	All target sections/sites; There is no impact on cultural and historical heritage.
6 Water right, Common right	C	All target sections/sites; There is no existing water right or common right, which is legally protected.
7 Health and sanitation	C	All target sections/sites; There is no possibility of deterioration of health and sanitary condition. However, it is necessary to pay attention to safety and sanitary management at the camp sites during construction stage.
8 Waste	C	All target sections/sites; A large amount of surplus soil or construction waste will not be generated.
9 Disaster (Risk)	C	Dili – Aileu, Aituto – Cassa; The present slope stability will be improved by installation of drainage and slope protection. However, the stones and rocks are being quarrying out from the existing slope in some spots of the Project road by the local people who expect a requirement of gabion materials for future construction works. Such uncontrolled quarrying will cause a probable slope failure, and it is necessary to cope with this issue adequately.
	C	Mola Bridge and 60km Bridge; There is little risk of disaster such as the collapse of slope.

Note: The evaluation was conducted based on the JICA environmental consideration guideline with the following classification.
A: Serious impact is expected. B: Some impact is expected. C: There is negligible or no impact expected.

Table-2.52 (2) Result of Environmental Evaluation (Natural Environment)

Environmental Item	Evaluation	Basis for Evaluation
10 Topography and Geology	C	All target sections/sites; Quarrying, cutting/embanking or underground digging with large scale is not planned.
11 Soil Erosion	C	Dili – Aileu, Aituto – Cassa; The present status on soil erosion will be improved by drainage and slope protection works. However, the stones and rocks are being quarried out from the existing slope in some spots of the Project road by the local people who expect a requirement of gabion materials for future construction works. Such uncontrolled quarrying will cause a probable soil erosion, and it is necessary to cope with this issue adequately.
	C	Mola Bridge and 60km Bridge; Soil erosion will not be caused due to the Project implementation.
12 Groundwater	C	All target sections/sites; It is not planned to pump up the groundwater or to construct large-scale facilities which will cause serious impact to groundwater condition.
13 Lake and River	C	Dili – Aileu, Aituto – Cassa; The Project road will not traverse the lake, and there is no plan to install such facilities or to apply such work items of construction as those which will cause negative impact on hydrological regime of the rivers.
	C	Mola Bridge; There is no possibility to cause serious impact on hydrological regime of the river. Morphological change of the river due to the Project implementation will be very limited, and there is no river use for navigation to be considered. However, it can be observed that the local people use the river at upstream and downstream of Mola bridge for bathing, washing and irrigation intake. Therefore, due consideration is to be given during construction stage to keep the current channel and watercourse of the river.
	C	60km Bridge; There is no possibility to cause serious impact on hydrological regime of the river. Morphological change of the river due to the Project implementation will be very limited, and there is no river use for fluvial navigation to be considered.
14 Coastal/sea areas	C	All target sections/sites; The Project road will not traverse the coastal zones or sea areas.
15 Flora and fauna	C	All target sections/sites; Open forest (36-38 km, 114-115 km station, etc.) and pine forest intercropped by coffee trees (85-87 km, 91-93 km, 104-106 km station, etc.) were found limitedly, and they will not be directly affected. There is no natural vegetation along the Project road, and it is not expected that the construction activities would cause habitat disturbance or disappearance of the terrestrial or aquatic fauna. In addition, all target sections/sites will not pass through sensitive areas such as a protected or designated area. And species such as precious ones, on which a special attention is to be paid, have not been reported in and around the target sections/sites.
16 Meteorology	C	All target sections/sites; No change of micrometeorology is expected.
17 Landscape	C	Mola Bridge; The bridge with about 400 m full length is planned to be constructed. However, the plan is to extend the existing bridge with about 180 m length, and will not worsen regional landscape.
	C	Other target sections/sites; It is not planned to change topographic conditions which will cause serious impact to regional landscape, nor to construct a large-scale facility.

Note: The evaluation was conducted based on the JICA environmental consideration guideline with the following classification:

A: Serious impact is expected B: Some impact is expected C: There is negligible or no impact expected.

Table-2.52 (3) Result of Environmental Evaluation (Environmental Pollution)

Environmental Item	Evaluation	Basis for Evaluation
18 Air Pollution	C	All target sections/sites; The work items, scale and range for construction are limited to pavement, drainage, slope protection etc., and both heavy and light vehicles generated for construction will be 10 per day at most. Even though heavy vehicles will pass through Dili – Maliana - Zumalai road for improvement of Mola Bridge and rehabilitation of Aituto – Cassa section, the generated volume will be five per day at most and the period of passing is limited. Furthermore, although coarse particulate (dust) will be generated in the heating and drying process of aggregate in the asphalt plant to be constructed in the suburb of Ainaro, dust-collecting equipment is planned to be installed at the vent to remove coarse particulate. Therefore, the impact of air pollution due to coarse particulate or exhaust gas during construction stage is expected to be insignificant or mitigatable. In operation stage, the traffic volume as of 2011 is expected to be less than 800 per day. (ADB estimates the present traffic volume at 500 per day.) The significant impact of air pollution due to automobile exhaust gas will not be caused to the area along the Project road.
19 Water Pollution	C	Dili – Aileu: There is no possibility to cause serious impact of water pollution both during construction and in operation stages.
	C	Aituto – Cassa: There is no possibility to cause serious impact of water pollution both during construction and in operation stages. But in construction stage, it is planned to collect construction materials such as asphalt aggregate at the Sarai river located near 121km station of the Project road. Since the river including the downstream (up to Cassa) is used by local people for bathing and washing, it is necessary to pay attention to avoidance of turbid water inflow into the river due to extraction activities at the riverbed. In addition, although a crusher plant is planned to be equipped at the site nearby, no discharge of turbid wastewater from the plant is expected because of no aggregate washing process.
	C	Mola Bridge and 60Km Bridge; There is no possibility to cause serious impact of water pollution both during construction and in operation stages.
20 Soil pollution	C	All target sections/sites; There expects to generate no toxic substance which will cause soil pollution.
21 Noise and Vibration	C	All target sections/sites; The work items, scale and range for construction are limited at pavement, drainage, slope protection, etc., and both heavy and light vehicles generated for construction will be 10 per day at most. Even though heavy vehicles will pass through Dili – Maliana - Zumalai road for improvement of Mola Bridge and rehabilitation of Aitot – Cassa section, the generated volume will be five per day at most and the period of passing is limited. Therefore, the serious impact of noise and vibration during construction stage is expected to be insignificant. In operation stage, the traffic volume as of 2011 is expected to be less than 800 per day. (ADB estimates the present traffic volume at 500 per day.) The serious impact on the environment by automobile passing will not be caused to the area along the Project road.
22 Subsidence	C	All target sections/sites; Pumping up of groundwater is not planned, so land subsidence is not expected.
23 Odor	C	All target sections/sites; There is no source of odor.

Note: The evaluation was conducted based on the JICA environmental consideration guideline with the following classification:

A: Serious impact is expected B: Some impact is expected C: There is negligible or no impact expected.

Chapter3

Project Evaluation and Recommendations

Chapter 3 Project Evaluation and Recommendations

3-1 Project Effect

3-1-1 Direct Effect of the Project Implementation

Section		Existing Condition and Problem	Countermeasure of this Project	Effect/Improvement of the Project
ROAD	Aituto - Cassa (km79 - km130)	<Pavement> Many unpaved & damaged sections and cave-ins by land slides from km79 to km110. It is impossible for some passenger cars (sedan type) to pass this section. <Drainage> More side ditches are installed than the other sections but side ditch & cross pipe are still insufficient in some sections. <Slope> There are many continuous slope failures at mountainside. Valley side is relatively stable condition but widening by retaining structures are necessary to secure the road width.	Pavement for unpaved area and cave-ins & damaged locations for almost all lines. Overlay for surface is also necessary. Installation of side ditches and cross pipes for about 25 km section. Stone masonry retaining wall for mountainside slope, and gravity type retaining wall & gabion blocks for valley side slope for about 8 km sections.	Any type of vehicles will be able to pass due to paving for unpaved area and rehabilitation of slope protection/drainage of road surface. Therefore, traffic function of the road between Dili and Suai can be recovered/improved. In the same way, saving driving cost, improvement of time, and reducing of damaged agricultural production will be expected.
	Dili - Aileu (km2 - km45)	<Pavement> Asphalt pavement constructed in Indonesia era is still almost functioning. Average road width of 4.5 m is kept. <Drainage> Side ditch is not installed for almost all the route. <Slope> Collapsing and dangerous slopes exist. The cave-in at km40 was restored by JEG (Japan Engineer Group).	Pavement for partial unpaved area and patching for damaged area. Installation of side ditches and cross pipes for about 30 km section. Stone masonry retaining wall for mountainside slope, and gravity type retaining wall & gabion blocks for valley side slope for 11 locations.	Traffic condition will be improved due to rehabilitation of pavement and drainage of road surface, thus saving driving cost, improvement of time, and reducing damaged agricultural production will be expected.
BRIDGE	km60.3 Bridge	Serious damage is on the partition wall by ground settlement and scouring. Collapse is possibly expected.	There is no land acquisition problem. Bridge beam should be examined carefully about type (RC slab) and location(L=10.5m)	Safety for passing users can be secured by reconstructing the quite dangerous bridges.
	Mola Bridge (km146)	Driving and crossing in the river is necessary. It is impossible for some passenger cars (sedan type) and people to pass the river when raining.	Land acquisition(rightbank), scale of flood, method of construction and cost cutback should be considered for bridge type (4 span steel truss; L=239m)	During rain, crossing the river can be done and traffic function of the road will be improved. Daily life of the inhabitants (transportation of life goods, going school/hospital, etc.) will be improved.

3-1-2 Indirect Effect of the Project Implementation

Indirect Profit Population: Approximately 787,000 (source: Population of Timor-Leste)

i) Promotion of agricultural activity: Smooth road traffic flow will be secured, and speedy delivery of agricultural production will be possible.

ii) Improvement of inhabitants' life level: Access of market and transportation of life goods will be easier.

iii) Efficiency to regional level: Improvement of bottleneck road area and bridges will promote the economic and industry development around the area

iv) Efficiency to national level: Development plan of road sector of National Development Plan will be contributed to.

3-1-3 Establishment of Result Index and Forecast of Index after Improvement

Result Index for daily traffic volume (road traffic) and daily traffic volume of crossing bridge are set up. Forecast of index after improvement is set up as the numerical target.

Section	Existing Traffic Volume (No./day)	2011 Traffic Volume (No./day)
Dili – Aileu	500	665
Aileu – Aituto	147	196
Aituto – Ainaro	75	100
Ainaro – Cassa	47	63
Traffic Volume of River Crossing	Existing Traffic Volume (No./day)	2011 Traffic Volume (No./day)
Mola Bridge (Vehicle)	63	84
Mola Bridge (Passenger)	646	756

3-2 Recommendations

The Government of Timor-Leste, to achieve the project effect, shall properly carry out operation, maintenance and management of road and bridge. JICA is planning technical transfer by specialist dispatched to support strengthening of the organization of operation, maintenance and management. Further more, to carry out the technical support as soft component is desirable to increase effectiveness.

Attachment

Attachment-1 Member List of Study Team

・First Study

(1)	Team Leader	:	Yukihiko EJIRI	(Japan International Cooperation Agency)
(2)	Chief Consultant/O&M Planning	:	Haruo SAKASHITA	(Pacific Consultants International)
(3)	Road Design Ⅰ	:	Yoshiteru YAMAMURA	(Pacific Consultants International)
(4)	Road Design Ⅱ	:	Nobuo MONOE	(Pacific Consultants International)
(5)	Topo. Survey/Geology	:	Yasushi MOMOSE	(Nippon Koei)
(6)	Construction Planning/Cost Estimate	:	Masakazu TOKI	(Pacific Consultants International)
(7)	Administrator	:	Kenji SASHIDA	(Pacific Consultants International)

・Second Study

(1)	Team Leader	:	Hiroyuki HAYASHI	(Japan International Cooperation Agency)
(2)	Chief Consultant/O&M Planning	:	Haruo SAKASHITA	(Pacific Consultants International)
(3)	Environmental Analysis	:	Norihiko INOUE	(Nippon Koei)
(4)	Road Design Ⅰ	:	Yoshiteru YAMAMURA	(Pacific Consultants International)
(5)	Road Design Ⅱ	:	Nobuo MONOE	(Pacific Consultants International)
(6)	Bridge Design	:	Yoichi MOROISHI	(Nippon Koei)
(7)	Topo. Survey/Geology	:	Yasushi MOMOSE	(Nippon Koei)
(8)	River/Hydrology	:	Syuji HIROTA	(Nippon Koei)
(9)	Construction Planning/Cost Estimate	:	Masakazu TOKI	(Pacific Consultants International)

No.2 Itinerary for 2nd Survey

Itenary for 2nd Survey			Team Leader	Chief Consul. OMP	Environment	Road Design I	Road Design II	Bridge Design	Geology	Hydrology	Cost Estimation
No	Date	Day	Mr. H. HAYASHI	Mr. H. SAKASHITA	Mr. N. INOUE	Mr. YAMAMURA	Mr. N. MONOE	Mr. Y. MOROISHI	Mr. Y. MOMOSE	Mr. S. HIROTA	Mr. M. TOKI
1	12-May	Mon		Narita ~ Denpasar (by air)							
2	13-May	Tue		Denpasar ~ Dili (by air), Courtesy Call on EOJ, JICA							
3	14-May	Wed		Courtesy Call on MTCPW, UNMISEDT; Explanation & Discussion of Interim Report					Ordering & Coordination of Site Survey	Collection of Relevant Data	Meeting with Subcontractor & Supplier
4	15-May	Thu		Site Survey (Dili~Maubisse~Aituto by car); Stay at Maubisse							
5	16-May	Fri		Site Survey (Aituto~Cassa~Suai by car); Stay at Suai)							
6	17-May	Sat		Suai → Dili							
7	18-May	Sun		Data Classification & Evaluation							
8	19-May	Mon		Collection of Data for Maintenance Planning	Collection of Relevant Laws & Regulations	Site Survey for Basic Design (Dili~Suai) & Basic Design		Data Collection of Mola Bridge			Data Collection of Work Cost, Machinery and Materials in East Timor
9	20-May	Tue									
10	21-May	Wed									
11	22-May	Thu									
12	23-May	Fri									
13	24-May	Sat									
14	25-May	Sun		Dili ~ Narita (by air)							
15	26-May	Mon									
16	27-May	Tue									
17	28-May	Wed									
18	29-May	Thu							Supervision of Survey Work and Data collection	Site Survey and Hearing from local resident; Data Collwection	
19	30-May	Fri									
20	31-May	Sat									
21	1-Jun	Sun									
22	2-Jun	Mon									
23	3-Jun	Tue									
24	4-Jun	Wed									
25	5-Jun	Thu									
26	6-Jun	Fri									
27	7-Jun	Sat									
28	8-Jun	Sun									
29	9-Jun	Mon									
30	10-Jun	Tue									
31	11-Jun	Wed		Narita ~ Dili (by air)	Site Survey for Required Land, Survey and Coordination of Interested Parties			Site Survey for Mola Bridge & Basic Design			Site Survey of Borrow Pit, Plant Area and Roads & Bridges
32	12-Jun	Thu									
33	13-Jun	Fri		Preliminary Drawing of B/D, Preliminary Project Cost, M/D							
34	14-Jun	Sat			Dili ~ Narita (by air)	Preliminary Drawing of B/D, Preliminary Project Cost, M/D, Data Classification & Analysis	Dili ~ Narita (by air)	Preliminary Drawing of B/D, Preliminary Project Cost, M/D, Data Classification & Analysis	Dili ~ Narita (by air)	Dili ~ Narita (by air)	PrelimimaryDrawing of B/D, Preliminary Project Cost, M/D, Data Analysis
35	15-Jun	Sun	Narita~Denpasar								
36	16-Jun	Mon	Denp~Dili;EoJ,JICA	EoJ,JICA w/ Leader							
37	17-Jun	Tue	Courtesy Call on MTCPW, UNMISET								
38	18-Jun	Wed	Meeting and Discussion with MTCPW &								
39	19-Jun	Thu	Relevant Agencies			Explanation & Discussion of M/D		Explanation & Discussion of M/D			Explanation & Discussion of M/D
40	20-Jun	Fri	Meeting & Signing of M/D with MTCPW			Basic Design		Basic Design			Basic Design
41	21-Jun	Sat	Site Survey (Dili~Aituto~Cassa~Suai)			Report to EOJ, JICA		Report to EOJ, JICA			Report to EOJ, JICA
42	22-Jun	Sun	Suai → Dili			Dili ~ Narita (by air)		Dili ~ Narita (by air)			Dili ~ Narita (by air)
43	23-Jun	Mon	Report to EOJ and JICA								
44	24-Jun	Tue	Dili ~ Narita								
45	25-Jun	Wed	(by air)								

Attachment-3 List of Interviewer

Name	Title	Assign
Ovidio de Jesus Amaral	Minister	Ministry of Transport, Communication and Pubric Works (MTCPW)
Aicha Bassarewan	Vice-Minister	Ministry of Planning and Finance
Joao B. F. Alves	Secretary of State for Pubric Works	Ministry of Transport, Communication and Pubric Works (MTCPW)
Jose Gsper Piedade	Director General	Ministry of Transport, Communication and Pubric Works (MTCPW)
Evaristo D. S. Piedade	Director	Ministry of Transport, Communication and Pubric Works (MTCPW)
Yogesh Saksena	Advisor	Ministry of Transport, Communication and Pubric Works (MTCPW)
Jaime Goldnez	Advisor	Ministry of Transport, Communication and Pubric Works (MTCPW)
Vicente da Costa Pinto	Director of Mining, Energy & Mineral Resources Dept.	Ministry of Development and Environment
Jorge Rui de Carvalho Martins	Director of Environment	Ministry of Development and Environment
Gerald Cheung	Advisor	Ministry of Development and Environment
Pedro de Sousa Xavier	Director of Land and Property	Ministry of Justice
Basilio M. X. Teixeira	Director	Land Transporta
Dr. Edwin Urresta	UN Land and Property Advisor	Ministry of Justice
Noki Takyo	Assistant Representative	UNDP East Timor Office
Jesus P. Tolentino	Head	UNOPS ETIF
Junko Miura	Associate Portfolio Manager	UNOPS ETIF
Hideo Fukushima	Ambassador of Japan	Japan Embassy
Akinori Wada	Counselor	Japan Embassy
Toshiyuki Koga	Second Secretary	Japan Embassy
Makoto Inaba	Reprsentative	JICA East Timor Office
Masayoshi Takehara	Assistant Representative	JICA East Timor Office
Katsuhiko Ohara	Staff	JICA East Timor Office
Hikaru Niki	Advisor	JICA East Timor Office
Ichiro Yamada	Manager	UNMISET Engineer Cell

Attachment-4. Minutes of Discussions (M/D)

Minutes of Discussions
on the Basic Design Study
on the Project for the Improvement of Roads and Bridges
in the Democratic Republic of Timor-Leste
(The first field survey)

In response to the request from the Government of the Democratic Republic of Timor-Leste (hereinafter referred to as "Timor-Leste"), the Government of Japan decided to conduct a Basic Design Study on the Project for Improvement of Roads and Bridges (hereinafter referred to as "the Project") and entrusted the study to the Japan International Cooperation Agency (hereinafter referred to as "JICA").

JICA sent to Timor-Leste the Basic Design Study Team (hereinafter referred to as "the Team"), headed by Mr. Yukihiko Ejiri, a Senior Assistant to the Managing Director, the Office of Technical Coordination and Examination, the Grant Aid Management Department, JICA, and the Team is scheduled to stay in the country from March 27 to April 18, 2003.

The Team held discussions with the concerned officials of the Government of Timor-Leste.

In the course of the discussions, both sides have confirmed the main items of described in the attached sheets. The Team will proceed to further study and prepare the Basic Design Study Report.

Dili, April 2, 2003

Yukihiko Ejiri
Team Leader
Basic Design Study Team
Japan International Cooperation Agency
(JICA)

Ovidio de Jesus Amaral
Minister
Ministry of Transport, Communication and
Public Works (MTCPW)
Democratic Republic of Timor-Leste

Vicha Bassarewan
Vice-Minister
Ministry of Planning and Finance
Democratic Republic of Timor-Leste

João B.F. Alves
Secretary of State for Public Works
Ministry of Transport, Communication and
Public Works (MTCPW)
Democratic Republic of Timor-Leste

ATTACHMENT

1. Objective

The objective of the Project is to improve the Dili--Aituto-Suai Road especially the road of Aituto-Cassa section and the Mola bridge

2. Project Site

The sites of the Project are shown in Annex-1.

3. Responsible and Implementing Organizations

(1) The responsible and implementing organization is the Ministry of Transport, Communication, and Public Works (hereinafter referred to as "MTCPW").

