## 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:

i) Geotechnical investigation for bridges
ii) Road alignment soil survey
iii) Road construction material investigation.

The objectives of geological surveys were:

i) To obtain necessary geological data for bridge design
ii) To obtain data on subgrade strength of study routes for pavement design
iii) To obtain information for weak foundation countermeasure planning
iv) To obtain latest information/data on possible borrow pits and quarries as well as physical properties of the materials.

### 6.2.1 Geological Investigation for Bridges

#### (1) Bridge Location and Methodology

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. Figure 6.2.1 shows location of these bridges.

Mechanical boring was carried out at abutments for the bridge between 20 m and 40 m in length. 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. During SPT operation, the soil samples were taken and kept in plastic sack with sampling data information on it. These N-values were recorded in drilling logs. For rock layers, value of presentation RQD (Rock Quality Destination) for identifying rock strength was observed and recorded in “geological drilling log".

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.

As to details of the investigation results, Appendix E is referred.

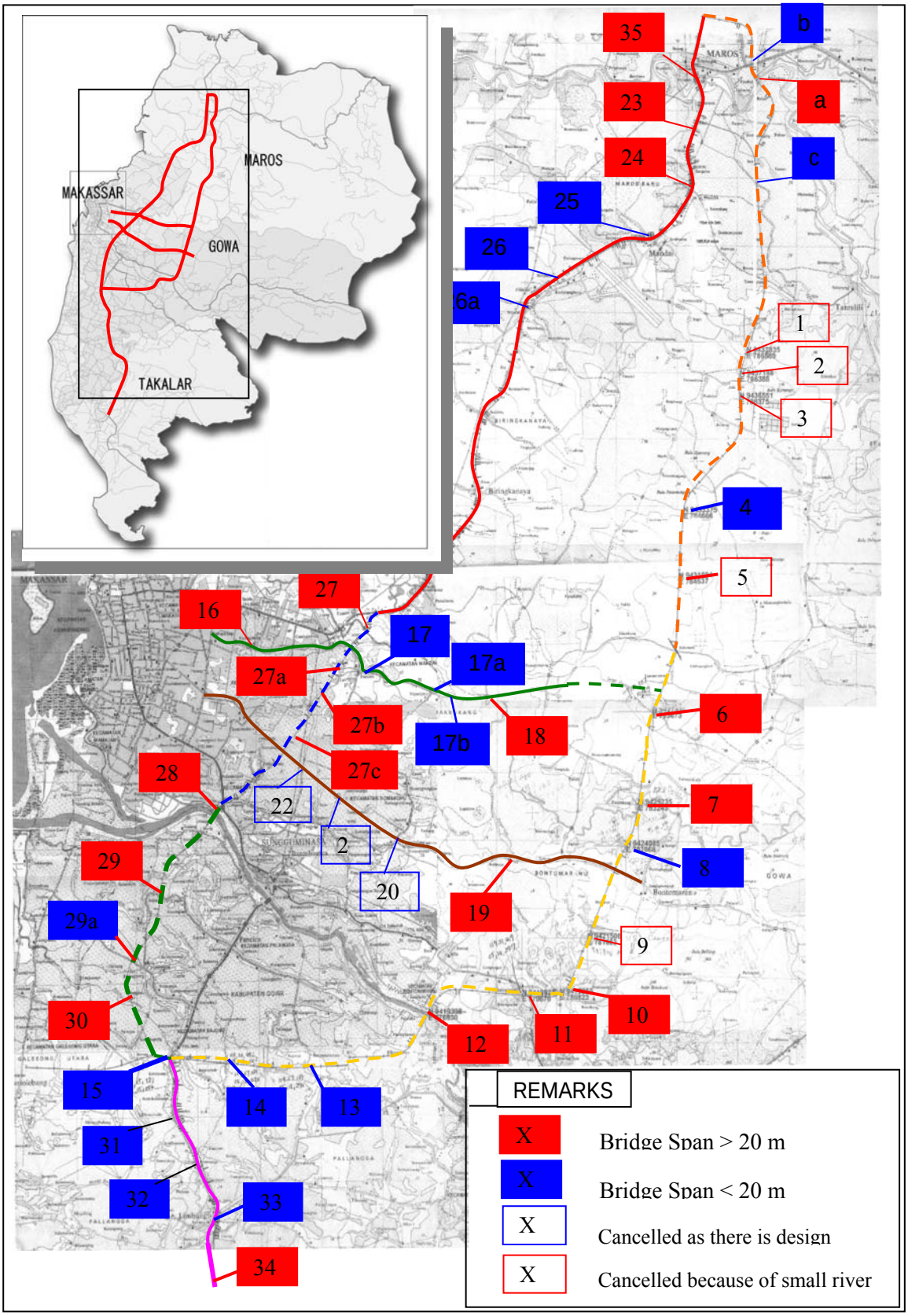



