PART-II PRE FEASIBILITY STUDY

Chapter 10

Preparatory Engineering for Pre-Feasibility Route

Chapter 10 PREPARATORY ENGINEERING FOR PRE-FEASIBILITY ROUTE

10.1 Design Standards

The geometric design standards basically employs the "Standard Specification for Geometric Design of Road"(December 1990) of Bina Marga together with AASHTO and Japanese design standards. The Bina Marga standards are in the same group with AASHTO, and Japanese design standards.

10.1.1 Design Policy

The applicable criteria and elements of design of the roads have been decided based on the Bina Marga, AASHTO and Japanese design standards.

(1) Road Function and Design Speed

Standard road development should follow the function of the road. Roads are classified into four categories. The geometric standard in road development needs to meet the functional requirement. The governmental regulation for roads (No.26, 1986) mentions minimum design speeds and minimum roadbed width according to road function. When applying design criteria and control to road development, it should be taken into account that terrain conditions have considerable influence on construction cost. Where topography becomes steeper, some reduction of geometric standard level should be acceptable. Table 10-1-1 shows the design speed of road to be used in the pre-feasibility study according to road function.

Table 10-1-1 Design Speed According to Road Function

Traffic volume (pcu/day)	3000 to 20000		Less than 3000	
Terrain	Flat and rolling	Mountainous	Flat and rolling	Mountainous
Pavement width (m)	6.0	6.0	4.5	4.5
Design Speed (Km/h)				
Arterial Road	60	40	50	30
Collector 1	50	30	50	30(20)
Collector 2	50	30 (20)	40	30(20)
Collector 3	50	30 (20)	40	20

Note: ( ): special case

Source: Bina Marga

(2) Road Traffic

Study results of traffic forecast for Pre-feasibility routes are as shown in Table 10-1-2. These figures will be reflected in pavement design and road width.

Table 10-1-2 Future Traffic Volumes of Pre-F/S Routes

Link No. / Vehicle Type	Link 4 (veh/day)		Link 5 (veh/day)		Link 8 (veh/day)	
	2003	2018	2003	2018	2003	2018
Motorcycles	106	37	8	33	934	2664
Passenger Cars	5	17	7	22	318	1115
Buses	14	10	6	19	454	1593
Trucks	14	15	3	10	768	2788
Total	139	79	24	84	2474	8160
Link No. / Vehicle Type	**Link 15 (veh/day)**		**Link 16 (veh/day)**		**Link 22 (veh/day)**	
	2003	2018	2003	2018	2003	2018
Motorcycles	261	577	352	502	335	441
Passenger Cars	126	352	190	285	162	224
Buses	242	480	349	385	333	347
Trucks	396	862	602	816	569	750
Total	1025	2271	1493	1988	1399	1762
Link No. / Vehicle Type	**Link 31 (veh/day)**		**Link 32 (veh/day)**		**Link 33 (veh/day)**	
	2003	2018	2003	2018	2003	2018
Motorcycles	70	313	400	543	335	450
Passenger Cars	10	83	176	239	162	230
Buses	110	280	415	417	333	352
Trucks	142	464	601	775	569	769
Total	332	1140	1592	1974	1399	1801

Source: Study Team

10.1.2 Geometric Design Standard

Based on the above study, geometric design standards have been established as shown in Table 10-1-3.

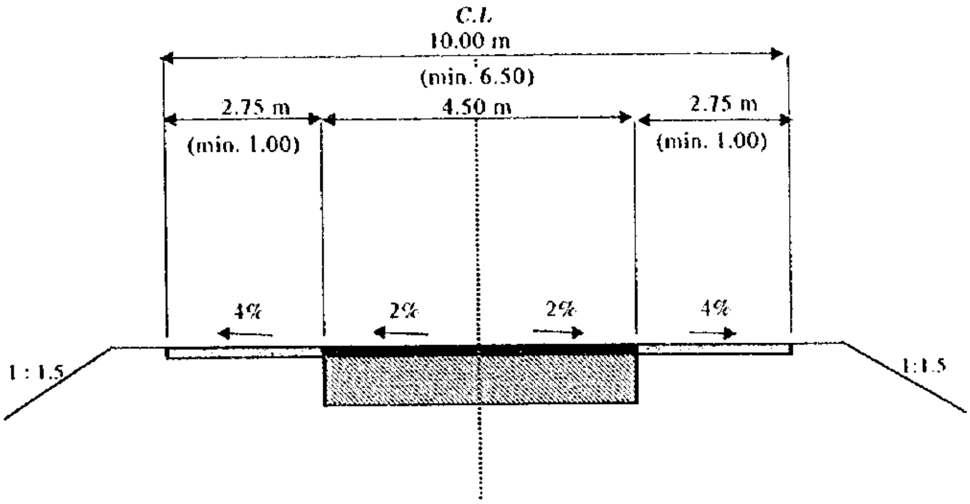
Table 10-1-3 Geometric Design Standard (Two Lanes)

Terrain		Flat, Rolling	Mountain	Mountain
Design Speed	Km/h	60	40	30
Lane Width	M	3.00 x 2	3.00 x 2	3.00 x 2
Shoulder Width	M	2.0~1.0	2.0~1.0	2.0~1.0
Crossfall of Pavement	%	2	2	2
Crossfall of Shoulder	%	4	4	4
Min. Radius Curve	M	115	50	30
Min. Curve Length	M	100	70	50
Max. Gradient	%	5	7	8
Abs. Max. Gradient	%	9	11	12

Source: Study Team

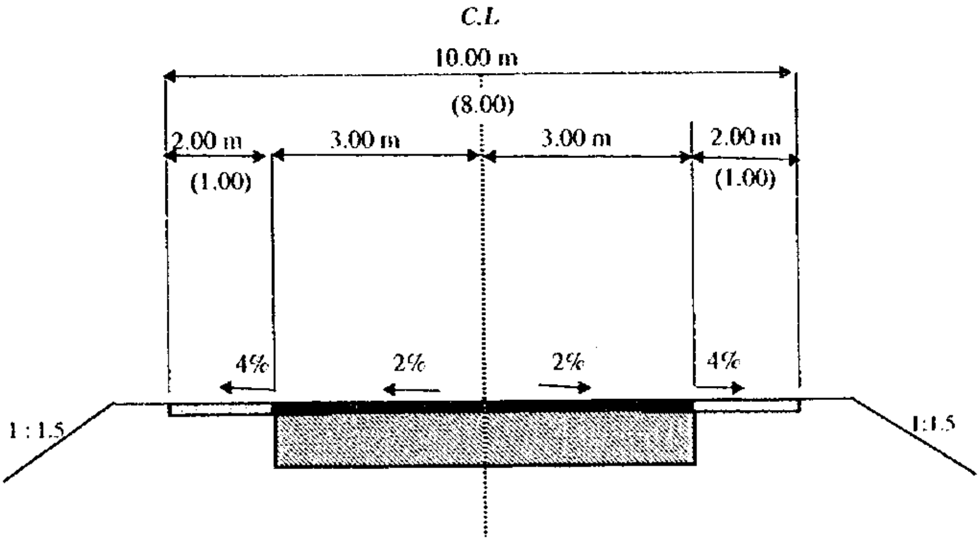
10.1.3 Typical Cross Section

In general, total width of more than 6.50 m with a pavement width of 4.5 m and min. shoulder width of 1.00 m has a capacity of 3000 PCU/day or less (Type 1). In case of future daily traffic volume of 3000 to 20000 PCU, total width of 10.0 m (Type 2) with a carriageway of 3.0 m x 2 and shoulder of 2.0 m x 2 is needed, considering improvements of the traffic functions and principle wide enough for two-way traffic. For the pavement width, the two types shown below are planned on the basis of the above standards to cope with a future daily traffic volume of 3000 PCU. Typical cross sections for standard type are shown in Figure 10-1-1 and 10-1-2.



Source: Study Team

Figure 10-1-1 Typical Cross Section of Type 1
(Future daily traffic volume of 3000 PCU or less)



Source: Study Team

Figure 10-1-2 Typical Cross Section of Type 2
(Future daily traffic volume of 3000 PCU or over)

10.1.4 Pavement Design Standard

Pavement design should consider the following conditions:

- There are two types of design: that of flexible pavement and rigid (concrete) pavement;
- Two categories of road construction are involved in the project: widening or overlay of existing pavement and new construction road;
- In the section of pavement type, investment efficiency sometimes should be considered in addition to the construction cost; and
- Construction aspects and local conditions sometimes govern the selection of pavement type when the reconstruction/adjustment of related roads is necessary.

(1) Method of Design

AASHTO Guide for Design of Pavement Structure by AASHTO and Japanese pavement design standard by the Japan Road Association were used for the design.

(2) Design CBR

Design CBR of 5% to 6 % was used based on the results of the CBR Test conducted by the study team.

(3) Design Life Period

The design life period is to be 20 years.

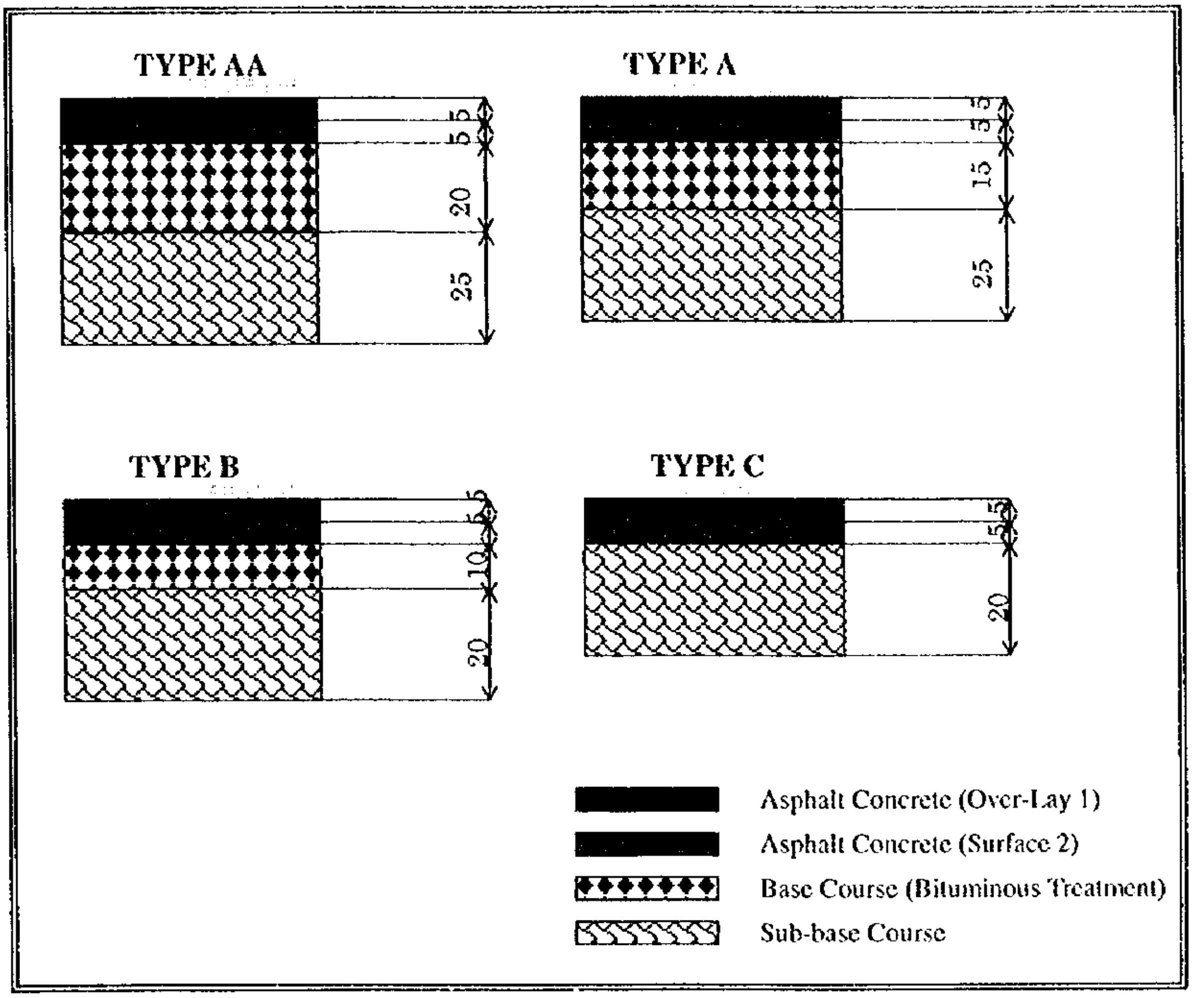
(4) Design Traffic Volume for the Pavement

Design traffic volume for the pavement design is to be for a period of 20 years.
For the pavement structure, the four types shown in Table 10-1-4 are planned on the basis of the traffic volumes of heavy vehicles (buses and trucks) in the year 2018. The pavement surface is planned to be in two layers by considering the overlay to be provided in the future while using an asphalt surface course for the surface. Namely, the base course is treated with asphalt while the subbase is made from mechanical stabilized crushed stone.

Table 10-1-4 Pavement Types for Traffic Volume of Heavy Vehicles

Pavement Type	Heavy Vehicles Traffic (Vehicles/Day)
AA	More than 3000
A	1000 – 3000
B	250 – 1000
C	Less than 250

Source: Bina Marga



Source: Study Team

Figure 10-1-3 Pavement Structure by Type

10.1.5 Bridge Design Standards

(1) General

The design work of the proposed bridge structures was carried out in accordance with the "Bridge Design Code (Directorate General of Highways, Indonesia)" (hereinafter referred to as "Indonesian Bridge Design Code") as the prime design standards. Although the principal design concept is in accordance with the Indonesian Design Code, a bridge specification established by the American Association of State Highway and Transportation Officials (hereinafter referred to as "AASHTO") and a specification issued by the Japan Road Association as listed in (2) below was applied as the need arises.

The structural calculation method for the bridge design follows the "Allowable Stress Design (working stress design) Method" in accordance with the Indonesian Bridge Design Code. However, prestressed concrete structures were designed to ensure their safety in the ultimate loading conditions prescribed in the code.

(2) Bridge Design Standard

1) Authorized Design Standards to Be Applied

The following standards were applied for this study.

【The Republic of Indonesia】

- Bridge Design Code
  - Volume I (December, 1992)
  - Volume II (December, 1992)
- Standard Design of Bridge Superstructure (1993)
  (Reinforced concrete girder, prestressed concrete girder, composite girder)
- Standard Design of Box Culvert (1993)

【U.S.A】

[American Association of State Highway and Transportation Officials]

- Standard Specifications for Highway Bridges (Fifteenth Edition, 1992)

[American Concrete Institute] (hereinafter referred to as "ACI")

- Building Code Requirements for Reinforced Concrete (ACI 318-83)

【Japan】

[Japan Road Association]

- Specifications for Highway Bridges (February, 1996)
  - Part Ⅰ, Part Ⅱ, Part Ⅲ, Part Ⅳ, Part Ⅴ

[Japan Highway Public Corporation]

- Design Standard for Highway and Bridges (February, 1994)
  - Part Ⅰ, Ⅱ, Ⅲ, Ⅳ, Ⅴ

2) Design Manuals

【The Republic of Indonesia】
[Directorate General of Highways]
• Bridge Design Manual

【Japan】
[Japan Road Association]
• Design Guideline for Concrete Highway Bridges (February, 1994)
• Construction Guideline for Concrete Highway Bridges (February, 1994)

(3) Loading Specifications

1) Bridge Loading Classification

Bridge design loadings to be applied are listed in Table 10-1-5 in accordance with the Indonesian Bridge Design Code. Design loadings in the code are grouped according to their origin into three groups and also classified by duration into two categories. In addition, an overstress is permitted in the basic working stress for some load combinations since these combinations have a low probability of occurrence and a short duration. These load combinations for working stress design are listed in Table 10-1-6 and the permitted overstresses is also given in Table 10-1-6 as a percentage of the allowable working stress.

Detailed application is referred to the Indonesian Bridge Design Code.

2) Application of Traffic Loads

Present traffic loads for design of road bridges consist of the "D" lane loading and the "T" truck loading. The "D" lane loading is applied across the full width of the bridge roadway and produces effects in the bridge equivalent to a queue of real vehicles. The total amount of "D" lane loading applied depends upon the width of the bridge roadway.

The "T" truck loading is a single heavy vehicle with three axles which is applied in any position in a design truck lane. Each axle comprises of two patch loadings which are intended to simulate the effects of the wheels of heavy vehicles. Only one "T" truck may be applied per design traffic lane.

Design Traffic Lanes

Design traffic lanes are to be 2.75m wide. The maximum number of design traffic lanes to be used for various bridge widths is shown in Table 10-1-7.