The organization chart of the implementing agency is shown in Annex-2

4. Items Requested by the Government of Timor-Leste

After discussions with the Team, the following items were finally requested by the Timor-Leste side. After the general request of the Government of Timor-Leste, JICA will assess the appropriateness of the request and will recommend to the Government of Japan for approval

(1) Improvement of the Dili Aituto-Suai Road, especially the Aituto-Cassa section by rehabilitating and/or repairing part of sub-section

(2) Improvement of the Mola bridge by rehabilitating and/or repairing of the bridge itself and/or access roads including river bank protection, if needed.

5. Japan's Grant Aid Scheme

(1) The Timor-Leste side was briefed on the system and characteristics of Japan's Grant Aid Scheme as described in Annex-3. It was emphasized by the Japanese side that necessary measures, as described in Annex-3 are required for smooth implementation of the Project, provided that the Japanese Grant Aid is extended.

(2) The Timor-Leste side understood the need for providing the services and extending the tax exemptions referred to in Annex-3 and Annex-4, and will take the measures necessary to appropriate the required funds for the works and services, and extend the tax exemptions in accordance with such agreements as will be concluded between the Government of Timor-Leste and the Government of Japan.

6. Schedule of the study

(1) The consultants will proceed to further studies in Timor-Leste by April 18, 2003.

(2) JICA will prepare the interim report and dispatch a team for the second field survey to Timor-Leste in order to discuss its contents and to study in detail at the sites around May, 2003.

(3) JICA will prepare the draft report in English and dispatch a team to Timor-Leste in order to explain its contents around October, 2003.

(4) In case that the contents of the report are accepted in principle by the Government of Timor-Leste, JICA will complete the final report and send it to the Government of Timor-Leste by November, 2003.

7 Other Relevant Issues

(1) The Timor-Leste side will submit answers in English to the Questionnaire, which the Team handed to the Timor-Leste side, by April 9, 2003.

(2) The Timor-Leste side shall arrange the budget allocation for securing land(s), undertakings to be done by the Timor-Leste side described in Annex-4.

(3) The Timor-Leste side shall provide necessary number(s) of counterpart personnel to the Team during the period of their studies in Timor-Leste.

(4) The Timor-Leste side shall maintain sound accessibility to the Project site during the construction stage.

(5) The Team conducted the preliminary site survey on the Dili–Aituto-Suai road to check the present condition of the each section of the road, and then both sides held discussions to specify the scope of the Basic Design Study. As the result, the item described in the clause 4-(1) of the attachment were finally requested by the Timor-Leste side in order to reduce an impassable period in the mountain area caused by the heavy rain in the rainy season. The Timor-Leste side understands that the Team will conduct the second field survey in accordance with the inventory of the object, which shall be prepared by the Team based on the results of the first field survey and submitted to the Timor-Leste side as the part of the interim report.

(6) Regarding the Mola bridge, which described in the clause 4-(2) of the attachment, the Timor-Leste side understands that the Team will conduct the second field survey to study the most effective countermeasure for improving the bridge from the point of view of the soundness of the each portion of the bridge and hydrological analysis of the river characteristics.

(7) Japanese side strongly emphasized that the necessary undertakings, described in Annex-4, are standard mandatory requirements by the Japanese Government for the smooth implementation of the Project by the Timor-Leste side.

1) Explanation from the Timor-Leste side

The Timor-Leste side explained that the commitments in Annex-4, such as items 1, 2 and so on, will require budgetary appropriation which will be requested in the context of the bi-annual budget review. Items 9(2), 10 and 11 of Annex-4 are currently the subject of negotiation between the Government of Japan and the Government of Timor-Leste, in the context of the Cooperation Agreement between the two countries, since such exemptions require the approval of the Council of Ministers and legislative action by Parliament.

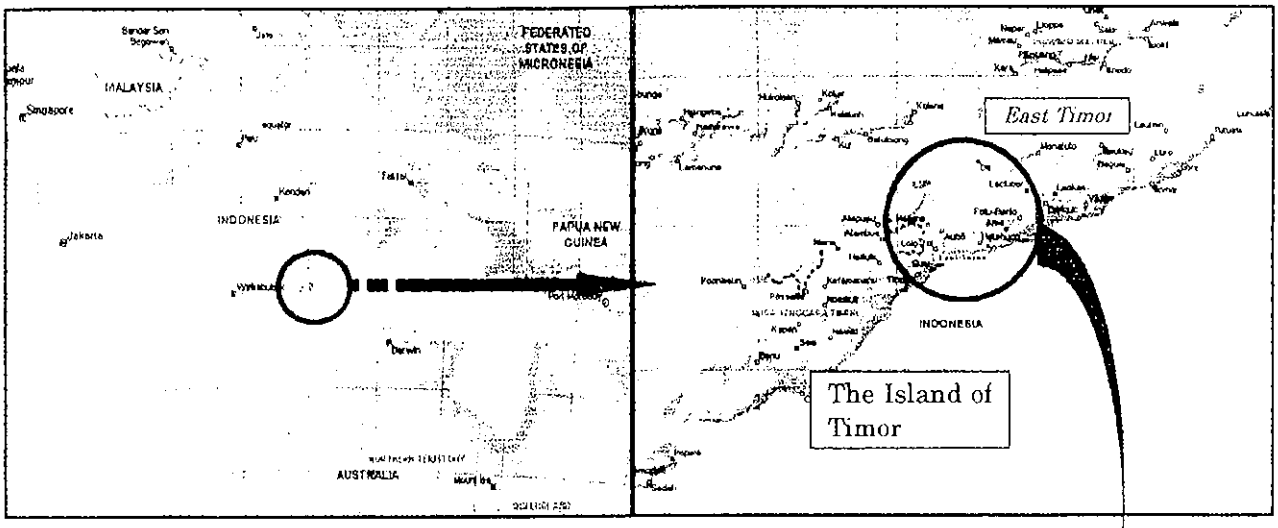
2) Agreed points by both sides

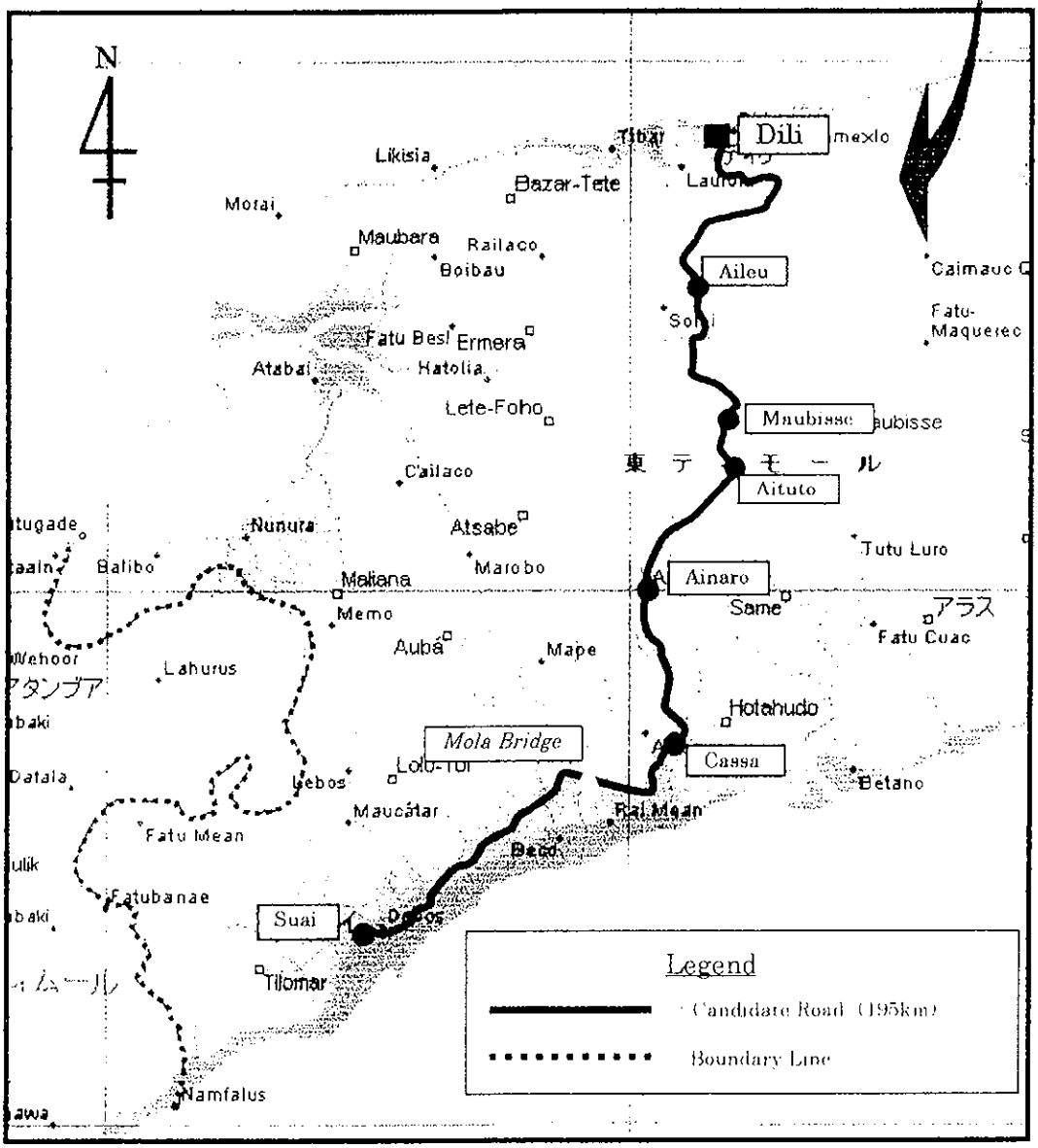
Both parties agreed on the other items in Annex-4, and further agreed to exert effort to get mutual consent of whole items by early July 2003.

(8) The Timor-Leste side shall ensure that the Team and/or the contractor to be engaged in the Project are accessible to any quarry site and borrow pit, and that the contractor procures necessary construction materials from the quarry/borrow sites with the minimum compensation cost for the relevant communities or the owner of concessions.

(9) The Timor-Leste side shall acquire the land for relocation of road sections, widening of road and so on if necessary, and also shall ensure the temporary use of the land for the asphalt and /or crusher plant, the site office, stockyard, workshop for bridges and so on.

(10) The Timor-Leste side shall be responsible for the environmental assessment and to obtain the related approvals from the relevant authority by the designated date for the implementation of the Project if necessary.

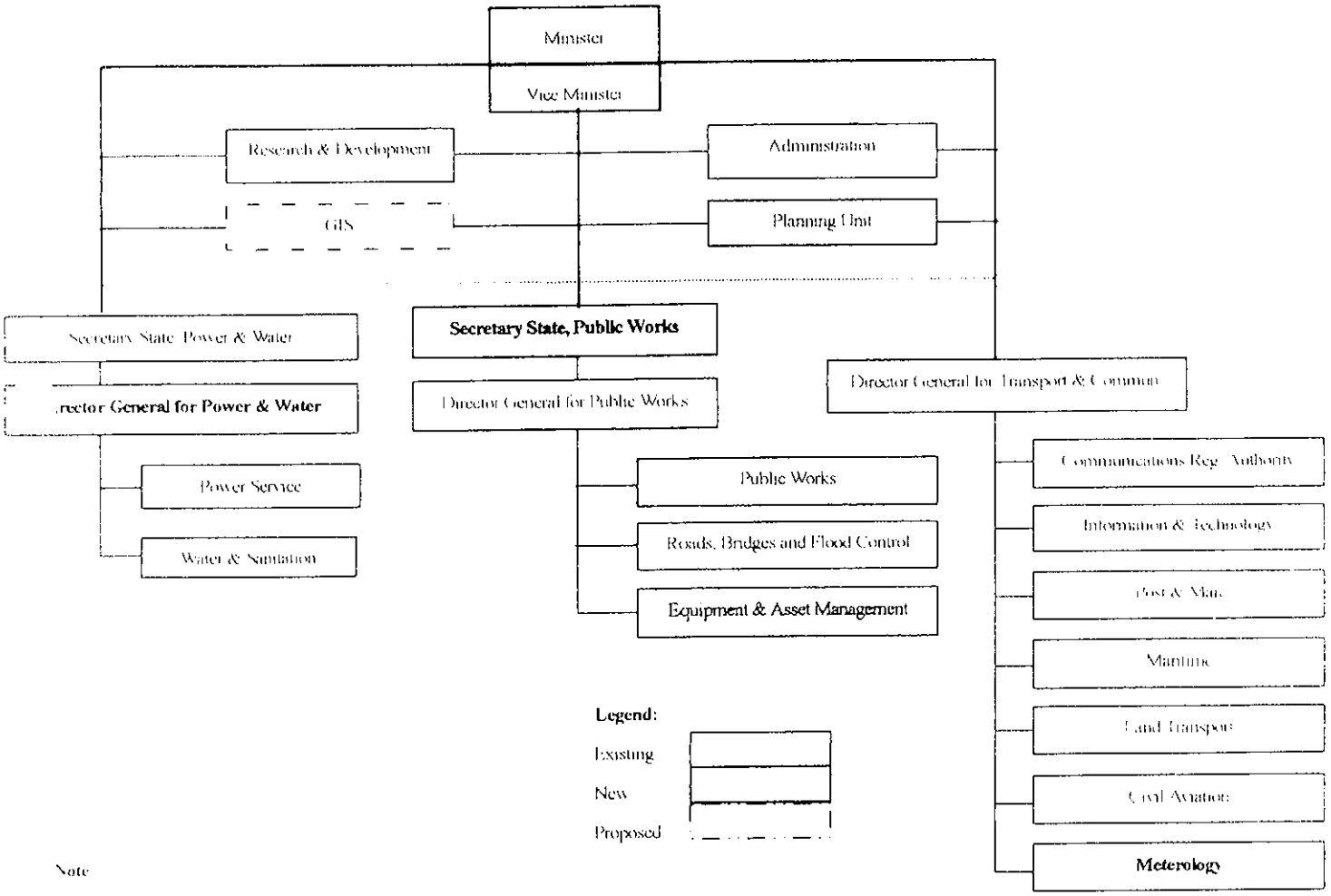




LOCATION MAP

Annex-2

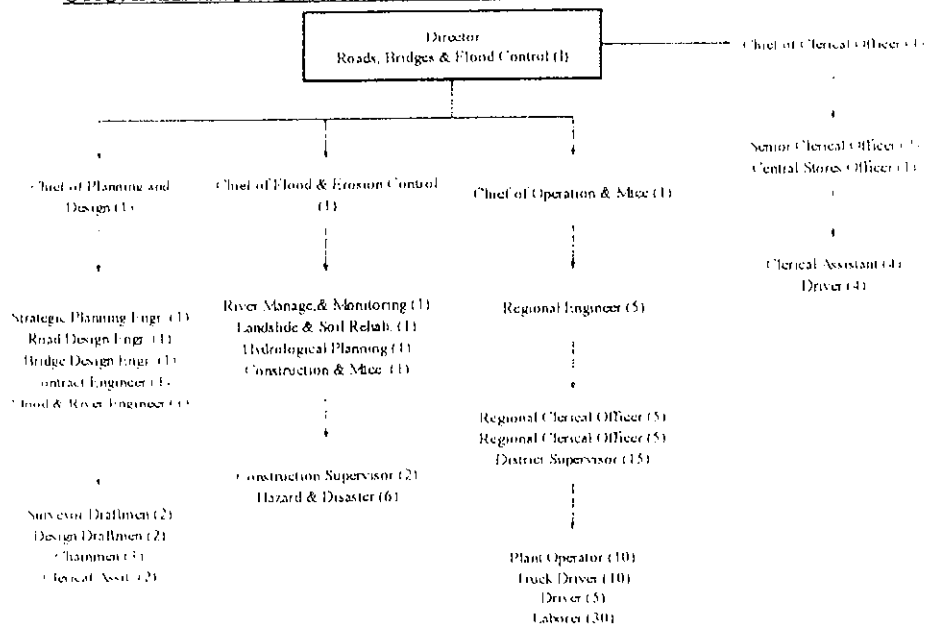
ORGANIZATION CHART OF MINISTRY OF TRANSFORT, COMMUNICAITON & PUBLIC WORKS



Note

1. Administrative function of Facilities Unit under Directorate of Administration
2. Administrative function of Government Transport under Directorate of Environment

ORGANIZATION CHART OF THE DIRECTORATE OF PUBLIC WORKS



JAPAN'S GRANT AID

The Grant Aid Scheme provides a recipient country with non-reimbursable funds to procure the facilities, equipment and services (engineering services and transportation of the products, etc.) for economic and social development of the country under principles in accordance with the relevant laws and regulations of Japan. The Grant Aid is not supplied through the donation of materials as such

1. Grant Aid Procedures

Japan's Grant Aid Scheme is executed through the following procedures.

Application	(Request made by the recipient country)
Study	(Basic Design Study conducted by JICA)
Appraisal &Approval	(Appraisal by the Government of Japan and Approval by the Cabinet)
Determination of Implementation	(The Note exchanged between the Governments of Japan and recipient country)

Firstly, the application or request for a Grant Aid project submitted by a recipient country is examined by the Government of Japan (the Ministry of Foreign Affairs) to determine whether or not it is eligible for Grant Aid. If the request is deemed appropriate, the Government of Japan assigns JICA (Japan International Cooperation Agency) to conduct a study on the request.

Secondly, JICA conducts the study (Basic Design Study) using (a) Japanese consulting firm(s)

Thirdly, the Government of Japan appraises the project to see whether or not it is suitable for Japan's Grant Aid Scheme, based on the Basic Design Study report prepared by JICA, and the results are then submitted to the Cabinet for approval.

Fourthly, the project, once approved by the Cabinet, becomes official with the Exchange of Notes (E/N) signed by the Governments of Japan and the recipient country.

Finally, for the implementation of the project, JICA assists the recipient country in such matters as preparing tenders, contracts and so on

2. Basic Design Study

(1) Contents of the study

The aim of the Basic Design Study (hereafter referred to as "the Study") conducted by JICA on a requested project (hereafter referred to as "the Project") is to provide a basic document necessary for the appraisal of the Project by the Government of Japan. The contents of the Study are as follows

- Confirmation of the background, objectives, and benefits of the Project and also institutional capacity of agencies concerned of the recipient country necessary for the Project's implementation
- Evaluation of the appropriateness of the Project to be implemented under the Grant Aid Scheme from a technical, social and economic point of view
- Confirmation of items agreed on by both parties concerning the basic concept of the Project
- Preparation of a basic design of the Project
- Estimation of costs of the Project

The contents of the original request are not necessarily approved in their initial form as the contents of the Grant Aid project. The Basic Design of the Project is confirmed considering the guidelines of the Japan's Grant Aid Scheme

The Government of Japan requests the Government of the recipient country to take whatever measures are necessary to ensure its self-reliance in the implementation of the Project. Such measures must be guaranteed even though they may fall outside of the jurisdiction of the organization in the recipient country actually implementing the Project. Therefore, the implementation of the Project is confirmed by all relevant organizations of the recipient country through the Minutes of Discussions.

(2) Selection of Consultants

For smooth implementation of the Study, JICA uses (a) registered consulting firm(s). JICA selects (a) firm(s) based on proposals submitted by interested firms. The firm(s) selected carry(ies) out a Basic Design Study and write(s) a report, based upon terms of reference set by JICA. The consultant firm(s) used for the Study is(are) recommended by JICA to the recipient country to also work on the Project's implementation after the Exchange of Notes, in order to maintain technical consistency.

3.Japan's Grant Aid Scheme

(1) Exchange of Notes (E/N)

Japan's Grant Aid is extended in accordance with the Notes exchanged by the two Governments concerned, in which the objectives of the Project, period of execution, conditions and amount of the Grant Aid, etc., are confirmed.

(2) "The period of the Grant Aid" means the one fiscal year which the Cabinet approves the Project for. Within the fiscal year, all procedures such as exchanging of the Notes, concluding contracts with (a) consultant firm(s) and (a) contractor(s) and final payment to them must be completed. However, in case of delays in delivery, installation or construction due to unforeseen factors such as national disaster, the period of the Grant Aid can be further extended for a maximum of one fiscal year at most by mutual agreement between the two Governments.

(3) Under the Grant Aid, in principle, Japanese products and services including transport or those of the recipient country are to be purchased. When the two Governments deem it necessary, the Grant Aid may be used for the purchase of the products or services of a third country. However, the prime contractors, namely, consulting, constructing and procurement firms, are limited to "Japanese nationals". (The term "Japanese nationals" means persons of Japanese nationality or Japanese corporations controlled by persons of Japanese nationality.)

(4) Necessity of "Verification"

The Government of recipient country or its designated authority will conclude contracts denominated in Japanese yen with Japanese nationals. Those contracts shall be verified by the Government of Japan. This "Verification" is deemed necessary to secure accountability to Japanese taxpayers.

