6. NATURAL CONDITION SURVEYS AND ANALYSIS

6.1 Hydrology

(1) Review of Existing Data and Plans

1) Rainfall Data

The daily/hourly rainfall data were collected from rainfall gauging stations in the study area to review the recent rainfall tendency and update probable rainfall analyses. The average maximum daily rainfall of each river basin had been calculated by the "Thiessen Polygon Method", the "Arithmetric Mean Method" or the "Isohyetal Method", in the previous study. Therefore correlations between the basin average daily maximum rainfall and the point rainfall of each rainfall station were calculated, and the correlation ratios were determined.

The accumulative rainfall data by minute/hour were collected from the Salorijang Rainfall Station (the Maros River Basin) and Takalar Rainfall Station (the Pappa River Basin) to prepare probable rainfall intensity-duration-frequency curves.

2) Flood Inundation Records

Maros River

The Maros river runs meandering through the downstream area along Maros town. Due to the meandering, serious flood inundation frequently occurs particularly in and around Maros town during the rainy season despite the construction of a river embankment of about 4.5 km in length. Recent occurrences of major floods by river overflow are indicated below.

i) In 1986, the dike of Maros was breached by flood discharge, and the low-lying area of about 13,000 ha along the river was inundated.
ii) In 1999, flood overflow occurred causing inundation over an area of about 12,700 ha which recorded the maximum inundation depth of about 0.8 m and lasted for almost two (2) days.
iii) In 2000, the river flood flow was blocked by an illegally constructed access road from the river channel leading to flood inundation over an area of about 500 ha.

Tallo River

Despite of habitual flood inundation, industrial estates tend to expand along the new arterial road constructed in the lower reaches of the Tallo River, which leads to the increment of flood damage potential. A recent flood occurred in February 2000, inundating an area of 2,535 ha with the maximum inundation depth reaching 1.5m.

Jeneberang River

The Jeneberang River has not caused any serious flood overflow since the completion of the river

improvement works and construction of the Bili-Bili Dam.

Gamanti River and Pappa River

The Pappa River caused flood overflow in 2000 when a residential area of 3,000 ha and fishponds of 700 ha in total were inundated. Flood overflow also occurred along the Gamanti River in 1999 causing flood inundation in an area of 1,415 ha.

3) Design Standard of Flood Control

The Study referred to the Flood Control Manual, 1993 issued by the Ministry of Public Works. **Tables 6.1 and 6.2** are scales and freeboard for dyke adopted for the target river stretches.

Table 6.1 Design Scale by Rivers

River	Protection Area (ha)	Target City to be protected	Population to be protected	Design Scale	Design Discharge (m^3/sec)
Maros	13,000	Maros	22,000	25-year	1,240
Tallo	4,600	Makassar	430,000	50-year	1,010
Bringkassi	1,500	Takalar	6,300	10-year	130
Pappa					520

Source: Comprehensive Water Management Plan Study for Maros Jeneberang River Basin, Nov. 2001 prepared by P.U.

Table 6.2 Design Criteria for Height of Freeboard

Design Discharge (m^3/sec)	Freeboard
Q < 200	0.5
200 < Q <500	0.8
500 < Q < 2,000	1.0
2,000 < Q < 5,000	1.2
5,000 < Q < 10,000	1.5
10,000 < Q	2.0

4) Flood Control Plans

The Makassar City and all regencies in the study area suffer from chronic inundation by river overflow and storm water discharge. The major causes of flood are classified into the following:

- Insufficiency of river flow capacity
- Insufficiency of urban drainage capacity
- Incremental flood runoff discharge associated with lack of vegetation in the upper reaches.

The following flood control projects were identified by the 2001 JICA Study for the study area:

- Maros River Flood Control Project (Maros City)
- Tallo River Flood Control Project (Makassar City)
- Gamanti/Pappa River Flood Control Project (Takalar City).

A summary of the measures to be included in the optimum flood mitigation plan for each of the target river is presented in **Table 6.3**.

Table 6.3 Measures Included in the Flood Mitigation Plan

River	Structural Measures			Non-structural Measures		
	Dike	Shortcut	Retarding Basin	Restriction Area	Flood Information	Flood Risk Map
Maros	O	O	O	O	O	O
Tallo	O	O	O	O	O	O
Gamanti	O	-	-	-	O	O
Pappa	O	-	-	O	O	O

Source: Comprehensive Water Management Plan Study for Maros Jeneberang River Basin, Nov. 2001 prepared by P.U.

However, the economic viability of these projects is not so high according to the 2001 JBIC Study.

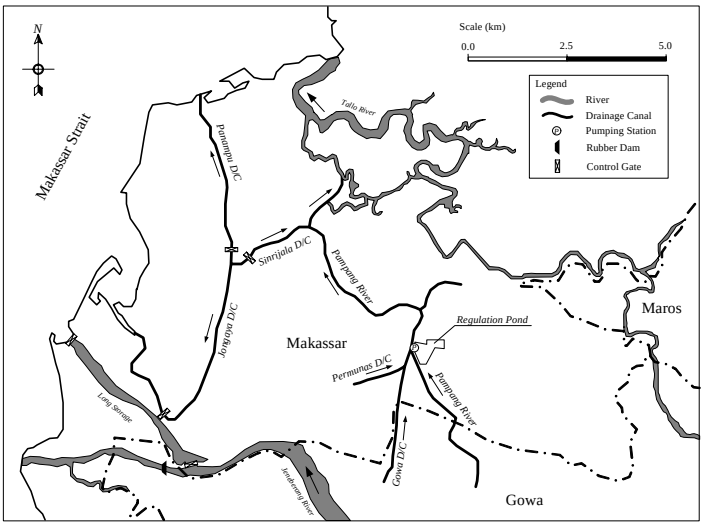
In 1989, the Bili-Bili Multipurpose Dam with a flood capacity of 41 million m^3 was completed to control the flood discharge of the Lower Jeneberang River, particularly, along the urban area of the Makassar City. As a result, the city is currently protected against the probable river flood overflow of 50-year return period. The design discharges brought about by the above river channel improvement and flood regulation by the Bili-Bili Dam are summarized in **Table 6.4**.

Table 6.4 Design Discharge at Sungguminasa Bridge

Description	Discharge (m^3/sec)
Basic Flood Discharge (50-year return period)	3,700 m^3/sec
Discharge regulated by the Bili-Bili Dam	1,200 m^3/sec
Design Flood Discharge	2,500 m^3/sec
Design Return Period	50-year return period

Source: Comprehensive Water Management Plan Study for Maros Jeneberang River Basin, Nov. 2001 prepared by P.U.

Figure 6.1 illustrates the existing drainage system for Makassar City. Primary drainage channel improvement of 30.7 km was carried out with financial assistance from JBIC for a drainage area of 64.3 km^2 in the Makassar City. The design scale of this improvement work was determined for a 20-year return period. However, some local inundation problem still remains.



Source: Mamminasata Study

Figure 6.1 Existing Drainage System of Makassar

(2) Flood Analysis

1) Storm Rainfall

According to the rainfall records, recently most heavy rainfall on monthly basis, 1,473 mm/month at the Salorijang (Maros) station, and 1,469 mm/month at the Ujung Pandang station (Makassar) occurred on January 1999 respectively. The most heavy one-year rainfall, 6,992 mm/year and 4,949 mm/year, were recorded during the period from October 1998 to September 1999, at the Salorijiang and Ujung Pandang rainfall stations respectively.

2) Probable Rainfall

Probable Maximum Daily Rainfall

Probable 1-day rainfall of each representative rainfall station and river basin was calculated by Gumbel-Chow Method, which includes the additional rainfall data (2000-2006) as in **Table 6.5**.

Table 6.5 Revised Probable Maximum Daily Rainfall

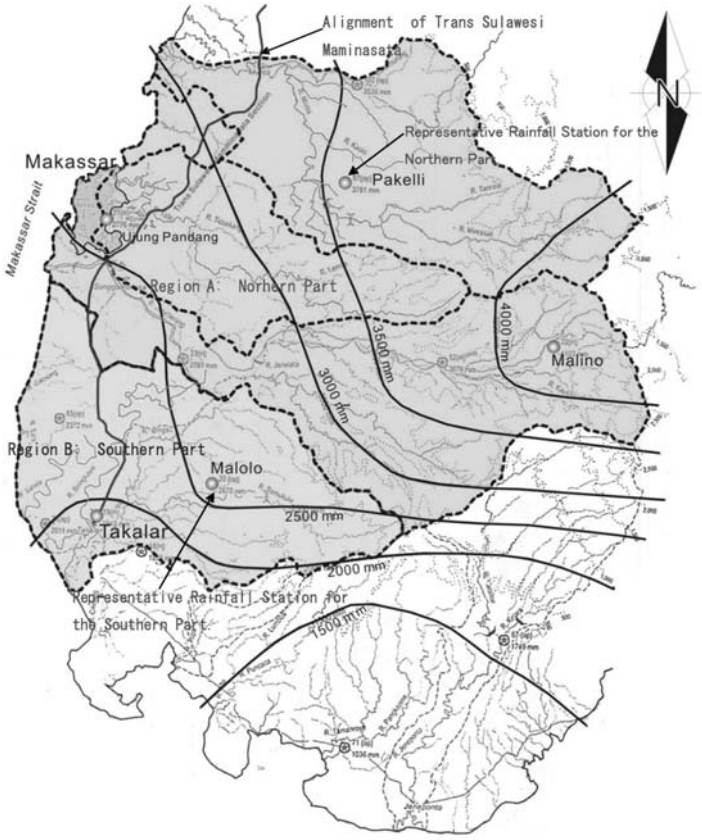
(Unit:mm)

River Basin	Maros			Tallo			Jeneberang			Pappa		
Return Period (Year)	Existing Study *1	Revised Values*2	Change Rate(%)	Existing Study *1	Revised Values*2	Change Rate(%)	Existing Study *1	Revised Values*2	Change Rate(%)	Existing Study *1	Revised Values*2	Change Rate(%)
2	146	173	19%	120	146	22%	107	128	20%	116	124	7%
5	186	197	6%	160	174	9%	145	150	3%	154	144	-7%
10	212	217	2%	185	198	7%	171	169	-1%	179	161	-10%
20	237	239	1%	210	226	8%	196	190	-3%	202	181	-11%
50	269	272	1%	243	269	11%	228	222	-3%	234	210	-10%
100	293	300	2%	266	306	15%	251	250	0%	258	236	-9%
200	317	330	4%	290	349	20%	275	282	2%	280	264	-6%

*1: Comprehensive Water Management Plan Study for Maros Jeneberang River Basin, Nov. 2001
*2: Probable Rainfall Analyses were made with including additional rainfall data from 2000 to 2006.

Probable Rainfall Intensity

The rainfall intensity data recorded at the Pakelli (Maros River Basin) and Malolo (Pappa River Basin, Takalar) rainfall stations shall be adopted to show the regional rainfall intensity pattern of the northern part and southern part of the study area. The regional area for calculation of rainfall intensity is shown in **Figure 6.2**.



Source: Isohyetal Map, Comprehensive Water Management Plan Study for Maros Jeneberang River Basin, Nov. 2001

Figure 6.2 Area of Regional Rainfall Intensity Analysis

The results of probable rainfall intensity of the Pakelli and Malolo rainfall stations are analyzed and their probable rainfall intensity-duration-frequency curves were made as representative of the regional rainfall intensity for the Study area as shown in **Figure 6.3**.