Table 10-1-5 Summary of Design Actions

Design load		Duration	Group
Name	Symbol		
Self Weight	PMS	Permanent	Permanent action
Superimposed dead load	PMA	Permanent	Permanent action
Shrinkage & creep	PSR	Permanent	Permanent action
Prestress	PPR	Permanent	Permanent action
Earth pressure	PTA	Permanent	Permanent action
Permanent construction	PPL	Permanent	Permanent action
'D' lane load	TTD	Transient	Traffic load
'T' truck load	TTT	Transient	Traffic load
Breaking force	TTB	Transient	Traffic load
Centrifugal force	TTR	Transient	Traffic load
Pedestrian load	TTP	Transient	Traffic load
Collision load	TTC	Transient	Traffic load
Settlement	PES	Permanent	Environmental action
Temperature	TET	Transient	Environmental action
Stream/Debris	TEF	Transient	Environmental action
Hydro/Buoyancy	TEU	Transient	Environmental action
Wind	TEW	Transient	Environmental action
Earthquake	TEQ	Transient	Environmental action
Bearing friction	TBF	Transient	Other action
Vibration	TVI	Transient	Other action
Construction	TCL	Transient	Other action

Source: Study Team

Table 10-1-6 Load Combinations for Working Stress Design

Load combination	Combination No.						
	1	2	3	4	5	6	7
Permanent actions	○	○	○	○	○	○	○
Traffic loads	○	○	○	○			
Temperature effects		○					
Stream/Debris/Hydro/Buoyancy	○	○	○	○	○		
Wind load			○	○			
Earthquake effects					○		
Collision loads							○
Construction loads						○	
Permitted overstress	0%	25%	25%	40%	50%	30%	50%

Source: Study Team

Table 10-1-7 Number of Design Traffic Lanes

Bridge type	Bridge roadway width (m)	No. of design traffic lanes
Single lane	4.00 – 5.00	1
Two-way, no median	5.50 – 8.25	2
	11.30 – 15.00	4
Multiple-roadway	8.25 – 11.25	3
	11.30 – 15.00	4
	15.10 – 18.75	5
	18.80 – 22.50	6

Source: Study Team

"D" Lane Loading

The "D" lane loading consists of a uniformly distributed load (UDL) combined with a knife-edge load (KEL) as shown in Figure 10-1-3.

Uniformly distributed Load: the UDL has an intensity q kPa, where the value of q depends on the total length L as follows:

$$L \leq 30\,m: \quad q = 8.0\,kPa$$

$$L > 30\,m: \quad q = 8.0\left(0.5 + \frac{15}{L}\right)kPa$$

Knife-edge load: a single KEL of p kN/m is placed in any position along the bridge. The KEL is applied perpendicular to the direction of traffic on the bridge. The value of p is 44.0 kN/m.

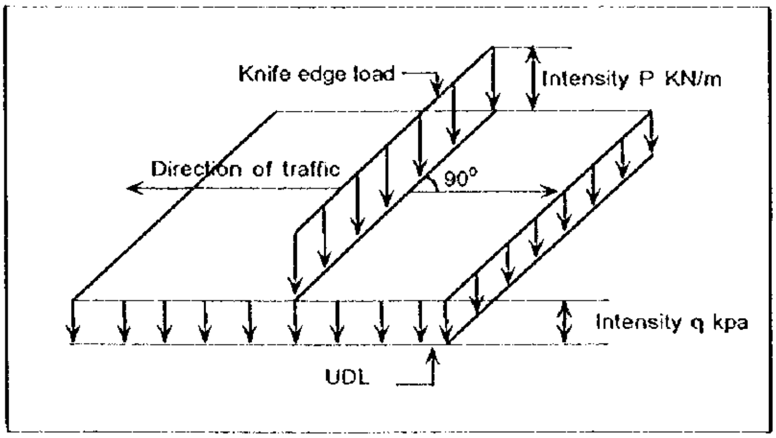
The "D" lane loading is arranged laterally in such a way as to produce the maximum effect. The lateral arrangements of UDL and KEL components of the "D" lane loading are to be the same. The concept of lateral distribution of "D" lane loading is shown in Figure 10-1-4.

"T" Truck Loading

The "T" truck loading consists of a tractor truck and semitrailer with axle weights and configuration as shown in Figure 10-1-5. The weight from each axle is to be distributed equally between two uniformly loaded patches which represent the constant areas of the wheels. The spacing between the two heavy axles may vary from 4.0 m to 9.0 m in order to produce the maximum longitudinal effect.

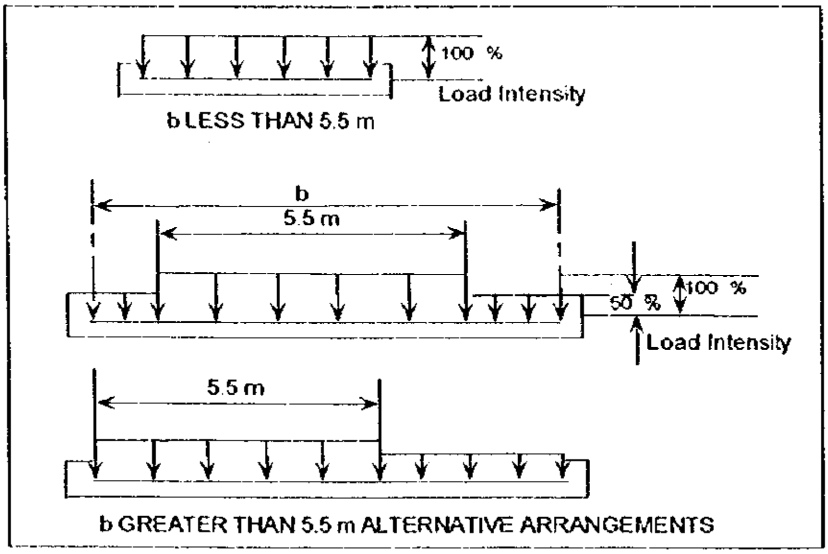
(4) Seismic Design

Although a full dynamic analysis is required for large, complex and important bridges, equivalent static analysis is appropriate for proposed bridges in this study area.
Detailed description of seismic design can be referred to in the Indonesian Bridge Design Code.



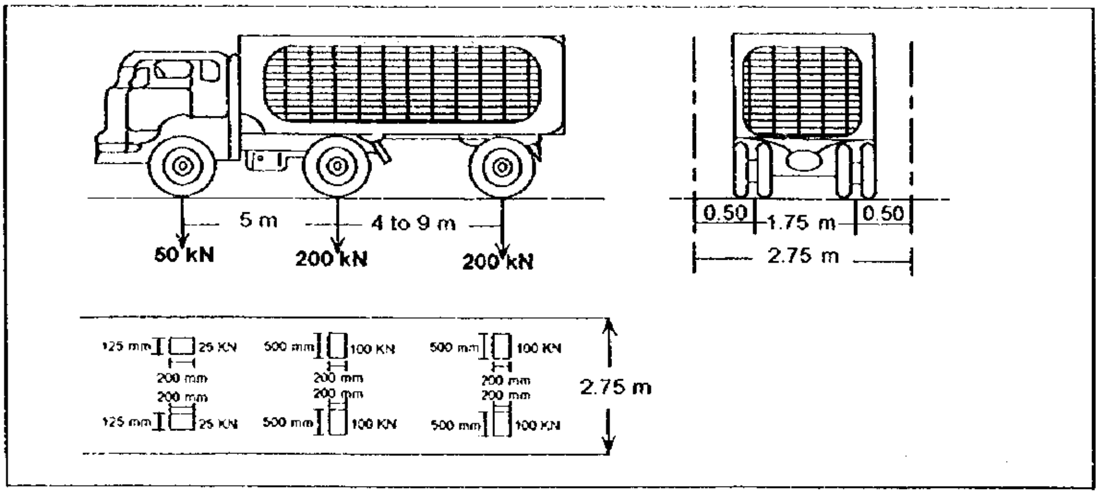
Source: Study Team

Figure 10-1-4 "D" Lane Loading



Source: Study Team

Figure 10-1-5 Lateral Distribution of "D" Lane Loading



Source: Study Team

Figure 10-1-6 "T" Truck Loading

10.1.6 Tunnel Design Standard

(1) General

Use of tunnel is one of the most effective means of the preventing slope failure and land-slides, protecting existing environmental conditions, and securing proper road alignment within the mountain range. However, there are some disadvantages to be considered such as those indicated below:

- Construction cost is higher than that of roads and bridges
- Maintenance cost for ventilation system is needed
- Psychological problem due to closed space
- Potential of secondary disaster following traffic accidents

At present, there is no design standard for road tunnels in Indonesia. For this study, there is a need to establish tunnel design standards for a dual-lane traffic tunnel. "SPECIFIKASI STANDAR UNTUK PERENCAN GEOMETRIC JALAN LUAR KOTA" and "BRIDGE DESIGN CODE" published by Bina Marga, and "Design Standard for Road Tunnel" and "Standard Specification for Tunnel" published by the Japan Road Association were employed for the establishment of tunnel standard for the study.

(2) Interior Section and Construction Limit of Tunnel

The shape and dimensions of a tunnel should be determined based on the facilities required for the tunnel's interior and its stability.
Construction limit for tunnel is not mentioned in the "Specifikasi Standar Untuk Perencan Geometric Jalan Luar Kota", but, concerning roads, it is mentioned that the roadway should be at least 5.0 m in width. Also, concerning vertical clearance at Bridge Design Code mentions that parts of the superstructure or substructure of bridge crossing over a road or a railway should be at least 100 mm greater than the operation vertical clearance to allow for settlement and road resurfacing. Considering the above two items, a construction limit of 5.0 m for tunnels is applicable.
Shoulder width is selected to be 0.75 m, considering the Classes 3 to 4 of Bina Marga standards.
Shoulder height of tunnel is decided based on "A POLICY OF GEOMETRIC DESIGN OF HIGHWAY AND STREETS 1994". In this material, a trailer height of 4.1 m plus 0.1 m freeway is the minimum construction limit for shoulder space. Therefore 4.2 m is applicable for shoulder height.

Also, a maintenance gallery with a width of 0.75 m should be provided on both sides of the traffic lanes.

Lighting and ventilation facility can be provided between construction limit and interior area of tunnel.

(3) Horizontal Alignment

Alignment standards should follow road alignment standard as the tunnel is a part of the road.
Since traffic accidents are prone to occur at the entrance of the tunnel, an application of higher standards for the tunnel entrances is desirable.
Curves with small radii are not applicable for this tunnel, as wider section needs to be designed in order to accommodate minimum sight distance, thereby increasing construction cost. Necessary considerations for design of tunnel are as mentioned below:

- Tunnel should be planned to be straight since drivers in Indonesia are unaccustomed to tunnels.
- Relation between design speed and minimum radius are shown below:

Design Speed	40 km/h	R=800 m
Design Speed	30 km/h	R=500 m
Design Speed	20 km/h	R=300 m

(4) Vertical Alignment

Tunnel gradient should be minimized for the following reasons:

- In consideration of the use of rail hauling in excavation, a tunnel gradient of less than 2 % is preferable.
- As exhaust density rises in proportion to tunnel gradient, it should be less than 3 %.
- A steep grade causes excessive driving speed as well as dangerous passing maneuvers.

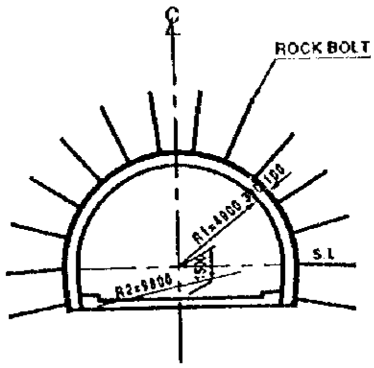
In consideration of the above, the following standards were established;

- 4 % gradient is applicable (the maximum grade that a truck can drive at half of design speed)
- Minimum gradient of tunnel is 0.3 % for drainage purposes.

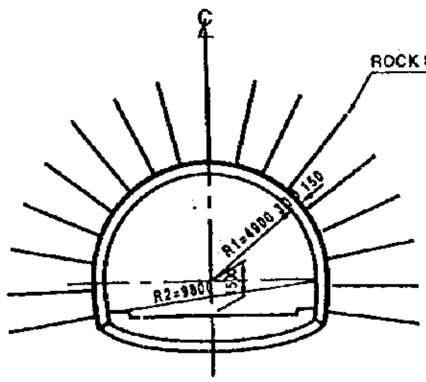
(5) Tunnel Cross Section

Tunnel cross-section should be decided based on soil conditions, excavation method, width of traffic lane and type of tunnel support. Tunnel support are a vital part of tunnel structure, protecting the overall tunnel structure from failure of rock mass and earth pressure which constantly bears upon it. These tunnel supports function to stabilize the excavated section.
A tunnel cross section was decided as shown Figure 10-1-7.

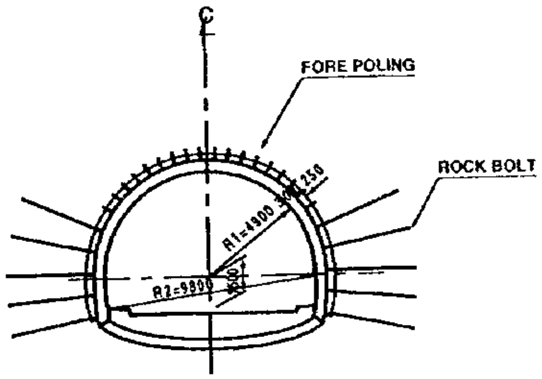
C II



D I



D III



Source: Study Team

Figure 10-1-7 Tunnel Cross Section by Rock Classification

10.1.7 Design Concept of Disaster Prevention Work

(1) Type of Slope Protection

The main purpose of the slope protection works is to prevent weathering and erosion, therefore the type of prevention should be selected based on geological and topographical conditions. The study team recommends the types found in following Table 10-1-8 as follows, for selection of type of slope protection works.

Table 10-1-8 Types of Slope Protection Works and their Purposes

Kind of Work	Purposes and Features
Shotcrete Stone pitching Block pitching	For preventing weathering and erosion
Concrete block cribworks	For preventing erosion when filled up with sediment or gravel
Concrete pitching Sprayed concrete cribworks Slope anchor works	For preventing collapse of surface layer of slope, preventing separation of bedrock, and retaining earth where there is earth pressure.
Wicker works Slope gabion works	For controlling erosion of surface layer of slope and outflow of surface layer due to spring water
Rockfall prevention nets Rockfall prevention fences Rockfall shed	For prevention of rockfall

Source: Study Team

(2) Concept of Application for Slope Protection Works

For the following reasons, countermeasures by preventive work are required for the steep terrain where slope failure is prone to occur:

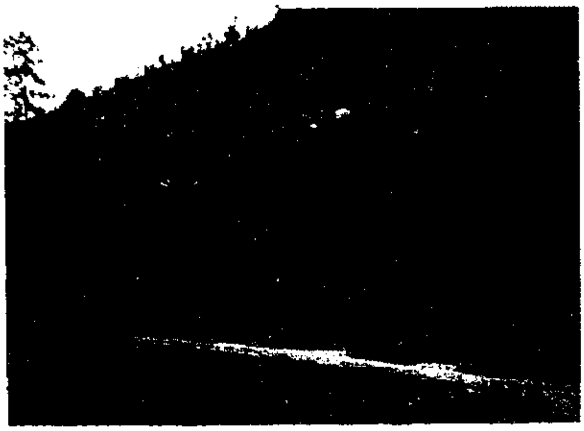
- Increment quantity of cut volume is required when cut is conducted according to safe gradients for cut slope.
- In case of insufficient drainage facilities, slope failure can easily occur even if required cut is conducted according to safe gradients.
- Due to geological conditions, quick erosion is to be expected.
- Slope failure has serious effects on society, the economy and the environment.

Countermeasure works are applied based on the following concepts;

- Countermeasure works should adopt semi-permanent facilities for durability for all road classes of the roads concerned,
- When combining the prevention countermeasures of for works and surface drainage, run-off rain does not penetrate structures, therefore, durability of slope protection works will be long-lasting.
- Countermeasure works should use semi-permanent structures of the most economic type.

Sprayed Concrete Cribwork Type

Existing Slope



Proposed Slope Protection

Shotcrete Type

Existing Slope

Proposed Slope Protection

Source: Study Team

Figure 10-1-8 Image of Slope Protection

10.2 Preparatory Engineering Design

10.2.1 Field Reconnaissance

In order to gain an understanding of the roadside topography and current road conditions, including the pavement, road slope, and bridge conditions for the 1,000-km section of the road to be examined in the pre-feasibility study, site reconnaissance was made on the basis of the 1:50000 topographic map, existing road inventory, geologic map, and current load use. Consideration was also given to the possibility of roadside land use/development.

(1) Routes covered by the pre-feasibility study

Figure 10-2-1 shows the location of the routes for the pre-feasibility study, which have been selected from the overall road network improvement master plan.

(2) Road pavement condition (road surface, drainage system)

Table 10-2-1 shows the road inventory of each link.

1) Tolitoli – Buol (Link No.4)
Road link length totals 174.2 km, 37.2 of which is gravel, paved for 12.1 km on the Toli Toli end and 10.5 km along the Lakea settlement area. The remaining 114.4 km is finished by simple pavement with penetration macadam. The gravel road is narrow in terms of both shovel-packed gravel and shoulder widths. There are many sections where the two-way traffic is difficult. The road surface drainage system mainly consists of an open earth ditch.