(5) Undertakings required of the Government of the Recipient Country

In the implementation of the Grant Aid Project, the recipient country is required to undertake such necessary measures as the following:

a) To secure land necessary for the sites of the Project and to clear, level and reclaim the land prior to commencement of the construction,

b) To provide facilities for the distribution of electricity, water supply and drainage and other incidental facilities in and around the sites,

c) To secure buildings prior to the procurement in case the installation of the equipment,

d) To ensure all the expenses and prompt execution for unloading, customs clearance at the port of disembarkation and internal transportation of the products purchased under the Grant Aid,

e) To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which will be imposed in the recipient country with respect to the supply of the products and services under the Verified Contracts,

f) To accord Japanese nationals, whose services may be required in connection with the supply of the products and services under the Verified contracts, such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work.

(6) "Proper Use"

The recipient country is required to maintain and use the facilities constructed and the equipment purchased under the Grant Aid properly and effectively and to assign staff necessary for this operation and maintenance as well as to bear all the expenses other than those covered by the Grant Aid.

(7) "Re-export"

The products purchased under the Grant Aid should not be re-exported from the recipient country.

(8) Banking Arrangements (B/A)

a) The Government of the recipient country or its designated authority should open an account in the name of the Government of the recipient country in a bank in Japan (hereinafter referred to as "the Bank"). The Government of Japan will execute the Grant Aid by making payments in Japanese yen to cover the obligations incurred by the Government of the recipient country or its designated authority under the Verified Contracts.

b) The payments will be made when payment requests are presented by the Bank to the Government of Japan under an Authorization to Pay (A/P) issued by the Government of the recipient country or its designated authority.

(9) Authorization to Pay (A/P)

The Government of the recipient country should bear an advising commission of an Authorization to Pay and payment commissions to the Bank.

(end)

Major Undertakings to be taken by Each Government

No	Items	To be covered by Grant Aid	To be covered by Recipient Side
1	To secure land		●
2	To clear, level and reclaim the site when needed		●
3	To construct gates and fences in and around the site		●
4	To construct the parking lot	●	
5	To construct roads		
	1) Within the site	●	
	2) Outside the site		●
6	To construct the buildings	●	
7	To provide facilities for the distribution of electricity, water supply, drainage and other incidental facilities		
	1) Electricity		
	a. The distributing line to the site		●
	b. The drop wiring and internal wiring within the site	●	
	c. The main circuit breaker and transformer	●	
	2) Water Supply		
	a. The city water distribution main to the site		●
	b. The supply system within the site (receiving and elevated tanks)	●	
	3) Drainage		
	a. The city drainage main (for storm, sewer and others to the site)		●
	b. The drainage system (for toilet sewer, ordinary waste, storm drainage and others) within the site	●	
	4) Telephone System		
	a. The telephone trunk line to the main distribution frame/panel (MDF) of the building		●
	b. The MDF and the extension after the frame/panel	●	
	5) Furniture and Equipment		
	a. General furniture		●
	b. Project equipment	●	
8	To bear the following commissions to the Japanese bank for banking services based upon the B/A		
	1) Advising commission of A/P		●
	2) Payment commission		●
9	To ensure unloading and customs clearance at port of disembarkation in recipient country		
	1) Marine (Air) transportation of the products from Japan the recipient	●	
	2) Tax exemption and custom clearance of the products at the port of disembarkation		●
	3) Internal transportation from the port of disembarkation to the project site	●	
10	To accord Japanese nationals whose service may be required in connection with the supply of the products and the services under the verified contact, such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work.		●
11	To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the supply of the products and services under the verified contracts		●
12	To maintain and use properly and effectively the facilities constructed and equipment provided under the Grant Aid		●
13	To bear all the expenses, other than those to be borne by the Grant Aid, necessary for construction of the facilities as well as for the transportation and installation of the equipment		●

(B/A Banking Arrangement, A/P Authorization to pay)

Minutes of Discussions
on the Basic Design Study
on the Project for the Improvement of Roads and Bridges
in the Democratic Republic of Timor-Leste
(The second field survey)

In response to the request from the Government of the Democratic Republic of Timor-Leste (hereinafter referred to as "Timor-Leste"), the Government of Japan decided to conduct a Basic Design Study on the Project for the Improvement of Roads and Bridges (hereinafter referred to as "the Project") and entrusted the study to the Japan International Cooperation Agency (hereinafter referred to as "JICA").

JICA sent to Timor-Leste the Basic Design Study Team (hereinafter referred to as "the Team"), headed by Mr. Hiroyuki Hayashi, an officer of the Third Project Management Division, the Grant Aid Management Department, JICA, and is scheduled to stay in the country from May 13 to June 24, 2003.

The Team held discussions with the officials concerned of the Government of Timor-Leste.

In the course of the discussions, both sides have confirmed the main items of described in the attached sheets. The Team will proceed to further works and prepare the Basic Design Study Report.

Dili, June 19, 2003

Hiroyuki Hayashi
Leader
Basic Design Study Team
Japan International Cooperation Agency

Ovidio de Jesus Amaral
Minister
Water and Public Works Department
Ministry of Transport, Communication and Public Works (MTCPW)
Democratic Republic of Timor-Leste

Witness

Gastão Francisco de Sousa
Director
Ministry of Planning and Finance
Democratic Republic of Timor-Leste

João B. F. Alves
Secretary of State for Public Works
Ministry of Transport, Communication and Public Works (MTCPW)
Democratic Republic of Timor-Leste

ATTACHMENT

1. Items requested by the Government of Timor-Leste

After discussions with the Team, the following items were finally requested by the Timor-Leste side.

(1) Improvement of the Aituto-Cassa section and Dili-Aileu section by rehabilitating and/or repairing part of sub-section.

(2) Improvement of the Mola bridge and 60.3Km bridge (at Sta.60+300) by rehabilitating and/or repairing of the bridge itself and/or access roads including river bank protection, if needed.

The details of the above requests are shown in Annex-1.

2. Japan's Grant Aid Scheme

(1) The Timor-Leste side understands the Japan's Grant Aid scheme and the necessary measures to be taken by the Government of Timor-Leste explained by the Team as described in Annex-3 and Annex-4 of the Minutes of Discussions signed by both sides on April 2, 2003.

(2) The Timor-Leste side shall provide the services and extending the tax exemption referred to the clause 7-(7)-1), Annex-3 and Annex-4 of the Minutes of Discussions signed by the both sides on April 2, 2003.

3. Schedule of the study

(1) The consultants will proceed to further studies in Timor-Leste until June 24, 2003.

(2) JICA will prepare the draft report and dispatch the team to Timor-Leste in order to explain its contents around October, 2003.

(3) In case that the contents of the report are accepted in principle by the Government of Timor-Leste, JICA will complete the final report and send it to the Government of Timor-Leste by November, 2003.

4. Other Relevant Issues

(1) The Timor-Leste side requested JICA to improve the drainage together with pavement and slope protection for the Dili-Aileu section by rehabilitating and/or repairing part in accordance with the schedule shown in Annex-1. The Timor-Leste side shall avoid any duplication of improvement plan on the Dili-Aileu section with the request shown in Annex-1.

(2) The Team explained the preliminary construction plan including allocation of engineers and operators, and that some of them will be engaged from the third countries. The Timor-Leste side agreed to the above-mentioned plan in principle.

(3) The Team explained that tangent (new alignment) and curved (existing alignment) alignments have been studied for the location of Mola bridge, considering land acquisition (removal of a house and cultivating lands) and hydrological analysis of the river characteristics. Bridge type and span length will be determined based on flood water volume/table, construction cost, construction method and aesthetics point. The Team will present the results of the study at the time of the explanation of the draft report.

(4) The Timor-Leste side shall be responsible for the environmental assessment and obtain the related approval from Ministry of Development and Environment as per schedule shown in Annex-2.

(5) Regarding land acquisition, the Timor-Leste side shall be responsible for the basic agreement by committee for land acquisition and for individual agreement on handover/evacuation of land as per schedule shown in Annex-3.

(6) The Timor-Leste side requested the consultant service, so called "the Soft Component", for the management of the improvement, rehabilitation, periodic and routine maintenance of the roads and bridges, including the capacity-building mainly for the staffs of MTCPW, peoples related with the Community Based Maintenance. The Team will study the appropriate contents and period for the Soft Component and show the results of the study at the time of the explanation of the draft report.

Annex-1

THE PROJECT FOR THE IMPROVEMENT OF ROADS AND BRIDGES IN THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE

Request of Timor-Leste Side for Basic Design

1. Aituto (km79) – Cassa (km130) Section

(1) Pavement

(2) Side Ditch + Cross Drainage

(3) Slope Protection

(4) Traffic Marking (Road Marking)

(5) Guard Rail

2. Mola Bridge

- New construction of about 240m to existing bridge of 180m

3. Km60.3 Bridge

- Reconstruction for existing bridge

4. Dili (km2) – Aileu (km45) Section

(1) Pavement (Damaged spots only)

(2) Lined Drainage (20km)

(3) Slope Protection (11 locations)

THE PROJECT FOR THE IMPROVEMENT OF ROADS AND BRIDGES IN THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE

Japan International Cooperation Agency | PACIFIC CONSULTANTS INTERNATIONAL | NIPPON KOEI CO.,LTD.

Room 309, SAKURA Tower Apartment, Jalan 15 Oktober, No. 18 Audian, Dili, East Timor
TEL : 724-3576 (cellular phone)

MEMORANDUM OF DISCUSSION

DATE & MEETING PLACE: May 27 (MoDE office) and 28 (MTCPW office), 2003
PRESENT: Timor Leste Side; Mr. Joao B. F. Alves (MTCPW)
Mr. Jose Gaspar Piedade (MTCPW),
Mr. Jorge Rui de Carvalho Martins (MoDE),
Mr. Joao Da Cunha (MoDE, EIA officer),
Mr. Gerard Cheong (MoDE, EIA adviser)
JICA Study Team; Mr. Norihiko Inoue, Mr. Yoshiteru Yamamura
PROJECT NAME: Improvement of the Dili–Aituto-Suai Road and the Mola Bridge

SUBJECT: Procedure for an Environmental Approval for the Project

DISCUSSION was made as follows;

1. Messrs. Inoue and Yamamura explained that JICA sent to Timor-Leste the Basic Design Study Team (hereinafter referred to as "the Team"), headed by Mr. Haruo Sakashita, Chief Consultant of the Team, JICA, and the Team is scheduled to stay in the country from May 13 to June 24, 2003.
The Team asked about the expected procedure on an environmental approval for the Project implementation.

2. Timor-Leste side answered as follows;

(1) A law and legal framework on an environmental approval and/or an environmental impact assessment (EIA) have not yet come into effect. Accordingly, necessary environmental procedure for the Project implementation should be made in compliance with Guideline No.1 (Environmental Requirements for Development Projects) and Guideline No.6 (Environmental Screening), which were issued in 2001.

(2) It is recognized that the plan of the Project is mainly composed of rehabilitation of the existing road such as pavement repair, slope protection, improvement of the drainages, and rebuilding bridges. And the Project area is not located in environmentally or socially sensitive areas, such as sensitive/valuable ecosystems, historical/cultural sites, densely populated areas where a certain resettlement/pollution impact is conceivable, an area inducing the natural resource confliction, and an area of groundwater recharge or reservoir catchments for potable water supply.

(3) According to the said guidelines, the Project can be classified as a "Category B" project on which not EIA but environmental management plan (EMP) is required. Therefore, the procedure described below is to be applicable before the Project implementation.

- MTCPW should prepare an application for environmental screening decision and EMP, and should submit it to DoE/MoDE by the middle of November, 2003, based on the result of basic design of the Project to be provided in October, 2003.
- MTCPW will, by the end of November 2003, be informed from DoE/MoDE about the result of review and approval of environmental screening decision and EMP for the Project implementation.

Attachment. Expected Schedule for Environmental Approval for the Project for the Improvement of Dili-Suai Road and Bridges

Signed by

Haruo Sakashita
Chief Consultant
Basic Design Study Team
Japan International Cooperation Agency

Leonisa dos Santos Lobato. Acting Director

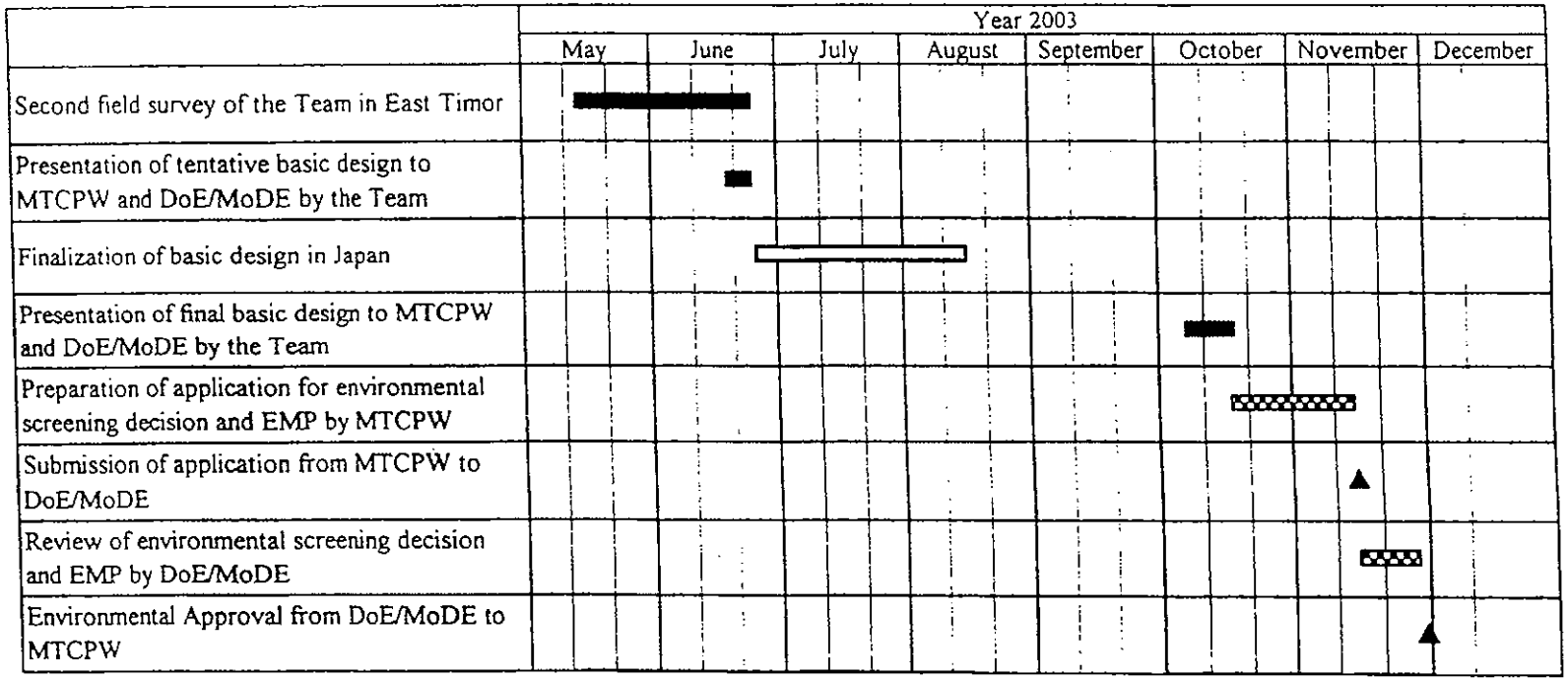
Jorge Rui de Carvalho Martins
Director of Environment
Ministry of Development and Environment
Democratic Republic of Timor-Leste

Joao B.F. Alves
Secretary of State for Public Works
Ministry of Transport, Communication
and Public Works
Democratic Republic of Timor- Leste

Jose Gaspar Piedade
Director General of Public Works
Ministry of Transport, Communication
and Public Works
Democratic Republic of Timor-Leste

Attachment

Expected Schedule for Environmental Approval
for the Project for the Improvement of Dili-Suai Roads and Bridges



MTCPW: Ministry of Transport, Communication and Public Works
DoE/MoDE: Division of Environment, Ministry of Development and Environment
EMP: Environmental Management Plan

THE PROJECT FOR THE IMPROVEMENT OF ROADS AND BRIDGES IN THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE

Japan International Cooperation Agency
PACIFIC CONSULTANTS INTERNATIONAL
NIPPON KOEI CO.,LTD.

Room 309, SAKURA Tower Apartment, Jalan 15 Oktober, No. 18 Audian, Dili, East Timor
TEL : 724-3576 (cellular phone)

MEMORANDUM OF DISCUSSION

DATE & MEETING PLACE: May 21 and 22, 2003 at the Office of MoJ and MTCPW
PRESENT: Timor Leste Side; Mr. Joan B.F. Alves (MTCPW), Mr. Jose Gaspar Piedade (MTCPW), Mr. Pedro De Sousa Xavier (MoJ), Dr. Edwin Urresta (UN Adviser)
JICA Study Team; Mr. Haruo Sakashita, Mr. Norihiko Inoue
PROJECT NAME: Improvement of the Dili–Aituto-Suai Road and the Mola Bridge

SUBJECT: Procedure for a land acquisition for the Project

DISCUSSION was made as follows;

1. Mr. Sakashita explained that JICA sent to Timor-Leste the Basic Design Study Team (hereinafter referred to as "the Team"), headed by Mr. Yukihiko Ejiri, a Senior Assistant to the Managing Director, the Office of Technical Coordination and Examination, the Grant Aid Management Department, JICA, and the Team is scheduled to stay in the country from May 13 to June 24, 2003.
   The Team proposed an overall process as attached regarding land acquisition for the Project, based on the memorandum of discussion on April 11, 2003.

2. Timor-Leste side answered as follows;
(1) A legal framework on land ownership/use and legal procedure on land/property acquisition have not yet been established. These issues are to be coped with on every particular case.
(2) It is understood that, in the case of the Project, the overall process proposed in the attached is acceptable Timor-Leste side will proceed to and ensure the necessary arrangement and agreement in line with the proposed process.
(3) As a temporary use of a land for construction work including stock yards and site camps would be required, the necessary arrangement would be made by the same manner as attached.

Signed by

Haruo Sakashita
Chief Consultant
Basic Design Study Team
Japan International Cooperation Agency

Pedro De Sousa Xavier
Director of Land and Property
Ministry of Justice
Democratic Republic of Timor-Leste

Joao B.F. Alves
Secretary of State for Public Works
Ministry of Transport, Communication and Public Works
Democratic Republic of Timor- Leste

Jose Gaspar Piedade
Director General of Public Works
Ministry of Transport, Communication and Public Works
Democratic Republic of Timor-Leste

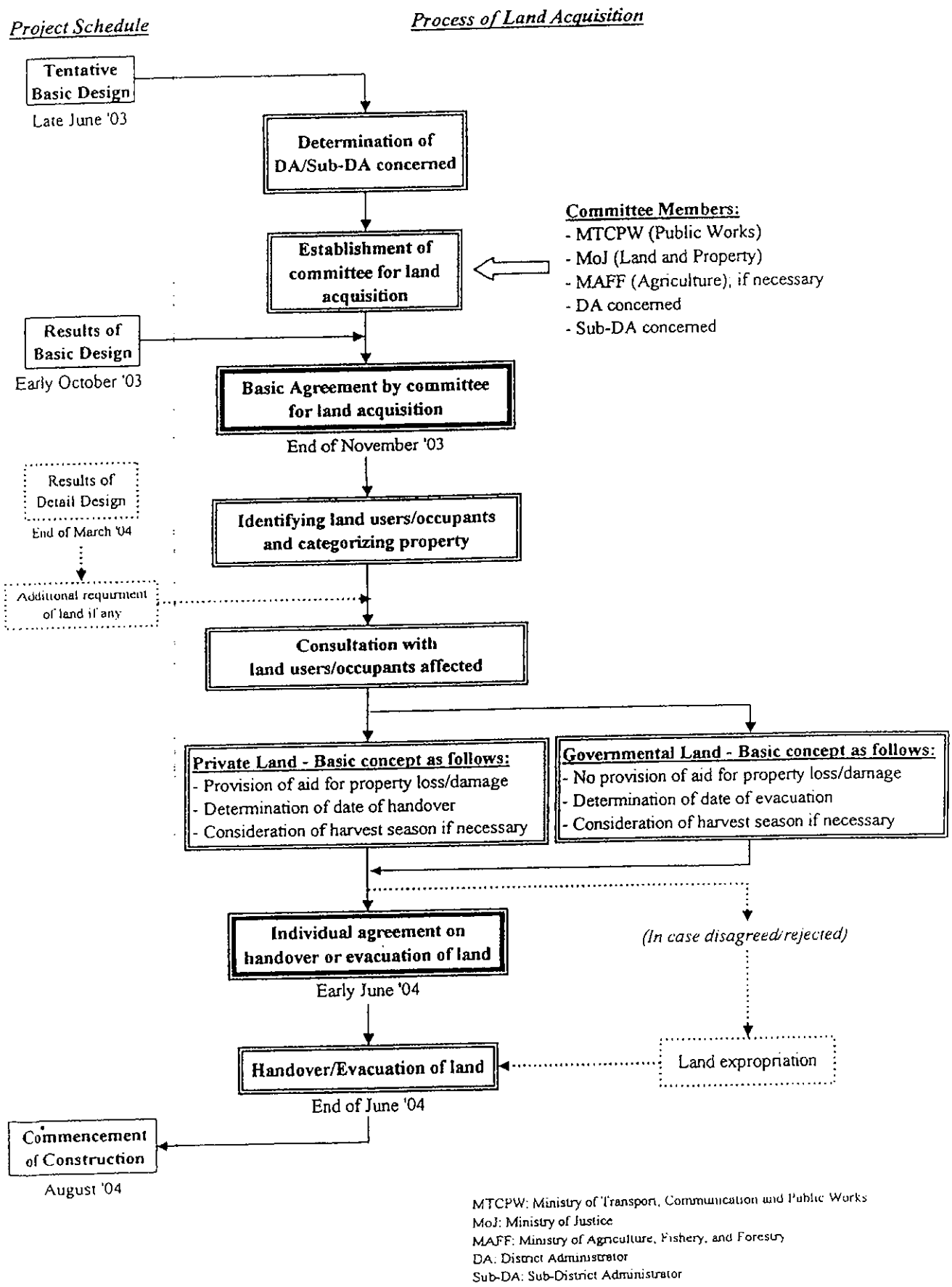


Figure Overall Process on Land Acquisition for the Project

Minutes of Discussions
on the Basic Design Study
on the Project for the Improvement of Roads and Bridges
in the Democratic Republic of Timor-Leste
(Explanation on the Draft Report)

In response to the request from the Government of the Democratic Republic of Timor-Leste (hereinafter referred to as "Timor-Leste"), the Government of Japan decided to conduct a Basic Design Study on the Project for the Improvement of Roads and Bridges (hereinafter referred to as "the Project") and entrusted the study to the Japan International Cooperation Agency (hereinafter referred to as "JICA").