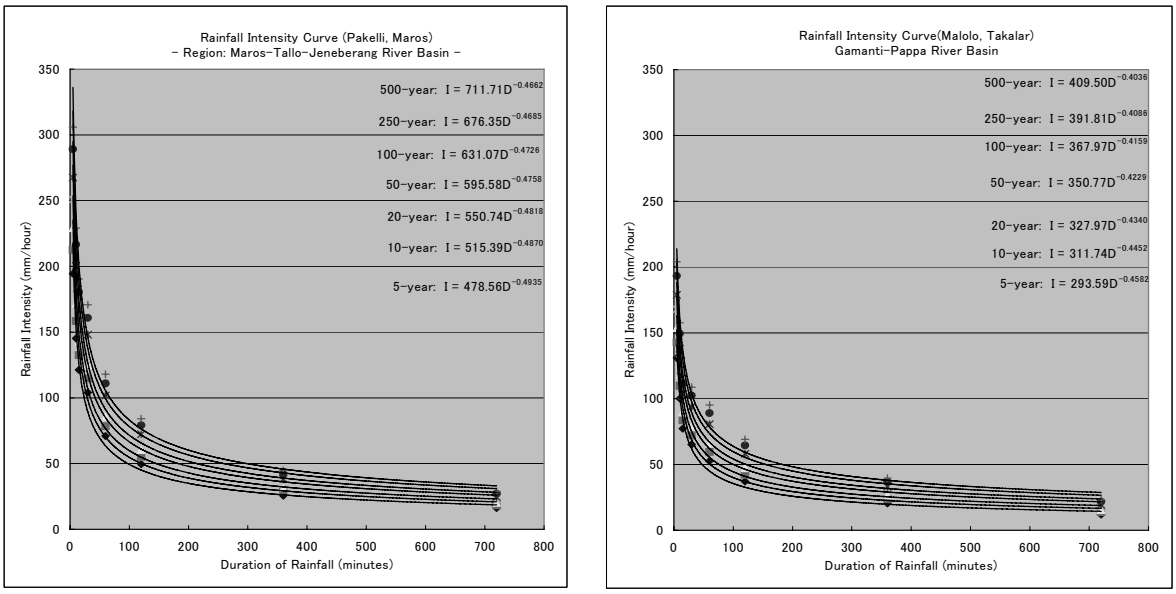


Figure 6.3 Probable Rainfall Intensity-Duration-Frequency Curves for the Study Area

Probable Annual Rainfall

The return period of annual storm rainfall depth at the Salojirang (Maros) and Ujungpandang (Makassar) rainfall stations from October to the next September was calculated to evaluate the level of recent floods, and the results are shown in **Figure 6.4**:

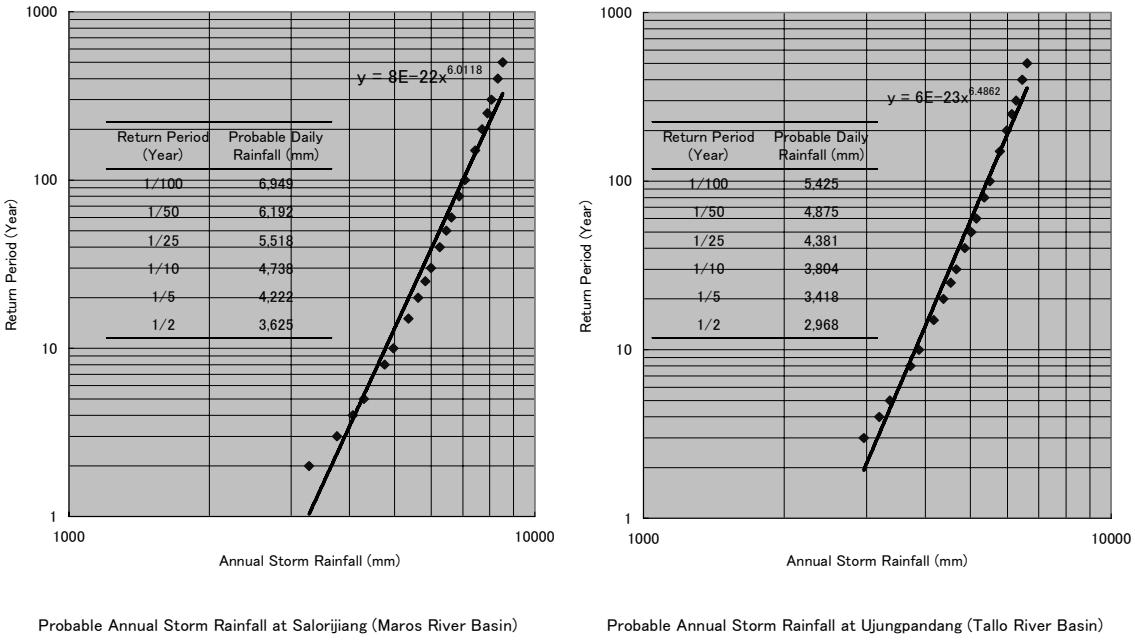


Figure 6.4 Probable Annual Storm Rainfall in the Maros and Tallo River Basins

3) Flood Inundation Depth and Road Alignment

Maros River Basin

The proposed alignments of the Trans Sulawesi road and Mamminasa Bypass run through the flood inundation area and flood retarding basin in/around the Maros City. A new bridge on the Mamminasa Bypass was designed. It will cross over the Maros River at 1 km upstream of the Alliritengae Bridge where no flood control structures such as dike will be constructed in the flood control plan.

A flood inundation survey was conducted in the proposed road alignments and a bridge site to set the design flood water levels temporarily. Locations of flood inundation areas, flood control plans, and interview surveys on the flood inundation in/around the Maros City are shown in **Figure 6.5**.

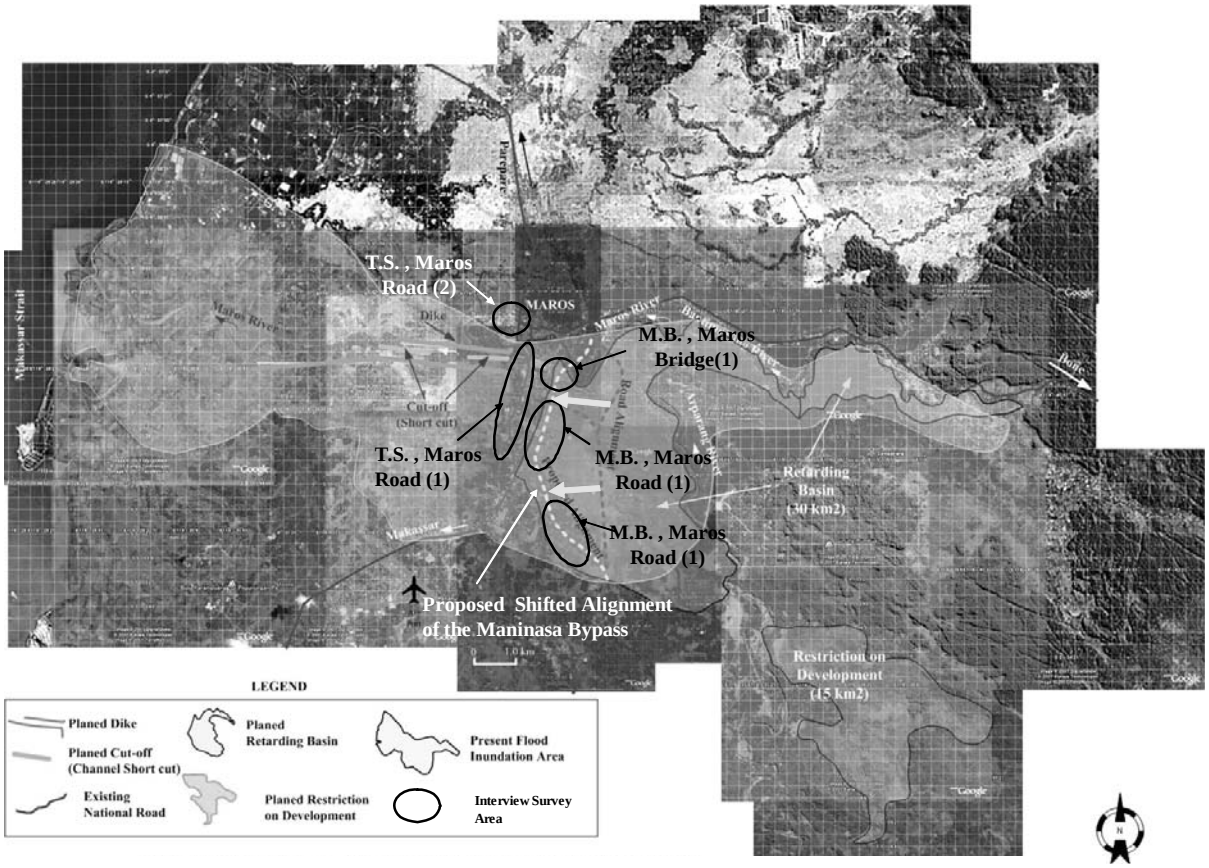


Figure 6.5 Locations of Flood Inundation Area, Flood Control Plan, and Interview Survey in Maros

From the flood control viewpoint, the originally proposed alignment of the Mamminasa Bypass passing through the retarding basin (existing paddy field) should be sifted to the existing national road as much as possible to avoid reducing area of the flood retarding basin.

Tallo River Basin

The proposed alignments of the Trans Sulawesi, Outer Ring Road, and Abdullah Daeng Sirua Road run through the flood inundation area, flood control facilities in/around the Tallo River. Three proposed bridges on the Trans-Sulawesi Road, Outer Ring Road, and Abdullah Daeng Sirua Road were designed crossing the Tallo River, which will be affected by flood control structures such as dike and short cut channel.

The proposed alignment of the Outer Ring Road should be located on the left bank of the Tallo River to avoid reducing the areas of flood retarding basin and restriction of development from the hydraulic viewpoint as shown in **Figure 6.6**.

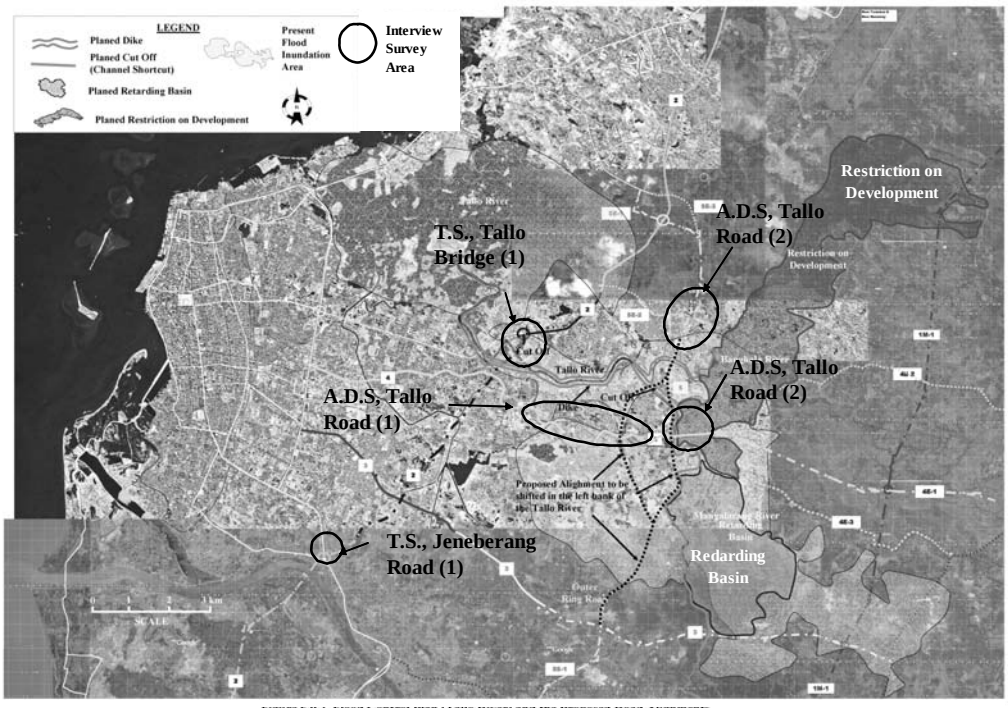


Figure 6.6 Locations of Flood Inundation Area, Flood Control Plan, and Interview Survey in Makassar City

Gamanti and Pappa River Basins

According to the existing flood record, the proposed alignment of the Trans Sulawesi Mamminasata Road may not be affected by flood inundation so much in the center of Takalar City. The alignment was not designed to pass through the flood retarding basin and the area of restriction of development, and there will be no proposed bridges crossing the Gamanti and Pappa Rivers.

Jeneberang River Basin

Flood control projects on the Jeneberang River, such as construction of dike, river diversion, and river dredging, have been completed, and thus the Makassar City and Gowa Regency are currently protected against the probable river flood overflow of a 50-year return period. The design level of the proposed bridges crossing the Jeneberang River through the Trans Sulawesi and Outer Ring Road, should be set based on design level of the existing flood control facilities such as dike.

4) Hydraulic Analysis

Normal flow analyses were conducted by using the computer software "HEC-RAS" to introduce flood water level at each design peak discharge for the following proposed 4 bridge sites:

i) Maros River: At 1.1 km upstream of the Alliritengae Bridge, along the Mamminasa Bypass Route

ii) Tallo River: At 1.3 km upstream of the Tallo Bridge (JL. Perintis), along the Trans-Sulawesi Mamminasata Route

iii) Jeneberang River: At 2.8 km downstream of the Sungguminasa Bridge, along the Trans-Sulawesi Mamminasata Route and 9.5 km upstream of the Sungguminasa Bridge, along the Mamminasa Bypass Route

Hydraulic calculations by normal flow analyses were made based on the topographic survey data obtained during this study, and the results of the analyses are shown in **Table 6.6**.