2) Buol – Umu (Link No.5)
Road link length totals 141.0 km, 38.0 km of which is gravel, and the remaining 103 km section is finished by simple pavement with penetration macadam. The road surface drainage system, an open earth ditch, is poorly maintained.

3) Uwekuli - Kolonadale – Nuha (Link No.15)
Road link length totals 128.8 km, 34.7 km of which is finished by simple pavement with asbuton (natural asphalt) between Kolonadale and Beteleme. There is no existing road for the section of about 29 km between Malino and Kolonadale. The remaining 65.1 km is a gravel road. The entire drainage system is an open earth ditch. This route is designated as provincual road.

4) Tompira - Wosu (Umpanga) – Bungku (Link No. 16)
The 55.4 km section between Tompira and Wosu is currently being repaved with asphalt concrete. Of the 48.5 km Wosu - Bungku section, the 21.3 km on the Wosu side is finished with asphalt concrete, but its road surface is poorly maintained. The remaining 27.2 km section is a gravel road. The feasibility study is limited to the latter Wosu - Bungku section. The road is located in the flat land along the coast and the entire drainage system is an open earth ditch.

5) Bungku – Border (Link No. 22)
The section concerned is either gravel or earth road, and there is almost no drainage system. The road surface of the developed section in the flat land has been maintained relatively well. But, in the mountainous land configuration approaching the coast, the road width is narrow and the road surface is poorly maintained.

6) Barru – Kasipute (Link No. 31)
The entire 188 km section is designated as a provincial road. The total length of paved sections with asphalt concrete is 25.1 km, including the Barru - Baula section and the junction to Baula. From Baula to Bambea, which is 119 km, the road is finished by simple pavement with asbuton. The 43.8 km Bambaca - Kashipute section is gravel or earth road. The 20.2 km Barru - Baula section of 20.2 km has an open channel for drainage. For the other sections, the drainage system for construction of cut sections is open earth ditch.

7) Pohara – Asera (Link No. 32)
The entire route is designated to be a provincial road. The 10-km section on the Pohara side is finished by simple pavement with penetration macadam. The remaining 71.4 km section is a gravel road, except for the 35-km section between Pohara and Sandangpangan, which is under improvement with pavement. Accordingly, the feasibility will be made for the 46.4 km section between Sandangpangan - Asera. This section is planned totally as gravel or earth road without road surface drainage.

8) Asera – Border (Link No. 33)
The entire route is designated to be a provincial road. Three major bridges are currently under construction. The road is entirely a gravel or earth road without road surface drainage.

9) Toboli – Poso (Link No.8)
This route is designated as a part of the Trans-Sulawesi road. It is 4.5 m wide and the entire route is paved with asphalt concrete. Most sections are provided with an open channel road surface drainage system.

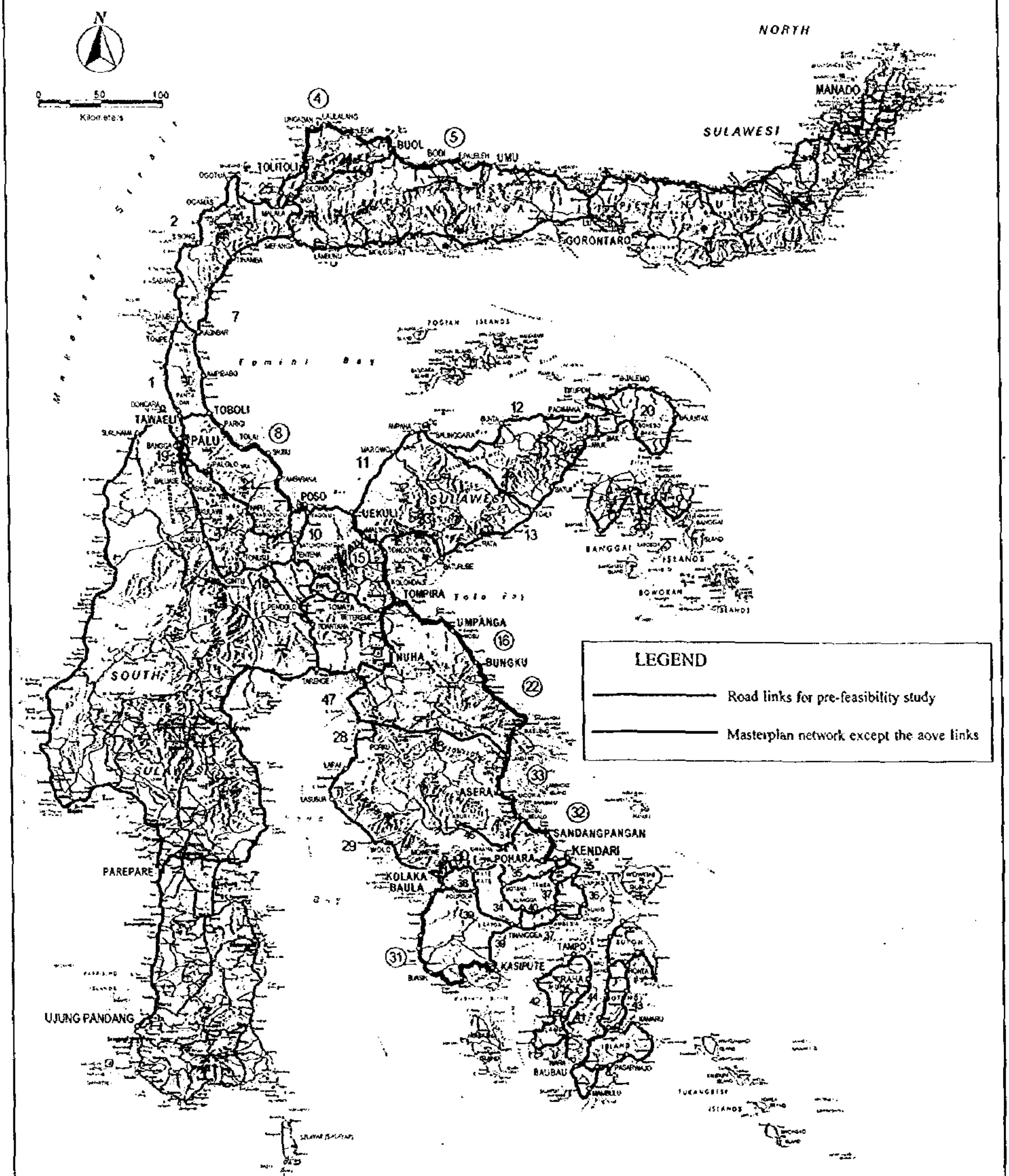


Figure 10-2-1 Road Link Map of Pre-feasibility Study

Source: Study Team

Table 10-2-1 (1) Road Inventory for Pre-F/S Roads

Tolitoli - Buol Link No. 4												
No. of Province	Road No.		Status	Function	Length (km)	Surface Type	Width of C. Way (m)	Shoulder Width R) (m)	Shoulder Width(L) (m)	No. of Pothole	No. of Cracks	Total Width (m)
52	011		N	K1	12.1	11	5.3	1.3	1.2	2	0	7.8
52	011		N	K1	4.0	6	3.5	1.1	1.1	59	26	5.7
52	011		N	K1	4.0	6	3.5	1.4	1.4	0	0	6.3
52	011		N	K1	10.0	6	3.5	1.5	1.5	51	40	6.5
52	011		N	K1	4.0	6	3.5	1.0	0.9	75	40	5.4
52	011		N	K1	4.9	6	3.5	1.5	1.4	4	29	6.4
52	011		N	K1	6.7	6	3.5	1.4	1.4	2	9	6.3
52	011		N	K1	4.9	6	3.9	1.2	1.3	31	40	6.4
52	027	1	P	K1	8.0	6	3.5	1.0	1.0	7	7	5.5
52	027	1	P	K1	11.7	8	4.3	1.0	1.0	12	16	6.3
52	027	2	N	K1	12.4	6	4.5	1.2	1.2	1	9	6.9
52	027	2	N	K1	3.8	6	4.5	1.0	1.0	4	25	6.5
52	027	2	N	K1	16.2	2	3.5	0.0	0.0	13	0	3.5
52	027	2	N	K1	9.5	2	4.5	0.0	0.0	10	0	4.5
52	027	2	N	K1	6.7	2	4.5	0.0	0.0	13	0	4.5
52	027	3	N	K1	10.5	11	4.5	1.0	1.0	3	7	6.5
52	027	3	N	K1	5.7	6	4.5	1.0	1.0	1	4	6.5
52	027	3	N	K1	0.9	6	4.5	1.0	1.0	0	5	6.5
52	027	3	N	K1	1.0	2	5.0	0.0	0.0	25	0	5.0
52	027	3	N	K1	2.8	2	5.0	0.0	0.0	25	0	5.0
52	027	3	N	K1	0.9	6	3.5	1.0	1.0	25	20	5.5
52	027	3	N	K1	12.4	6	3.5	1.0	1.0	29	29	5.5
52	027	3	N	K1	14.1	6	3.5	1.0	1.0	42	29	5.5
52	027	3	N	K1	6.8	6	3.5	1.0	1.0	4	7	5.5
4					174.0							

Source: Study Team

Table 10-2-1 (2) Road Inventory for Pre-F/S Roads

Tolitoli - Buol Link No. 4												
No. of Province	Road No.		Status	Function	Length (km)	Surface Type	Width of C. Way (m)	Shoulder Width R) (m)	Shoulder Width(L) (m)	No. of Pothole	No. of Cracks	Total Width (m)
52	028	1	N	K1	13.0	6	3.5	1.0	1.0	5	5	5.5
52	028	1	N	K1	8.0	6	3.5	1.0	1.0	5	5	5.5
52	028	1	N	K1	5.0	6	3.5	1.0	1.0	5	5	5.5
52	028	1	N	K1	1.0	2	4.0	1.0	1.0	75	0	6.0
52	028	1	N	K1	1.0	6	3.5	1.0	1.0	25	40	5.5
52	028	1	N	K1	7.0	6	3.5	1.0	1.0	9	9	5.5
52	028	1	N	K1	4.0	6	3.5	1.0	1.0	10	13	5.5
52	028	1	N	K1	9.0	6	3.5	1.0	1.0	7	7	5.5
52	028	2	N	K1	5.0	6	3.7	1.0	1.0	5	5	5.7
52	028	2	N	K1	4.0	6	4.5	1.0	1.0	5	5	6.5
52	028	2	N	K1	1.0	2	4.0	0.0	-0.0	75	0	4.0
52	028	2	N	K1	5.0	2	4.0	0.2	0.2	41	0	4.4
52	028	2	N	K1	7.0	2	4.0	1.0	1.0	46	0	6.0
52	028	2	N	K1	2.0	2	4.0	1.0	1.0	51	0	6.0
52	028	2	N	K1	1.0	6	3.5	1.0	1.0	25	20	5.5
52	028	2	N	K1	4.0	6	3.5	1.0	1.0	25	25	5.5
52	028	2	N	K1	1.0	2	4.0	1.0	1.0	25	0	6.0
52	028	2	N	K1	5.0	2	4.0	1.0	1.0	45	0	6.0
52	028	2	N	K1	5.0	2	4.0	1.0	1.0	27	0	6.0
52	028	2	N	K1	1.0	6	3.5	1.0	1.0	0	5	5.5
52	028	2	N	K1	5.0	6	3.5	1.0	1.0	13	11	5.5
52	028	3	N	K1	6.0	6	3.5	1.0	1.0	5	5	5.5
52	028	3	N	K1	5.0	6	3.5	1.0	1.0	5	5	5.5
52	028	3	N	K1	3.0	6	3.5	1.0	1.0	5	5	5.5
52	028	3	N	K1	1.0	2	4.0	1.0	1.0	25	0	6.0
52	028	3	N	K1	6.0	2	4.0	1.0	1.0	50	0	6.0
52	028	3	N	K1	4.0	2	4.0	1.0	1.0	63	0	6.0
52	028	3	N	K1	6.0	6	3.5	1.0	1.0	25	23	5.5
52	028	3	N	K1	7.0	6	3.5	1.0	1.0	19	18	5.5
52	028	3	N	K1	4.0	6	3.5	1.0	1.0	25	25	5.5
52	028	3	N	K1	5.0	6	3.5	1.0	1.0	35	28	5.5
					141.0							

Source: Study Team

Table 10-2-1 (3) Road Inventory for Pre-F/S Roads

Tawaeli - Poso Link No. 8

No. of Province	Road No.		Status	Function	Length (km)	Surface Type	Width of C. Way (m)	Shoulder Width R) (m)	Shoulder Width(L) (m)	No. of Pothole	No. of Cracks	Total Width (m)
52	005		N	A	5.8	II	4.5	2.3	2.1	4	20	8.9
52	005		N	A	5.7	II	4.5	2.3	2.3	0	9	9.1
52	005		N	A	4.0	II	4.5	2.1	2.1	1	1	8.7
52	016		N	A	13.9	II	6.0	1.5	1.5	0	0	9.0
52	016		N	A	15.9	II	4.7	1.5	1.5	3	3	7.7
52	017		N	A	13.0	II	4.7	1.5	1.5	0	1	7.7
52	017		N	A	15.5	II	4.7	1.5	1.5	4	6	7.7
52	018		N	A	4.3	II	9.6	1.5	1.5	3	13	12.6
52	018		N	A	16.3	II	9.6	1.5	1.5	1	3	12.6
52	018		N	A	0.9	II	9.6	1.5	1.5	25	20	12.6
52	019		N	A	6.1	II	4.6	1.5	1.5	1	1	7.6
52	019		N	A	5.9	II	4.6	1.5	1.5	10	14	7.6
52	019		N	A	4.0	II	4.6	1.5	1.5	1	8	7.6
52	019		N	A	19.7	II	4.6	1.5	1.5	1	4	7.6
52	019		N	A	16.0	II	4.6	1.5	1.5	0	1	7.6
					147.0							

Source: Study Team

Table 10-2-1 (4) Road Inventory for Pre-F/S Roads

Uekuuli - Nuha Link No. 15

No. of Province	Road No.		Status	Function	Length (km)	Surface Type	Width of C. Way (m)	Shoulder Width R) (m)	Shoulder Width(L) (m)	No. of Pothole	No. of Cracks	Total Width (m)
52	021	2	P	KI	3.1	8	4.5	1.5	1.5	75	40	7.5
52	021	2	P	KI	3.0	8	4.5	1.5	1.5	75	40	7.5
52	021	2	P	KI	1.0	8	4.5	1.5	1.5	75	40	7.5
52	021	2	P	KI	1.0	8	4.5	1.5	1.5	75	40	7.5
52	021	2	P	KI	1.0	8	4.5	1.5	1.5	75	40	7.5
52	021	2	P	KI	3.1	8	4.5	1.5	1.5	75	40	7.5
52	021	2	P	KI	2.0	8	4.5	1.5	1.5	75	40	7.5
52	021	2	P	KI	1.0	8	4.5	1.5	1.5	25	40	7.5
52	021	2	P	KI	1.0	8	4.5	1.5	1.5	25	40	7.5
52	021	2	P	KI	2.3	8	4.5	1.5	1.5	25	40	7.5
52	021	2	P	KI	2.0	8	4.5	1.5	1.5	50	30	7.5
52	021	2	P	KI	1.0	8	4.5	1.5	1.5	75	40	7.5
52	021	2	P	KI	1.0	8	4.5	1.5	1.5	75	40	7.5
52	021	2	P	KI	2.4	8	4.5	1.5	1.5	75	40	7.5
52	021	2	P	KI	1.7	8	4.5	1.5	1.5	75	28	7.5
52	021	2	P	KI	1.0	8	4.5	1.5	1.5	75	40	7.5
52	021	2	P	KI	2.9	8	4.5	1.5	1.5	75	40	7.5
52	021	2	P	KI	1.1	8	4.5	1.5	1.5	75	40	7.5
52	021	2	P	KI	3.1	8	4.5	1.5	1.5	58	40	7.5
PO	PO0171		K		3.0	6	3.5	1.0	1.0			5.5
PO	PO0172		K		2.0	6	3.5	1.0	1.0			5.5
PO	PO0173		K		21.4	6	3.5	1.0	1.0			5.5
PO	PO0341		K		14.0	1	0.0	0.0	0.0			0.0
PO	PO0342		K		6.0	1	0.0	0.0	0.0			0.0
PO	PO0343		K		9.0	1	0.0	0.0	0.0			0.0
PO	PO0101		K		0.5	6	3.5	1.0	1.0			5.5
PO	PO0102		K		4.8	6	3.5	1.0	1.0			5.5
PO	PO0103		K		17.0	2	2.5	0.0	0.0			2.5
PO	PO0181		K		3.0	6	3.5	1.0	1.0			5.5
PO	PO0182		K		2.0	6	3.5	1.0	1.0			5.5
PO	PO0183		K		11.4	6	3.5	1.0	1.0			5.5
					128.8							