JICA dispatched a Basic Design Study Team to Timor Leste and prepared a draft report of the study through discussion with the Timor Leste side, field survey, and technical analysis of the results in Japan.

In order to explain and to consult with the Timor-Leste side on the contents of the draft report, JICA sent the Basic Design Explanation Team (hereinafter referred to as "the Team") to Timor-Leste, headed by Mr. Toshiaki Tanaka, Resident Representative of the JICA East Timor Office, and is scheduled to stay in the country from October 22 to 31, 2003.

As a result of discussions, both sides have confirmed the main items described in the attached sheets

Dili, October 29, 2003

Toshiaki Tanaka
Leader
Basic Design Explanation Team
Japan International Cooperation Agency

Ovidio de Jesus Amaral
Minister
Ministry of Transport, Communication and
Public Works (MTCPW)
Democratic Republic of Timor-Leste

Witness

Aicha Bassarewan
Vice-Minister
Ministry of Planning and Finance
Democratic Republic of Timor-Leste

João B.F. Alves
Secretary of State for Public Works
Ministry of Transport, Communication and
Public Works (MTCPW)
Democratic Republic of Timor-Leste

ATTACHMENT

1. Contents of the Draft Report

The Timor-Leste side agreed and accepted in principle the contents of the Draft Report explained by the Team.

2. Japan's Grant Aid Scheme

(1) The Timor-Leste side understands the Japan's Grant Aid scheme and the necessary measures to be taken by the Government of Timor-Leste explained by the Team as described in Annex-3 and Annex-4 of the Minutes of Discussions signed by both sides on April 2, 2003 (hereinafter referred to as "the previous M/D").

(2) The Timor-Leste side shall provide the services and extending the tax exemption referred to the clause 7-(7)-1), Annex-3 and Annex-4 of the previous M/D.

3. Schedule of the Study

JICA will complete the Final Report in accordance with the confirmed items and send it to the Timor-Leste side by the middle of January 2004.

4. Other Relevant Issues

4-1. Regarding the alignment for the location of the Mola bridge, the Team studied the curved (existing alignment) alignments (hereinafter referred to as "the Route-A") and the tangent alignment (hereinafter referred to as "the Route-B") and explained the results of the study to the Timor-Leste side as follows:

(1) The Land acquisition is the most sensitive matter between residents and the government due to the lack of laws, acts, and proper procedure(s) for land properties in the Timor-Leste. Therefore, the Team studied and examined this point carefully, and finally proposed the Route-A as the alignment for the location of the Mola Bridge in order to avoid land acquisition (removal of a house and cultivating lands).

(2) On the other hand, from the view points of hydrological analysis of the river characteristics, flood water volume, construction cost, construction method, and aesthetics point, the Route-B shall be better than the Route-A.

(3) Accordingly, the Timor-Leste side shall continue to make efforts to solve the land acquisition for Route-B. In case that the Timor-Leste side succeeds in solving the matter without any problem with residents before the commencement of detailed design stage for the Mola Bridge, the design of the bridge will be changed from the Route-A to the Route-B because of the above-mentioned reasons.

4-2. The Timor-Leste side shall complete Basic Agreement for the Land Acquisition till the end of November 2003 based on the procedures with the process shown in Appendix-1.

4-3. The Timor-Leste side shall obtain the related approval of EMP till the end of November 2003 concerning the environmental assessment from Ministry of Development and Environment as per schedule shown in Appendix-2.

4-4. As for the consultant service, so called "the Soft Component", for the management of the improvement, rehabilitation, periodic and routine maintenance of the roads and bridges, including the

capacity-building mainly for the staff of MTCPW, people related with the Community Based Maintenance, the Team explained the contents and period to the Timor-Leste side. The Timor-Leste side shall allocate budget, designate counter personnel, and others necessary for the Soft Component in accordance with the training plan explained by the Team.

4-5. The Timor-Leste side requested the Team to carry out the counterpart training in Japan on the management of the maintenance of roads and bridges as a technical cooperation by JICA, and the Timor-Leste side understands that another official request will be needed to submit from the Timor-Leste side to the Japanese side through the JICA East Timor Office.

4-6. The Team informed that the Government of Japan had mentioned that the Exchange of Notes (E/N) shall take into force upon the approval of the Diet of the Timor-Leste about the tax exemption within two months after signing E/N. The Timor-Leste side understood the Japanese Government policy and agreed to make efforts to obtain Diet approval before the above mentioned time limit.

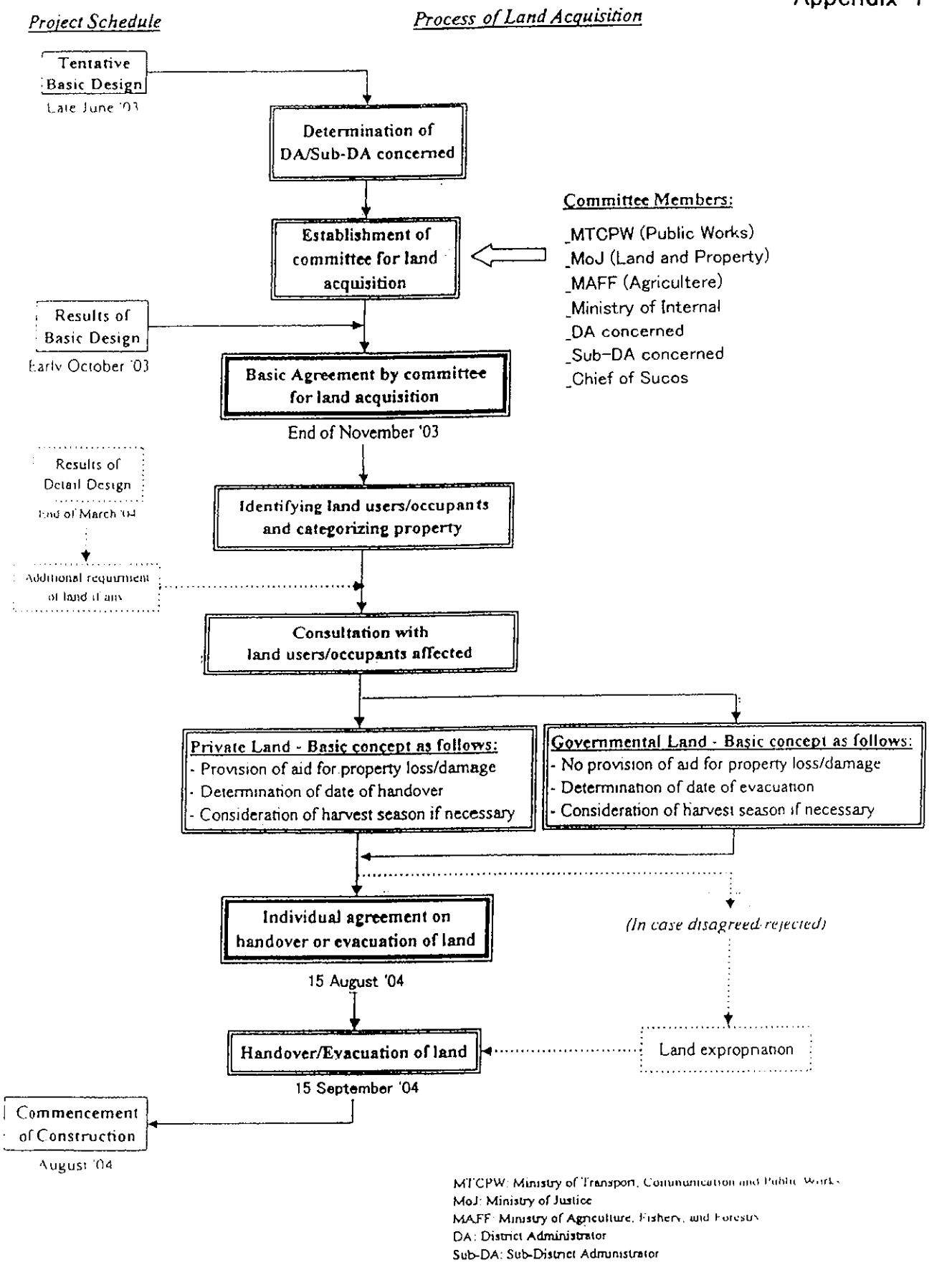
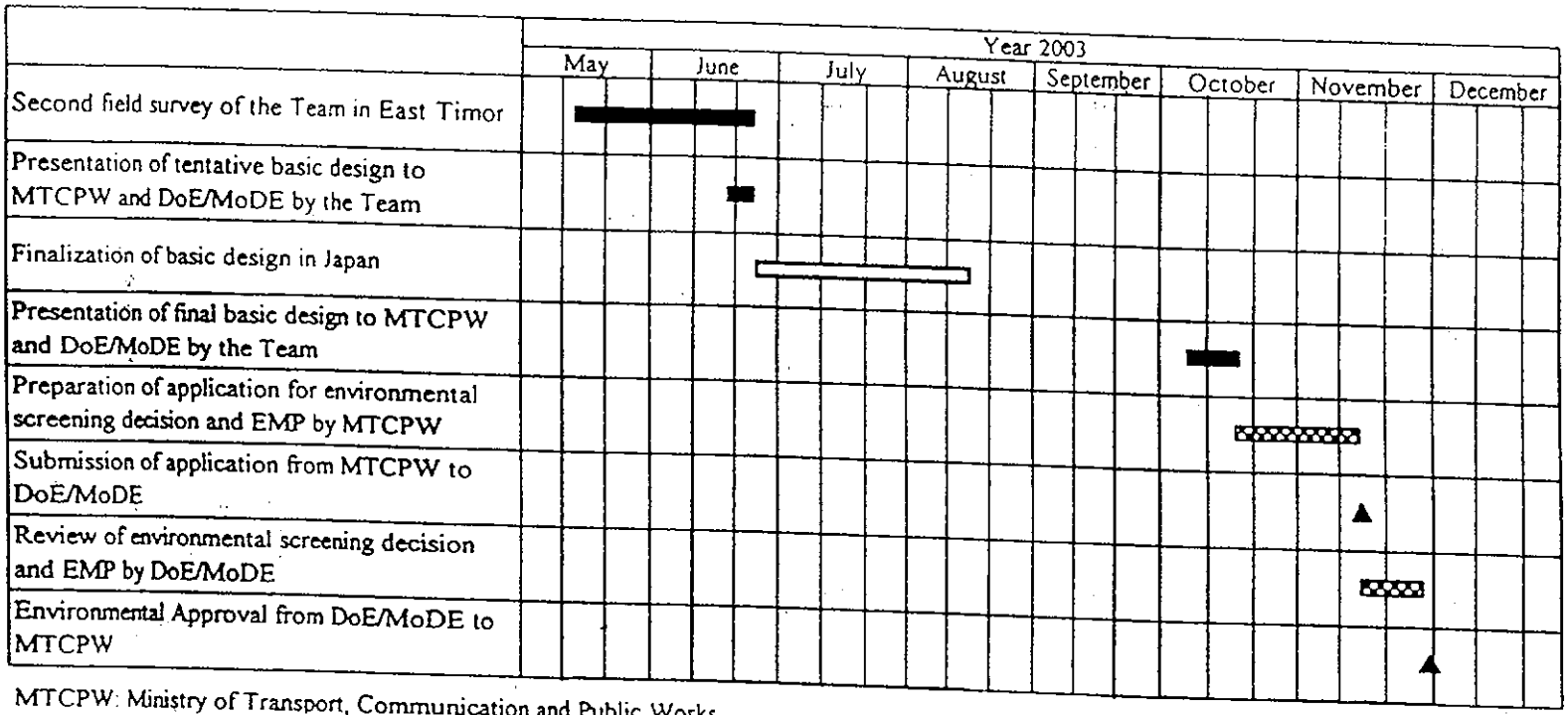


Figure Overall Process on Land Acquisition for the Project

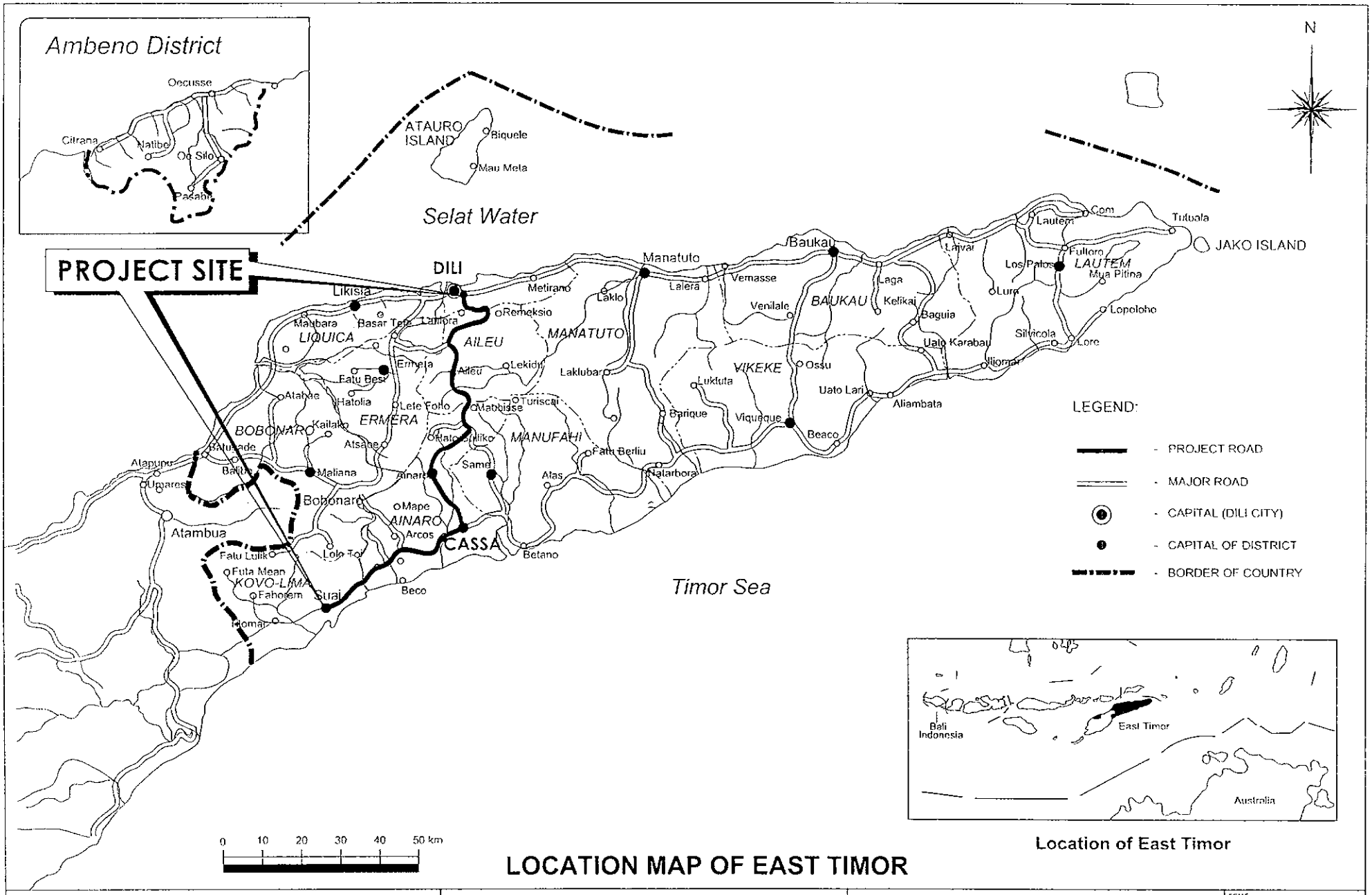
Expected Schedule for Environmental Approval for the Project for the Improvement of Dili-Suai Roads and Bridges



MTCPW: Ministry of Transport, Communication and Public Works
DoE/MoDE: Division of Environment, Ministry of Development and Environment
EMP: Environmental Management Plan

Appendix-2

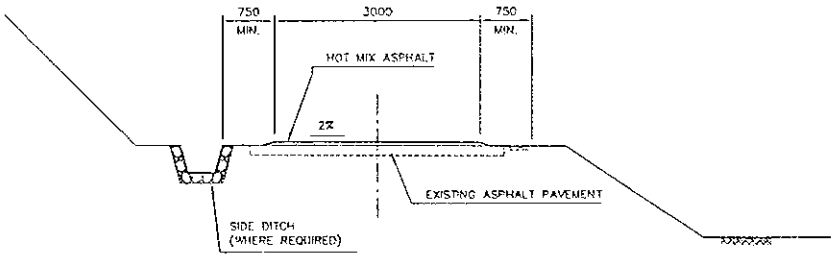
Attachment-5. Basic Design Drawing



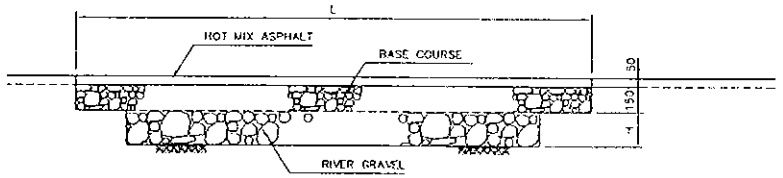
LOCATION MAP OF EAST TIMOR

THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE MINISTRY OF TRANSPORT, COMMUNICATION AND PUBLIC WORKS (MTCPW)	JAPAN INTERNATIONAL COOPERATION AGENCY PACIFIC CONSULTANTS INTERNATIONAL NIPPON KOEI CO.,LTD.	THE PROJECT FOR THE IMPROVEMENT OF ROADS AND BRIDGES IN THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE DRAWING TITLE LOCATION MAP OF EAST TIMOR AND PROJECT SITE	SCALE NTS DRAWING NO. G-001 SHEET NO. Sheet of

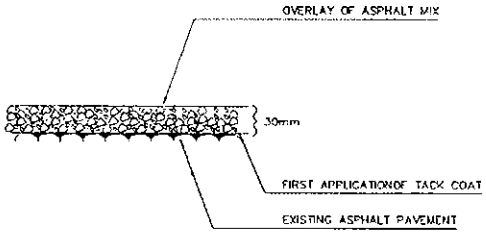
STANDARD DRAWING FOR REPAIR METHOD
OVERLAY OF PAVEMENT



SECTION
SCALE 1: 75

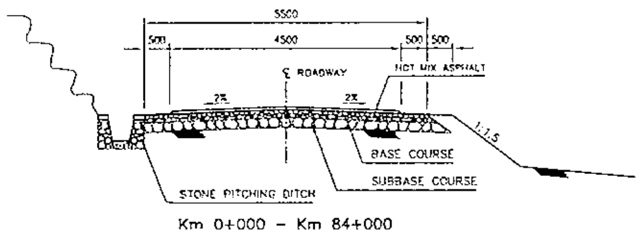


REPAIRING OF POT HOLE
NTS



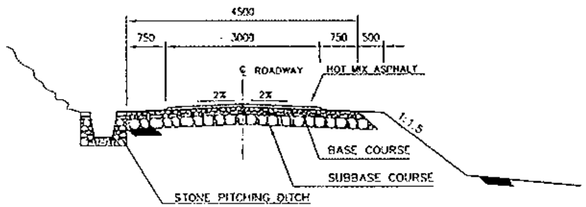
PAVEMENT DETAIL
NTS

THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE MINISTRY OF TRANSPORT, COMMUNICATION AND PUBLIC WORKS (MTCPW)	JICA JAPAN INTERNATIONAL COOPERATION AGENCY PACIFIC CONSULTANTS INTERNATIONAL NIPPON KOEI CO.,LTD.	THE PROJECT FOR THE IMPROVEMENT OF ROADS AND BRIDGES IN THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE DRAWING TITLE STANDARD DRAWING FOR REPAIR METHOD (TYPE OF OVERLAY OF POTHOLE)	SCALE AS SHOWN DRAWING No. SHEET No. Sheet 1 of 3