Table 6.6 Hydraulic Calculation Results at Bridge Sites

Bridge Site	Riverbed Slope	Design Discharge (m^3/sec)	Max. Flow Velocity (m/sec)	Design Flood Water Level (EL. m)	Design Crest Level of Dyke *1 (EL. m)	Proposed Bridge Level *2 (EL. m)
a) Maros River	1/4,500	1,260 (25-year)	1.11	5.67	7.66	7.66
b) Tallo River	1/10,000	830 (50-year)	0.72	4.14	2.80	5.14
c) Jeneberang River (upstream)	1/1,120	2,500 (50-year)	3.31	8.86	10.96	10.96
d) Jeneberang River (downstream)	1/1,120	2,500 (50-year)	2.42	3.91	7.55	7.55

Note: *1: Proposed Design Crest Level of Dyke in existing flood control plan, Comprehensive Water Management Plan Study for Maros Jeneberang River Basin, Nov. 2001
*2: Bottom Level of Bridge Girder

(3) Conclusions

1) Flood Water Level

It is proposed that the flood water levels be set temporarily as follows, based on interview survey on flood inundation, review of flood control plans, and completed flood control facilities.

i) Maros River Basin

- Trans Sulawesi (Road): 0.5 m to 1.0 m above existing road level in Maros City
- Mamminasa Bypass (Bridge): 1.0 m to 1.5 m above ground level (left bank)
- Mamminasa Bypass (Shifted Road): 0.5 m to 1.0 m above ground level (paddy field)

ii) Tallo River Basin

- Trans Sulawesi (Bridge): 2.0 m to 3.0 m above ground level (left bank)
- Outer Ring Road (Bridge): 1.0 m to 1.5 m above ground level (left bank)
- Abdullah Daeng Sirua (Bridge): 1.0 m to 1.5 m above ground level (left bank)
- Outer Ring Road (Road): 0.1 m to 0.7 m above ground level (right bank)
- Abdullah Daeng Sirua (Road): 0.1 m to 0.5m above ground level (left and right banks)

iii) Jeneberang River Basin

- Trans Sulawesi (Road): 0.3 m to 0.5 m above existing road level in Sungguminasa
- Mamminasa Bypass (Bridge): 2.0 m to 3.0 m above ground level (right bank)

The design flood water levels at the major bridge sites are given on the river cross section in **Figures 6.7** and **6.8.**

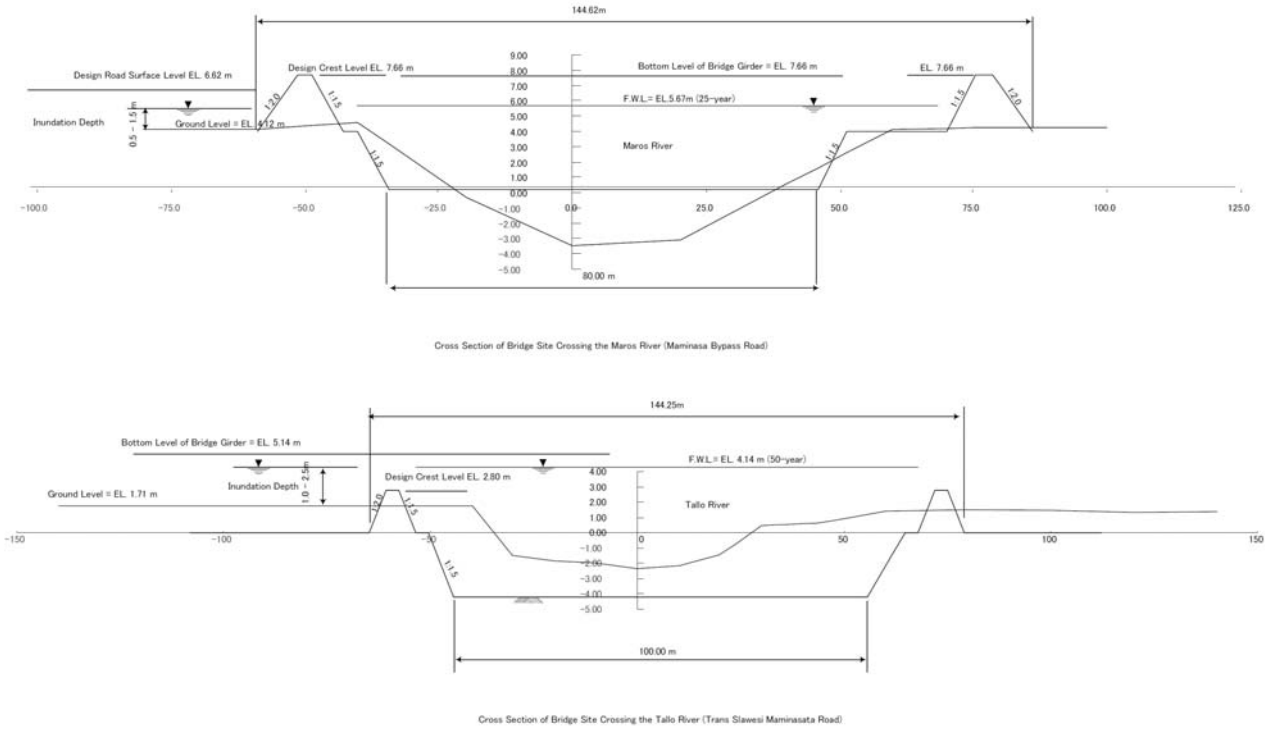


Figure 6.7 Section of Proposed Bridge Site over the Maros River and Tallo River

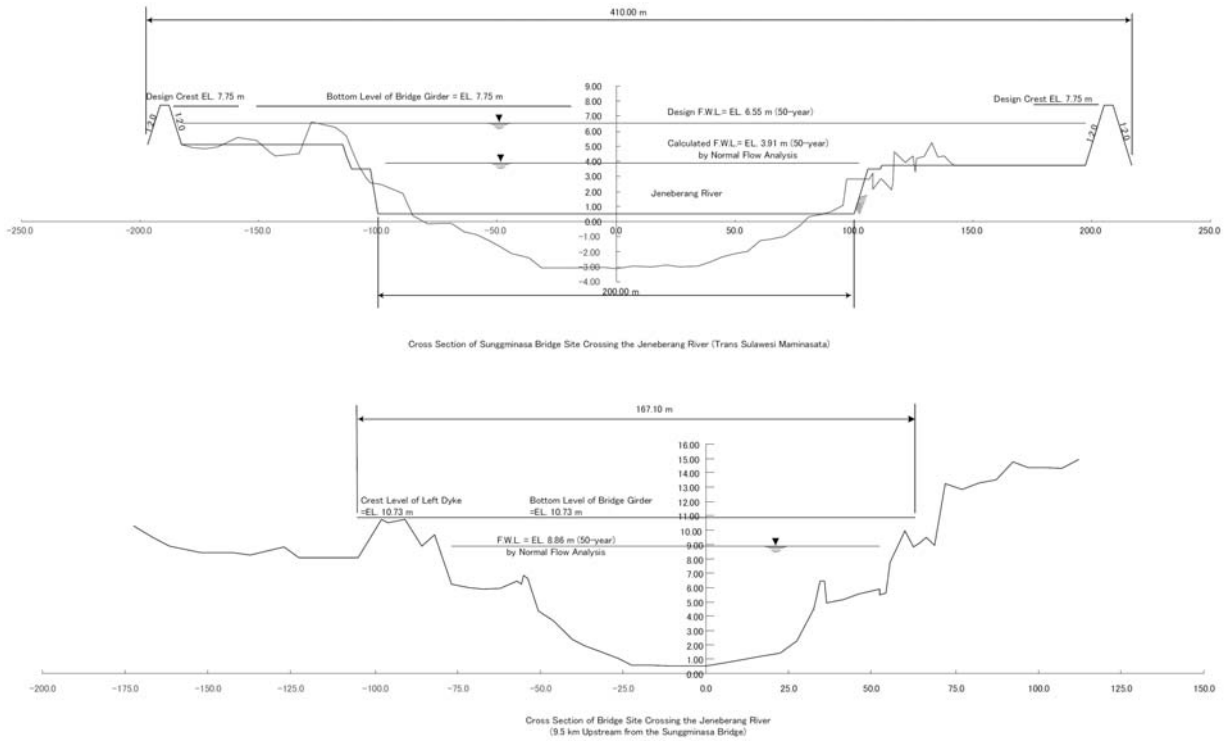


Figure 6.8 Section of Proposed Bridge Site over the Jeneberang River

Dyke construction works along the Tallo River have not yet been carried out, and the alignment of the Outer Ring Road is proposed to be located on the left bank, *Abdullah Daeng Sirua area*, along the Mangalarang River and the Tallo River. To ensure efficient landuse, combined design of the dike and traffic road is recommended as illustrated in **Figure 6.9**.

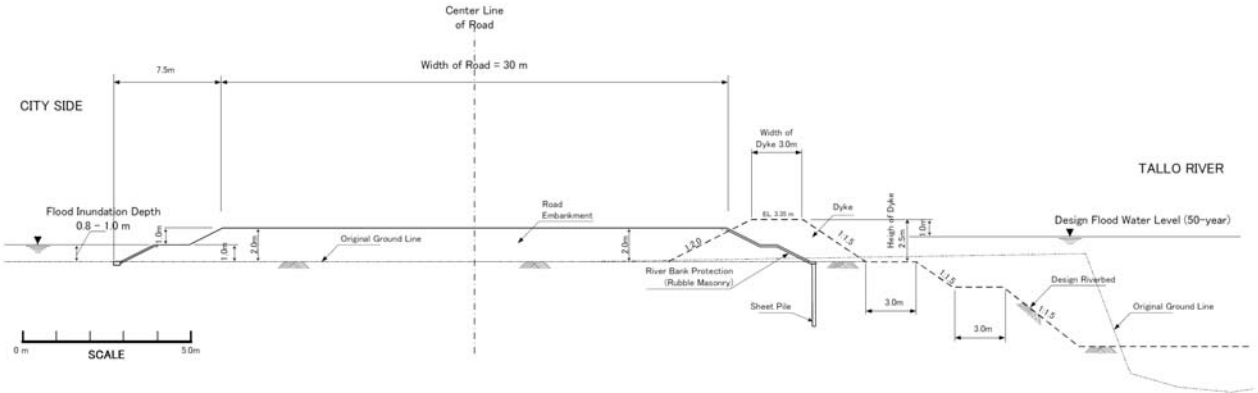


Figure 6.9 Typical Section of Dyke and Highway along Outer Ring Road

2) Flood Protection Works

Designs of flood protection works should be made based on the maximum flood velocity at the following portions:

i) Bridge abutment and river bank
ii) Bridge pier
iii) Slope protection on road embankment.

The maximum flood velocities at 4 bridge sites are summarized in **Table 6.7**.

Table 6.7 Maximum Flood Velocity at Bridge Sites

Bridge Site	Max. Flow Velocity (m/sec)	Design Discharge (m^3/sec)
a) Maros River	1.1	1,260 (25-year)
b) Tallo River	0.7	830 (50-year)
c) Jeneberang River (upstream)	3.3	2,500 (50-year)
d) Jeneberang River (downstream)	2.4	2,500 (50-year)

The following flood protection works should be designed at each bridge site against scouring, erosion.

6.2 Geotechnical Investigation and Construction Material Survey

Geological surveys and investigations were conducted to obtain information on the subsurface geological condition required for the preliminary design of the proposed bridges and roads on the F/S roads. The survey is comprised of:

- Geotechnical investigation for bridges
- Road alignment soil survey
- Road construction material investigation.

The objectives of geological surveys were to obtain necessary geological data for bridge design, to obtain data on subgrade strength of study routes for pavement design, to obtain information for weak foundation countermeasure planning and o obtain latest information/data on possible borrow pits and quarries as well as physical properties of the materials.

(1) Geological Investigation for Bridges

The survey and investigation works covered 36 bridges consisting of seven bridges with a span of > 40 m, 13 bridges with a span of 20 - 40 m, and 17 bridges with a span of < 20 m.

Table 6.8 shows a list of the bridges subjected to geological investigation.

Table 6.8 List of Bridge for Bore Hole Investigation (L>20m)

No	Bridge ID No	Route	Bridge Length (m)	Number of Bore Hole	Bridge Name / River Name
1	1-16	Mamminasa Bypass	25	2	Ticcekang River
2	1-19	Mamminasa Bypass	60	2	Pahundukang River
3	1-26	Mamminasa Bypass	25	2	Kaccikang River
4	1-28	Mamminasa Bypass	16	2	Jenemanjalling River
5	1-31	Mamminasa Bypass	154	3	Jeneberang No.1
6	4-1	Abdullah Daeng Sirua	35	2	
7	4-5	Abdullah Daeng Sirua	60	2	Tallo River
8	3-2	Hertasning	20	2	Tallo River
9	2-1	Maros – Middle Ring Road	40	2	
10	2-2	Maros – Middle Ring Road	40	2	
11	2-6	Middle Ring Road, Trans-Sulawesi Mamminasata	136	3	Tallo River
12	2-7	Middle Ring Road	50	2	
13	2-8	Middle Ring Road	50	2	
14	2-9	Middle Ring Road	50	2	
15	2-11	Middle Ring Road Access, Trans-Sulawesi Mamminasata	393	3	Jeneberang No.2
16	2-12	Middle Ring Road Access	35	3	Bayoa River
17	2-14	Middle Ring Road Access	20	2	Barombong River
18	2-18	M.R.R. Access - Takalar	40	3	
19	1-5	Mamminasa Bypass	126	3	Maros

Mechanical boring was carried out at abutments for the bridges between 20 m and 40 m long. An additional boring at river center was carried out for the bridge of more than 40 m in length. Sub surface geological investigation was made by core drilling to identify the type of soil and rock layers, and details of physical and mechanical condition. Core samples were taken at a 1 meter depth interval. The SPT based on ASTM D1586 was conducted with an interval 1.50 meter up to the layer of N > 50 blows or reached to bedrock layer. Since accurate geological information is essential for planning and design of major bridges, three (3) borings were made for each bridge. The boring logs and geological cross sections for these bridges are shown in Appendix B.

Cone Penetrating Tests (CPT) was carried out for the bridges less than 20 m in length to identify the foundation soil classification, the bearing capacity and friction of each layer. Used appliance is Dutch Cone Penetrometer with the capacity of 2.5 ton.

(2) Road Alignment Soil Survey

The road alignment soil survey was conducted for the four F/S roads. The survey is comprised of test pits excavation for observation and sampling, laboratory tests (CBR, soil classification, etc.) and Dynamic Cone Penetrometer (DCP) tests. The quantity of survey by the F/S roads is indicated in the following stable.