Source: Study Team

Table 10-2-1 (5) Road Inventory for Pre-F/S Roads

Tompira - Bunku Link No. 16

No. of Province	Road No.		Status	Function	Length (km)	Surface Type	Width of C. Way (m)	Shoulder Width R) (m)	Shoulder Width(L) (m)	No. of Pothole	No. of Cracks	Total Width (m)
52	023	1	P	K2	3.1	6	3.5	1.5	1.5	75	40	6.5
52	023	1	P	K2	8.0	8	4.4	1.1	1.1	41	40	6.6
52	023	1	P	K2	8.2	8	4.5	1.0	1.0	10	40	6.5
52	023	1	P	K2	2.1	2	5.0	0.0	0.0	75	0	5.0
52	023	1	P	K2	1.4	2	5.0	0.0	0.0	75	0	5.0
52	023	1	P	K2	1.8	8	3.5	1.0	1.0	75	40	5.5
52	023	1	P	K2	4.3	8	3.5	1.0	1.0	75	40	5.5
52	023	1	P	K2	1.1	8	3.5	1.0	1.0	75	40	5.5
52	023	1	P	K2	1.0	8	3.5	1.0	1.0	75	40	5.5
52	023	1	P	K2	1.0	8	3.5	1.0	1.0	75	40	5.5
52	023	1	P	K2	3.1	8	3.5	1.5	1.5	25	33	6.5
52	023	1	P	K2	3.0	8	3.5	1.5	1.5	75	40	6.5
52	023	1	P	K2	1.1	8	3.5	1.5	1.5	75	40	6.5
52	023	1	P	K2	5.1	8	3.5	1.5	1.5	75	40	6.5
52	023	1	P	K2	2.1	8	3.5	1.5	1.5	75	40	6.5
52	023	1	P	K2	1.3	8	4.5	1.0	1.0	25	20	6.5
52	023	1	P	K2	0.7	8	4.5	1.0	1.0	25	20	6.5
52	023	1	P	K2	3.1	8	4.5	0.0	0.0	19	40	4.5
52	023	1	P	K2	4.0	2	5.0	1.0	1.0	75	0	7.0
52	023	2	P	K	11.2	8	4.5	1.5	1.5	38	28	7.5
52	023	2	P	K	6.1	8	3.5	1.5	1.5	75	40	6.5
52	023	2	P	K	4.0	8	3.5	1.5	1.5	50	35	6.5
52	023	2	P	K	4.9	2	5.0	1.5	1.5	75	0	8.0
52	023	2	P	K	2.0	2	5.0	1.5	1.5	75	0	8.0
52	023	2	P	K	1.0	2	5.0	1.5	1.5	75	0	8.0
52	023	2	P	K	1.9	2	5.0	1.5	1.5	75	0	8.0
52	023	2	P	K	2.9	2	5.0	1.5	1.5	75	0	8.0
52	023	2	P	K	1.0	2	5.0	1.5	1.5	75	0	8.0
52	023	2	P	K	2.0	2	5.0	1.5	1.5	75	0	8.0
52	023	2	P	K	1.0	2	5.0	1.5	1.5	75	0	8.0
52	023	2	P	K	1.9	2	5.0	1.5	1.5	75	0	8.0
52	023	2	P	K	1.0	2	5.0	1.5	1.5	75	0	8.0
52	023	2	P	K	0.9	2	5.0	1.5	1.5	75	0	8.0
52	023	2	P	K	1.0	2	5.0	1.5	1.5	75	0	8.0
52	023	2	P	K	2.0	2	5.0	1.5	1.5	75	0	8.0
52	023	2	P	K	0.9	2	5.0	1.5	1.5	75	0	8.0
52	023	2	P	K	1.0	2	3.5	1.5	1.5	25	0	6.5
52	023	2	P	K	1.7	6	3.5	1.5	1.5	5	20	6.5
					103.9							

Source: Study Team

Table 10-2-1 (6) Road Inventory for Pre-F/S Roads

Bungku – S.E. Link No. 22

No. of Province	Road No.		Status	Function	Length (km)	Surface Type	Width of C. Way (m)	Shoulder Width R) (m)	Shoulder Width(L) (m)	No. of Pothole	No. of Cracks	Total Width (m)
PO	PO0041		K		17.0	2	3.5	0.5	0.5			4.5
PO	PO0042		K		26.9	2	3.5	2.0	2.0			7.5
PO	PO0051		K		4.1	2	3.5	0.5	0.5			4.5
PO	PO0052		K		10.6	2	3.5	2.0	2.0			7.5
PO	PO0053		K		6.6	2	3.5	0.5	0.5			4.5
PO	PO0054		K		7.8	2	3.5	0.5	0.5			4.5
PO	PO0055		K		10.0	2	3.5	2.0	2.0			7.5
PO	PO0056		K		4.3	2	3.5	0.5	0.5			4.5
PO	PO0057		K		7.7	2	3.5	0.5	0.5			4.5
PO	PO0058		K		20.0	1	3.5	2.0	2.0			7.5
22					115.0							

Source: Study Team

Table 10-2-1 (7) Road Inventory for Pre-F/S Roads

Barru - Kasipute Link No. 31

No. of Province	Road No.		Status	Function	Length (km)	Surface Type	Width of C. Way (m)	Shoulder Width R) (m)	Shoulder Width(L) (m)	No. of Pothole	No. of Cracks	Total Width (m)
56	012		P	K2	4.3	9	4.5	2.0	2.0	0	0	8.5
56	012		P	K2	4.0	9	4.5	2.3	2.0	0	0	8.8
56	012		P	K2	4.9	9	4.5	1.9	2.0	2	0	8.4
56	012		P	K2	7.0	9	4.5	1.9	2.0	0	0	8.4
56	013	1	P	K2	4.9	9	4.5	0.3	2.0	9	2	6.8
56	013	1	P	K2	4.0	8	5.0	2.0	2.0	8	0	9.0
56	013	1	P	K2	4.4	7	4.9	1.7	2.0	18	0	8.6
56	013	1	P	K2	4.2	7	4.5	1.3	2.0	16	0	7.8
56	013	1	P	K2	4.2	8	4.5	1.5	2.0	16	0	8.0
56	013	1	P	K2	2.0	8	4.5	1.5	2.0	5	0	8.0
56	013	1	P	K2	1.1	8	4.5	1.5	2.0	5	0	8.0
56	013	1	P	K2	4.1	8	4.5	1.5	2.0	5	0	8.0
56	013	1	P	K2	6.1	7	4.5	1.3	2.0	20	40	7.8
56	013	1	P	K2	6.4	8	4.5	1.2	2.0	16	14	7.7
56	013	2	P	K2	1.0	8	4.5	1.4	2.0	40	0	7.9
56	013	2	P	K2	1.1	8	4.5	1.4	2.0	40	0	7.9
56	013	2	P	K2	15.1	6	4.4	1.4	3.0	13	11	8.8
56	013	3	P	K2	4.1	8	3.5	1.5	4.0	15	0	9.0
56	013	3	P	K2	5.2	8	3.5	1.5	4.0	32	0	9.0
56	013	3	P	K2	4.3	8	3.5	1.5	3.0	30	0	8.0
56	013	3	P	K2	4.1	8	3.5	1.5	2.0	21	0	7.0
56	013	3	P	K2	4.2	8	3.5	1.5	2.0	8	0	7.0
56	013	3	P	K2	4.3	8	3.5	1.3	2.0	2	0	6.8
56	013	3	P	K2	7.1	8	4.5	1.3	2.0	25	0	7.8
56	013	4	P	K2	0.3	8	4.5	0.5	3.0	40	0	8.0
56	013	4	P	K2	0.9	8	4.5	0.5	3.0	40	0	8.0
56	013	4	P	K2	9.4	8	4.5	1.3	4.0	36	0	9.8
56	013	4	P	K2	1.0	8	4.5	0.7	4.0	40	0	9.2
56	013	4	P	K2	3.8	8	4.5	1.4	3.0	35	0	8.9
56	013	4	P	K2	0.9	8	4.5	1.5	3.0	20	0	9.0
56	013	4	P	K2	14.8	8	4.5	1.5	3.0	37	0	9.0
56	013	4	P	K2	0.9	8	4.5	0.9	2.0	5	5	7.4
56	013	4	P	K2	0.9	2	4.5	0.9	3.0	0	0	8.4
56	013	4	P	K2	0.9	2	4.5	0.9	3.0	0	0	8.4
56	013	4	P	K2	0.9	2	4.5	1.2	3.0	0	0	8.7
56	013	4	P	K2	0.9	2	4.5	1.2	3.0	0	0	8.7
56	013	4	P	K2	4.3	2	4.5	1.3	3.0	0	0	8.8
56	013	4	P	K2	0.9	2	4.5	1.5	3.0	0	0	9.0
56	013	5	P	K2	5.2	7	4.5	1.2	1.0	0	0	6.7
56	013	5	P	K2	4.1	2	4.5	0.8	1.0	0	0	6.3
56	013	5	P	K2	1.0	2	4.5	0.8	1.0	0	0	6.3
56	013	5	P	K2	2.1	2	4.5	0.8	1.0	0	0	6.3
56	013	5	P	K2	1.0	7	4.5	1.5	1.0	20	0	7.0
56	013	5	P	K2	3.0	2	4.5	1.4	1.0	20	0	6.9
56	013	5	P	K2	4.0	7	4.5	1.4	1.0	11	3	6.9
56	013	5	P	K2	6.1	2	4.5	1.0	1.0	0	0	6.5
56	013	5	P	K2	1.1	7	4.5	1.0	1.0	0	0	6.5
56	013	5	P	K2	7.4	2	4.5	1.8	1.0	0	0	7.3
					187.9							

Source: Study Team

Table 10-2-1 (8) Road Inventory for Pre-F/S Roads

Pohara - Asera Link No. 32

No. of Province	Road No.		Status	Function	Length (km)	Surface Type	Width of C. Way (m)	Shoulder Width R) (m)	Shoulder Width(L) (m)	No. of Pothole	No. of Cracks	Total Width (m)
56	018	1	P	K2	1.1	7	3.5	1.0	2.0	0	0	6.5
56	018	1	P	K2	8.9	7	3.5	1.0	2.0	1	0	6.5
56	018	1	P	K2	6.9	8	4.5	1.0	2.0	4	1	7.5
56	018	1	P	K2	5.9	7	3.5	1.0	2.0	3	0	6.5
56	018	1	P	K2	17.7	7	3.6	0.7	2.0	3	3	6.3
56	018	2	P	K2	4.4	6	8.0	0.0	2.0	9	0	10.0
56	018	3	P	K2	4.1	7	6.0	0.0	2.0	5	0	8.0
56	018	3	P	K2	8.1	7	6.0	0.0	2.0	5	0	8.0
56	018	3	P	K2	1.0	2	6.0	0.0	3.0	0	0	9.0
56	018	3	P	K2	11.4	2	6.0	0.0	2.0	0	0	8.0
56	018	4	P	K2	4.1	2	6.0	0.0	2.0	0	0	8.0
56	018	4	P	K2	8.1	2	6.0	0.0	2.0	0	0	8.0
32					81.7							

Source: Study Team

Table 10-2-1 (9) Road Inventory for Pre-F/S Roads

Asera – Bts. Pro. Link No. 33

No. of Province	Road No.		Status	Function	Length (km)	Surface Type	Width of C. Way (m)	Shoulder Width R) (m)	Shoulder Width(L) (m)	No. of Pothole	No. of Cracks	Total Width (m)
56	018	5	P	K2	25.4	2	6.0	0.0	2.0	0	0	8.0
56	018	5	P	K2	15.2	2	6.0	0.0	2.0	0	0	8.0
56	018	6	P	K2	25.3	2	6.0	0.0	2.0	0	0	8.0
56	018	6	P	K2	10.2	2	6.0	0.0	2.0	0	0	8.0
32					76.1							

Source: Study Team

10.2.2 Toli Toli -Buol (Link No.4)

(1) Rout Description (see Figure 10-2-2)

The road concerned is 174.2 km in length and connects Toli Toli, the seat of the kabupaten with Buol, a principal city in the northern part of the kabupaten. This road is also a part of the road running from South Sulawesi to North Sulawesi. Both Buol and Tolitoli are collection and distribution centers of agricultural products from Kabupaten Tolitoli, located near the Makassar Straits. Villages engaged mainly in agriculture, forestry, and fishery are dotted over the flat plain along the route. The road is used for agricultural development of the adjacent area, for shipping and for daily life of residents along the route. The pavement of the existing road connecting these cities is poorly maintained and the bridges and structures spanning over the road are damaged considerably. The road structure is based on a low standard of design in terms of vertical and horizontal alignments and width, which often limits the number of vehicles that can pass through during the rainy season. The road is often closed also due to collapse of the face of the slope. On the other hand, high waves in the sea area to the east of this district caused by strong wind during the rainy season cause the stoppage of the offshore traffic of small ships. As a consequence, this road is the only on-land transportation route available during the rainy season.

Location of Link No. 4

- Province: Central Sulawesi
- Kabupaten: Buol Tolitoli,
- Kecamatan: Boalan, Galang, Urara Tolitoli, Biau, Momunu
- Major cities and settlement Tolitoli, LauLang, Kali, Lamadong
- Link Length 174.2 km

(2) Road Traffic

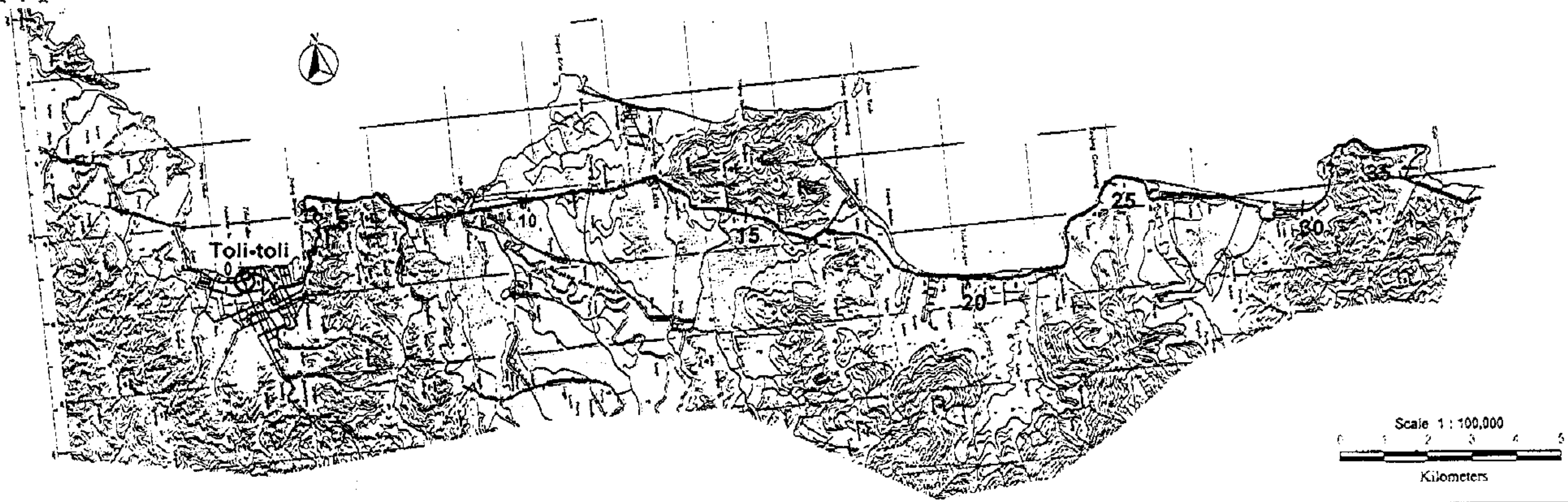
The future traffic demand of the road link are summarized as indicated in Table 10-2-2.