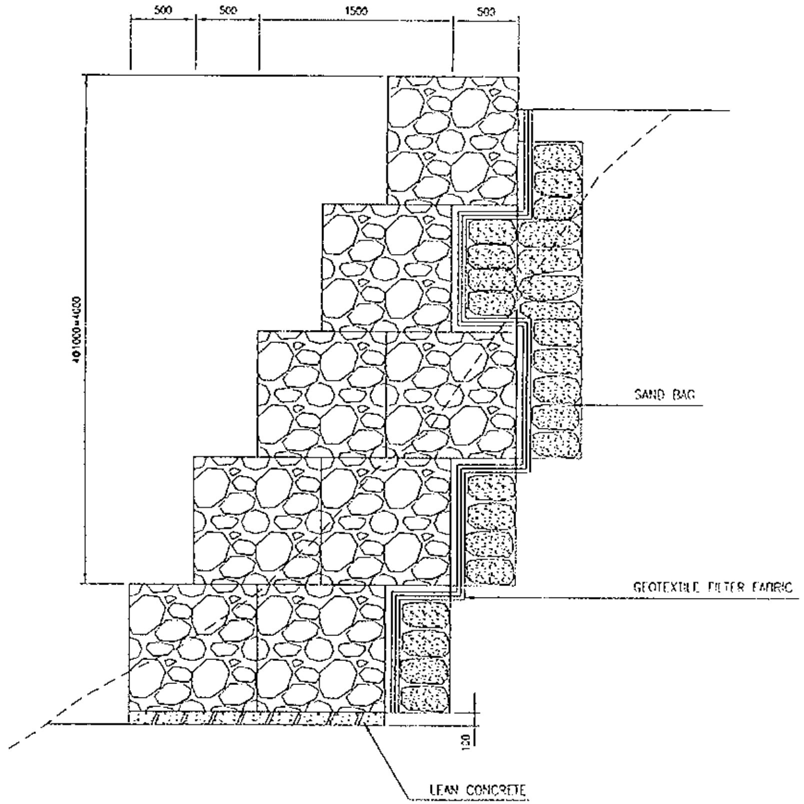
Km 0+000 – Km 84+000

TWO LANE ROAD
SCALE 1:100



Km 84+000 – Km 132+000

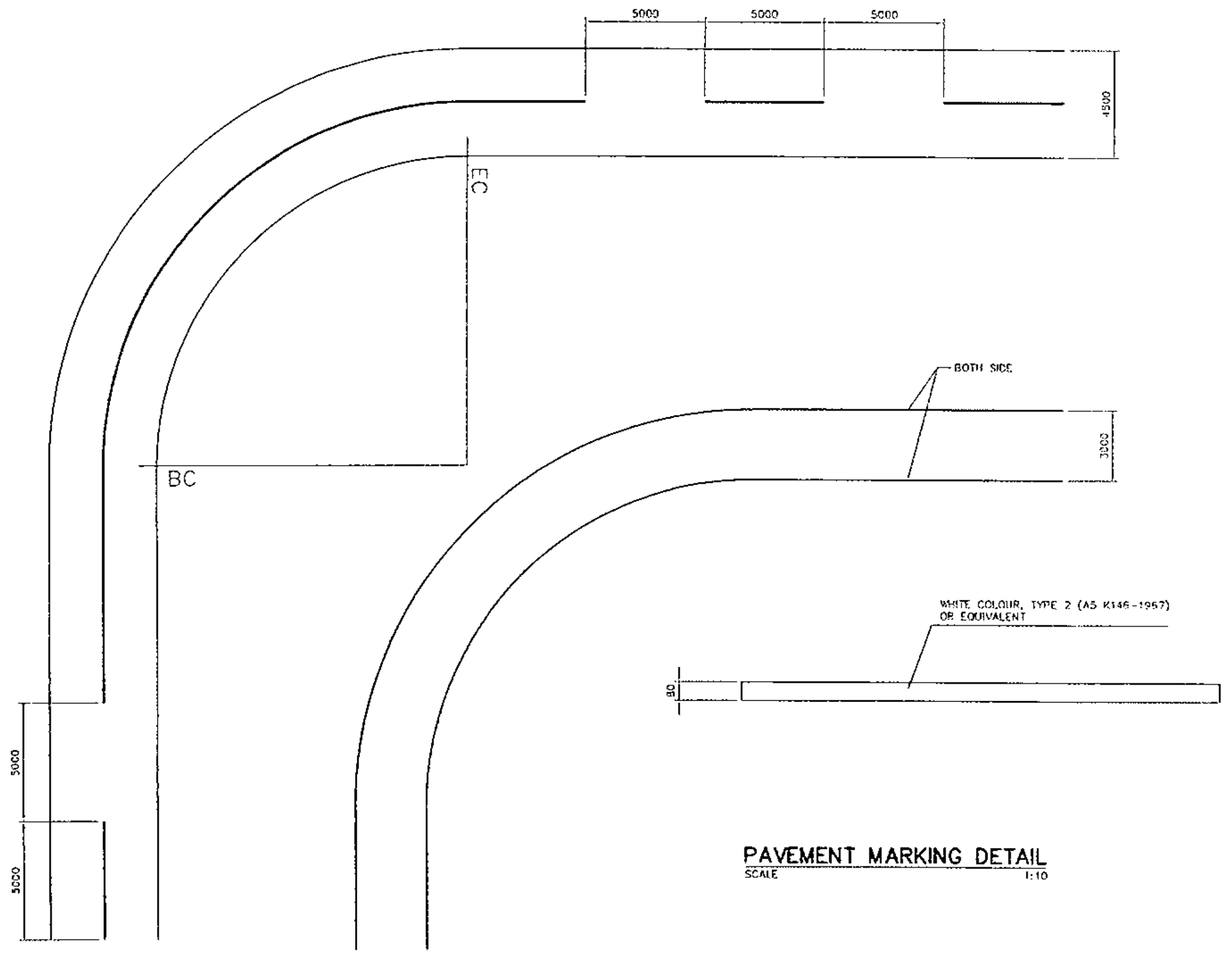
ONE LANE ROAD
SCALE 1:100



GABION BLOCK
SCALE 1:40

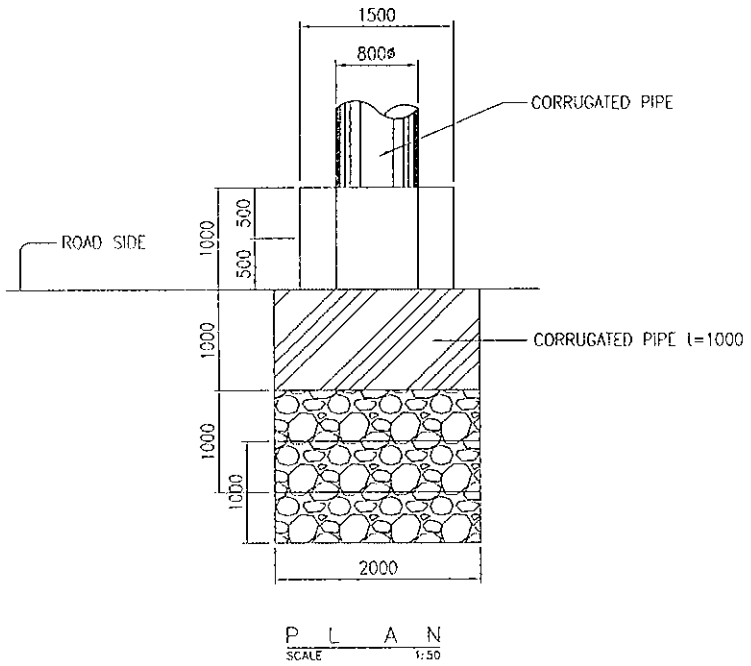
THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE MINISTRY OF TRANSPORT, COMMUNICATION AND PUBLIC WORKS (MTCPW)	JICA JAPAN INTERNATIONAL COOPERATION AGENCY PACIFIC CONSULTANTS INTERNATIONAL NIPPON KOEI CO.,LTD.	THE PROJECT FOR THE IMPROVEMENT OF ROADS AND BRIDGES IN THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE DRAWING TITLE TYPICAL CROSS SECTION, SUPERELEVATION AND WINENING ON CURVES	SCALE DRAWING No. SHEET No. Sheet

PAVEMENT MARKING

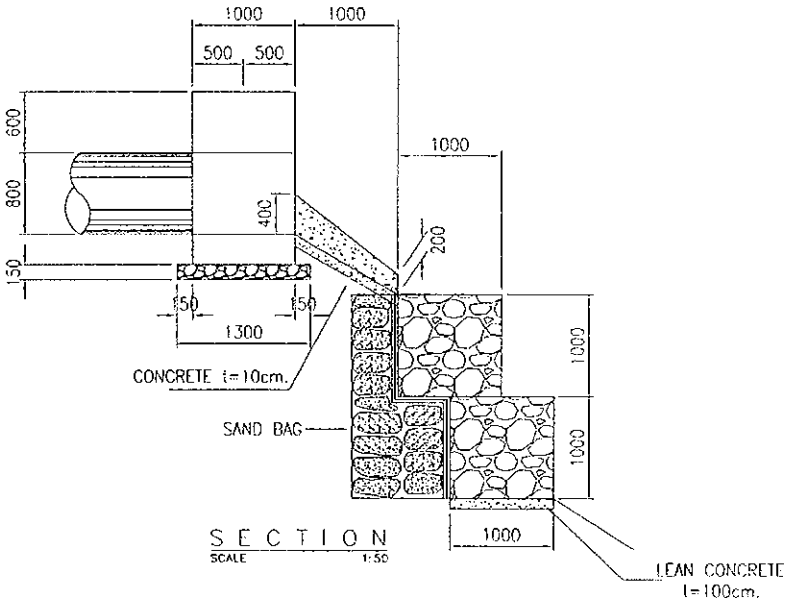


PAVEMENT MARKING DETAIL
SCALE 1:10

THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE MINISTRY OF TRANSPORT, COMMUNICATION AND PUBLIC WORKS (MTCPW)	JAPAN INTERNATIONAL COOPERATION AGENCY PACIFIC CONSULTANTS INTERNATIONAL NIPPON KOEI CO.,LTD.	THE PROJECT FOR THE IMPROVEMENT OF ROADS AND BRIDGES IN THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE DRAWING TITLE: PAVEMENT MARKING	SCALE: AS SHOWN 000



P L A N
SCALE 1:50



S E C T I O N
SCALE 1:50

CONCRETE : (2.0 x 1.0 x 0.0) + (0.4 + 0.2)/2 x 1.0 x 0.25 = 0.28m^3

LEAN CONCRETE : 2.0 x 1.0 x 0.1 = 0.02m^3

CRUSHING STONE : 1.3 x 1.8 x 0.15 = 0.35m^3

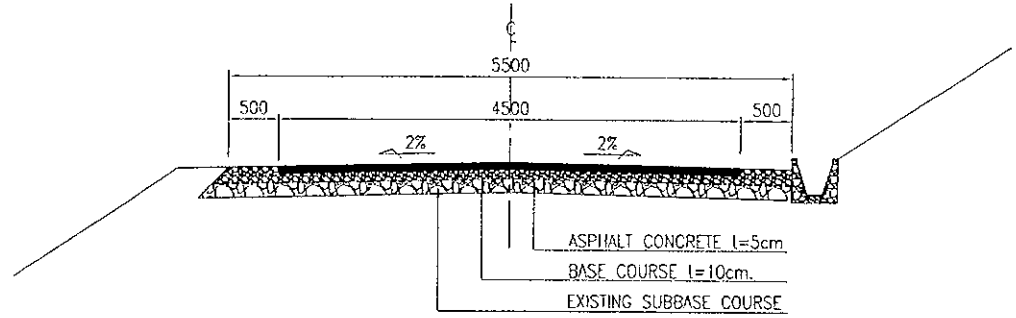
RIP RAP : (1.0 x 1.5 x 1.5) − (0.4m^2 x 3.14 x 1.0) = 1.75m^3

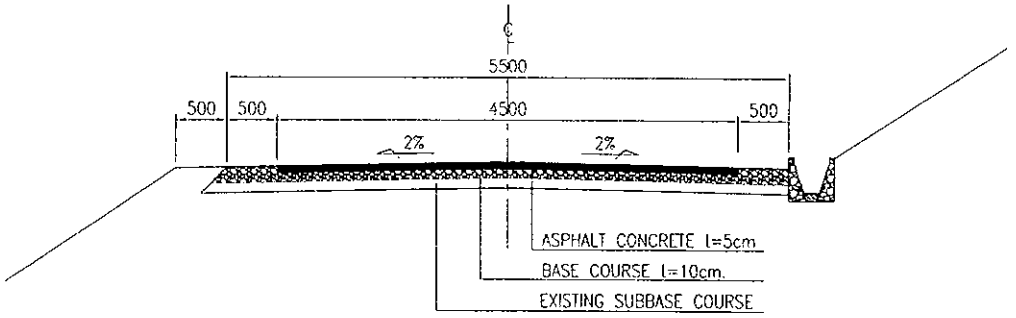
GABION : 1.0 x 1.0 x 2.0 x 2 = 4.00m^3

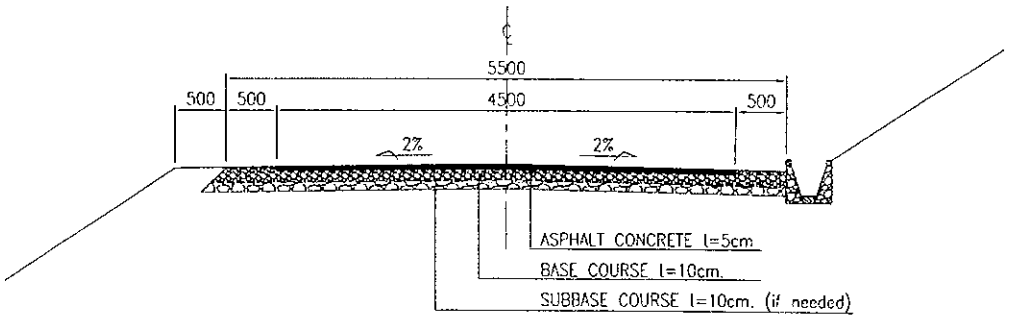
FORM : (0.1 x 1.0 x 2) + (1.0 x 0.1 x 2) + (2.0 x 0.1 x 2) + {(0.4 + 0.2)/2 x 1.0 4} = 2.00m^2

CORRUGATED PIPE : 800 ø 50.m

THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE MINISTRY OF TRANSPORT, COMMUNICATION AND PUBLIC WORKS (MTCPW)	JAPAN INTERNATIONAL COOPERATION AGENCY PACIFIC CONSULTANTS INTERNATIONAL NIPPON KOEI CO.,LTD.	THE PROJECT FOR THE IMPROVEMENT OF ROADS AND BRIDGES IN THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE DRAWING TITLE: CORRUGATED PIPE	SCALE 1:50 DRAWING NO. 000 SHEET NO.



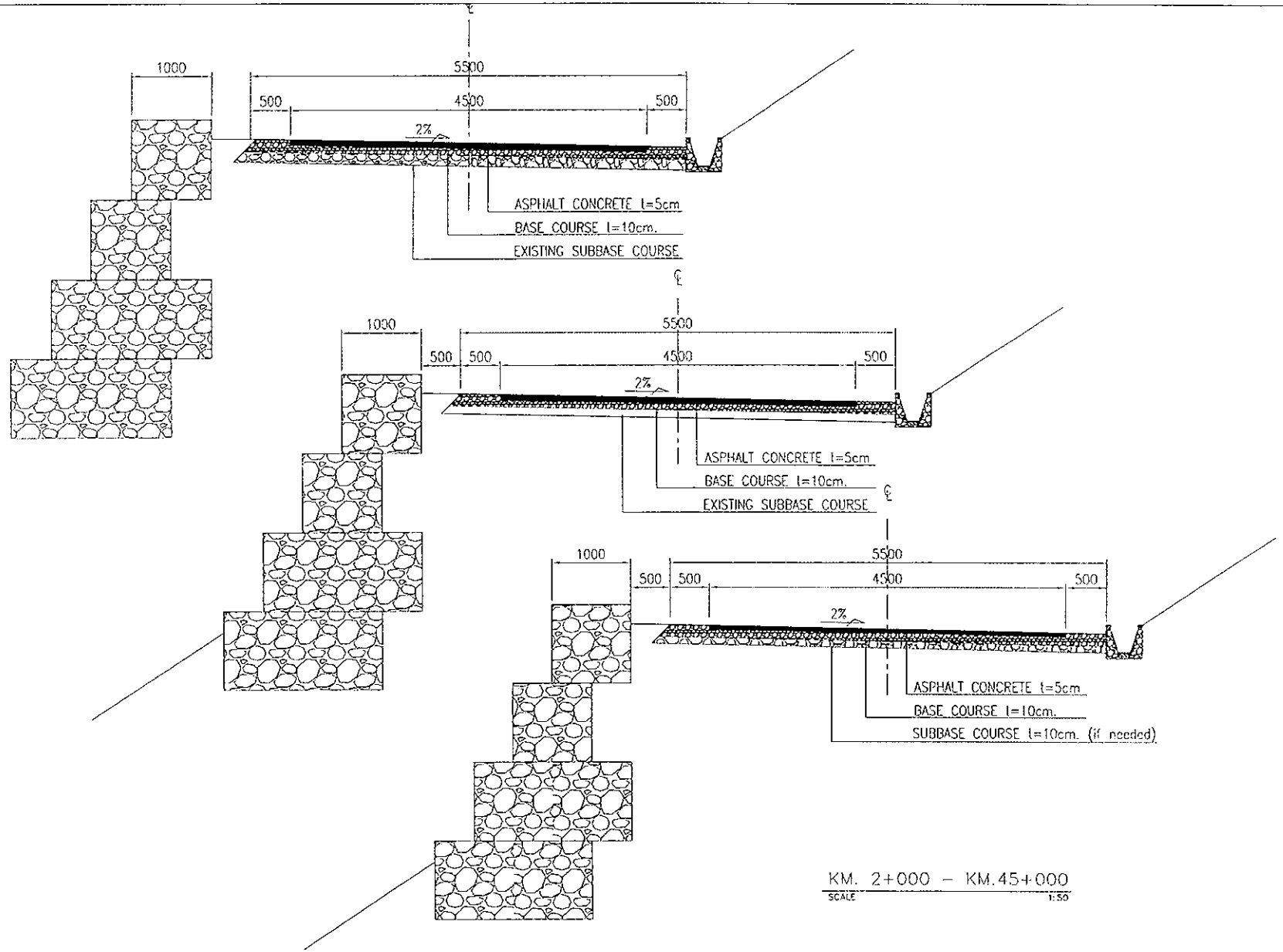




KM. 2+000 – KM.45+000

SCALE 1:50

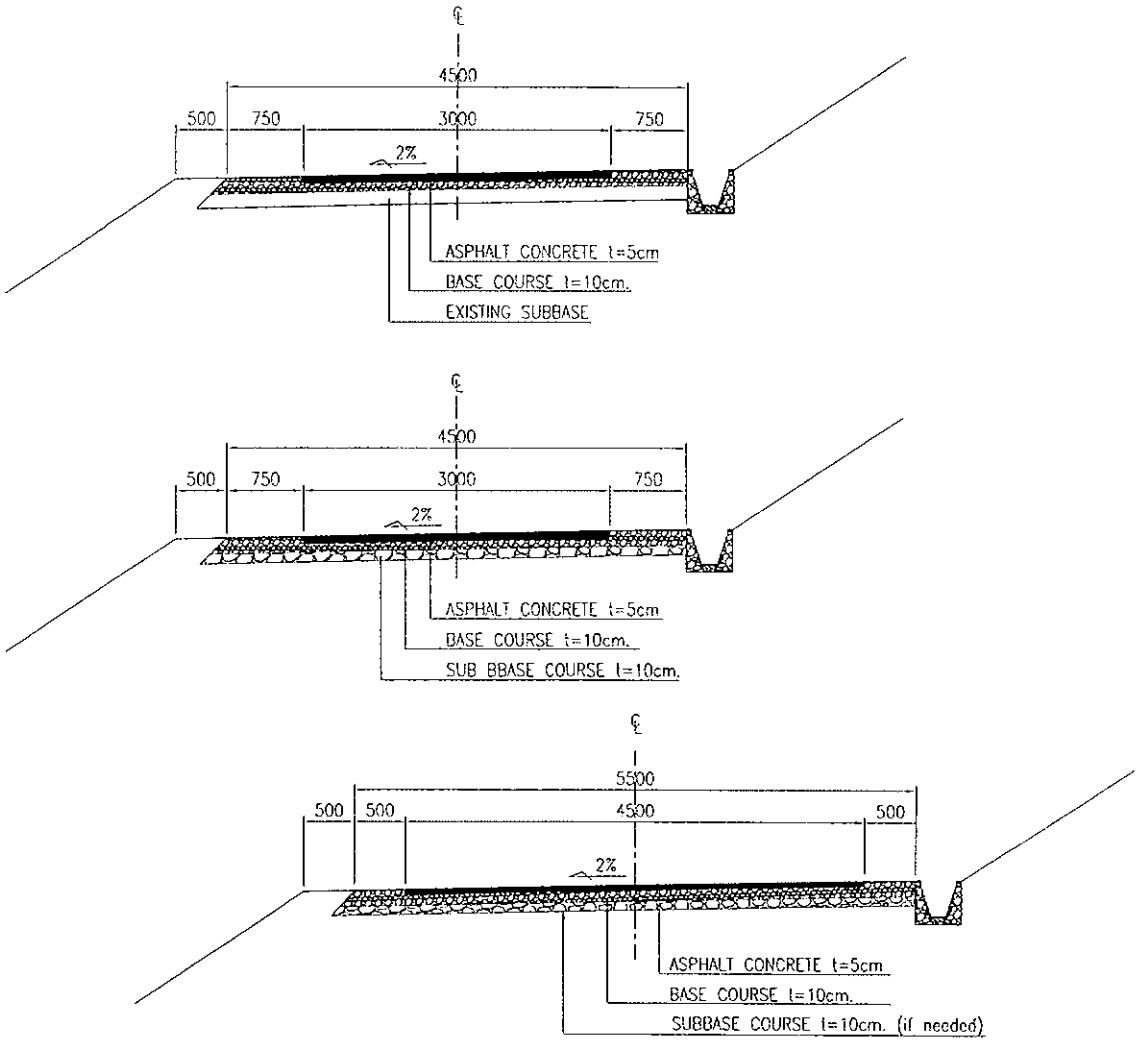
THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE MINISTRY OF TRANSPORT, COMMUNICATION AND PUBLIC WORKS (MTCPW)	JICA JAPAN INTERNATIONAL COOPERATION AGENCY PACIFIC CONSULTANTS INTERNATIONAL NIPPON KOEI CO.,LTD.	THE PROJECT FOR THE IMPROVEMENT OF ROADS AND BRIDGES IN THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE DRAWING TITLE TYPICAL CROSS SECTION OF THE ROAD KM. 2+000 to KM. 45+000	SCALE AS SHOWN DRAWING NO. SHEET NO.