Table 6.9 List of Soil Survey for the F/S Roads

No.	Name of Roads Section		Length (km)		Quantity		
			Total	Survey	Test Pit	CBR Lab	DCP
1	Mamminasa bypass I		26	26	14	14	82
	II		19	19	11	11	66
2	Trans-Sulawesi Roads Mamminasata Section	Maros - MRR	23	23	12	12	70
		Middle Ring Road	7	5	5	5	22
		MRR - Access	9	9	5	5	25
		MRR Access - Takalar	22	22	10	10	68
3	Hertasning Road		15	8	3	3	25
4	Abdullah Daeng Sirua Road		18	18	8	8	23

1) Trans-Sulawesi Mamminasata Road

The average asphalt concrete and base thicknesses of the existing pavement for Perintis Kemerdekaan Road are 17 cm and 50 cm, respectively. Those for Sungguminasa (Boka) – Takalar road are 15 cm and 26 cm, respectively.

Sections B (Middle Ring Road) and Section C (Middle Ring Road Access) are new roads. Subgrade soil of those sections is mostly silty clay covered by top organic soil.

The average CBR values of subgrade for Tarns-Sulawesi Mamminasata Road by laboratory tests and DCP are 3.4% and 2.2%, respectively.

2) Mamminasa Bypass

Mamminasa Bypass is new road construction mostly passing through paddy fields and cultivated or uncultivated lands. The average CBR values of subgrade for Mamminasa Bypass by laboratory tests and DCP are 4.6% and 2.2%, respectively.

3) Hertasning Road and Abdullah Daeng Sirua Road

Hertasning Road (only Section D) is widening of the existing road. Abdullah Daeng Sirua Road is either new construction of additional two lanes, widening of the existing road, or new construction (Section F). The average CBR values of subgrade for Hertasning Road by laboratory tests and DCP are 1.7% and 3.4%, respectively. The average CBR value of subgrade for Abdullah Daeng Sirua Road by DCP is 2.3%.

(3) Road Construction Material Investigation

Construction material source survey was carried out to obtain information on available materials for road construction for coarse aggregate, fine aggregate and borrow soil. The JICA Study Team

identified several material sources near the F/S roads. Site observation, sampling, recording, laboratory tests and available quantity estimate are made by material source.

Sampling for the coarse aggregate materials (sandy gravel), fine aggregates (sand) and borrow materials was made at river bed or at quarries and brought to laboratory for testing.

The following **Table 6.10** shows material sources, distance from Makassar and estimated quantities available for the F/S road construction.

Table 6.10 Location and Estimated Quantity of Construction Materials

Item	No	Name of Quarry	Distance from Makassar	Estimated Quantity (m^3)
Coarse Aggregate	1	Lekocaddi Area	55 km	100.000
	2	Lekopancing Area	20 km	250.000
	3	Borong Bulu Area	15 km	250.000
	4	Madinging Village	10 km	200.000
Fine Aggregate	1	Lekopancing Area	20 km	30.000
	2	Mangasa Village	10 km	50.000
	3	Bili-bili Village	15 km	150.000
Borrow Materials (CBR > 6%)	1	Carangki Hill	18 km	50.000
	2	Moncong Loe Hill	10 km	1,500.000
	3	Bollangi Hill	15 km	100.000
	4	Sela Village	20 km	100.000

6.3 Topographic Survey and Mapping

The objective of the topographic survey works is to prepare 1:5,000 scale photo mosaics, road profile, road cross-sections, flat plan topographic maps and their digital data as basic materials used for the preliminary design of the F/S and Pre F/S roads.

The quantity of the survey works (for existing roads and proposed roads) are shown in **Table 6.11**.

Table 6.11 Locations of Topographic Surveys

No	Route (or Section)	Aerial photography and Mosaiking Length (km)		Route Survey Length (km)
		Proposed Road	Improvement (Existing) Road	
1	Mamminasa Bypass	42	0	42
2	Trans Sulawesi Mamminasata Section	15	43	58
3	Hertasning Road	10	0	10
4	Abdullah Daeng Sirua Road	10	8	18
5	Outer Ring Road	9	5	0
	Sub-Total	**86**	**56**	
Total		**142**		**128**

The scope of topographic survey works included the following:

1) 1:5,000 Scale Digital Photo Mosaicking

i) 1:10,000 Scale Aerial Photography (Coverage area : 142 line-km in total) including Photo Scanning and Contact Printing.

ii) Ground Control Survey (40 points in total) including Monumentation, GPS Survey and Leveling.

iii) Preparation of Photo Mosaics
- Aerial Trianglation (160 models in total)
- DTM and 5m Contour Generation (Length : 86km, Width : 2.3km)
- 1m Contour Plotting (Length : 56km, Width : 100m) / Including Photo Image Rectification, Photo Mosaiking and Photo Mosaic Compilation

iv) Output

2) Route Survey
i) Road Centerline Survey (Length : 128 km, 7,680 points in total)
ii) Road Profile Section Survey (Length : 128km in total)
iii) Road Cross-Section Survey (Width : 100m, 7,680 sections in total)
iv) Preparation of Flat Plan (Length : 128km, Width : 100m, Contours: 1m)
v) Output

Aerial photography covering the existing and proposed roads and their surrounding areas of approximately 142 line-km for 1:5,000 scale digital photo mosaiking was carried out.

Ground control survey was carried out to prepare necessary horizontal (planimetric position) and vertical (height) control data for photo control points (control point) along the existing and proposed roads and their surrounding areas for aerial triangulation for 1:5,000 scale digital photo mosaiking.

7. ENGINEERING STUDY

7.1 General

The Feasibility Study ("F/S" or "FS") covers the four (4) priority roads of sixteen (16) road projects recommended by the study on Implementation of Integrated Spatial Plan for the Mamminasata Metropolitan Area.

Table 7.1 List of F/S and Pre-F/S Roads

	No.	Name of Road/Road Section		Length (km)	Function	Administrative Status
F/S	1	Mamminasa Bypass		49.1	Arterial	- #
	2	Trans-Sulawesi Road Mamminasata Section (Total: 58 km)	Maros-Middle Ring (Perintis Kemerdekaan Road)	19.6	Arterial (Primary)	National
			Middle Ring Road	7.3	Arterial (Secondary)*	- **
			Middle Ring Road Access	8.6	Arterial (Secondary)*	- **
			Middle Ring Road Access-Takalar	22.5	Arterial (Primary)	National
	3	Hertasning Road (Section D Only)		4.9	Arterial (Secondary)*	Province
	4	Abdullah Daeng Sirua Road (Excluding Section B)		15.3	Arterial (Secondary)*	Makassar/ - #
Pre-F/S	5	Outer Ring Road		20.4	Arterial	- #
			Total:	147.7 km		

Notes: * Proposed function
** Proposed to be national road in future (strategic road)
# Proposed to be provincial road (strategic road)

The Study Team conducted a pre-feasibility study on the outer ring road and a supplemental study and made recommendation for the Tj. Bunga – Takalar Road**.**

7.2 Arterial Road Network System for Mamminasata Metropolitan Area

JICA conducted the "Ujung Pandang Highway Development Study"in 1989 (the 1989 JICA study) for the target year of 2009. Makassar City has developed the urban arterial road network according to recommendations of the 1989 JICA study. The arterial road network system in the Mamminasata Metropolitan Area comprises of five radial roads and three ring roads. These development plans are well coordinated with the spatial plan of Makassar City.

The Mamminasata Spatial Plan reviewed and added two new concepts, Mamminasa Bypass and Trans-Sulawesi Mamminasata Road, to the highway plan of JICA 1989 study. The Study Team updated and partially revised the existing road master plans to meet the latest development progress and solve key issues found through the study.

Figure 7.1 shows the urban arterial road network system in the long-term recommended by the 1989 JICA study, the Mamminasata Spatial Plan and updated in this F/S.

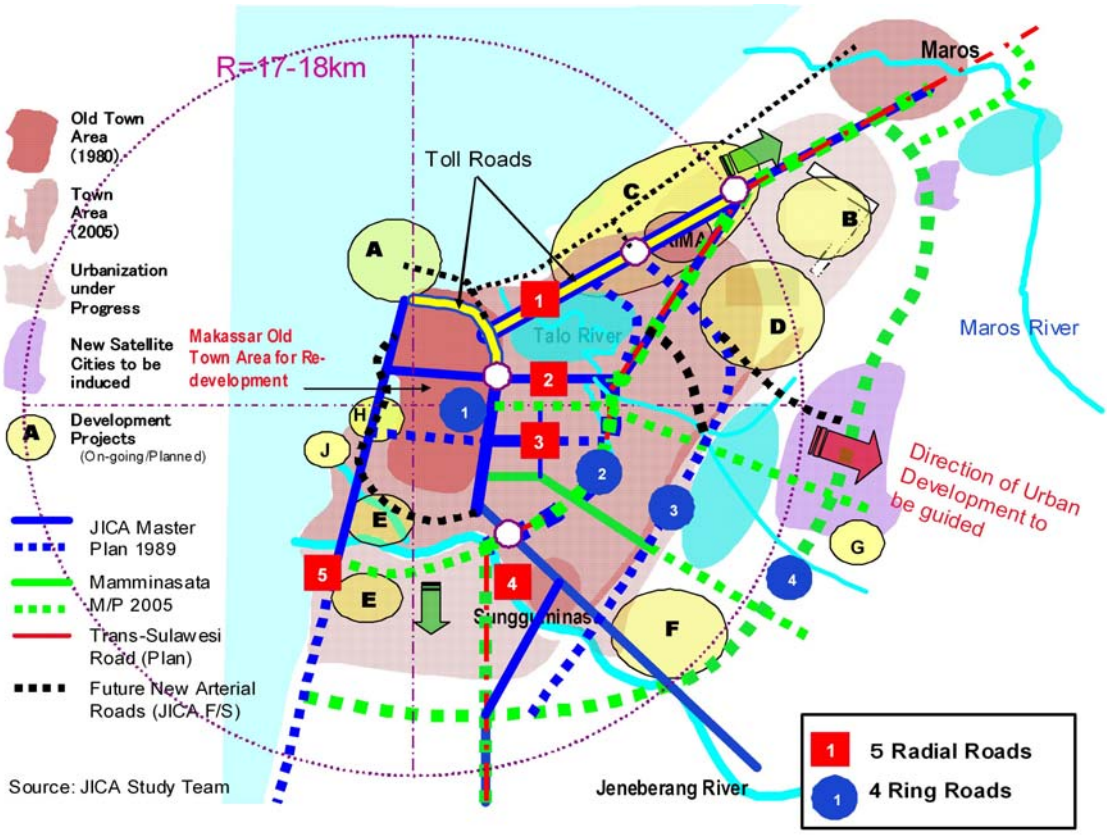


Figure 7.1 Urban Arterial Road Network System for Mamminasata Metropolitan Area

7.3 Review of the F/S Road Development Plan in the Mamminasata Spatial Plan

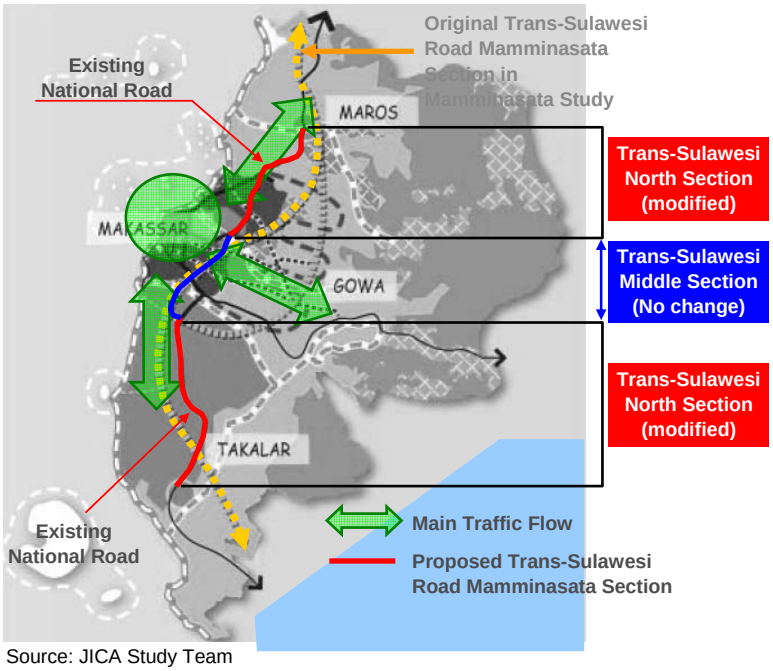
(1) Modification of Feasibility Study Road Routes

1) Trans-Sulawesi Road Mamminasata Section

The originally planned route of the Trans-Sulawesi Mamminasata Section was a new road running in parallel with the existing Trans-Sulawesi route (national road). However, the north and south sections were modified, taking difficulty in land acquisition and resettlement, traffic flow, topography (Tallo River basin and swamp) and required road function into consideration, to use the existing national roads in the Inception Report stage (**Figure 7.2**).

The middle section comprised of the Middle Ring Road and its southern extension over the Jeneberang River, which is the same as in the Mamminasata Plan.

The original route of the south section between Sungguminasa and Takalar Town in the Mamminasata Spatial Plan was a new route running in parallel with the existing national road.



Source: JICA Study Team

Figure 7.2 Modification of Route of Trans-Sulawesi Mamminasata Section

2) Location of Satellite Towns and Position of Mamminasa Bypass

The Study Team set up an appropriate location of Satellite Town at the west foot of Mt. Moncongloe, at the boarder of Maros and Gowa Regencies. The original location of the Mamminasa Bypass was along the existing Kabupaten road passing behind Mt. Moncongloe. But it was moved to the front of mountain in the Inception Report stage (**Figure 7.3**).