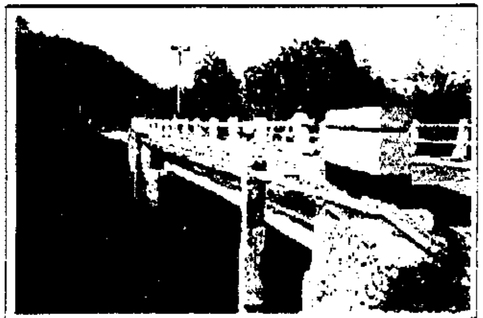
Table 10-2-2 Future Traffic Volume of Toli Toli – Buol

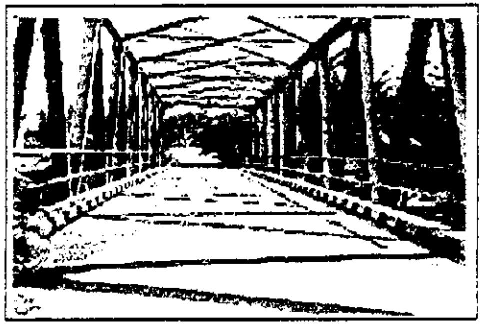
	Year 2003 (vehicle/day)	Year 2018 (vehicle/day)
Motorcycle	106	37
Passenger cars	5	17
Buses	14	10
Trucks	14	15
Total	139	79

Source: Study Team

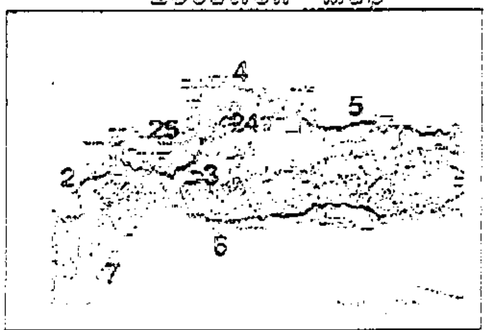
link 4-1

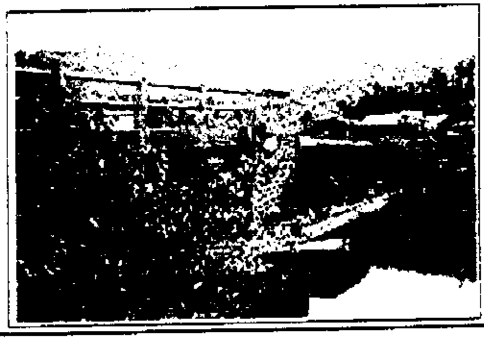




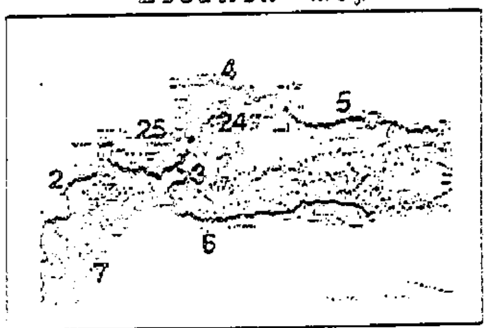


Location Map





link 4-2



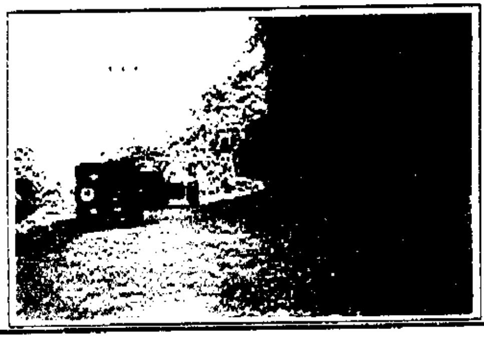
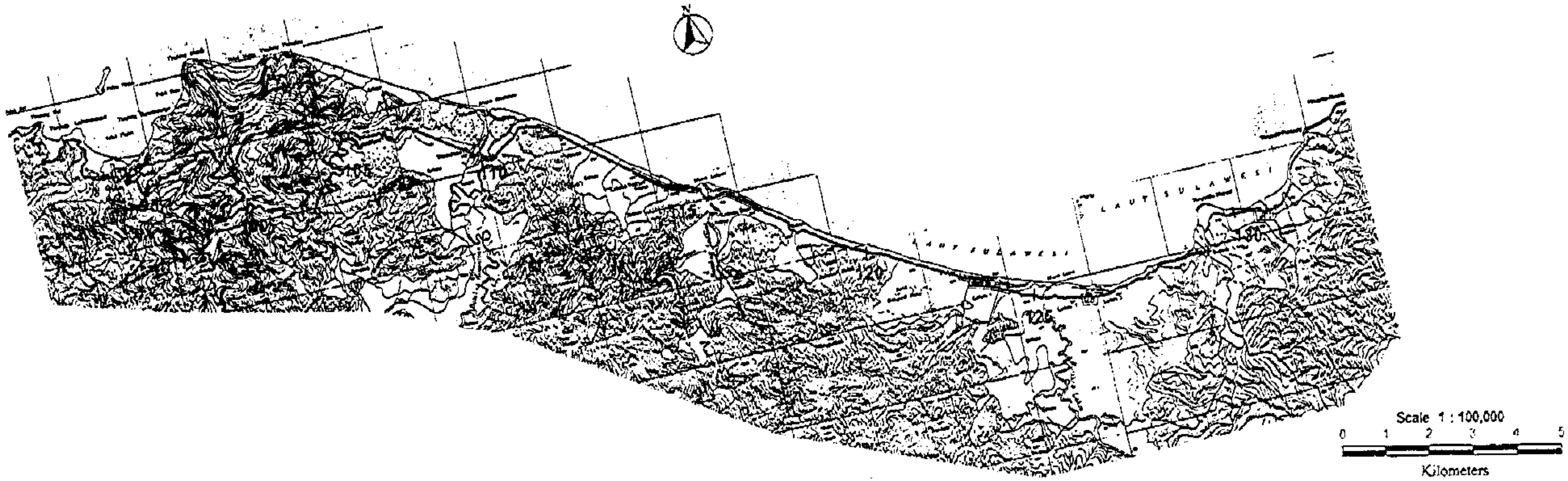


Figure 10-2-2 (2)

link 4-3



Location Map

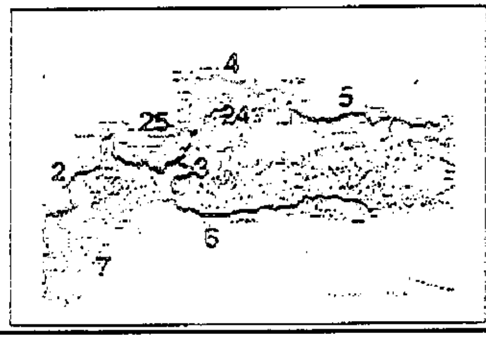


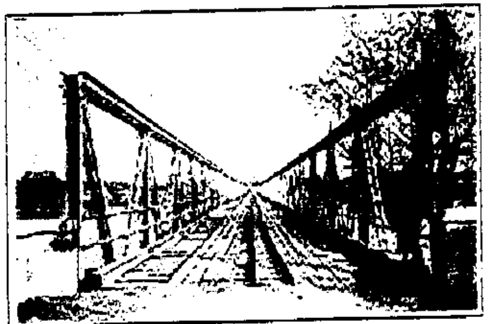
Figure 10-2-2 (3)

link 4-4

Scale 1 : 100,000

Kilometers

Location Map



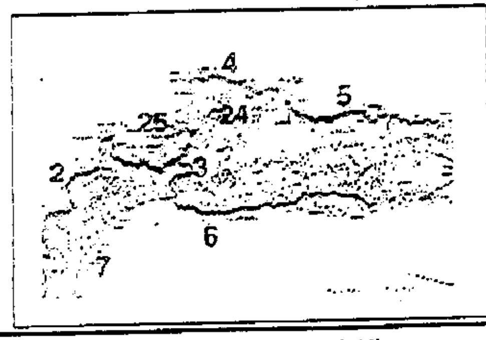
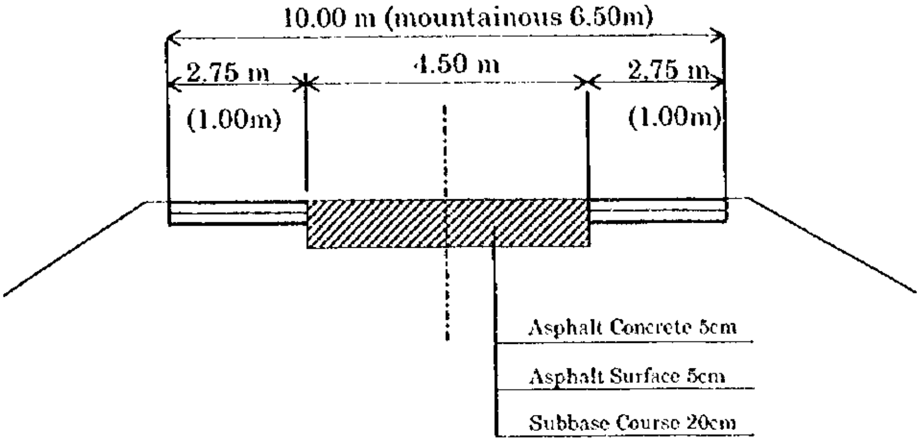


Figure 10-2-2 (4)

(3) Typical Cross Section and Pavement (Link No. 4)

The total width is 10 m (or 6.50m in mountainous area), including 4.5 m for the pavement of carriage way, 2.75 m for shoulders in flat area.



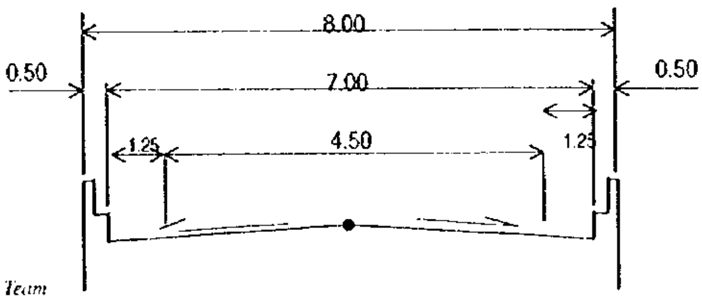
Source: Study Team

Figure 10-2-3 Typical Cross Section for Link No. 4

The pavement is of C type with a surface thickness of 5 cm. The plan also calls for an additional surface course of 5 cm as an overlay in seven years after road construction. Pavement thickness was decided by the future traffic demand with traffic demand.

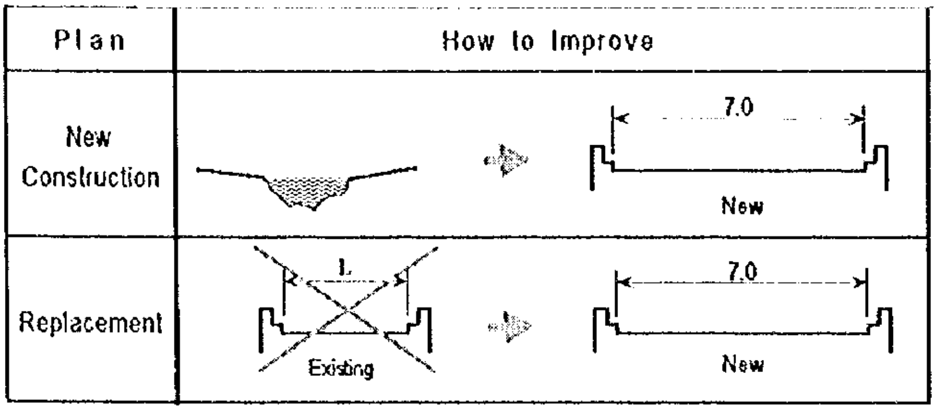
(4) Preparatory Engineering of Bridges (Link No. 4)

The minimum effective width of bridge is defined as 7.0 m according to the typical cross section of road. However, in consideration of economical improvement and single carriageway road, when the bridge has sufficient durability, the bridge is not to be improved from a judgement that traffic flow will not be affected by narrow width.
On the other hand the bridge with insufficient durability is to be replaced (reconstructed) in spite of sufficient width.
For roads of link Nos. 4 ,5 and 31, typical cross section of bridge is shown in Figure 10-2-4 and Figure 10-2-5 shows the concept of bridge improvement plan.



Source: Study Team

Figure 10-2-4 Typical Cross Section of New Bridge for Road Link Nos. 4,5 and 31



Source: Study Team

Figure 10-2-5 Bridge Improvement Plan for Road Link Nos. 4 ,5 and 31

Existing bridge condition on the road of link No.4 and the bridge improvement plan based on the above concept are listed in Table 10-2-3.

Quantity of bridge improvement on the road of link No.4 is summarized in Table 10-2-4.

Table 10-2-3 Existing Bridge and Bridge Improvement Plan for Road Link No.4

Road Link No.	Bridge No.	Location From	Km	Length (m)	Nos. Span	Width (m)	Type of Super-structure	Improvement Plan
4	1	Toli-Toli	148.30	4.0	1	5.4	Concrete Plate	Retain Existing
4	2	Toli-Toli	139.55	8.5	2	3.7	Wooden Girder	Replace
4	3	Toli-Toli	151.90	2.6	1	5.4	Concrete Plate	Retain Existing
4	4	Toli-Toli	152.00	4.3	1	5.4	Concrete Plate	Retain Existing
4	5	Toli-Toli	141.85	8.2	2	3.8	Wooden Girder	Replace
4	6	Toli-Toli	147.45	9.0	1	6.0	Wooden Girder	Retain Existing
4	7	Toli-Toli	138.65	11.2	1	6.0	Wooden Girder	Retain Existing
4	8	Toli-Toli	139.35	6.9	1	4.0	Wooden Girder	Replace
4	9	Toli-Toli	151.90	4.9	1	4.0	Concrete Plate	Retain Existing
4	10	Toli-Toli	140.45	6.5	1	4.5	Wooden Girder	Replace
4	11	Toli-Toli	141.55	4.9	1	4.3	Wooden Girder	Replace
4	12	Toli-Toli	167.70	214.5	7	4.4	Bailey	Replace

Source: Bina Marga

Table 10-2-4 Summary of Quantity of Bridge Improvement for Road Link No.4

	LINK NAME		ROAD LENGTH (km)	QUANTITY OF BRIDGE CONSTRUCTION (m²) CLASSIFICATION BY SPAN LENGTH : L(m) L<=10m	10m<L<=20m	20m<L<=30m	L>30m
4	TOLITOLI-BUOL						
	TOLITOLI	LINGADAN	50.7	293	68	95	0
	LINGADAN	LAULALANG	19.8	87	0	0	0
	LAULALANG	LEOK	48.7	270	0	0	189
	LEOK	BUOL	55.0	1,125	90	0	164
	TOTAL 4		174.2	1,775	158	95	353

Source: Bina Marga

(5) Preparatory Engineering of Slope Protection (Link No. 4)

Slope protection works are constructed to protect the slopes from erosion or weathering by covering them with vegetation or structures and also to stabilize the slopes by means of drainage works or retaining structures. The following types of slope protection works are adopted for the pre-feasibility route considering the terrain and geology, as shown in Table 10-2-5.
Necessary length of slope protection works for each link is shown in Figure 10-2-4.

Table 10-2-5 Quantities of Slope Protection

	Cut			Fill
	Sprayed Concrete Cribwork(m^2)	Shotcrete (m^2)	Stone Masonry (m^2)	Mat Gabion (m^2)
Quantity	10,697	0	6,554	10,557

Source: Study Team

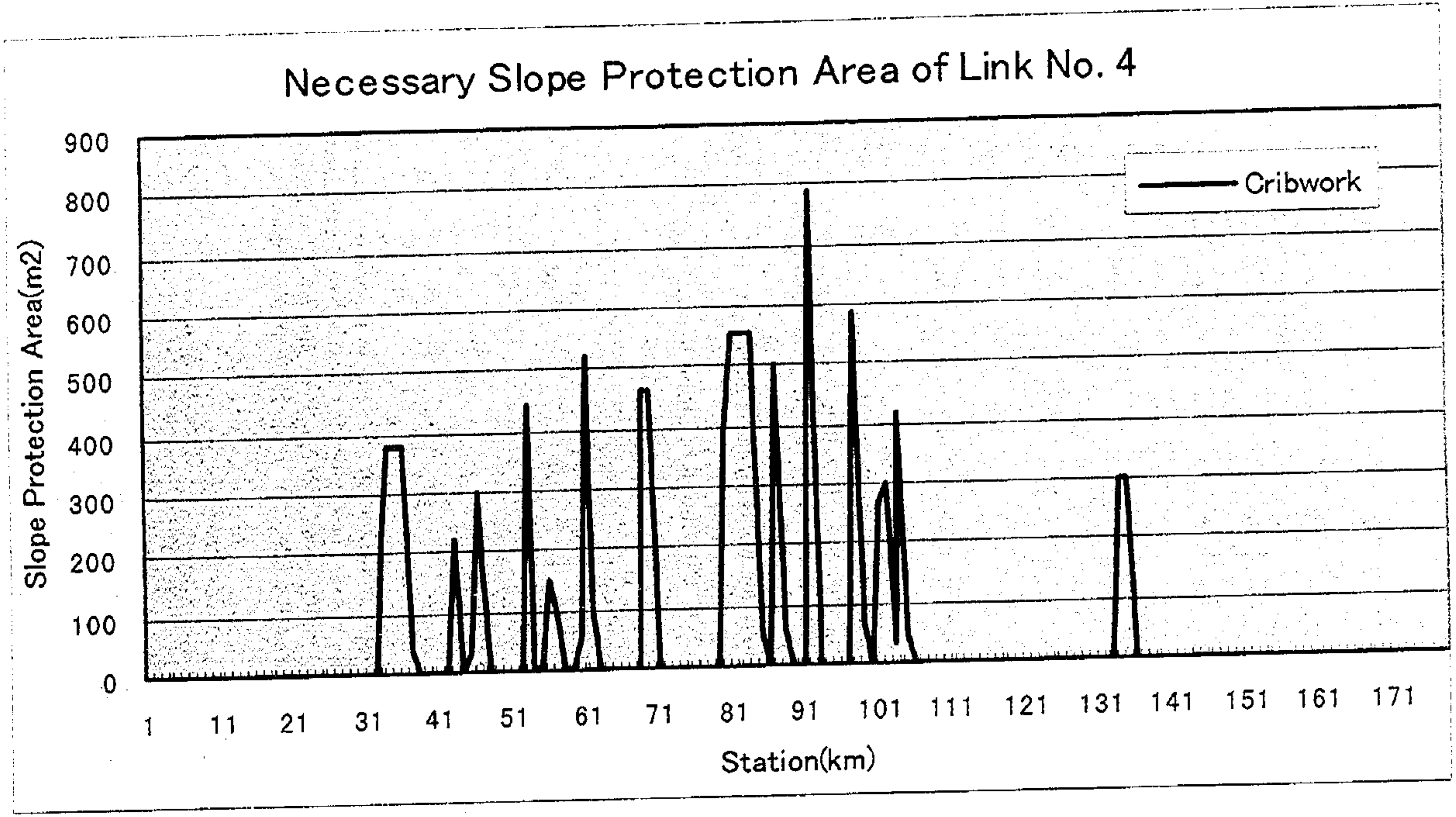
(6) Cost Estimation (Link No. 4)

1) Estimated Project Cost

Cost items consist of preparation works, pavement, earth work, drainage, bridge, slope protection and safety facilities works. The engineering service cost is estimated at 20% of the total cost of direct and indirect cost. A contingency allowance has been included in 10 % of total construction and engineering cost. Table 10-2-6 shows the result of estimated project cost.