KM. 2+000 – KM.45+000

SCALE 1:50

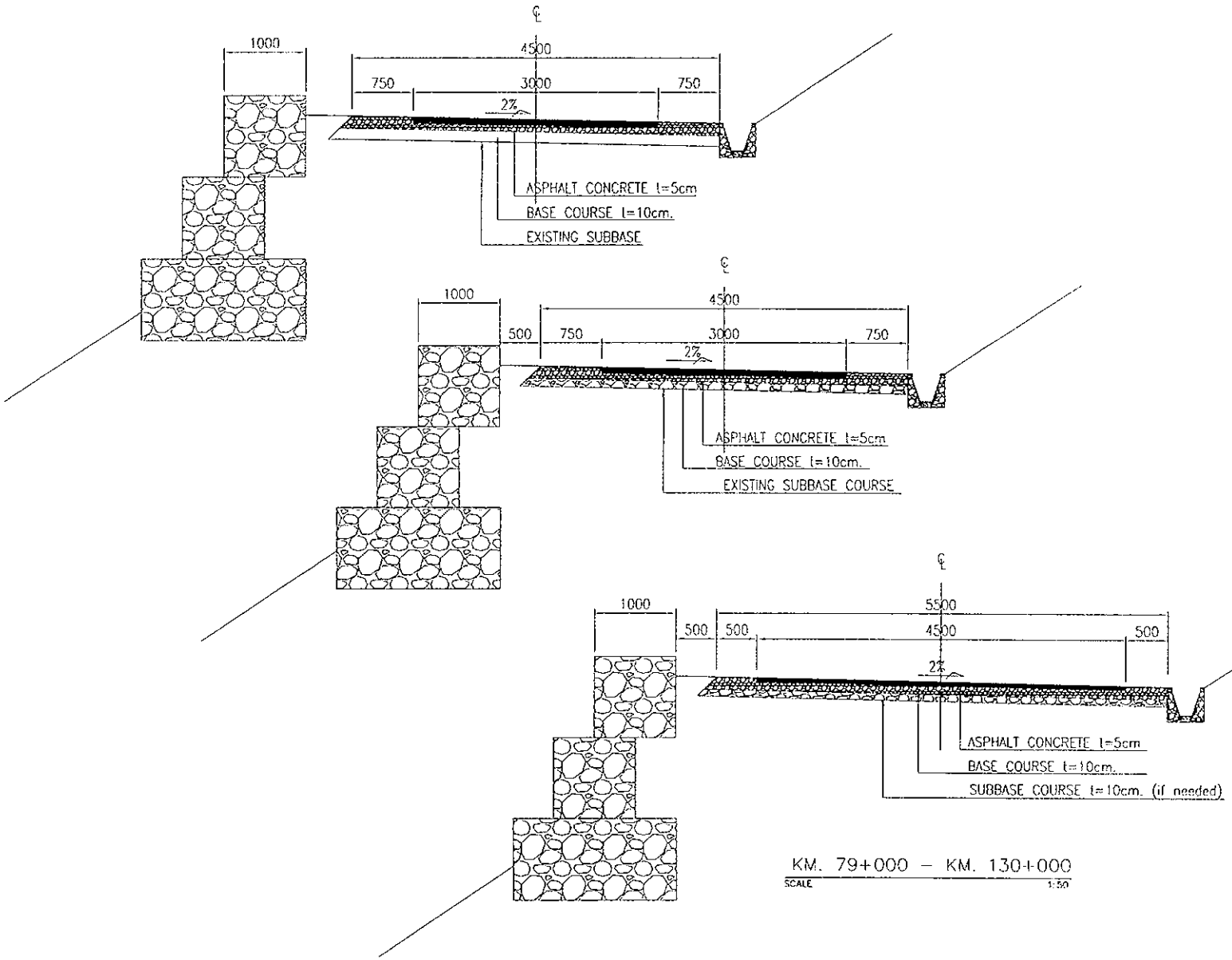
THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE MINISTRY OF TRANSPORT, COMMUNICATION AND PUBLIC WORKS (MTCPW)	JAPAN INTERNATIONAL COOPERATION AGENCY PACIFIC CONSULTANTS INTERNATIONAL NIPPON KOEI CO.,LTD	THE PROJECT FOR THE IMPROVEMENT OF ROADS AND BRIDGES IN THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE DRAWING TITLE SLOPE PROTECTION BY GABION TYPICAL CROSS SECTION OF THE ROAD KM. 2+000 to KM. 45+000	SCALE AS SHOWN DRAWING NO. SHEET NO.



KM. 79+000 – KM. 130+000

SCALE 1:50

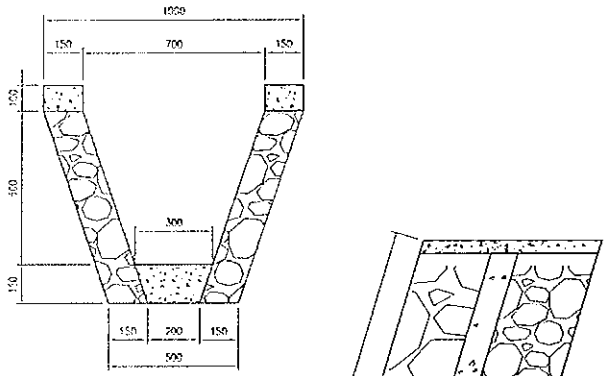
THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE MINISTRY OF TRANSPORT, COMMUNICATION AND PUBLIC WORKS (MTCPW)	JAPAN INTERNATIONAL COOPERATION AGENCY PACIFIC CONSULTANTS INTERNATIONAL NIPPON KOEI CO.,LTD.	THE PROJECT FOR THE IMPROVEMENT OF ROADS AND BRIDGES IN THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE DRAWING TITLE: TYPICAL CROSS SECTION OF THE ROAD KM 79+000 to KM 130+000	SCALE 1:50 DRAWING No. 000 SHEET No. Sheet of



KM. 79+000 – KM. 130+000

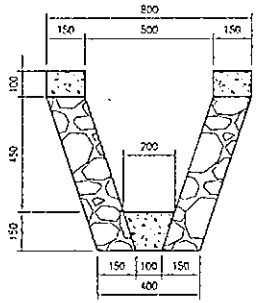
SCALE 1:50

THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE MINISTRY OF TRANSPORT, COMMUNICATION AND PUBLIC WORKS (MTCPW)	JAPAN INTERNATIONAL COOPERATION AGENCY PACIFIC CONSULTANTS INTERNATIONAL NIPPON KOEI CO.,LTD.	THE PROJECT FOR THE IMPROVEMENT OF ROADS AND BRIDGES IN THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE DRAWING TITLE	SCALE 1:50 DRAWING NO. SHEET NO.



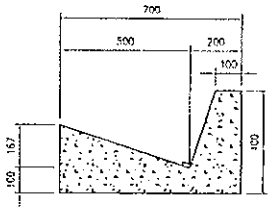
STONE DITCHING DITCH
TYPE A-1

SCALE 1:20



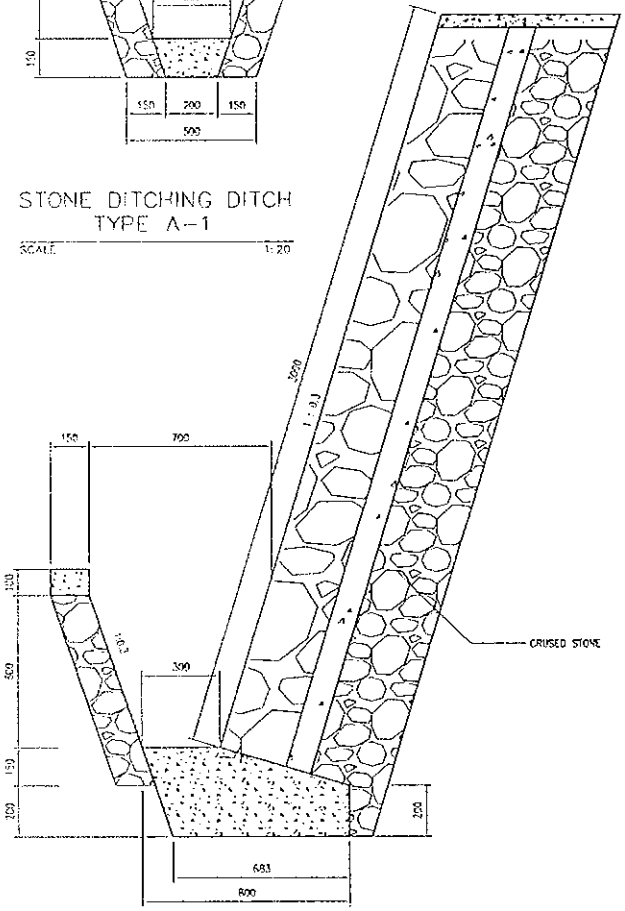
STONE DITCHING DITCH
TYPE B-1

SCALE 1:20



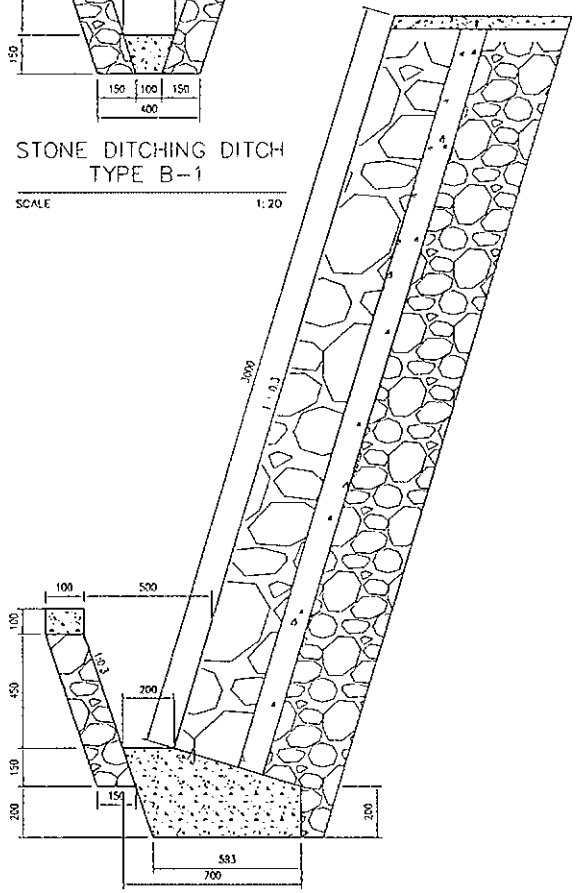
TYPE-C

SCALE 1:20



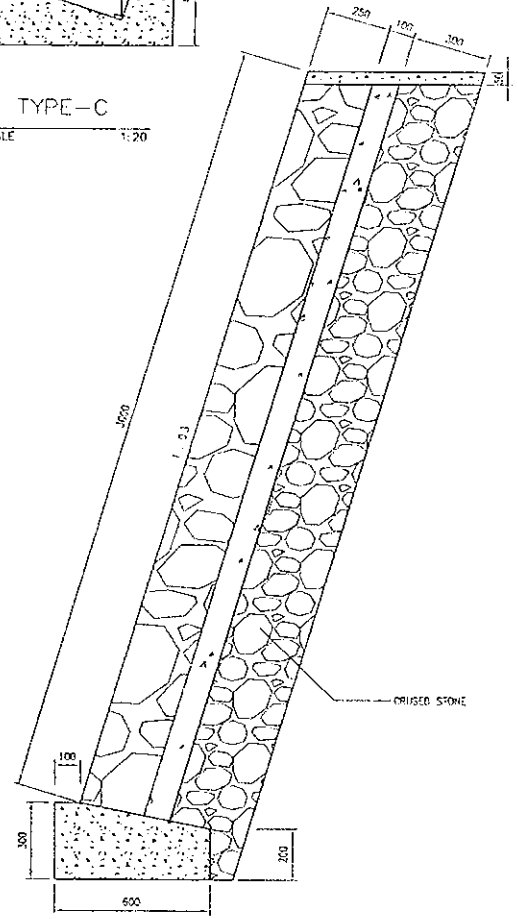
STONE DITCHING DITCH TYPE 0.70
TYPE A-2

SCALE 1:20



STONE DITCHING DITCH TYPE 0.50
TYPE B-2

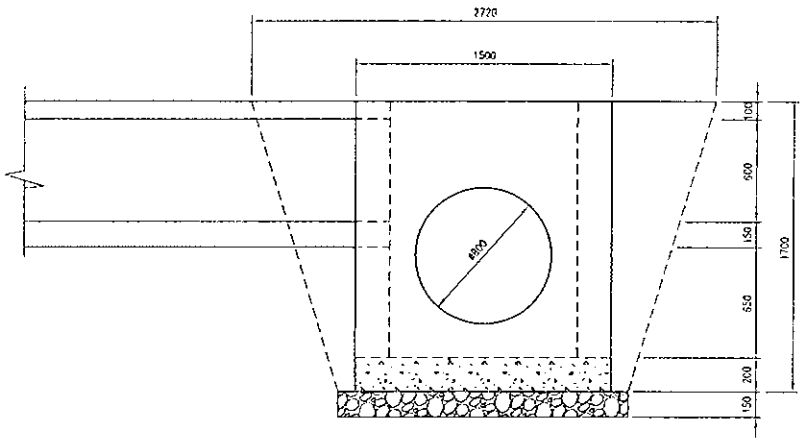
SCALE 1:20

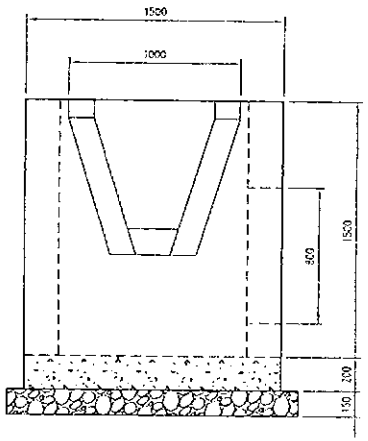


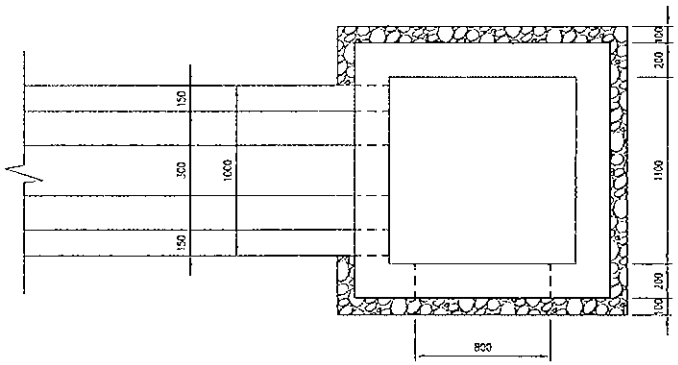
2.4(6) STONE MASONRY
SINGLE TYPE

SCALE 1:20

THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE MINISTRY OF TRANSPORT, COMMUNICATION AND PUBLIC WORKS (MTCPW)	JICA JAPAN INTERNATIONAL COOPERATION AGENCY PACIFIC CONSULTANTS INTERNATIONAL NIPPON KOEI CO.,LTD	THE PROJECT FOR THE IMPROVEMENT OF ROADS AND BRIDGES IN THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE DRAWING TITLE TYPICAL SECTION OF DITCH AND RETAINING WALL	SCALE AS SHOWN DRAWING No. SHEET No. Sheet of







RIP RAP : (1.5 x 0.2 x 1.5 x 2) / (1.1 x 0.2 x 1.5)
+ {(1.1 x 0.2 x 1.5 - (0.4 x 3.14 x 0.2 = 1.05m^3

CONCRETE : 1.5 x 1.5 x 0.2 = 0.45m^3

CRUSHED STONE : 1.7 x 1.7 x 0.15 = 0.43m^3

FORM : 1.5 x 0.2 x 4 = 1.2m^3

INLET DRAINAGE BOX

SCALE 1:30

THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE

MINISTRY OF
TRANSPORT, COMMUNICATION AND PUBLIC WORKS
(MTCPW)

JICA JAPAN INTERNATIONAL COOPERATION AGENCY

PACIFIC CONSULTANTS INTERNATIONAL

NIPPON KOEI CO.,LTD.