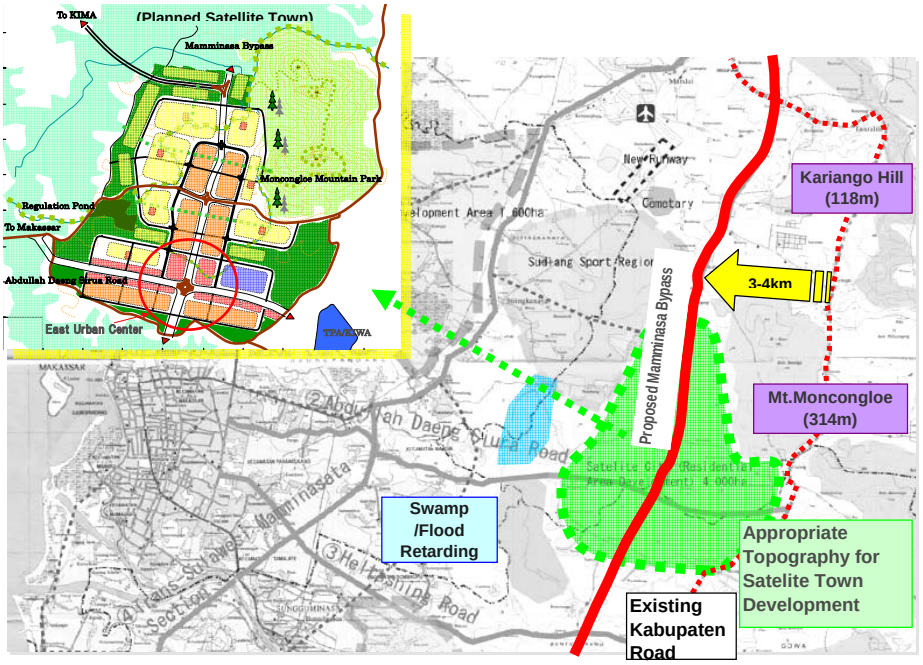


Figure 7.3 Location of Proposed Satellite Town and Mamminasa Bypass

(2) Busways (Bus-lane) and Left-lane-Use for Motorcycles

The Mamminasata Spatial Plan recommended introducing Busways for the major arterial roads to shift from mini buses (pete-pete) to large buses. Makassar City has prepared an implementation plan for the six routes.

Pedestrian bridges are planned at approximately 500 m intervals on these routes for road crossing and bus stops are located at the median. Pedestrian bridge construction has been commenced in 2006 and would be continued. Since the required number of lanes from Daya to Jl. Perintis / Middle Ring Road IC is six (6) until 2016, traffic capacity of the section will be affected if bus lanes are installed without additional lane construction. Negotiation with MOW and its agreement on the Busways introduction is necessary as this is a national road .

It is recommended to introduce a policy for shifting from small buses (pete-pete) to medium buses for passenger service while providing fixed bus stops at appropriate intervals to regulate these public transports.

(2) Left-lane-Use for Motorcycles

Makassar City has introduced a left-lane-use regulation for motorcycles passing through Jl. AP Pettarani, Jl. Jenderal Sudirman, Jl. Ahmad Yani and Jl. Perintis Kemerdekaan since January 2007. Motorcycles have to run on the left lane for safety and smooth traffic flow as shown in the following photographs.

Figure 7.4 Left-lane-Use for Motorcycles on Jl A.P. Pettarani

The dominant vehicles in 2023 will still be motorcycles and minibuses (pete-pete) on the F/S roads accounting for 41% and 12% of the total traffic, respectively. Motorcycles, minibuses and bicycles are competing on the same left lane and cross over at intersections. The current system should be carefully monitored for adoption of the most ideal method in the future.

(3) Review of Freeway and Toll Road Plan

DGH conducted an express freeway/toll road study for Sulawesi Island in 2006. The study recommended five road sections which could be implemented as priority development programs

in the period of 2006 – 2010. Three of such road sections are Trans-Sulawesi Maros-Mandai-Makassar, Middle Ring Road (Makassar - Sungguminasa) and Sungguminasa - Takalar. A joint investment by government and private sectors (Public Private Partnership) is required to secure the marginal FIIR of 16% for project implementation as in the following table.

Table 7.2 FIRR and PPP Indicators

No.	Route / Section	Length		Cost			FIRR 2011	Required Share of Government Investment (PPP)		
		Arterial	Toll	Construction (Mil.Rp)	ROW (Mil.Rp)	Total (Mil.Rp)	(%)	ROW	Construction	FIRR
1	Maros-Mandai - Makassar	13.30	12.00	410,130	43,470	453,600	11.41%	100.0%	45.9%	16.0%
2	Makassar - Sungguminasa (Middle Ring Road)	13.55	11.50	331,582	118,145	449,727	13.68%	100.0%	9.1%	16.0%
3	Sungguminasa - Takalar	37.26	26.00	888,616	94,185	982,801	7.94%	100.0%	76.1%	16.0%
Total		64.11	49.50	1,630,328 86%	255,800 14%	1,886,128 100%	11.01% (average)	100.0% (average)	43.7% (average)	16.0% (average)

Source: Penyusunan Program Pengembangan Jaringan Jalan Bebas Hambatan dan Jalan Tol Di Pulau Sulawesi, Bina Marga

The traffic share of motorcycles is 65.1% - 67.3% and that of small buses (mostly pete-pete) is 11.2 – 13.7% in the south section. As those vehicles will not divert to the express toll road, construction of the expressway is not recommended for this section.

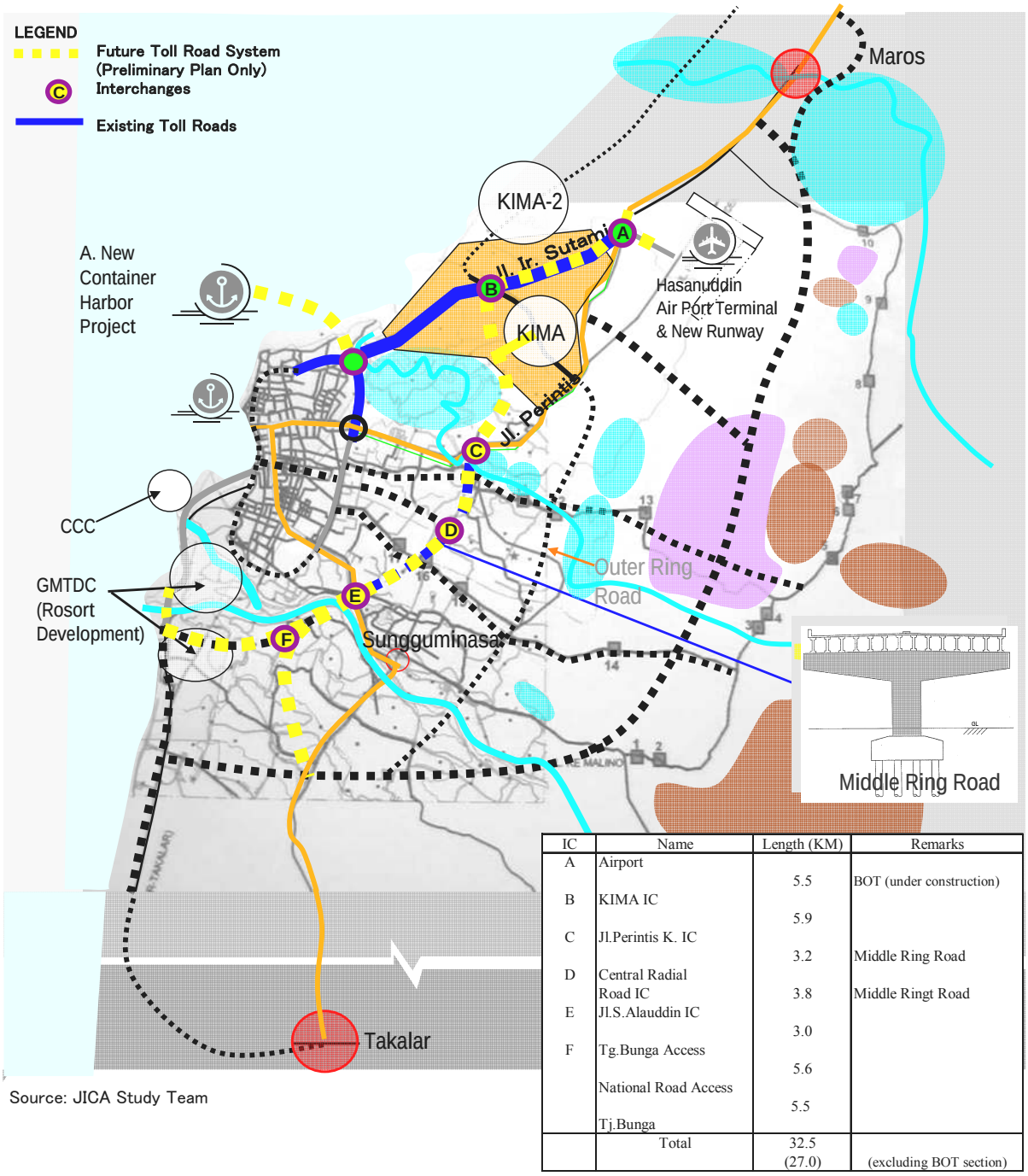
Interchanges, ramps and underpasses are required for access control of freeway/toll roads on four major roads (Abdullah Daeng Sirua Road, Central Radial Road, Borong Raya Road, Hertasning Road) and many other minor roads crossing the Middle Ring Road.

As the Middle Ring Road passes through a dense residential area of Makassar City, frontage roads on both sides of the expressway/freeway are required for local traffic.

A freeway/toll road through the Middle Ring Road might be required in the future. A preliminary plan for the freeway/toll road system is shown in **Figure 7.5**. The expressway will start from the airport and pass through Ir.Sutami Toll Road and divert to the south through the Middle Ring Road. It will be connected to both Tj.Bunga (GMTDC and CCC).

The JICA Study Team does not recommend constructing the expressway/freeway at this stage on the following technical aspects:

* Higher costs for access control facilities, including box culverts or bridges on crossing roads and off-/on-ramps at interchanges,
* Necessity of additional land acquisition and resettlement. The current ROW is 40 m wide but a width of 49.5 - 66.5 m is required for the expressway and frontage roads.



IC	Name	Length (KM)	Remarks
A	Airport	5.5	BOT (under construction)
B	KIMA IC	5.9	
C	Jl.Perintis K. IC	3.2	Middle Ring Road
D	Central Radial Road IC	3.8	Middle Ringt Road
E	Jl.S.Alauddin IC	3.0	
F	Tg.Bunga Access	5.6	
	National Road Access	5.5	
	Tj.Bunga		
	Total	32.5 (27.0)	(excluding BOT section)

Figure 7.5 Future Expressway/Toll Road System (Preliminary Study)

(4) Bikeways

Introduction of bikeway was studied to separate bicycle and motor vehicle traffic for enhancing safety and trafficability as large bicycle traffic is seen on several road sections, especially in Gowa Regency. Traffic survey stations No. 6, 7, 9, 10 and 14 have considerable bicycle traffic as shown in **Table 7.3**.

Table 7.3. Bicycle Traffic near Trans Sulawesi Road (12h)

Station	Bicycle	Becak	Motorcycle
6	3,080	177	14,472
7	189	83	9,634
9	142	77	13,362
10	6,960	333	32,336
14	468	165	55,644

The bicycle traffic on Sultan Alaudin Road (Station No.10) and Sungguminasa – Bajeng road (Station No.6) is outstanding. Substantial part of the bicycle traffic on this road is coming from Gowa Regency and going to public markets in the Makassar City center by transporting agricultural products. Therefore, introduction of bicycle lane on Section C (Kec.Bajeng (Boka IC) – Sultan Alaudin Road IC) of Trans- Sulawesi Mamminasata Road seems to be effective.

Design bicycle dimensions are defined in Standard Specifications for Geometric Design of Urban Roads, March 1992, DGH/MPW as in **Table 7.4**. However, the Study Team proposes a 1.2m "horizontal space occupied by a cyclist", because many bicycles carrying marine and agricultural products mostly occupy 1.2 m width of roadway.