2) Implementation Plan

As shown in Figure 10-2-7, the construction period was proposed to be 5 years consisting of one year for preparation of project for fund raising plan, 1.5 years for detailed design of the roads and 2.5 years for construction. Also, the investment plan is set in accordance with the construction plan.



Source: Study Team

Figure 10-2-6 Necessary Slope Protection Area

Table 10-2-6 Total Construction Cost for Tolitoli - Buol Road (Link No. 4)

Rate: 1US$ = 10,600 Rp. = 140 Yen

Item	Unit	Quantity	Unit Price			Total Price			
			Foreign (US$)	Financial (Rp)	Economic (Rp)	Foreign (US$)	Local Financial (Rp)	Local Economic (Rp)	Financial Total (Mill. Rp)
1. Preparation Works									
Clearing and Grubbing	m²	731,202	0.23	1,867	2,099	168,176	1,365,154,134	1,534,792,998	3,148
2. Pavement									
Road Asphalt Concrete + Sub Base (Type A)	m	0	39.50	436,896	392,152	0	0	0	0
Road Asphalt Concrete + Sub Base (Type B)	m	0	31.76	351,336	315,832	0	0	0	0
Road Asphalt Concrete + Sub Base (Type C)	m	174,200	16.15	188,584	175,452	2,813,330	32,851,332,800	30,563,738,400	62,673
Transport for Pavement Material (L = 43 km)	m³	165,980	5.49	40,920	47,740	910,782	6,791,831,888	7,923,803,870	16,446
Sub-2						3,724,112	39,643,164,688	38,487,542,270	79,119
3. Earth Work									
Excavation (Common)	m³	658,082	0.92	7,407	8,213	605,435	4,874,413,374	5,404,827,466	11,292
Excavation (Sound Rock)	m³	73,120	4.12	33,605	36,492	301,254	2,457,197,600	2,668,295,040	5,650
Disposal Soil (L = 5 km)	m³	73,120	1.20	8,610	10,050	87,744	629,564,922	734,858,010	1,560
Sub-3						994,433	7,961,175,896	8,807,980,516	18,502
4. Drainage									
Pipe Culvert (D = 100 cm)	m	1,742	44.35	634,758	554,426	77,258	1,105,748,436	965,810,092	1,925
Box Culvert (B = 2.0 m, H = 2.0 m)	m	871	325.89	3,064,762	2,510,606	283,850	2,669,407,702	2,186,737,826	5,678
U-Ditch (U = 30 cm)	m	58,067	1.71	41,910	36,720	99,295	2,433,587,970	2,132,220,240	3,486
Sub-4						460,403	6,208,744,108	5,284,768,158	11,089
5. Slope Protection									
Sprayed Concrete Cribwork	m²	10,697	14.68	127,197	88,984	157,032	1,360,626,309	951,861,848	30,255
Shotcrete Work	m²	0	11.82	101,390	67,157	0	0	0	0
Stone Masonry	m²	6,554	6.91	116,286	109,711	45,288	762,138,444	719,045,894	1,242
Mat Gabion	m²	10,557	9.20	72,584	61,374	97,124	766,269,288	647,925,318	1,796
Sodding	m²	138,507	0.08	3,238	2,851	11,081	448,485,666	394,883,457	566
Sub-5		27,808				310,525	3,337,519,707	2,713,716,517	6,629
6. Tunnel	m	0	3,500.00	22,400,000	17,920,000	0	0	0	0
7. Bridges									
L<=10 m	m²	1,775	206.20	2,233,568	1,843,094	366,010	3,964,583,348	3,271,492,590	7,844
10 m<L<=20 m	m²	158	287.55	2,506,242	2,008,820	45,432	395,986,291	317,393,596	878
20 m<L<=30 m	m²	95	313.65	2,643,773	2,102,930	29,797	251,158,479	199,778,395	567
30 m<L	m²	353	345.02	2,908,151	2,313,224	121,791	1,026,577,235	816,567,905	2,318
Sub-7		2,381				563,030	5,638,305,353	4,605,232,486	11,606
8. Safety Facilities Works									
Guard Railing	m	17,420	11.30	168,012	143,025	196,846	2,926,769,040	2,491,495,500	5,013
Traffic Sign	each	581	27.98	426,548	373,259	16,247	247,682,205	216,739,059	420
Line Marking	m	174,200	0.42	4,231	3,518	73,164	737,040,200	612,835,600	1,513
Sub-8						286,257	3,911,491,445	3,321,070,159	6,946
9. Mobilization & Temporally Works (20 % of Total Cost)						1,292,822	13,703,909,187	11,922,400,993	27,408
10. Sub-Total						7,799,758	81,769,464,518	76,677,504,097	164,447
11. Engineering Cost (20 % of 10)						2,171,940	15,348,378,289	12,278,702,631	38,371
12. Contingency (10 % of 10 + 11)						997,170	9,711,784,281	8,895,620,673	20,282
Ground Total Cost (10+ 11 + 12)						10,968,868	106,829,627,088	97,851,827,401	223,100

Source: Study Team

Item	Unit	Quantity	2002	2003	2004	2005	2006	Total
1. Preparation of Project								
2. Survey and Design	km	174.2						
3. Construction								
Earth Work	m^3	731,202.0						
Slope Protection	m^2	-						
Tunnel	m	0.0						
Bridges	m	-						
Pavement	km	174.2						
Foreign (US$)				597,284	2,056,472	2,512,086	5,803,028	10,968,869
Local Financial Cost (Rp)				4,220,804,030	18,540,696,281	23,621,298,444	60,446,828,334	106,829,627,089
Local Economic Cost (Rp)				3,376,643,224	17,187,474,323	20,866,431,293	56,421,278,560	97,851,827,399
Total Financial Cost (Mill. Rp)				10,552	40,339	50,249	121,959	223,100
Total Economic Cost (Mill. Rp)				9,708	38,986	47,495	117,933	214,122

Source: Study Team

Figure 10-2-7 Implementation Schedule for Tolitoli - Buol Road (Link No. 4)

(7) Economic Analysis (Link No. 4)

1) Economic Project Costs

The economic investment costs are estimated in constant 1998 prices. The financial investment costs in terms of market price include the component of taxes. The economic costs for economic analysis are obtained by subtracting the portion of transfer payment such as taxes from financial costs. The financial and economic costs (initial investment and maintenance costs) are summarized in Table 10-2-7.

Table 10-2-7 Initial Investment and Maintenance Costs

(Million Rp.)

	Economic Prices
Initial Investment Cost (Construction)	214,122
Routine Maintenance Cost Per Year	316
Periodic Maintenance Cost Per Year	25,305

Source: Study Team

The maintenance cost of the proposed road follows the engineering study results of the cost estimates. Besides, the maintenance cost of the proposed road in the case of "without the improvement of the proposed road" is treated as a negative cost.

2) Economic Benefits

Benefits are classified into two types, one is the direct benefit and the other is the indirect benefit or intangible benefit. The direct benefits which would be realized from the implementation of the Project are defined as the savings in travel costs, composed of the vehicle operating cost and vehicle time cost when comparing the "With" and "Without" project conditions.

The benefit of vehicle operating costs is estimated as a difference of vehicle operating costs between "With" Project case and "Without" Project case. The vehicle operating cost is derived from the obtained daily vehicle-kilometers and the unit vehicle operating cost by vehicle type. In addition, a promotion of traffic safety and a saving in accident costs are anticipated.

In this economic analysis, the above mentioned direct benefit, e.g. the vehicle operating cost saving is commuted as a quantified benefit. The calculation of direct benefits are made for the planning year of 2003 and 2018. As a result, the saving in vehicle operating cost is summarized as shown in Table 10-2-8.

Table 10-2-8 Estimated Economic Benefits

(Million Rp. at 1998 price)

Year	Benefit of Saving in VOC
2007	876
2018	3,285

Source: Study Team

3) Economic Cost-Benefit Analysis

The analysis follows the conventional discounted cash flow method in determining the economic internal rate of return (EIRR), the net present value (NPV) and the benefit cost ratio (B/C). (NPV and B/C are calculated at a discount rate of 15 percent). The project life is assumed to be 20 years after the completion of the construction.

The benefits in the intermediate years were interpolated and those beyond 2018 were assumed to be fixed. The total economic project costs and benefits streams are presented in Table 10-2-9.

Table 10-2-9 Estimated Economic Benefits

(Million Rp.)

	Year	Benefits		Costs			Maint. Cost (Without)	Net Cash Flow
		VOC Saving	Total	Invest. Costs	Maint. Cost (With)	Total		
1	1999			0	0	0	0	0
2	2000			0	0	0	0	0
3	2001			0	0	0	0	0
4	2002			0	0	0	0	0
5	2003	0	0	9,708	316	10,024	316	-9,708
6	2004	0	0	38,986	316	39,302	316	-38,986
7	2005	0	0	47,495	316	47,811	219,07	-25,904
8	2006	0	0	117,933	316	118,249	316	-117,933
9	2007	876	876	0	316	316	316	876
10	2008	1,095	1,095	0	316	316	316	1,095
11	2009	1,314	1,314	0	316	316	316	1,314
12	2010	1,533	1,533	0	316	316	21,907	23,124
13	2011	1,752	1,752	0	316	316	316	1,752
14	2012	1,971	1,971	0	316	316	316	1,971
15	2013	2,190	2,190	0	25,305	25,305	21,907	-1,208
16	2014	2,409	2,409	0	316	316	316	2,409
17	2015	2,628	2,628	0	316	316	316	2,628
18	2016	2,847	2,847	0	316	316	21,907	24,438
19	2017	3,066	3,066	0	316	316	316	3,066
20	2018	3,285	3,285	0	316	316	316	3,285
21	2019	3,285	3,285	0	316	316	21,907	24,876
22	2020	3,285	3,285	0	25,305	25,305	316	-21,704
23	2021	3,285	3,285	0	316	316	316	3,285
24	2022	3,285	3,285	0	316	316	21,907	24,876
25	2023	3,285	3,285	0	316	316	316	3,285
26	2024	3,285	3,285	0	316	316	316	3,285
27	2025	3,285	3,285	0	316	316	21,907	24,876
28	2026	3,285	3,285	0	316	316	316	3,285
				214,122	57,562	271,684	158,721	

Source: Study Team

Efficiency Measures	
EIRR	-2.9 %
NPV (Million Rp.)	-59,398
B/C	0.06

Source: Study Team

These results indicate that implementation of the Project (road development of link No. 4) was proposed to be undertaken as per schedule but its direct benefit is small.

10.2.3 Buol – Umu (Link No.5)

(1) Rout Description

The road concerned is 141.0 km in length and connects Buol, a principal city in the northern part of Kabupaten Toli Toli, with North Sulawesi. Villages engaged mainly in agriculture, forestry, and fishery are dotted over a flat plain along the route. The road is used for agricultural development of the adjacent area, for shipping and for the daily life of residents along the route. Along the planned road improvement section, development of paddy fields through transmigration is under way. The pavement of the existing road connecting these cities is poorly maintained and the bridges and structures spanning over the road are damaged considerably. The road structure is based on a low standard of design in terms of vertical and horizontal alignments and width. This often limits the number of vehicles that can pass through during the rainy season. The road is often closed also due to collapse of the face of slopes. High waves in the sea area to the east of this district due to strong wind during the rainy season, cause the stoppage of offshore traffic of small ships. As a consequence, this road is the only on-land transportation route available during the rainy season.

Location of roads concerned

- Province: Central Sulawesi
- Kabupaten: Boul Tolitoli,
- Kecamatan: Momunu, Bocat, Bunobogu, Palepaha
- Major cities and settlement: Lamadong, Bocat, Bunobogu, Paleleha
- Link length: 141.0 km

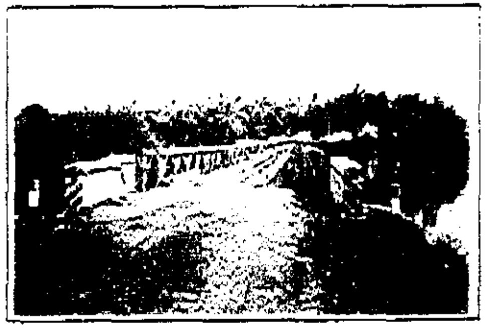
(2) Road Traffic

The future traffic demand of the road link are summerized as indicated in Table 10-2-10.

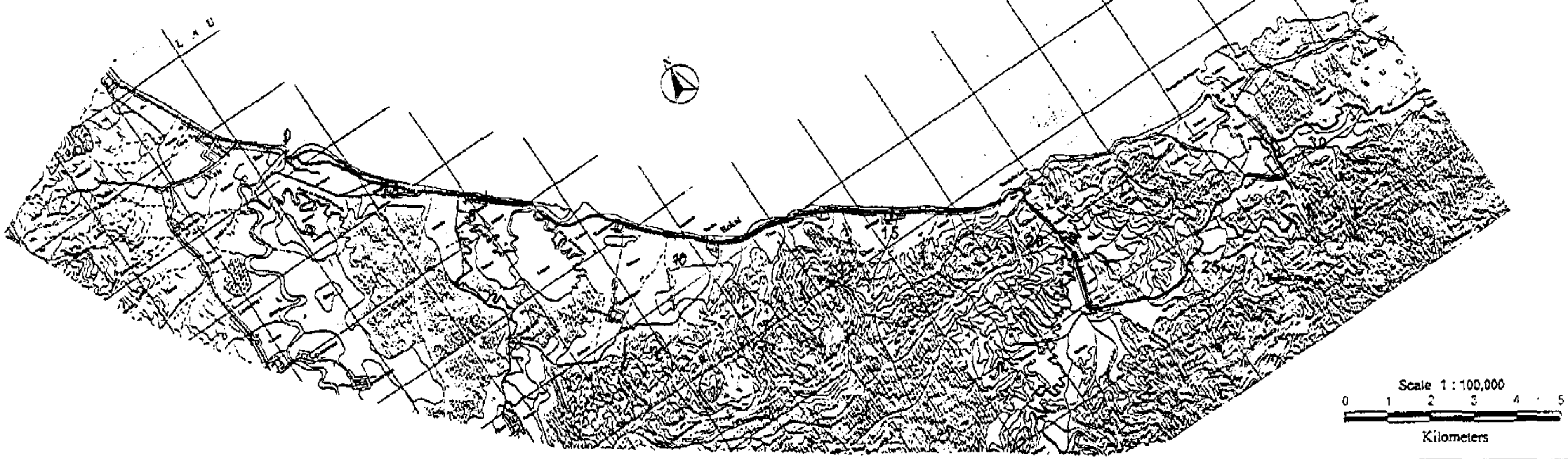
Table 10-2-10 Future Traffic Volume of Buol – Umu

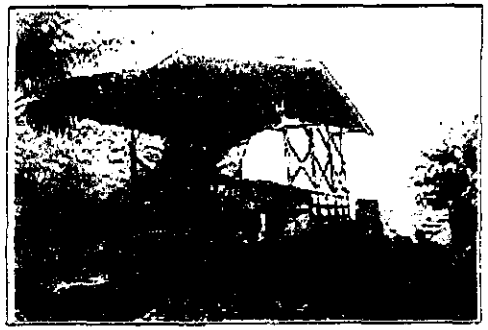
	Year 2003 (vehicle/day)	Year 2018 (vehicle/day)
Motorcycle	8	33
Passenger cars	7	2
Buses	6	19
Trucks	3	10
Total	24	84