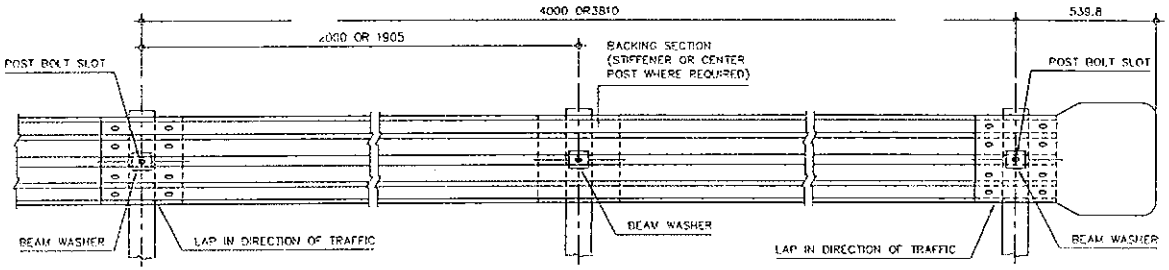
THE PROJECT FOR THE IMPROVEMENT OF ROADS AND BRIDGES
IN THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE

DRAWING TITLE
DETAILED DRAWING FOR DRAINAGE BOX

SCALE AS SHOWN

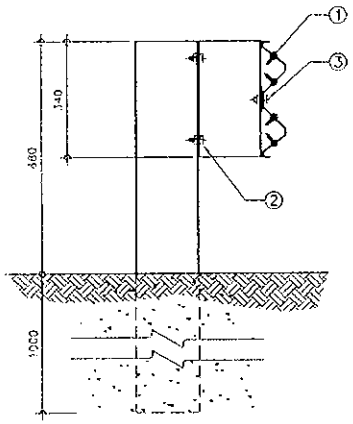
DRAWING No. 000

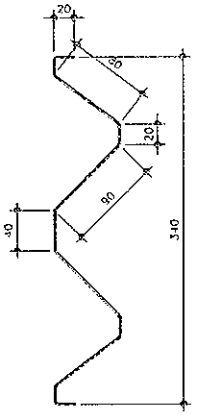
SHEET No. Sheet of



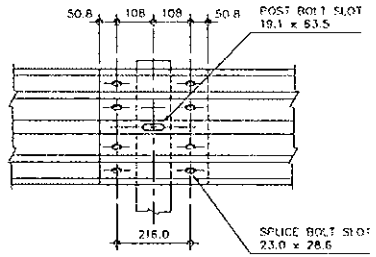
WOODEN POST SHOWN WHEN STEEL POST IS USED OFFSET IS REQUIRED TO MIN. WEB

SECTION THROUGH BEAM
SCALE 1:20

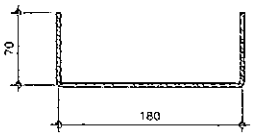




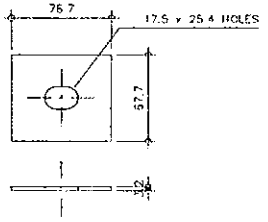
FLEX-BEAM
SCALE 1:5



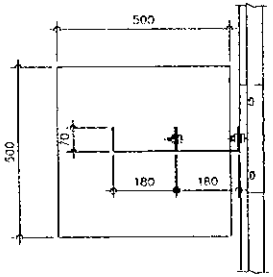
BEAM SPLICE
SCALE 1:15



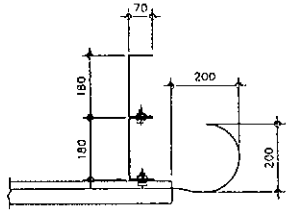
DETAIL
SCALE 1:5



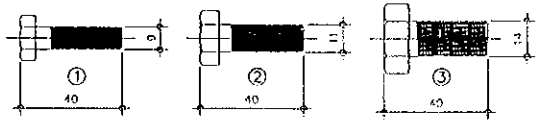
SPLICE WASHER
SCALE 1:4



POST DETAIL
SCALE 1:10



DETAIL
SCALE 1:10

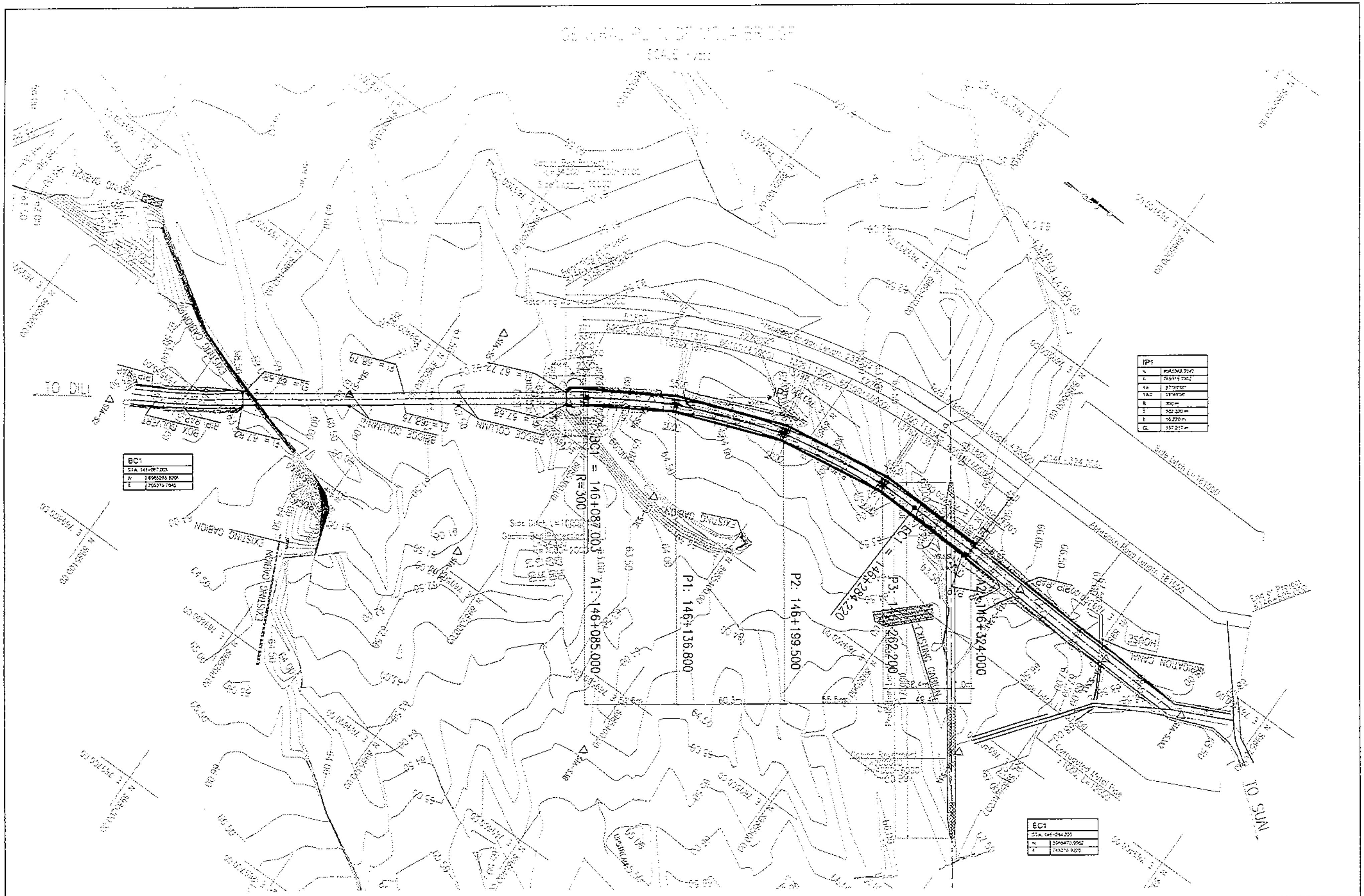


SPLICE BOLTS
SCALE 1:2

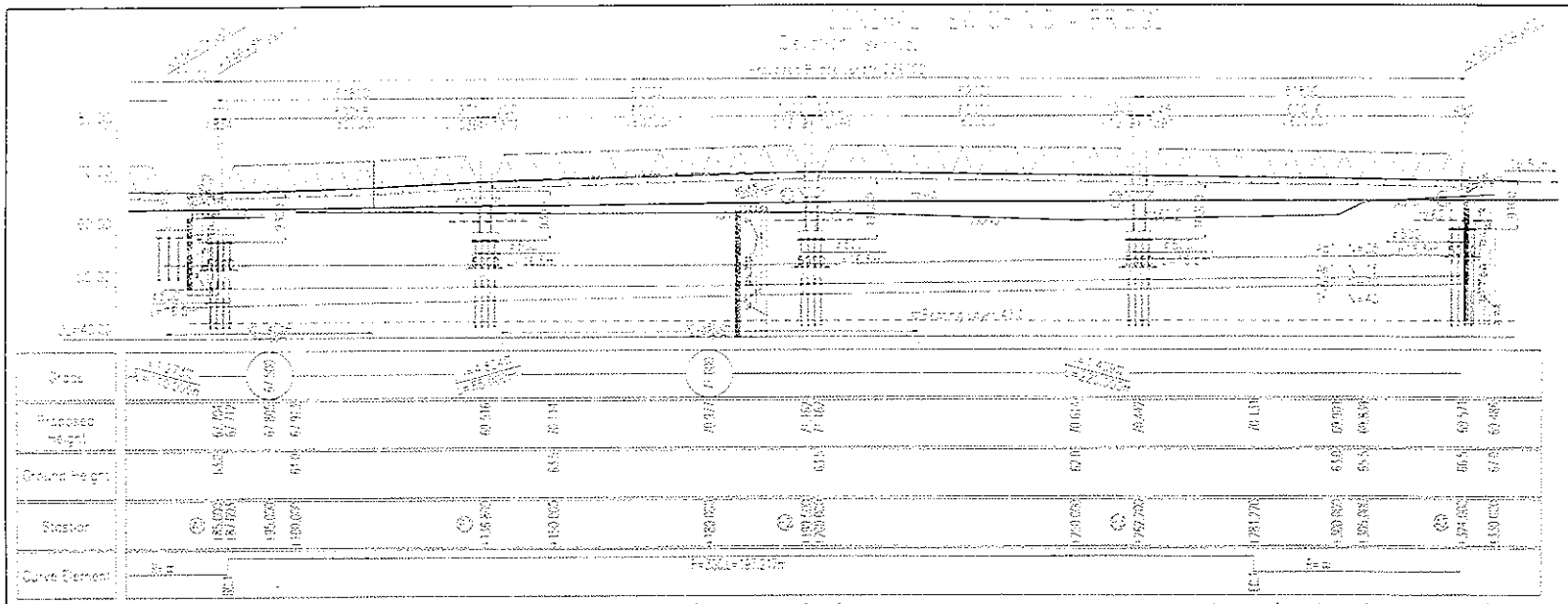
GUARD RAILS
SCALE AS SHOWN

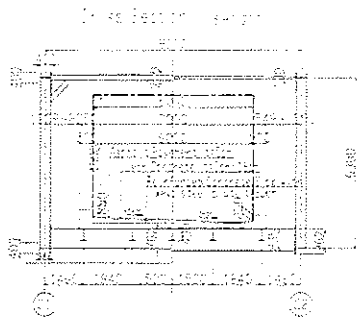
THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE MINISTRY OF TRANSPORT, COMMUNICATION AND PUBLIC WORKS (MTCPW)	JICA JAPAN INTERNATIONAL COOPERATION AGENCY PACIFIC CONSULTANTS INTERNATIONAL NIPPON KOEI CO.,LTD.	THE PROJECT FOR THE IMPROVEMENT OF ROADS AND BRIDGES IN THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE DRAWING TITLE GUARD RAIL & POST, AND ROAD EDGE GUIDE POST	SCALE: AS SHOWN DRAWING No. 000 SHEET No.

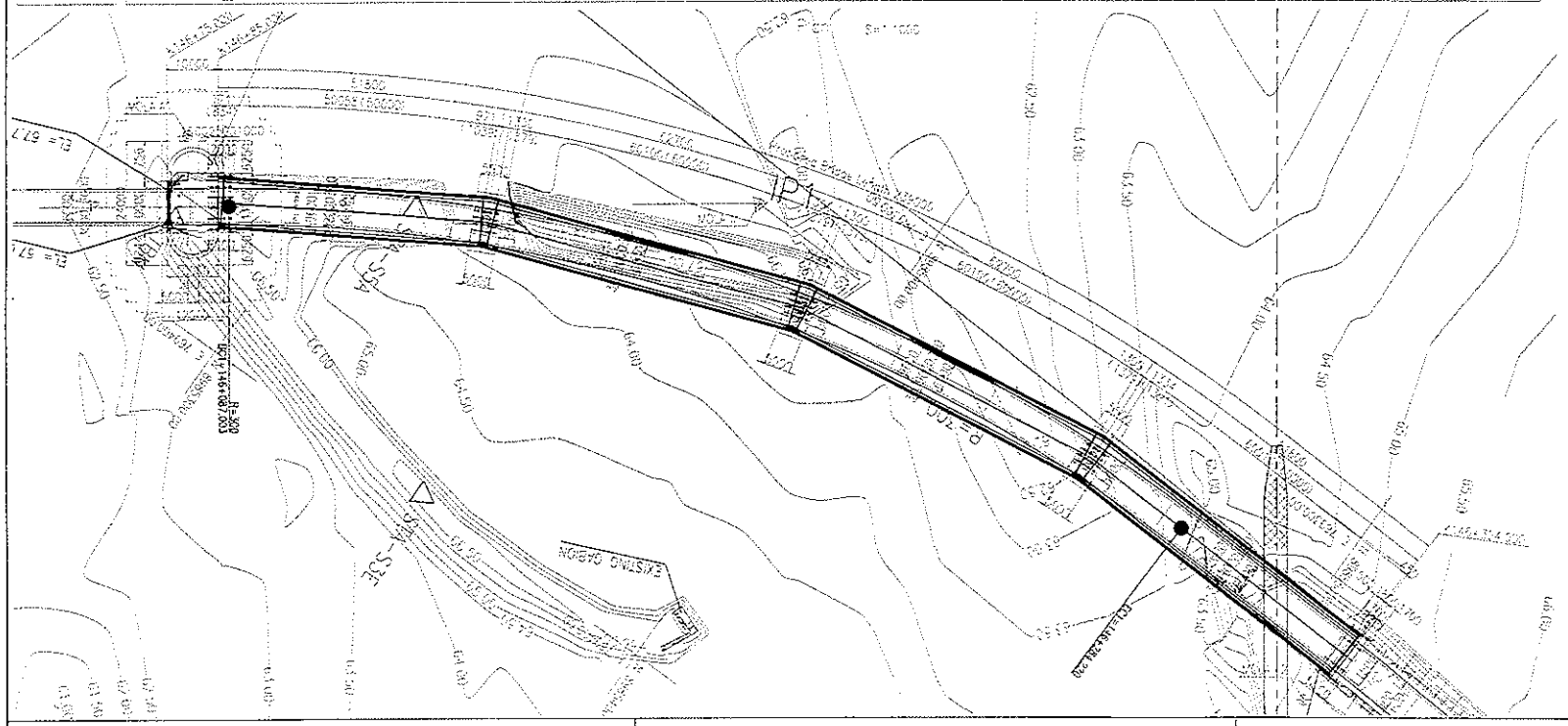
C:\VOLUME 1\BIBILI-SUAI ROAD (2003)\DESIGN DRAWINGS\GENERAL\004-GUARD RAILS AND POST AND ROAD EDGE OF GUARD POST.DWG OCT 13, 2003 11:45 AM



THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE MINISTRY OF TRANSPORT, COMMUNICATION AND PUBLIC WORKS (MTCPW)	JAPAN INTERNATIONAL COOPERATION AGENCY PACIFIC CONSULTANTS INTERNATIONAL NIPPON KOEI CO.,LTD.	THE PROJECT FOR THE IMPROVEMENT OF ROADS AND BRIDGES IN THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE DRAWING TITLE TITLE TITLE1 TITLE2	SCALE: SCALE DRAWING No.: DWG_NO SHEET No.: Sheet SHT of SHTS







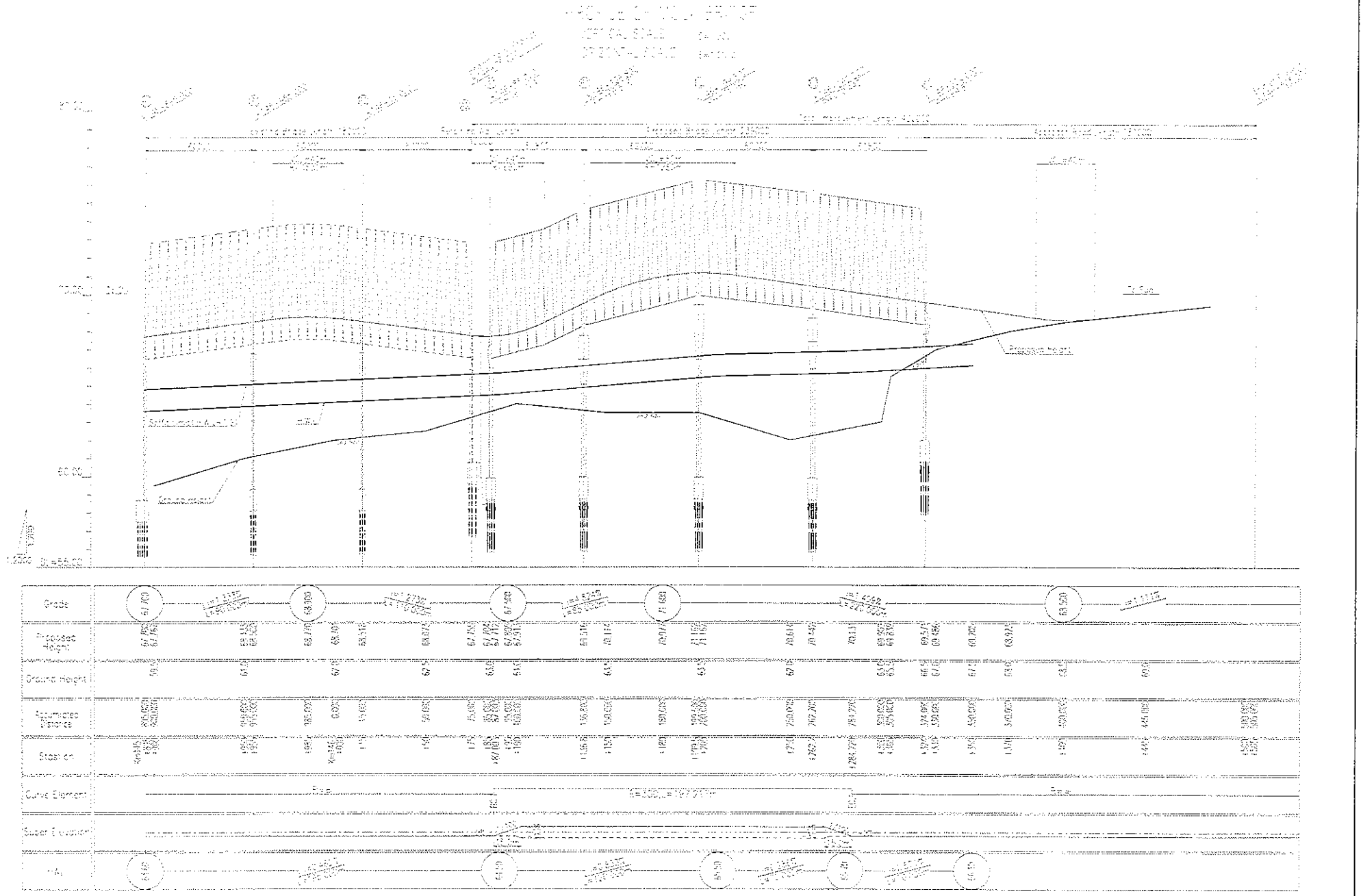
Design Criteria

Type of Bridge	Simple Slab Truss
Total Bridge Length	L = 535.000 m
Span Arrangement	40.000 m + 5 @ 80.000 m
Width	Carriage Way Width = 6.000 m
Live Load	AASHTO HS-20-44
Design Standard	AASHTO
Design Speed	40 km/h
Superstructure	Reinforced Concrete
Substructure	Reinforced Concrete
Foundation	Spread Foundation
Seismic Coefficient	Kh = 0.15

Materials

Concrete	f'c = 30 N/mm²
Steel	SD345
Reinforcement	SD295

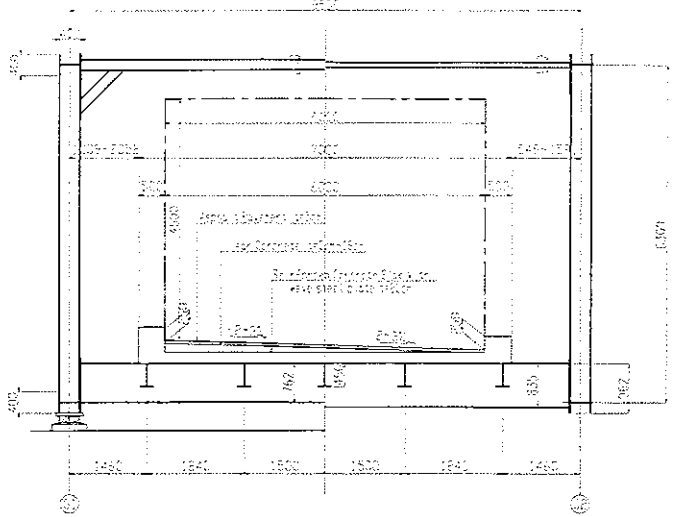
THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE	JAPAN INTERNATIONAL COOPERATION AGENCY	THE PROJECT FOR THE IMPROVEMENT OF ROADS AND BRIDGES IN THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE	SCALE: SCALE
MINISTRY OF TRANSPORT, COMMUNICATION AND PUBLIC WORKS (MTCPW)	PACIFIC CONSULTANTS INTERNATIONAL NIPPON KOEI CO.,LTD.	DRAWING TITLE: TITLE TITLE1 TITLE2	DRAWING No: DWG_NO SHEET No: Sheet SHT of SHTS



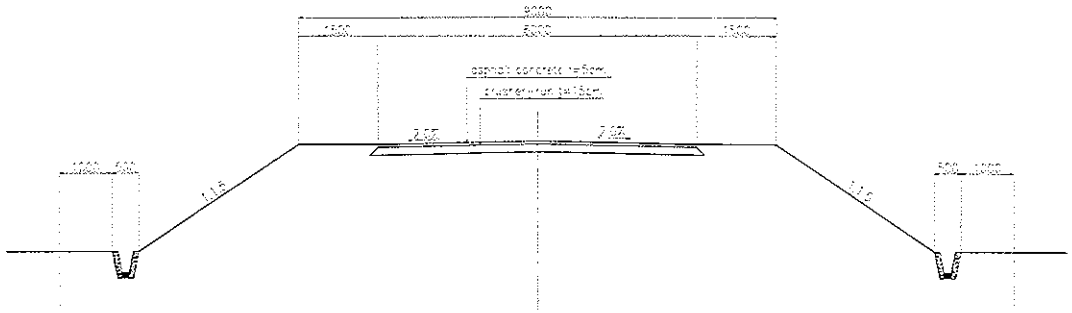
THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE MINISTRY OF TRANSPORT, COMMUNICATION AND PUBLIC WORKS (MTCPW)	JAPAN INTERNATIONAL COOPERATION AGENCY PACIFIC CONSULTANTS INTERNATIONAL NIPPON KOEI CO.,LTD.	THE PROJECT FOR THE IMPROVEMENT OF ROADS AND BRIDGES IN THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE DRAWING TITLE TITLE TITLE1 TITLE2	SCALE SCALE DRAWING No. DWG_NO SHEET No. Sheet SHT of SHTS