Table 7.4 Bicycle Dimensions

Type of Dimensions	Handleber Width	Horizontal Space Occupied by a cyclist	Cycle height	Vertical space occupied by a cyclist	Cycle Length	Pedal Height
Standard	0.6m	1.0m	1.0m	2.25m	1.9m	0.05m
Proposed	0.6m	**1.2m**	1.0m	2.25m	1.9m	0.05m

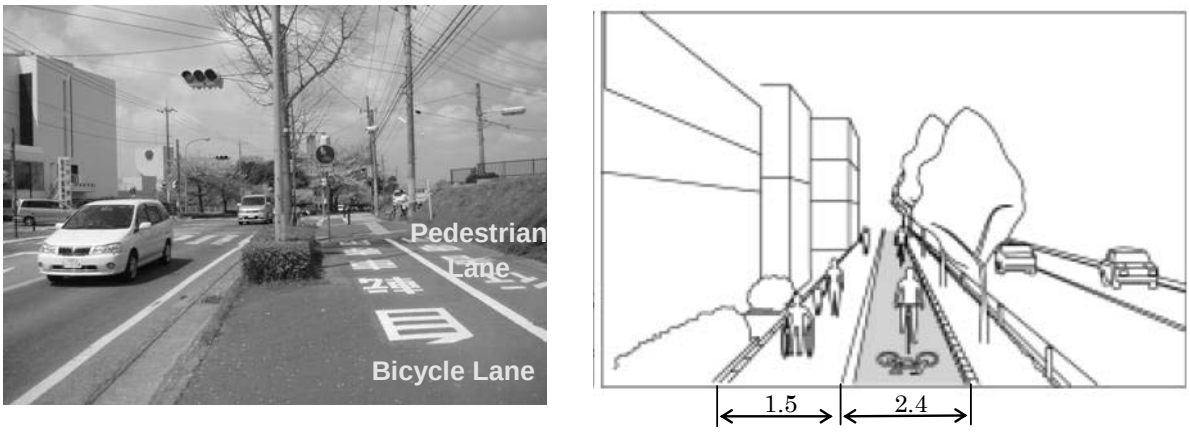


Figure 7.6 Typical Cross Section (Separated Bikeway on Sidewalk)

Some legal framework will be necessary if separated bicycle lanes are installed allowing bicycle passage on the sidewalk as an example in **Figure 7.6**. Traffic regulations are required to change and traffic management facilities are required modifying.

7.4 Proposed Geometric Design Criteria for F/S Roads

The roads and other road structures will be planned and designed based on Indonesian standards together with other international specifications. The following Indonesian design standards as well as the Road Law and the Road Regulations, including UU No 38 Year 2004 and PP No 34 Year 2006, have been referred to in the F/S.

The FS roads are classified either primary or secondary arterial road Type II, Class I in accordance with the Road Law, design guides and traffic demand forecast. Geometric design standards for the F/S roads were established in accordance with the design guidelins as outlined in **Table 7.5**.

Table 7.5 Geometric Design Standards

Item		Urban Road		Inter-City Road	
		Standard Value	Applied Value	Standard Value	Applied Value
Road Classification		Type-II, Class-I		Arterial, Class-I	
Design Speed		60km/h		70-120km/h	80km/h
Cross-section	Carriageway	3.5m	3.5m (3.25m)*	3.5m	3.5m (3.25m)*
	Median	2.0m (min)	2.0m (min)		
	Shoulder Width (Right)	0.5m	0.5m	2.5m (2.0m)**	2.5m
	Shoulder Width (inner shoulder)	0.5m	0.5m		
	Sidewalk Width	3.0m	3.0m		
Horizontal Alignment	Min. Radius	150m	150m (except intersections)	210m	210m
	Min. Curve Length	100m	100m		
	Omission of Transition	>600m	>600m	>900m	>600m
Vertical Alignment	Min. Curve Length	25m	25m	80m	25m
	Cross-fall	2.00%	2.00%	2.00%	2.00%

Notes: * Exceptional case is applied to minimize land acquisition or to follow the existing alignment.
**: Minimum case

7.5 Proposed Typical Cross Sections

The typical cross-sections for the F/S roads are examined carefully taking both traffic demand and road functions required for urban development and road network system into consideration. Since as a large number of inter-city and intra-city traffics will pass on the F/S roads, an appropriate number of lanes should be provided to meet the traffic demand while avoiding over-estimation.

The proposed standard cross-sections for the FS roads are as shown in **Figures 7.7** to **7.9**.

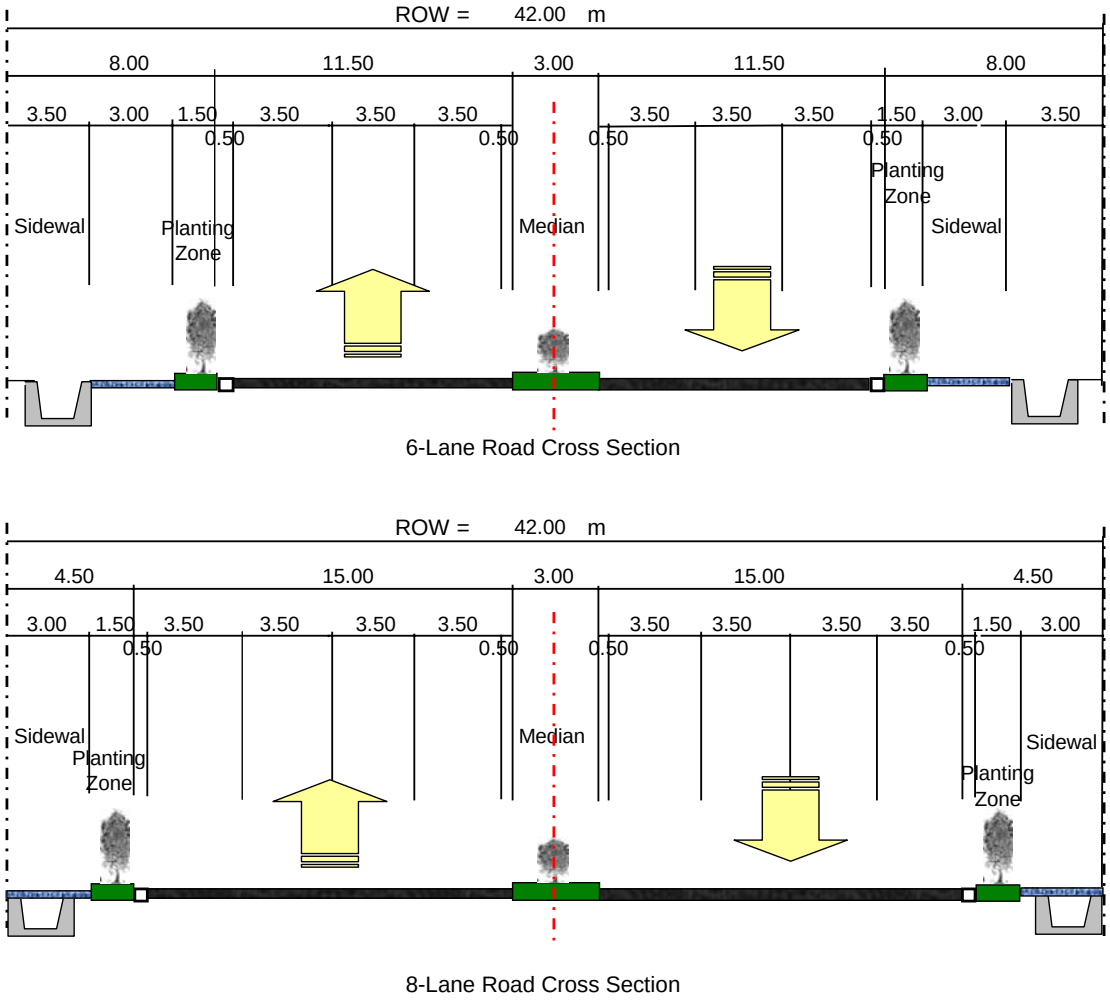
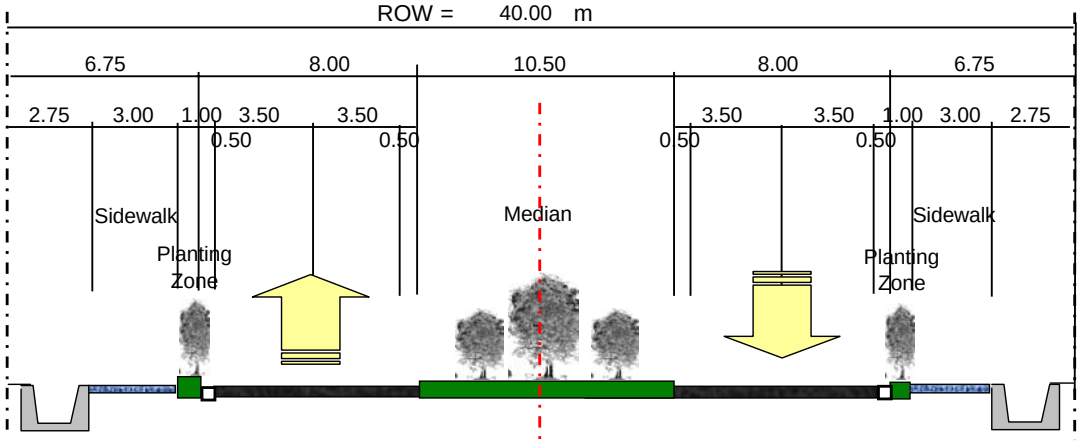
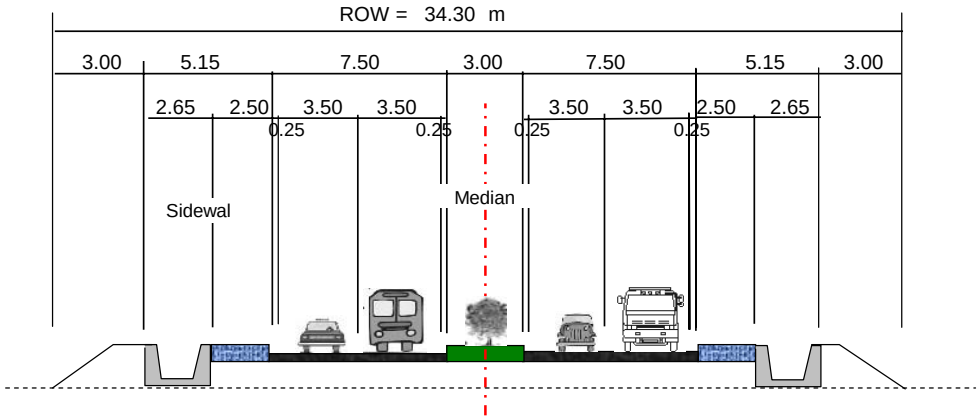


Figure 7.7 Typical Cross Section of Trans-Sulawesi Road (Perintis Kemerdekaan Road)



Source: JICA Study Team

Figure 7.8 Typical Cross Section for Mamminasa Bypass and Trans-Sulawesi Road C-Section



Source: JICA Study Team

Figure 7.9 Typical Cross Section for Hertasning Road and Trans-Sulawesi D-Section (Sungguminasa –Takalar)

7.6 Road Development Concept

(1) Trans-Sulawesi Road Mamminasata Section (Maros – Takalar)

The Trans-Sulawesi Road Mamminasata Section comprises four (4) sections. Section A is from Maros (Km 29.00) to the Middle Ring Road on the existing national road. Section B is the Middle Ring Road section between Perintis Kemerdekaan Road and Sultan Alauddin Road (border between Makassar City and Kabupaten Gowa). Section C is from the Middle Ring Road to Boka IC on the national road, approximately 5.3 km south of Sungguminasa. Section D is from Boka IC to Takalar on national road.

Table 7.6 shows the development concept of the Trans-Sulawesi Mamminasata Road by section.

Table 7.6 Development Concept of Trans-Sulawesi Mamminasata Road

No.	Section	Classification				Traffic Volume		Number of Lanes		Develop-ment Plan	ROW Width (m)	Current Staus of ROW Acquisition	Planned Interchanges (IC)
		Length (km)	Function	Administrative Status	Type / Class	2006	2023	Exsting	Plan				
A	Maros - Jl.Tol.Ir.Sutami IC	8.7	Arterial (Primary)	National	Types II / Class I	23000-30000	53000-54000	4	6	Widening	42	Not yet	Jl.Ir.Sutami
	Jl.Tol.Ir.Sutami IC-Middle Ring Road (Jl.Perintis)**	10.9	Arterial (Primary)	National	Types II / Class I	29000-62000	60000-100000	4	6-8	Widening	42	On-going	
B	Middle Ring Road	7.3	Arterial (Secondary)*	*	Types II / Class I	-	46000-52000	-	6	New Road	40-42	On-going	Jl.Sultan Alauddin
C	Middle Ring Road Access	8.6	Arterial (Secondary)*	*	Types II / Class I	-	47000	-	4	New Road	40	Not yet	-
D	Middle Ring Road Access-Takalar	22.5	Arterial (Primary)	National	Types II / Class I	13000-36000	30000-47000	2	4	Widening	30	Not yet	-
	Total:	58.0 km											

Notes: * Proposed status after construction
** DGH started 6-lane widening and complete it by 2010

The recommended development concept for the section from Maros to Ir.Sutami Toll Road in Section A is to widen the existing 4-lane road to a 6-lane road. No widening will be made for the Maros new town section to avoid adverse effects on the current town development concept.

The planned Middle Ring Road (Section B) is a new 6-lane road. Sidewalks will be provided on

the side ditches along the roadway as the ROW is 40m.

Four lanes are required for the Middle Ring Road Access (Section C) and its development concept is similar to that of the new airport access road (right photograph). A wide median of 10 m will be provided to secure a widening space in the future.

Section D is widening of the existing national from 2 lanes to 4 lanes with a median. The road within Takalar town is a non-divided 4-lane road.

(2) Mamminasa Bypass

The development objective of Mamminasa Bypass is to induce a new satellite town at about 15 km east of Makassar City, at the Kabupaten Gowa and Maros border. The southern part of this road is a part of the Outer Ring Road.

Mamminasata Bypass is comprised three (3) sections: south, middle and north sections. The north section is a bypass for the Maros town. Two outlets are planned; one before Maros town and the other after Maros town. The development concept of Mamminasa Bypass is to construct a new 4-lane road with a wide median (10 m for a widening space in the future).