Source: Study Team



Link 5-1





Location Map

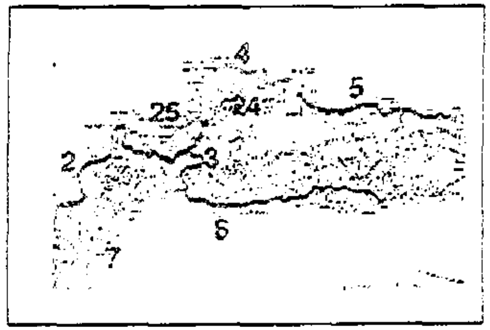
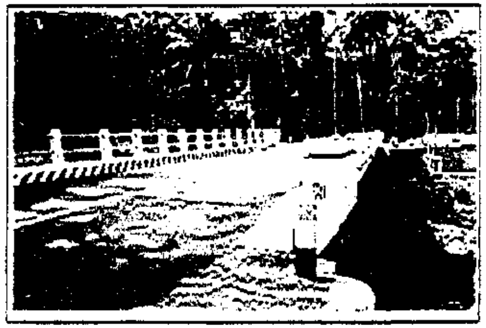
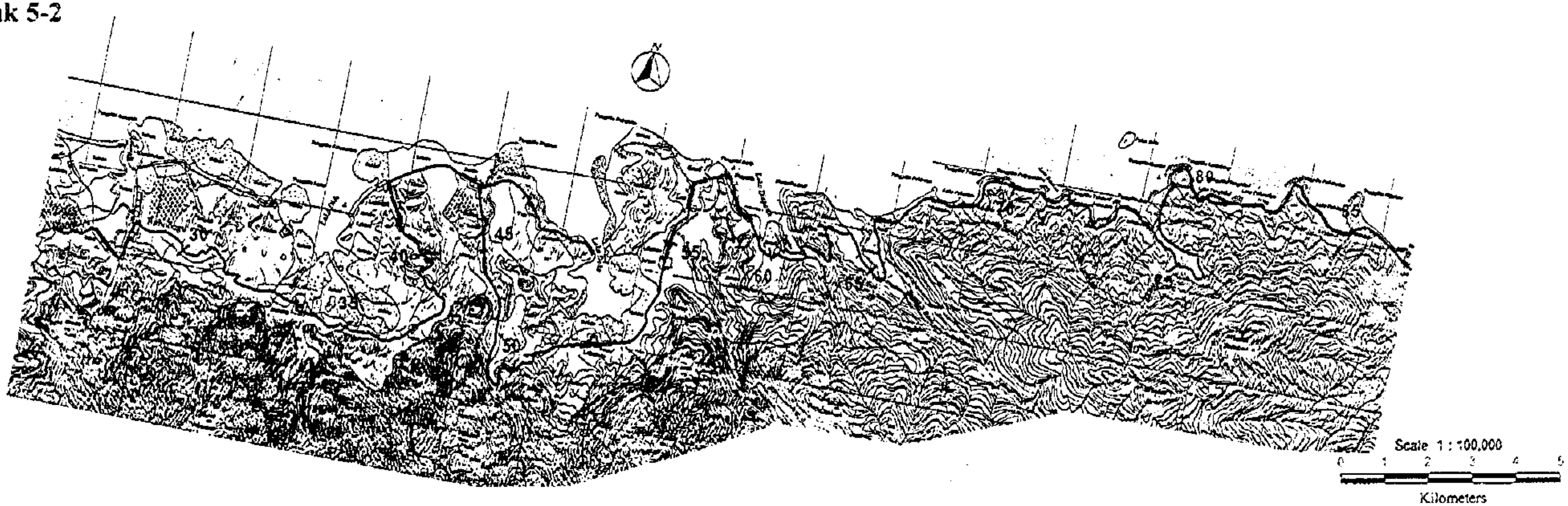
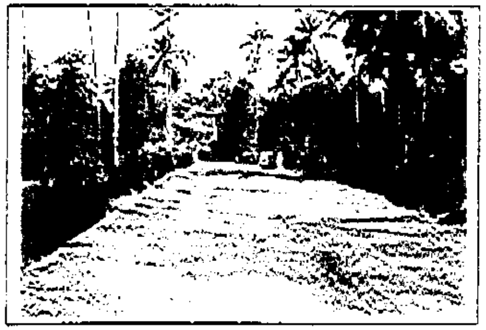


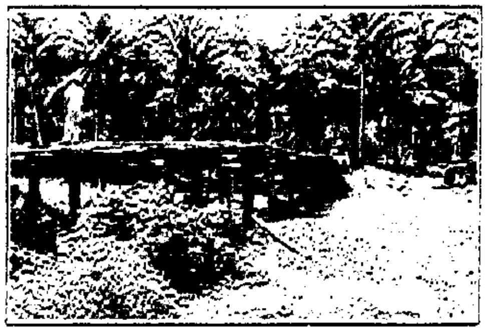
Figure 10-2-8 (1)



Link 5-2







Location Map

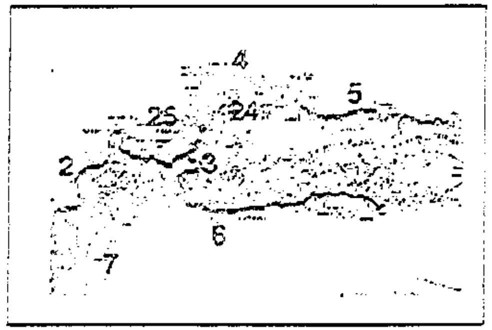
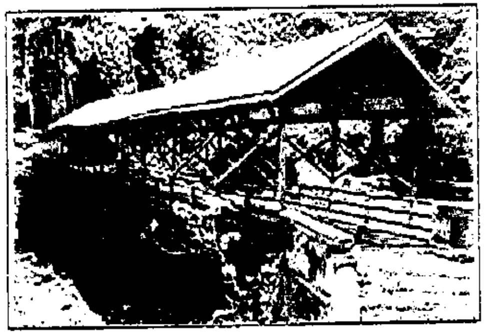
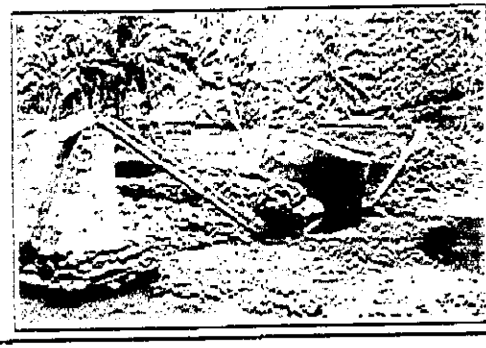
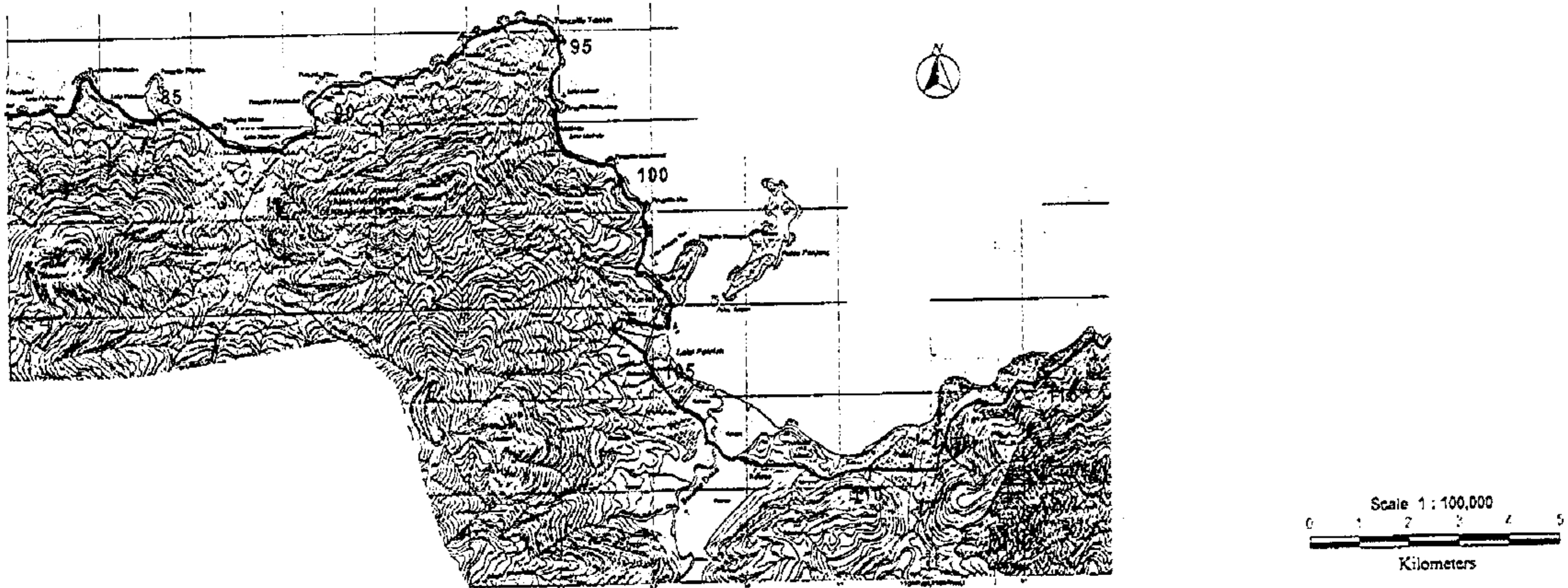


Figure 10-2-8 (2)



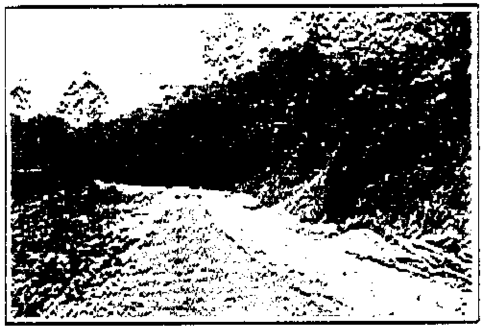


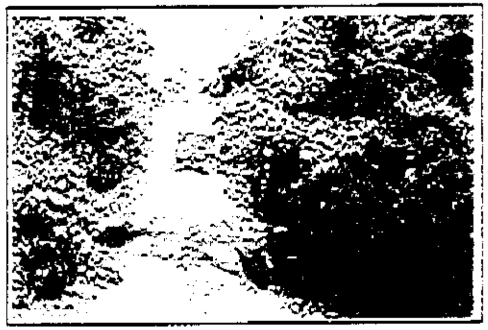
Link 5-3



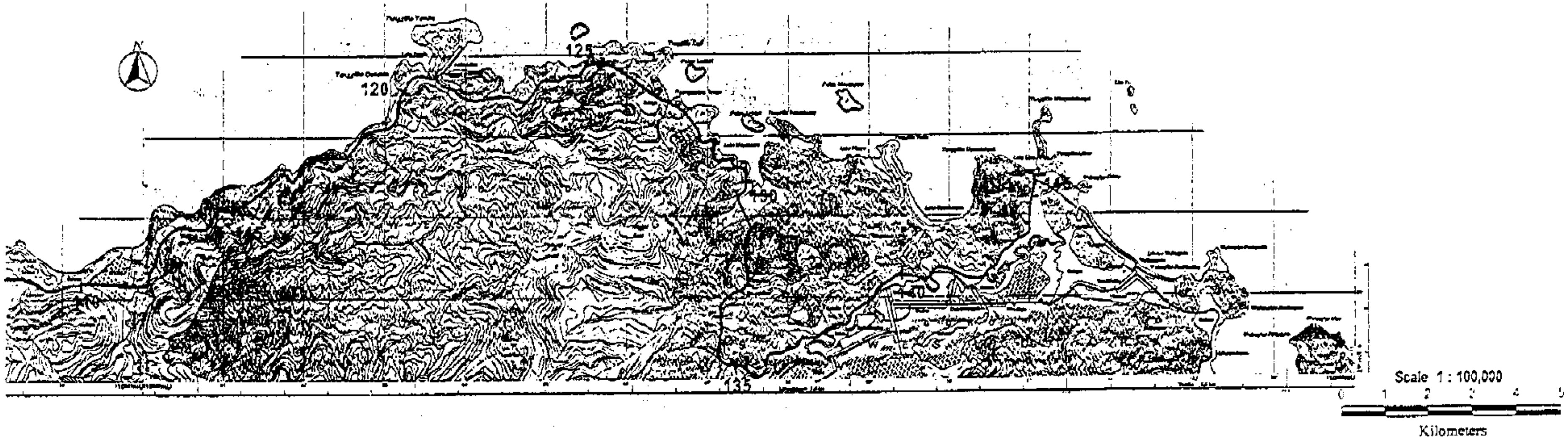
Location Map

Figure 10-2-8 (3)





Link 5-4



Location Map

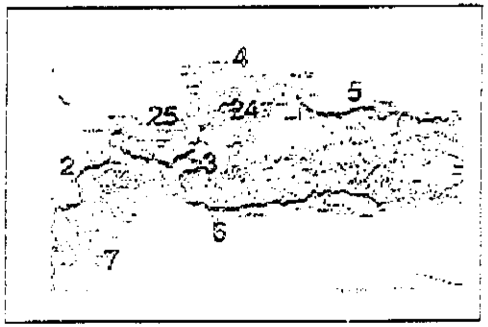
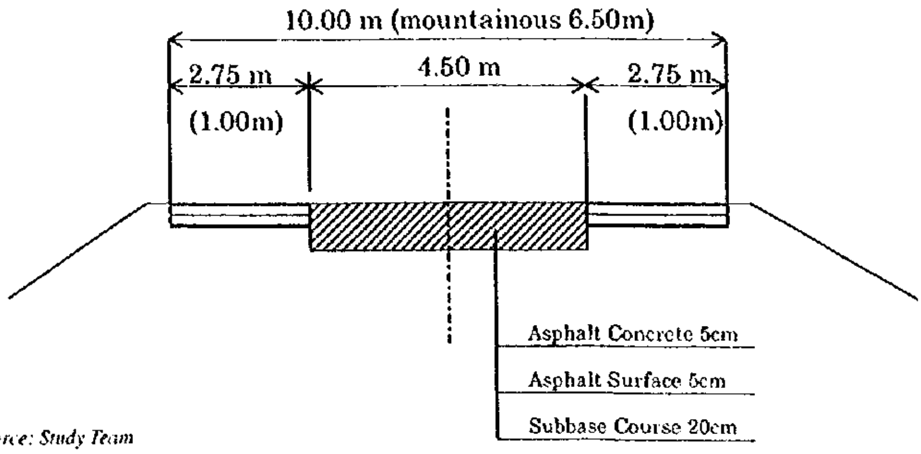


Figure 10-2-8 (4)

(3) Typical Cross Section and Pavement (link No. 5)

The total width will be 10 m (or 8 m in mountainous area), including 4.5 m for the pavement of carriage way, 2.75 m for shoulders in flat sections.



Source: Study Team

Figure 10-2-9 Typical Cross Section for Link No. 5

The pavement will be of C type with a surface thickness of 5 cm. The plan also calls for an additional surface course of 5 cm as an overlay in seven years after road construction. Pavement thickness was decided by the future traffic demand with traffic demand.

(4) Preparatory Engineering of Bridges (Link No. 5)

Typical cross section of bridge is shown in Figure 10-2-4 and the bridge improvement concept is shown in Figure 10-2-5.

Existing bridge condition and bridge improvement plan on the road of link No.5 are listed in Table 10-2-11.

Quantity of bridge improvement on the road link No.5 is summarized in Table 10-2-12.