**Figure 6.2.1 Location of Bridges**

### (2) Bridges > 20 m in Length

Table 6.2.1 shows a list of the bridges, of which length is more than 20m, subjected to geological investigation.

**Table 6.2.1 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 |

### (2) Investigation Results for Major Bridges (L>100m)

Four major bridges exceeding 100m in length exist on the F/S roads. Since accurate geological information is essential for bridge planning and design, three (3) boring tests were carried out for each major bridge.

1) Bridge Number 1-5, Maros Bridge, on Mamminasa Bypass

i) Bore Hole 08 at Left Bank

- In depth 0 – 13.0 m, type of material is clay sand, dark brown reddish, soft, plastic and cohesive. Loose at 0 m – 5 m.
- In depth >13.0 m, type of material is limestone, dark gray color, soft to hard and massive at 12.5 m - 15.0 m.

ii) Bore Hole 09 at River Center (River Bed)

- In depth 0 – 7 m, type of material is clay sand, dark brown reddish, soft, plastic and cohesive. Loose at 0 m – 5 m.
- At deepness > 7m, type of material is limestone, dark gray color, soft to hard and massive at 7.0m – 10.0 m.

iii) Bore Hole 10 at Right Bank

- In depth 0 – 13.0 m, type of material is clay sand, dark brown reddish, soft, plastic and cohesive. Loose at 0 m – 5 m.
- In depth >13.0 m, type of material is limestone, dark gray color, soft to hard and massive at 13.0 m – 15.0 m.

Figure 6.2.2 shows boring logs for the above three investigations and a geological cross section for the Maros Bridge site.