Table 7.7 Development Concept of Mamminasa Bypass

Section	Length (km)	Classification			Traffic Volume 2023(pcu)	Number of Lanes		Development Plan	ROW Width (m)	Bridge
		Function	Administrative Status	Type / Class		Existing	Plan			
South	16.7	Arterial * (Secondary)	Provincial **	Type II / Class I	20000 - 44000	-	4	New Road	40	Jeneberang River (L=154m)
Middle	19.7	Arterial * (Secondary)	Provincial **	Type II / Class I	15000 - 23000	-	4	New Road	40	-
North	12.6	Arterial * (Secondary)	Provincial **	Type II / Class I	11000 - 33000	-	4	New Road	40	Maros River (L=126m)
Total:	49.1 km									

Notes: * Proposed function
* Proposed administrative status is provincial strategic road

(3) Hertasning Road

Hertasning (15.6 km in total length) is divided into four (4) sections. Section A (5.2 km long) is from the AP Pettarani Road junction to the Makassar and Gowa border (the end of the current urban area), which was already improved to a 4-lane road. Section B (2.3 km) is under construction and Section C (3.7 km) is in detailed design stage. Section D is in a planning stage. **Table 7.8** shows current status and development concept of Hertasning Road by section. Only Section D (4.9 km in length) is subjected to the F/S. Its development concept is to widen the existing 2 lane road (4.5 m travelway) to a 4-lane road.

Table 7.8 Current Status and Development Concept of Hertasning Road

Section	Length (km)	Function	Administrative Status	Traffic Volume (2023)	Number of Lanes		Development Plan	ROW Width (m)	Current Status of ROW Acquisition
					Existing	Plan			
A	5.2	Arterial (Secondary)	Makassar	24000	4	4	Completed	34	-
B	2.3	Arterial (Secondary)	Provincial**	24000	2	4	Under construction	34	Completed
C	3.7	Arterial * (Secondary)	Provincial**	30000	2	4	Completed detailed design	34	Not yet
D	4.9	Arterial * (Secondary)	Provincial**	21000	2	4	Widening	34	Not yet
Total	16.1 km								

Notes: * Proposed status
* * Proposed administrative status is provincial strategic road

(4) Abdullah Daeng Sirua Road

Abdullah Daeng Sirua Road (17.8 km in total length) is divided into six (6) sections. The current status and alternative plans of this road are as summarized in **Table 7.9**. The existing 2-lane road will be improved to a 4-lane road. However, as Section A (1.4 km) is located in the dense residential and business area of Makassar City center, it is impossible to secure the right-of-way unless the land adjustment method. Only traffic control will be applied for this section.

Table 7.9 Current Status and Development Concept of Abdullah Daeng Sirua Road

Section	Section Name	Length (km)	Function	Administrative Status	Traffic Volume (2023)	Number of Lanes		Development Plan	ROW Width (m)	ROW Acquisition Status
						Existing	Plan			
A	Jl.Pettarani - Canal Penampu	1.4	Arterial * (Secondary)	Makassar	25000	2	2	Use of Existing Road with traffic control	-	-
B	Canal Penampu - Jl.Poros	2.5	Arterial * (Secondary)		25000	2	4	Under Construction	15	On-going
C	Jl.Antang Raya	0.8	Arterial * (Secondary)		25000	2	4	Additional 2 lanes (New)	15	Not Yet
D	Jl.Antang Raya - Bts.Makassar/ Maros	4.8	Arterial * (Secondary)		27000	2	4	Additional 2 lanes (New)	25	Not Yet
E	Bts.Makassar/ Maros (Tallo River) - Mangempang	1.2	Arterial * (Secondary)	Provincial**	21000	2	4	Additional 2 lanes (widneing)	40	Not Yet
F	Mangempang - Moncongloe (End)	7.1	Arterial (Secondary)*	Provincial**	21000	-	4	New	34	Not Yet
Total:		17.8	km							

Notes: * Proposed status
* * Proposed administrative status is provincial strategic road

7.7 FS Road Route Study

(1) Trans-Sulawesi Road Mamminasata Section (Maros – Takalar)

The Trans-Sulawesi Road Mamminasata Section is comprised of four (4) sections; A, B, C and D (refer to **Figure 7.10**). The basic concept of Sections A is to widen the existing national road. An initial alternative route study was conducted to reduce the resettlement along the national road in Kabupaten Maros, especially in Mandai area. However, no appropriate alternative routes were identified on engineering aspect. No alternative route study was conducted for Section B (the Middle Ring Road) as land acquisition is approximately 60% - 70% complete.

Three (3) alternative routes were studied for Section C (refer to Attachment 1 in Appendix A). Alternative 1 is a new road of 8.6 km in length with alignment aimed at minimizing resettlement. Alternative 2 applies better geometric curves and shorter route of 7.6 km in length. Alternative 3 uses the existing national road (8.7 km) without widening, which is treated as "zero option" under an environmental evaluation category. Alternative 3 cannot meet the traffic demand and may cause fatal traffic jam, especially at Sungguminasa.

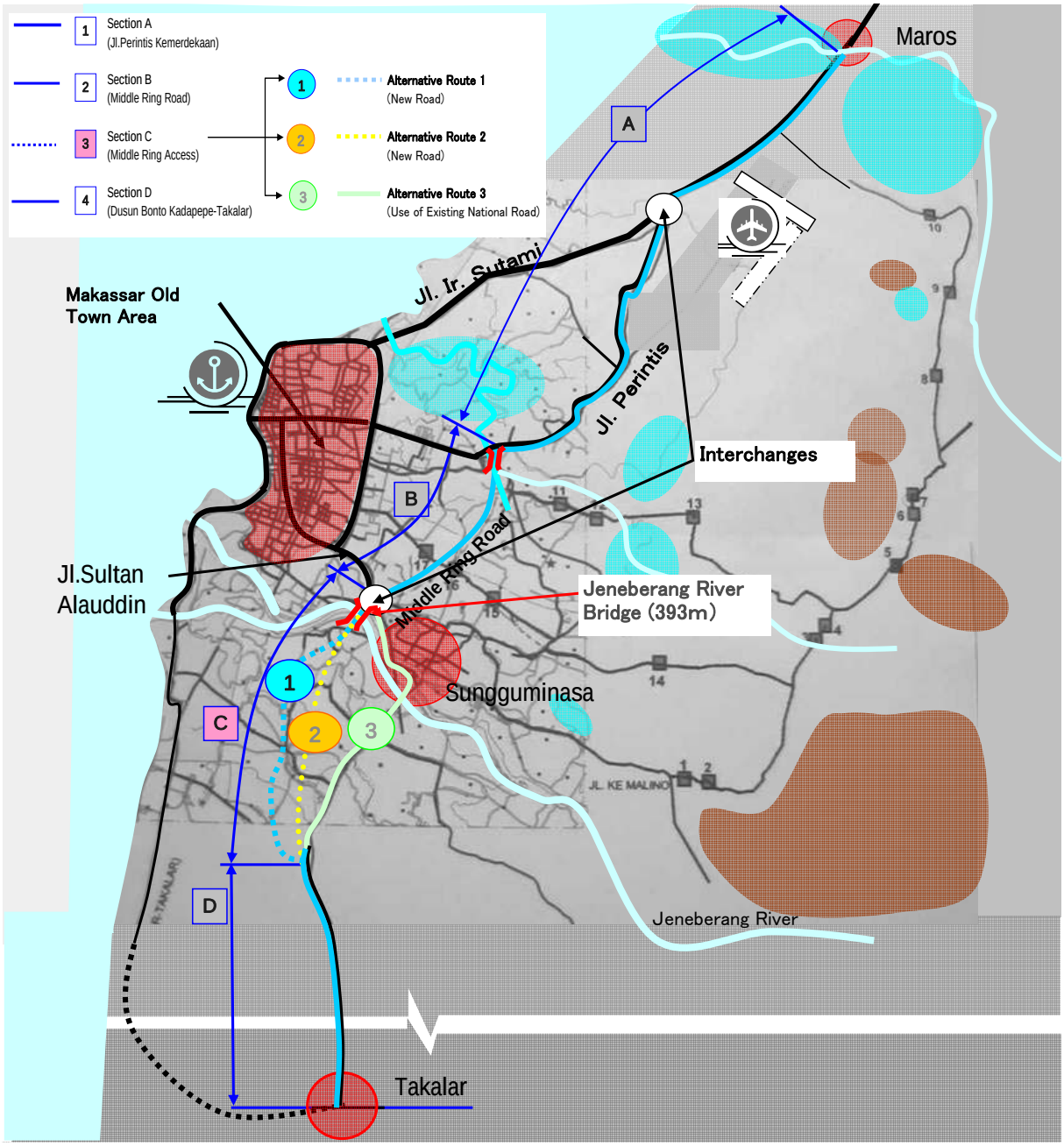


Figure 7.10 Proposed Route of Trans-Sulawesi Road Mamminasata Section

The alternatives, including zero option (without project case) at each section were evaluated on the engineering, economic and environmental aspects. Result of Multi Criteria Analysis (MCA) is summarized in **Table 7.10**. There is little difference between Alternatives 1 and 2 in the case of Section C. The JICA Study Team recommended Alternative 1 as the resettlement requirement was less compared with the latter.

Table 7.10 Summary of Evaluation of Alternatives for Trans-Sulawesi Road by Section

Item	Section A		Section B		Section C			Section D	
	Alternative 1	Zero Option	Alternative 1	Zero Option	Alternative 1	Alternative 2	Zero Option	Alternative 1	Zero Option
	Widening road	Existing road	New route	Existing road	New route	New route	Existing road through Sungguminasa	Widening road	Existing road
	19.6km	19.6km	7.3km	11.5km	8.6km	7.6km	8.7km	22.5km	22.5km
Engineering Aspects	45.0	35.0	46.6	33.4	46.6	46.6	26.7	47.1	32.9
Economic & Financial Aspects	38.0	22.0	36.4	23.6	31.1	33.8	25.2	36.4	23.6
Environmental Aspects	25.0	35.0	25.5	34.5	27.5	24.7	37.9	26.4	33.6
Total	108.0	92.0	108.5	91.5	105.2	105.1	89.8	109.9	90.1
Recommendation	O		O		O			O	

Note: Refer to Appendix B and C as to detailed of the MCA

(2) Mamminasa Bypass

The Mamminasata Bypass is comprised three (3) sections: south, middle and north sections as shown in **Table 7.11**, **Figure 7.11** and Attachments 2, 3 and 4 in Appendix A.

Table 7.11 Alternative Routes for Mamminasa Bypass by Section

Section	Alternatives		Length (km)	Administrative Status	Number of Lanes		Development Plan	ROW Width (m)	Bridge
					Existing	Plan			
South	1	Start point at 6 km south of Jeneberang River	16.8	Provincial *	-	4	New Road	40	Jeneberang River (L=154m)
	2	Start point at 12 km south of Jeneberang River	20.3	Provincial *	-	4	New Road	40	Jeneberang River (L=154m)
	3	Widening of existing Provincial road	9.1	Provincial	2 (width: 6-7m)	6	Widening	35	-
	4	Zero-option: Use of existing Provincial road**	9.1	Provincial	2 (width: 6-7m)	2 (width: 6-7m)	-	-	-
Middle	M1	New Road	19.7	Provincial *	-	4	New Road	40	-
	M2	Widening of existing Kabupaten road	26.4	Provincial *	2 (width: 4.5m)	4	Widening	30	-
	M3	Zero-option: Use of existing Kabupaten road**	27.4	Kabupaten	2 (width: 4.5m)	2 (width: 4.5m)	-	-	-
North	1	New Road (2-accesses)	12.6	Provincial *	-	4	New Road	40	Maros River (L=126m)
	2	New Road (1-access at south of Maros Town)	8.5	Provincial *	-	4	New Road	40	
	3	Widening of existing Kabupaten road	6.8	Provincial *	2 (width: 4.5m)	4	Widneing	30	-
	4	New Road (1-access at north of Maros Town)	11.8	Provincial *	-	4	New Road	40	Maros River (L=126m)
	5	Zero-option: Use of existing Kabupaten road**	6.8	Kabupaten	2 (width: 4.5m)	2 (width: 4.5m)	-	-	-

Notes: * Proposed administrative status
** zero option means without-project case