Table 10-2-11 Existing Bridge and Bridge Improvement Plan for Link No. 5

Road Link No.	Bridge No.	Location From	Location Km	Length (m)	Nos. Span	Width (m)	Type of Super-structure	Improvement Plan
5	1	Buol	0.00	155.0	5	3.5	Bailey	Rplace
5	2	Buol	13.90	51.4	1	6.0	Steel Truss	Retain existing
5	3	Buol	22.40	51.4	1	6.0	Steel Truss	Retain existing
5	4	Buol	23.10	10.0	1	3.5	Wooden Girder	Replace
5	5	Buol	26.40	9.5	1	4.4	Wooden Girder	Replace
5	6	Buol	27.20	51.4	1	6.0	Steel Truss	Retain existing
5	7	Buol	28.70	9.2	1	4.4	Wooden Girder	Replace
5	8	Buol	29.80	9.0	1	4.4	Wooden Girder	Replace
5	9	Buol	29.20	9.0	1	4.0	Wooden Girder	Replace
5	10	Buol	29.40	6.1	1	4.0	Wooden Girder	Replace
5	11	Buol	32.80	21.0	2	3.5	Wooden Girder	Replace
5	12	Buol	37.60	26.0	3	3.5	Wooden Girder	Replace
5	13	Buol	37.75	30.0	4	3.5	Wooden Girder	Replace
5	14	Buol	40.20	9.6	1	5.0	Wooden Girder	Replace
5	15	Buol	41.10	17.0	2	4.2	Wooden Girder	Replace
5	16	Buol	42.50	6.3	1	5.0	Wooden Girder	Replace
5	17	Buol	43.90	24.4	3	4.2	Wooden Girder	Replace
5	18	Buol	44.90	60.0	6	4.0	xxx	Replace
5	19	Buol	47.20	9.0	1	4.5	Concrete Girder	Retain existing
5	20	Buol	55.40	6.3	1	4.0	Concrete Girder	Retain existing
5	21	Buol	52.30	60.0	6	4.0	xxx	New Construction
5	22	Buol	61.70	40.0	8	4.0	Wooden Girder	Replace
5	23	Buol	61.80	29.8	4	4.0	Wooden Girder	Replace
5	24	Buol	65.60	15.0	2	4.0	Wooden Girder	Replace
5	25	Buol	64.00	25.0	5	4.0	xxx	New Construction
5	26	Buol	68.90	6.7	1	5.0	Concrete Girder	Retain existing
5	27	Buol	71.80	90.8	10	4.0	Concrete Girder	Retain existing
5	28	Buol	81.30	12.0	3	3.8	Bailey	Replace
5	29	Buol	81.60	7.3	1	3.0	Bailey	Replace
5	30	Buol	84.50	8.4	1	3.0	Bailey	Replace
5	31	Buol	92.95	20.0	1	0.0	xxx	New Construction
5	32	Buol	86.90	9.0	1	3.0	Bailey	Replace
5	33	Buol	97.80	90.0	1	0.0	Bailey	Replace
5	34	Buol	101.95	40.0	8	4.0	Wooden Girder	Replace
5	35	Buol	122.05	40.0	1	0.0	xxx	New Construction

Source: Bina Marga

Table 10-2-12 Summary of Quantity of Bridge Improvement for Road Link No.5

	LINK NAME		ROAD LENGTH (km)	QUANTITY OF BRIDGE CONSTRUCTION (m^2) CLASSIFICATION BY SPAN LENGTH : L(m)			
				L<=10m	10m<L<=20m	20m<L<=30m	L>30m
5	BUOL-UMU						
	BUOL	BODI	48.0	510	120	660	1,058
	BODI	PALELEH	46.0	239	300	330	1,590
	PALELEH	UMU	47.0	0	0	180	480
	TOTAL 5		141.0	749	420	1,170	3,128

Source: Bina Marga

(5) Preparatory Engineering of Slope Protection Works (Link No. 5)

Slope protection works are constructed to protect the slopes from erosion or weathering by covering them with vegetation or structures and also to stabilize the slopes by means of drainage works or retaining structures. The following types of slope protection works are adopted for the pre-feasibility route considering the terrain and geology, as shown in Table 10-2-13.

Necessary length of slope protection works for each link is shown in Figure 10-2-10.

Table 10-2-13 Quantities of Slope Protection (Link No. 5)

	Cut			Fill
	Sprayed Concrete Cribwork(m^2)	Shotcrete (m^2)	Stone Masonry (m^2)	Mat Gabion (m^2)
Quantity	5,811	0	3,561	5,735

Source: Study Team

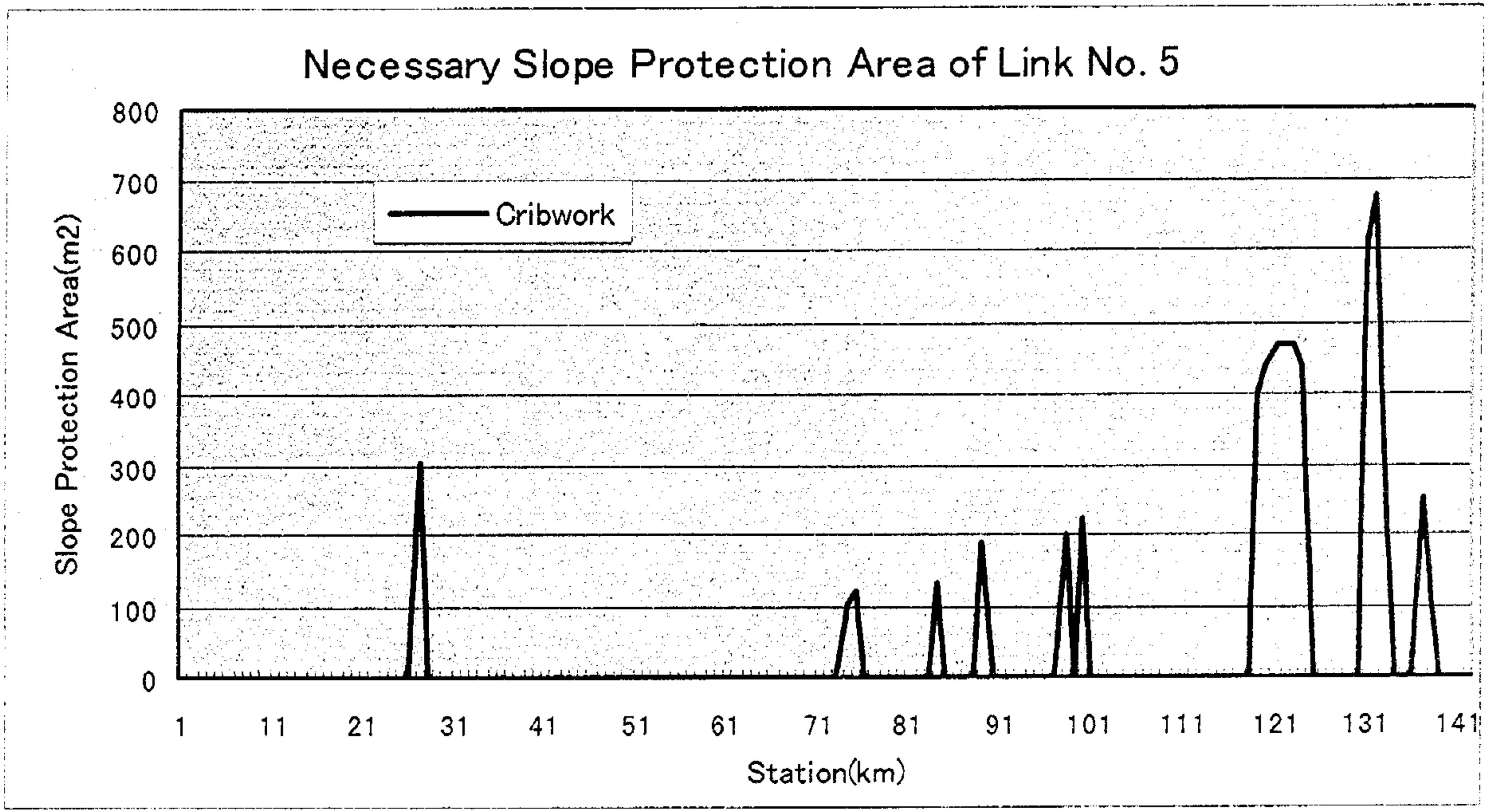
(6) Cost Estimation (Link No. 5)

1) Estimated Project Cost

Cost items consist of preparation works, pavement, earth work, drainage, bridge, slope protection and safety facilities works. The engineering service cost is estimated at 20% of the total cost of direct and indirect cost. A contingency allowance has been included in 10 % of total construction and engineering cost. Table 10-2-14 shows the result of estimated project cost.

2) Implementation Plan

As shown in Figure 10-2-11, the construction period was proposed to be 5 years consisting of one year for preparation of project for fund raising plan, 1.5 years for detailed design of the roads and 2.5 years for construction. Also, the investment plan is set in accordance with the construction plan.



Source: Study Team

Figure 10-2-10 Necessary Slope Protection Area

Table 10-2-14 Total Construction Cost for Buol - Umu Road (Link No. 5)

Rate: 1US$ = 10,600 Rp. = 140 Yen

Item	Unit	Quantity	Unit Price: Foreign (US$)	Unit Price: Financial (Rp)	Unit Price: Economic (Rp)	Total Price: Foreign (US$)	Total Price: Local Financial (Rp)	Total Price: Local Economic (Rp)	Total Price: Financial Total (Mill. Rp)
1. **Preparation Works**									
Clearing and Grubbing	m^2	620,331	0.23	1,867	2,099	142,676	1,158,157,977	1,302,074,769	2,671
2. **Pavement**									
Road Asphalt Concrete + Sub Base (Type A)	m	0	39.50	436,896	392,152	0	0	0	0
Road Asphalt Concrete + Sub Base (Type B)	m	0	31.76	351,336	315,832	0	0	0	0
Road Asphalt Concrete + Sub Base (Type C)	m	141,000	16.15	188,584	175,452	2,277,150	26,590,344,000	24,738,732,000	50,728
Transport for Pavement Material (L = 43 km)	m^3	7,050	4.45	33,143	38,667	31,373	233,658,150	272,602,350	566
Sub-2						2,308,523	26,824,002,150	25,011,334,350	51,294
3. **Earth Work**									
Excavation (Common)	m^3	547,211	0.92	7,407	8,213	503,434	4,053,191,877	4,494,243,943	9,390
Excavation (Sound Rock)	m^3	62,030	4.12	33,605	36,492	255,564	2,084,518,150	2,263,598,760	4,793
Disposal Soil (L = 5 km)	m^3	60,924	1.20	8,610	10,050	73,109	524,555,640	612,286,200	1,300
Sub-3						832,107	6,662,265,667	7,370,128,903	15,483
4. **Drainage**									
Pipe Culvert (D = 100 cm)	m	1,410	44.35	634,758	554,426	62,534	895,008,780	781,740,660	1,558
Box Culvert (B = 2.0 m, H = 2.0 m)	m	705	325.89	3,064,762	2,510,606	229,752	2,160,657,210	1,769,977,230	4,596
U-Ditch (U = 30 cm)	m	46,998	1.71	41,910	36,720	80,367	1,969,686,180	1,725,766,560	2,822
Sub-4						372,653	5,025,352,170	4,277,484,450	8,975
5. **Slope Protection**									
Sprayed Concrete Cribwork	m^2	5,811	14.68	127,197	88,984	85,305	739,141,767	517,086,024	1,643
Shotcrete Work	m^2	0	11.82	101,390	67,157	0	0	0	0
Stone Masonry	m^2	3,561	6.91	116,286	109,711	24,607	414,094,446	390,680,871	675
Mat Gabion	m^2	5,735	9.20	72,584	61,374	52,762	416,269,240	351,979,890	976
Sodding	m^2	75,241	0.08	3,238	2,851	6,019	243,630,358	214,512,091	307
Sub-5		15,107				168,693	1,813,135,811	1,474,258,876	3,601
6. **Tunnel**	m	0	3,500.00	22,400,000	17,920,000	0	0	0	0
7. **Bridges**									
L<=10 m	m^2	749	206.20	2,233,568	1,843,094	154,446	1,672,942,494	1,380,477,718	3,310
10 m<L<=20 m	m^2	420	287.55	2,506,242	2,008,820	120,769	1,052,621,787	843,704,495	2,333
20 m<L<=30 m	m^2	1,170	313.65	2,643,773	2,102,930	366,972	3,093,214,950	2,460,428,659	6,983
30 m<L	m^2	3,128	345.02	2,908,151	2,313,224	1,079,211	9,096,695,725	7,235,763,188	20,536
Sub-7		5,467				1,721,398	14,915,474,956	11,920,374,060	33,162
8. **Safety Facilities Works**									
Guard Railing	m	14,100	11.30	168,012	143,025	159,330	2,368,969,200	2,016,652,500	4,058
Traffic Sign	each	470	27.98	426,548	373,259	13,151	200,477,560	175,431,731	340
Line Marking	m	141,000	0.42	4,231	3,518	59,220	596,571,000	496,038,000	1,224
Sub-8						231,701	3,166,017,760	2,688,122,231	5,622
9. **Mobilization & Temporally Works (20 % of Total Cost)**						1,139,703	12,080,855,657	10,510,344,422	24,162
10. **Sub-Total**						6,917,454	71,645,262,148	64,554,122,061	144,970
11. **Engineering Cost (20 % of 10)**						1,914,702	13,530,558,336	10,824,446,669	33,826
12. **Contingency (10 % of 10 + 11)**						883,216	8,517,582,048	7,537,856,873	17,880
Ground Total Cost (10+ 11 + 12)						9,715,372	93,693,402,532	82,916,425,603	196,676

Source: Study Team

Item	Unit	Quantity	2003	2004	2005	2006	2007	Total
1. Preparation of Project								
2. Survey and Design	km	141.0						
3. Construction								
Earth Work	m^3	609,241.0						
Slope Protection	m^2	-						
Tunnel	m	0.0						
Bridges	m	-						
Pavement	km	141.0						
Foreign (US$)				526,543	1,763,995	2,993,119	4,431,713	9,715,371
Local Financial Cost (Rp)				3,720,903,542	15,852,714,202	26,846,388,323	47,273,396,465	93,693,402,532
Local Economic Cost (Rp)				2,976,722,834	14,668,985,379	23,059,433,952	42,211,283,436	82,916,425,601
Total Financial Cost (Mill. Rp)				9,302	34,551	58,573	94,250	196,676
Total Economic Cost (Mill. Rp)				8,558	33,367	54,786	89,187	185,899

Source: Study Team

Figure 10-2-11 Implementation Schedule for Buol - Umu Road (Link No. 5)

(7) Economic Analysis (Link No. 5)

1) Economic Project Costs

The economic investment costs are estimated in constant 1998 prices. The financial investment costs in terms of market price include the component of taxes. The economic costs for economic analysis are obtained by subtracting the portion of transfer payment such as taxes from financial costs. The financial and economic costs (initial investment and maintenance costs) are summarized in Table 10-2-15.

Table 10-2-15 Initial Investment and Maintenance Costs

(Million Rp.)

	Economic Prices
Initial Investment Cost (Construction)	185,898
Routine Maintenance Cost Per Year	256
Periodic Maintenance Cost Per Year	20,483

Source: Study Team

The maintenance cost of the proposed road follows the engineering study results of the cost estimates, Besides, the maintenance cost of the proposed road in the case of "without the improvement of the proposed road" is treated as a negative cost.

2) Economic Benefits

Benefits are classified into two types, one is the direct benefit and the other is the indirect benefit or intangible benefit.
The direct benefits which would be realized from the implementation of the Project are defined as the savings in travel costs, composed of the vehicle operating cost and vehicle time cost when comparing the "With" and "Without" project conditions.

The benefit of vehicle operating costs is estimated as a difference of vehicle operating costs between "With" Project" case and "Without" Project" case. The vehicle operating cost is derived from the obtained daily vehicle-kilometers and the unit vehicle operating cost by vehicle type. In addition, a promotion of traffic safety and saving in accident costs are anticipated.

In this economic analysis, the above mentioned direct benefit, e.g. the vehicle operating cost saving is computed as a quantified benefit. The calculation of direct benefits are made for the planning year of 2003 and 2018.
As a result, the saving in vehicle operating cost is summarized as shown in Table 10-2-16.

Table 10-2-16 Estimated Economic Benefits

(Million Rp. at 1998 price)

Year	Benefit of Saving in VOC
2008	234
2018	701

Source: Study Team

3) Economic Cost-Benefit Analysis

The analysis follows the conventional discounted cash flow method in determining the economic internal rate of return (EIRR), the net present value (NPV) and the benefit cost ratio (B/C). (NPV and B/C are calculated at a discount rate of 15 percent.) The project life is assumed to be 20 years after the completion of the construction.

The benefits in the intermediate years were interpolated and those beyond 2018 were assumed to be fixed. The total economic project costs and benefits streams are presented in Table 10-2-17. The efficiency measures were calculated and the summary is as follows:

Table 10-2-17 Economic Analysis for Link No. 5

(Million Rp.)

	Year	Benefits		Costs			Maint. Cost (Without)	Net Cash Flow
		VOC Saving	Total	Invest. Costs	Maint. Cost (With)	Total		
1	1999			0	0	0	0	0
2	2000			0	0	0	0	0
3	2001			0	0	0	0	0
4	2002			0	0	0	0	0
5	2003	0	0	0	0	0	0	0
6	2004	0	0	8,558	256	8,814	256	-8,558
7	2005	0	0	33,367	256	33,623	256	-33,367
8	2006	0	0	54,786	256	55,042	17,732	-37,310
9	2007	0	0	89,187	256	89,443	256	-89,187
10	2008	234	234	0	256	256	256	234
11	2009	280	280	0	256	256	256	280
12	2010	327	327	0	256	256	256	327
13	2011	374	374	0	256	256	17,732	17,850
14	2012	421	421	0	256	256	256	421
15	2013	467	467	0	256	256	256	467
16	2014	514	514	0	20,483	20,483	17,732	-2,237
17	2015	561	561	0	256	256	256	561
18	2016	607	607	0	256	256	256	607
19	2017	654	654	0	256	256	17,732	18,130
20	2018	701	701	0	256	256	256	701
21	2019	701	701	0	256	256	256	701
22	2020	701	701	0	256	256	17,732	18,177
23	2021	701	701	0	20,483	20,483	256	-19,526
24	2022	701	701	0	256	256	256	701
25	2023	701	701	0	256	256	17,732	18,177
26	2024	701	701	0	256	256	256	701
27	2025	701	701	0	256	256	256	701
28	2026	701	701	0	256	256	17,732	18,177
29	2027	701	701	0	256	256	256	701
				185,898	46,598	232,496	128,476	

Source: Study Team

Efficiency Measures	
EIRR	-5.6 %
NPV (Million Rp.)	-48,338
B/C	0.02

Source: Study Team

These results indicate that implementation of the Project (road development of link No. 5) was proposed to be undertaken as per schedule but its direct benefit is small.