TYPICAL CROSS SECTION OF ROADS

Bridge section



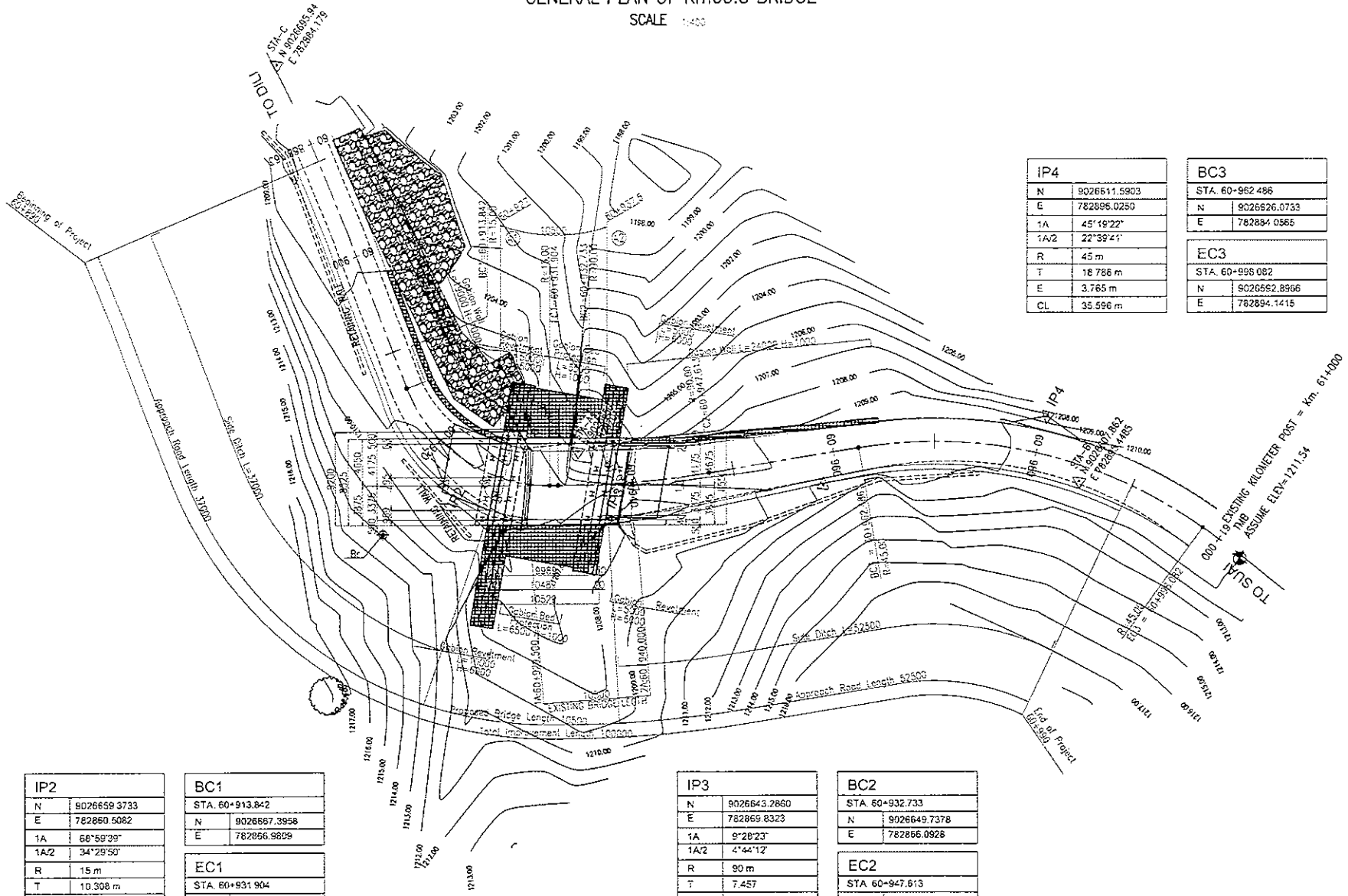
Road Section



THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE MINISTRY OF TRANSPORT, COMMUNICATION AND PUBLIC WORKS (MTCPW)	JAPAN INTERNATIONAL COOPERATION AGENCY PACIFIC CONSULTANTS INTERNATIONAL NIPPON KOEI CO.,LTD.	THE PROJECT FOR THE IMPROVEMENT OF ROADS AND BRIDGES IN THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE DRAWING TITLE: TYPICAL CROSS SECTION OF ROADS	SCALE: 1:100 DRAWING No: 004 SHEET No: Sheet 4 of 8

GENERAL PLAN OF Km60.3 BRIDGE

SCALE 1:400



IP4	
N	9026611.5903
E	782896.0250
1A	45°19'22"
1A/2	22°39'41"
R	45 m
T	18.786 m
E	3.765 m
CL	35.596 m

BC3	
STA. 60+962.486	
N	9026626.0733
E	782884.0565

EC3	
STA. 60+998.082	
N	9026582.8966
E	782894.1415

IP2	
N	9026659.3733
E	782860.5062
1A	66°59'39"
1A/2	34°29'50"
R	15 m
T	10.308 m
E	3.200 m
CL	18.062 m

BC1	
STA. 60+913.842	
N	9026667.3958
E	782866.9809

EC1	
STA. 60+931.904	
N	9026650.4549
E	782865.6772

IP3	
N	9026643.2860
E	782869.8323
1A	9°26'23"
1A/2	4°44'12"
R	90 m
T	7.457
E	0.308 m
CL	14.880 m

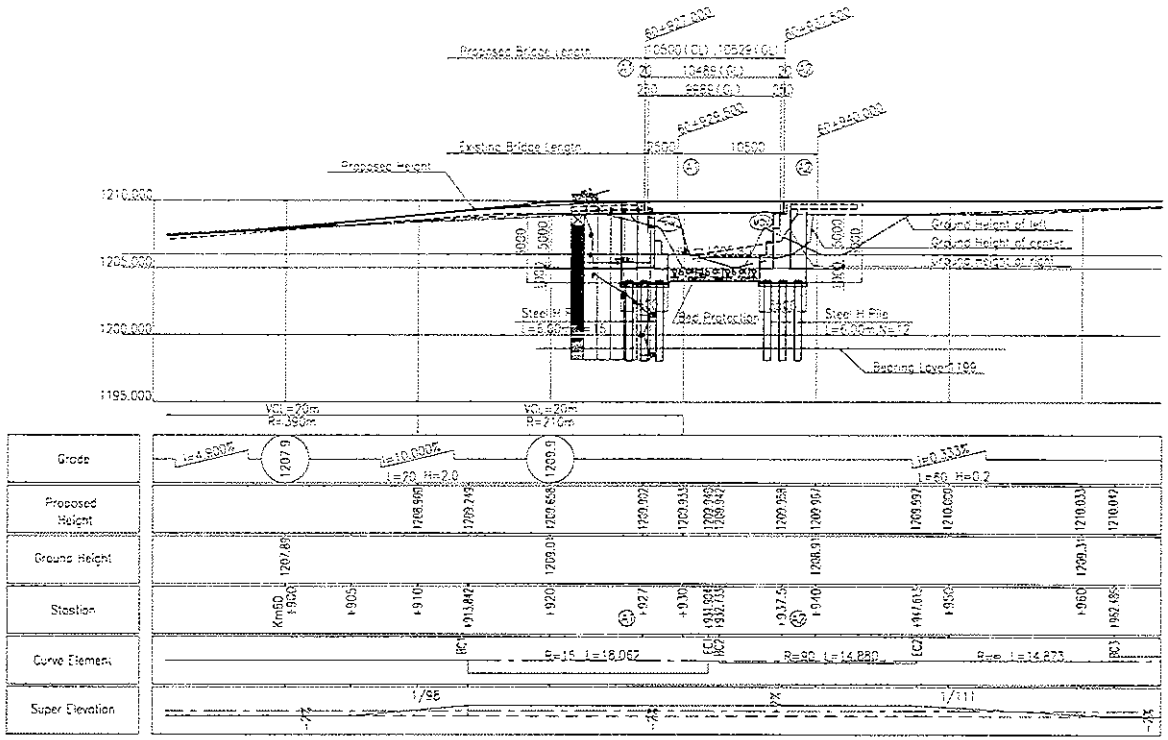
BC2	
STA. 60+932.733	
N	9026649.7378
E	782866.0928

EC2	
STA. 60+947.613	
N	9026637.5376
E	782874.5626

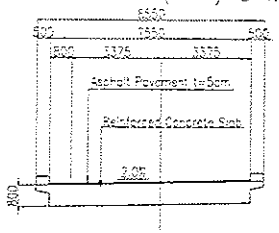
THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE MINISTRY OF TRANSPORT, COMMUNICATION AND PUBLIC WORKS (MTCPW)	JAPAN INTERNATIONAL COOPERATION AGENCY PACIFIC CONSULTANTS INTERNATIONAL NIPPON KOEI CO.,LTD.	THE PROJECT FOR THE IMPROVEMENT OF ROADS AND BRIDGES IN THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE DRAWING TITLE: GENERAL PLAN OF Km60.3 BRIDGE	SCALE: 1:400 DRAWING No: 006 SHEET No: Sheet 6 of 8

GENERAL VIEW OF Km60.3 BRIDGE

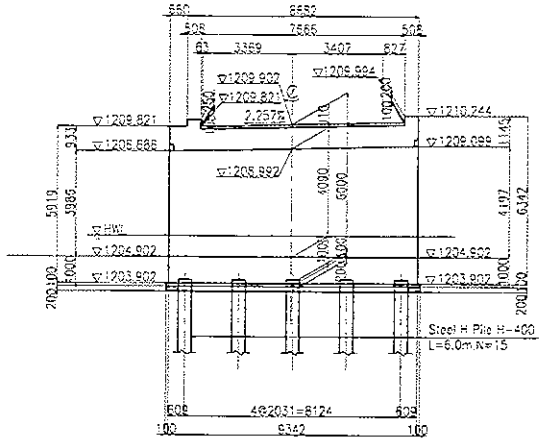
Elevation S=1:400



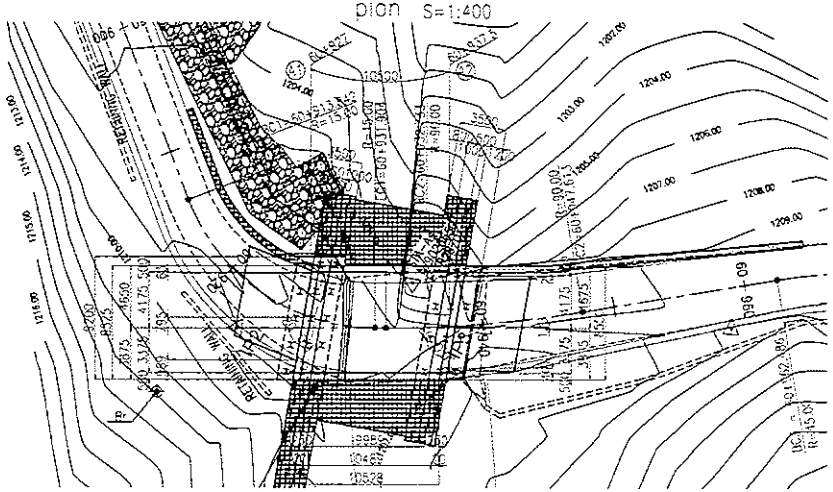
Cross Section(EC1) S=1:200



View of Abutment (A1) S=1:200



pion S=1:400



Design Criteria

Type of Bridge	Reinforced Concrete Slab
Total Bridge Length	L = 10.500 m
Girder Length	L = 10.489 m
Span	L = 9.969 m
Width	Carriage Way Width = 6.750 m
Live Load	AASHTO HS20-44X125%
Impact Coefficient	i=20/(50+L)
Seismic Coefficient	Kh=0.18
Angle of Skew	80° 00' 00"
Radius of Curvature	R=15.0m ~ R=∞ ~ R=90.0m
Longitudinal Slope	i=4.500% i=10.000% i=0.333%

Materials

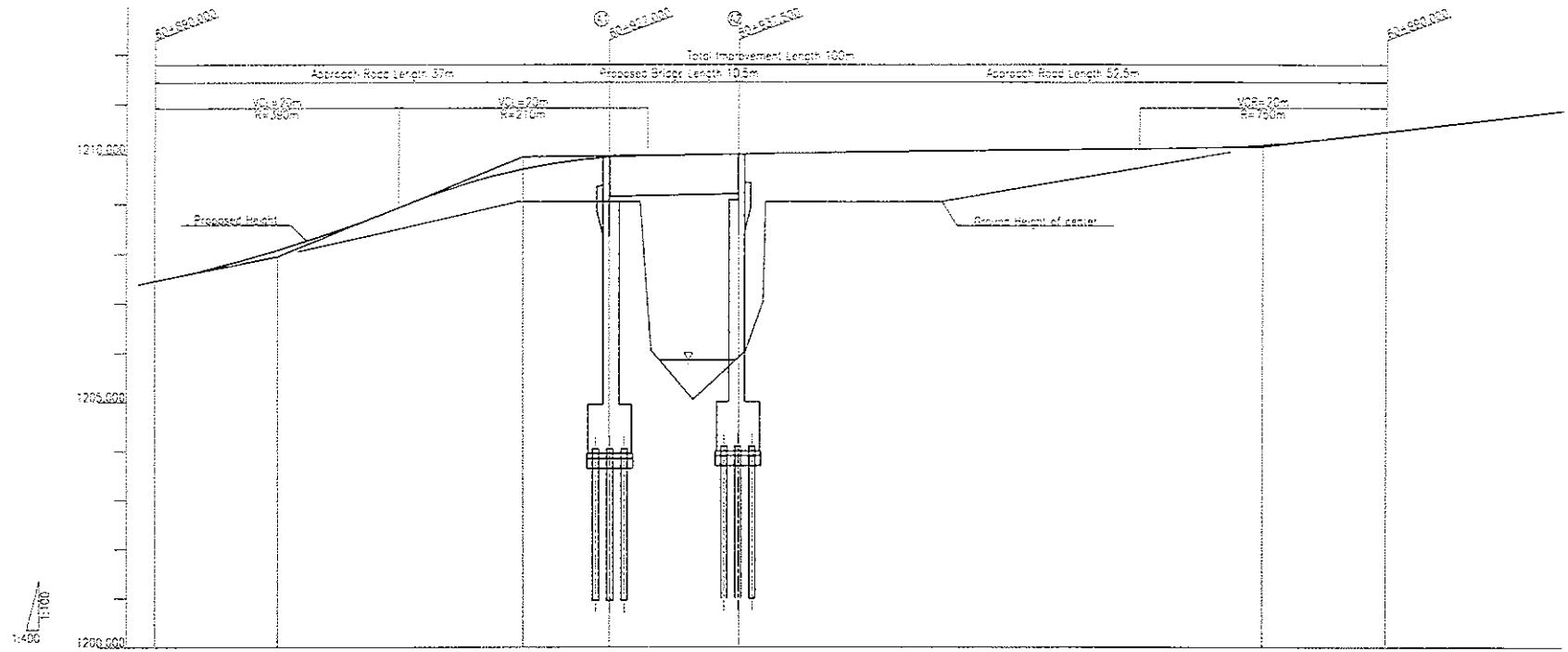
Concrete	Slab	σck=24N/mm²
	Substructure	σck=24N/mm²
Steel	Pile	SHK400
	Reinforcement	SD295

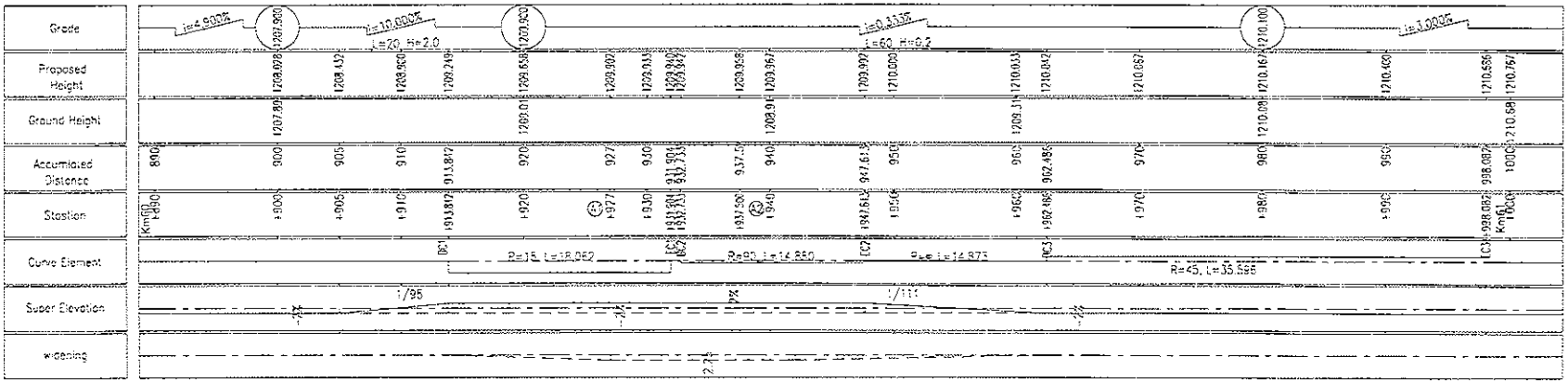
THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE MINISTRY OF TRANSPORT, COMMUNICATION AND PUBLIC WORKS (MTCPW)	JAPAN INTERNATIONAL COOPERATION AGENCY PACIFIC CONSULTANTS INTERNATIONAL NIPPON KOEI CO.,LTD.	THE PROJECT FOR THE IMPROVEMENT OF ROADS AND BRIDGES IN THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE DRAWING TITLE: GENERAL VIEW OF Km60.3 BRIDGE 60+927.000 to 60+942.000	SCALE: AS SHOWN DRAWING No.: 005 SHEET No.: Sheet 5 of 8

PROFILE OF Km60.3 BRIDGE

VERTICAL SCALE 1:100

HORIZONTAL SCALE 1:400



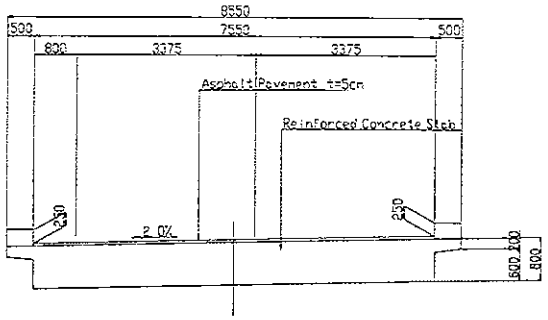


THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE MINISTRY OF TRANSPORT, COMMUNICATION AND PUBLIC WORKS (MTCPW)	JAPAN INTERNATIONAL COOPERATION AGENCY PACIFIC CONSULTANTS INTERNATIONAL NIPPON KOEI CO.,LTD.	THE PROJECT FOR THE IMPROVEMENT OF ROADS AND BRIDGES IN THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE DRAWING TITLE: PROFILE OF Km60.3 BRIDGE	SCALE V=1:100,H=1:400 DRAWING No. 007 SHEET No. Sheet 7 of 8

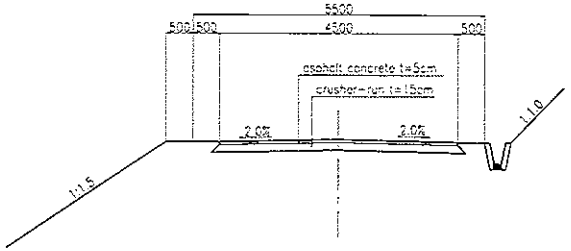
TYPICAL CROSS SECTION OF ROADS

SCALE 1:100

Bridge section



Road Section



THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE MINISTRY OF TRANSPORT, COMMUNICATION AND PUBLIC WORKS (MTCPW)	JAPAN INTERNATIONAL COOPERATION AGENCY PACIFIC CONSULTANTS INTERNATIONAL NIPPON KOEI CO.,LTD.	THE PROJECT FOR THE IMPROVEMENT OF ROADS AND BRIDGES IN THE DEMOCRATIC REPUBLIC OF TIMOR-LESTE DRAWING TITLE TYPICAL CROSS SECTION OF ROADS	SCALE 1:100 DRAWING No 008 SHEET No Sheet 8 of 8