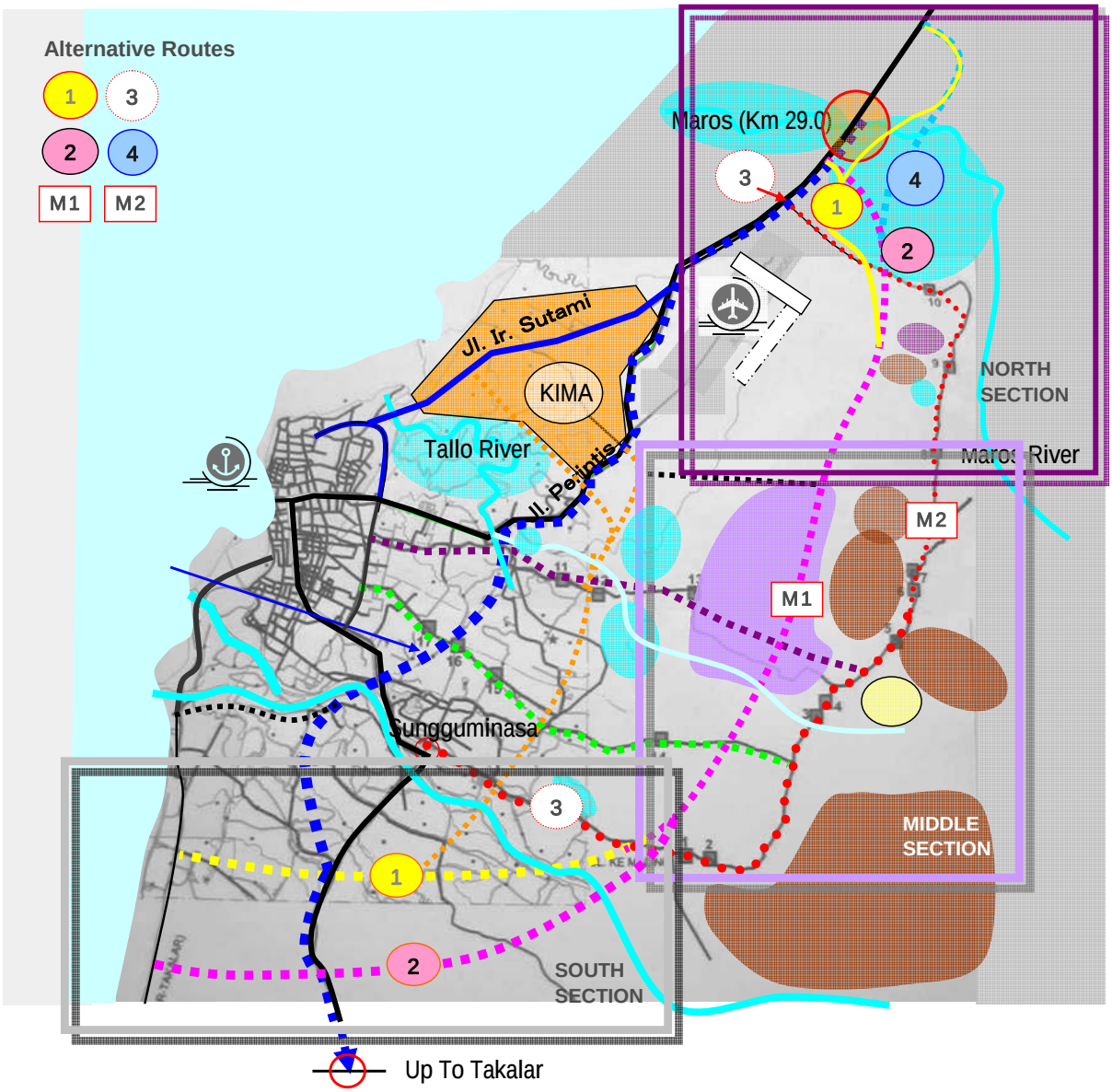


Figure 7.11 Alternative Routes for Mamminasa Bypass

1) South Section

Three (3) alternative routes were studied for the south section. Alternative 1 is a new road of 4.7 km in length. Alternative 2 is a ring road larger radius than Alternative 1. This route will have both ring road and bypass functions. The ring road in Alternative 2 is far from Makassar City when considering the current urbanization border. Alternative 3 requires many resettlements, especially at Sungguminasa and it does not constitute an appropriate ring for the Mamminasata urban area.

2) Middle Section

Two alternatives were set up. One is the widening of the existing Kabupaten road and the other is construction of a new road. Mt. Moncongloe, Maros River, a new runway for Hasanuddin Airport

and Kostrad Kariango (army quarters) are major control points (refer to Attachment 3 in Appendix A). Alternative 1 passes through a planned satellite town while avoiding the control points. Alternative 2 is the widening of the existing Kabupaten road (width 4.5 m) to a 4-lane road. Socio-environmental impact is negative for Alternative 2 as it requires a lot of resettlements and separates regional communities.

3) North Section

Four alternatives were set up for the north section near Maros Town. The major control points are a flood retarding basin, a crossing point (new bridge location) of the Maros River, and connection points to the national road (refer to Attachment 4 in Appendix A).

Alternative 1 is the route to avoid the planned flood retarding basin. Two accesses will be provided for the national road, one before the new Maros town and the other approximately 1.3 km after the Maros town for bypassing this town. Alternative 2 passes through the planned flood retarding basin and joins the national road before the Maros town. Alternative 4 also passes through the flood retarding basin but joins the national road after Maros Town by bypassing it. Alternative 3 is the widening of the existing Kabupaten road (width 4.5 m) to a 4-lane road and requires a lot of resettlements.

4) Summary of Evaluation of Alternatives

The alternatives, including zero option (without project case) at each section were evaluated on the engineering, economic and environmental aspects. Multi Criteria Analysis (MCA) and recommendations are as summarized in Ta**ble 7.12**.

Table 7.12 Summary of Evaluation of Alternatives for Mamminasa Bypass by Section

Item	South Section				Middle Section			North Section				
	Alternative 1	Alternative 2	Alternative 3	Zero Option	Alternative 1	Alternative 2	Zero Option	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Zero Option
	New route	New route	Widening existing	Existing road	New route	Widening road	Exsisting road	New route	New route	Widening road	New route	Existing road
	16.8km	20.3km	9.1km	9.1km	19.7km	26.4km	27.4km	12.6km	8.5km	6.8km	11.8km	6.8km
Engineering Aspects	50.8	43.0	34.1	32.1	57.2	35.3	27.6	51.1	40.2	36.9	43.6	28.2
Economic & Financial Aspects	40.8	23.8	32.2	23.2	40.1	31.3	18.6	34.6	30.2	33.9	26.4	24.9
Environmental Aspects	31.6	25.5	23.8	39.1	30.5	21.9	37.5	31.0	29.8	24.1	28.8	36.3
Total	123.2	92.4	90.0	94.4	127.8	88.5	83.7	116.7	100.2	95.0	98.7	89.5
Recommendation	O				O			O				

Note: Refer to Appendix B and C as to detailed of the MCA

(3) Hertasning Road

Only Section D is in a planning stage and subjected to the F/S. No alternative routes were studied as the project planning is almost complete. The improvement plan was compared with zero-option (without project case) as shown in **Table 7.13**.

Table 7.13 Summary of Evaluation of Alternatives for Hertasning Road

Item	Section D	
	Alternative 1 Widening road 4.9km	Zero Option Exsisting road 4.9km
Engineering Aspects	51.7	28.3
Economic & Financial Aspects	35.0	25.0
Environmental Aspects	26.0	34.0
Total	112.8	87.2
Recommendation	O	

Note: Refer to Appendix B and C as to detailed of the MCA

(4) Abdullah Daeng Sirua Road

Abdullah Daeng Sirua Road (17.8 km in total length) is divided into six (6) sections (refer to Attachment 5 in Appendix A). Alternative plans of this road are as summarized in **Table 7.14**.

1) Section A (Jl.Pettarani - Canal Penampu)

Section A is 1.35 km long and starts from the A.P.Pettarani Road junction to the drainage canal (Canal Penampu). Alternative 1 is use of the existing 2-lane road with one way traffic control. Alternative 2 is widening of the existing 2-lane road to 4-lane road with a median. As shops and houses are densely located on both sides of the street.

2) Section B (Penampu Canal– Poros Road)

The existing road in Section B (2.5 km in length) is located on the south side of the PDAM canal (water supply canal from the Maros River). A new 2-lane road is under construction by Makassar City on the opposite side. This on-going section was excluded from the F/S.

3) Section C (Antang Raya Road)

Section C is a short section of 0.8 km long. The proposed road is constructed by upgrading the Antang Raya Road and PDAM inspection road located opposite the PDAM canal (water supply canal). These existing roads will be improved to be a 4-lane road.

Table 7.14 Alternative Plans for Abdullah Sirua Road by Section

Section	Section Name	Alternative		Length (km)	Number of Lanes		Development Plan	ROW Width (m)	ROW Acquisition Status
					Existing	Plan			
A	Jl.Pettarani - Canal Penampu	1	Use of Existing Road with traffic control (one-way operation)	1.4	2	2	-	-	-
		2	Widening of Existing Road to 4 lanes		2	4	-	27	Not Yet
		3	Zero-option (no improvement)		2	2	-	-	-
B	Canal Penampu - Jl.Poros	1*	Construction of new 2 lanes at the opposite side of PDAM Canal	2.5	2	4	Under Construction	15	On-going
C	Jl.Antang Raya	1	Construction of new 2 lanes at the opposite side of PDAM Canal	0.8	2	4	Additional 2 lane construction (New)	15	Not Yet
		2	Zero-option (no improvement)	-	2	2	-	-	-
D	Jl.Antang Raya - Bts.Makassar/ Gowa (Tallo River)	1	New road along/on swamp and rice field	4.8	-	4	New 4 lanes	34	Not Yet
		2	A combination of a new 2 lanes at the opposite side of PDAM Canal and existing road widening		2	4	Additional 2 lanes (New)	15	Not Yet
		3	New road mostly on the PDAM		2	4	Additional 2/4 lane construction (New)	25	Not Yet
		4	Zero-option (no improvement)	-	2	2	-	-	-
E	Bts.Makassar/ Gowa (Tallo River) - Mangempang	1	Widening of Existing Road to 4 lanes	1.2	2	4	Additional 2 lanes (widneing)	40	Not Yet
		2	Zero-option (no improvement)	-	2	2	-	-	-
F	Mangempang - Moncongloe (End)	1	New road alignment	7.1	-	4	New Road	34	Not Yet
		2	Widening of Existing Road to 4 lanes		2	4	Additional 2 lanes (widneing)	25	Not Yet
		3	Zero-option (no improvement)	-	2	2	-	-	-

Note: * No zero options as this section is under construction.

(5) Section D (Antang Raya Road – Makassar City /Kab.Maros Boarder)

Three alternative routes were studied for Section D (length 4.8 km) as indicated in Attachment 5 in Appendix A. Alternative 1 is a new road through a swamp and paddy field aiming to minimize resettlement. Alternative 2 is the construction of a 2-lane road partly along/on the PDAM canal[1] and partly widening existing road. There are two methods. One is to construct a new road opposite the PDAM canal (same method currently applied for Section B). The other is to construct a new road over the PDAM canal replacing it with concrete lined steel pipes (Dia.1200mm x 2 pieces) as illustrated in **Figure 7.12**. The latter will change the current natural condition while it is able to avoid resettlement. The Study Team recommended keeping the clean water frontage environment as much as possible.

New Road at the side of PDAM Canal **New Road over the PDAM Canal**

Figure 7.12 Alternative Plans of New Road Construction for Section D

Alternative 3 is the new road construction on the PDAM for most of the section. Therefore, some part of the geometric alignment is poor as it will follow the PDAM alignment.

5) Section E (Makassar City/Kab.Maros Boarder– Mangempang)

Section E is a short section of 1.2 km long passing through paddy field and wetland. The proposed road improvement plan is to widen the existing 4.5m Kabupaten road to a 4-lane road.

6) Section F (Mangempang - Moncongloe)

Section F (7.1 km) is the end section and connected to a planned satellite town and the Mamminasa Bypass. This road is a direct access to KIWA (New Industrial Area of Kabupaten Gowa) and Regional Final Disposal Site (TPA).

Two alternative routes were studied for Section F. Alternative 1 is the construction of a new road

[1] PDAM Canal: Water supply canal from the Maros Rover. ROW of PDM is 15 m at each side.

with the alignment aimed at minimizing resettlement and connected to KIWA directly. Alternative 2 is the widening of the existing Kabupaten road.

7) Summary of Evaluation of Alternatives

The alternatives, including zero option (without project case) at each section were evaluated on the engineering, economic and environmental aspects. Summary of Multi Criteria Analysis (MCA) and recommendations are in the following table.

Table 7.15 Summary of Evaluation of Alternatives for Abdullah Daeng Sirua Road by Section

Item	Section A			Section C		Section D			
	Alternative 1	Alternative 2	Zero Option	Alternative 1	Zero Option	Alternative 1	Alternative 2	Alternative 3	Zero Option
	Wth traffic control	Widening road	Existing road	Widening road	Existing road	New route at Swamps	New road on PDAM and Existing Road	Widening Existing road	Existing road
	1.3km	1.3km	1.3km	0.8km	0.8km	4.9km	4.8km	4.8km	4.8km
Engineering Aspects	48.0	53.0	19.1	57.9	22.1	46.2	48.3	44.6	20.9
Economic & Financial Aspects	31.5	33.0	25.5	27.0	33.0	26.4	34.3	36.7	22.6
Environmental Aspects	30.7	27.6	31.7	32.1	27.9	34.7	30.6	25.5	29.2
Total	110.2	113.6	76.2	117.0	83.0	107.3	113.1	106.8	72.8
Recommendation	O			O			O		

Item	Section E		Section F		
	Alternative 1	Zero Option	Alternative 1	Alternative 2	Zero Option
	Widening road	Existing road	New route	Widening road	Existing road
	1.2km	1.2km	7.1km	7.3km	7.3km
Engineering Aspects	52.1	27.9	58.0	44.0	18.0
Economic & Financial Aspects	32.5	27.5	38.3	28.6	23.2
Environmental Aspects	30.8	29.2	34.0	25.6	30.4
Total	115.4	84.6	130.3	98.2	71.5
Recommendation	O		O		

Note: Refer to Appendix B and C as to detailed of the MCA