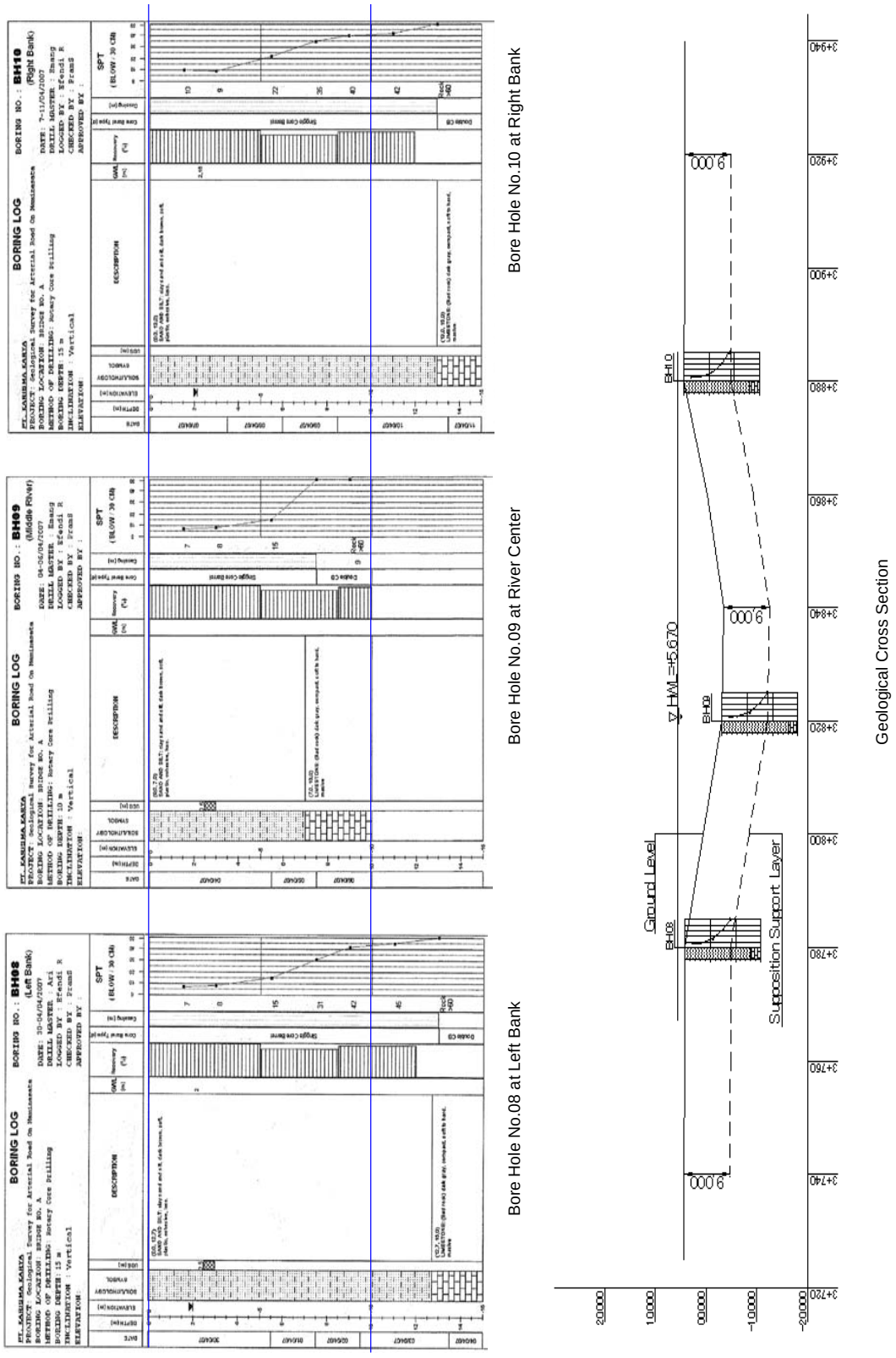



**Figure 6.2.2 Boring Logs and Geological Cross Section for Maros Bridge on Mamminasa Bypass**

2) Bridge Number 1-31 (Jeneberang Bridge No.1) on Mamminasa Bypass

i) Bore Hole 01 at Right Bank

- In depth 0 – 1.5 m, represented of top soil, high plasticity, dark brown color, many crop roots, and high consolidation. SPT Value on 1.5 m from ground surface is 12 blows/foot.
- In depth 1.5 – 4.0 m, represented of clay silt, brown color, and high plasticity. SPT Value on this layer t is 38 blows/foot.
- In depth > 4.00 m, represented of a soft to hard soil consist of pebble stone, dark grey color, compact and massive. SPT Value on this layer is 70 blows/foot.

ii) Bore Hole 2 at Left Bank

- In depth 0 – 1.5 m, represented of top soil, dark brown color, many crop roots, high consolidation. SPT Value on 1.5 m from ground surface is 7 blows/foot.
- In depth 1.5 – 6.0 m, represented of clay silt, black color, soft, high plasticity. SPT Value on this layer is 32 blows/foot.
- In depth > 6.0 m, represented of hard soil of pebble stone, dark grey color, compact and uniform. SPT Value on this layer is 60 blows/foot.

iii) Bore Hole 3 at River Center (River Bed)

- In depth 0 – 1.5 meters represented of top soil, dark brown color, many crop roots, high consolidation. SPT Value on 1.5 meter from ground surface is 7 blows/foot.
- In depth 1.5 – 5.0 m, represented of clay silt, black color, soft, high plasticity. SPT Value on this layer is 25 blows/foot.
- In depth > 5.0 m, represented of hard soil consist of pebble stone, dark grey color, compact and uniform. SPT Value on this layer is 60 blows/foot.

Figure 6.2.3 shows boring logs for the above three investigations and a geological cross section for the Jeneberang No.1 Bridge site.

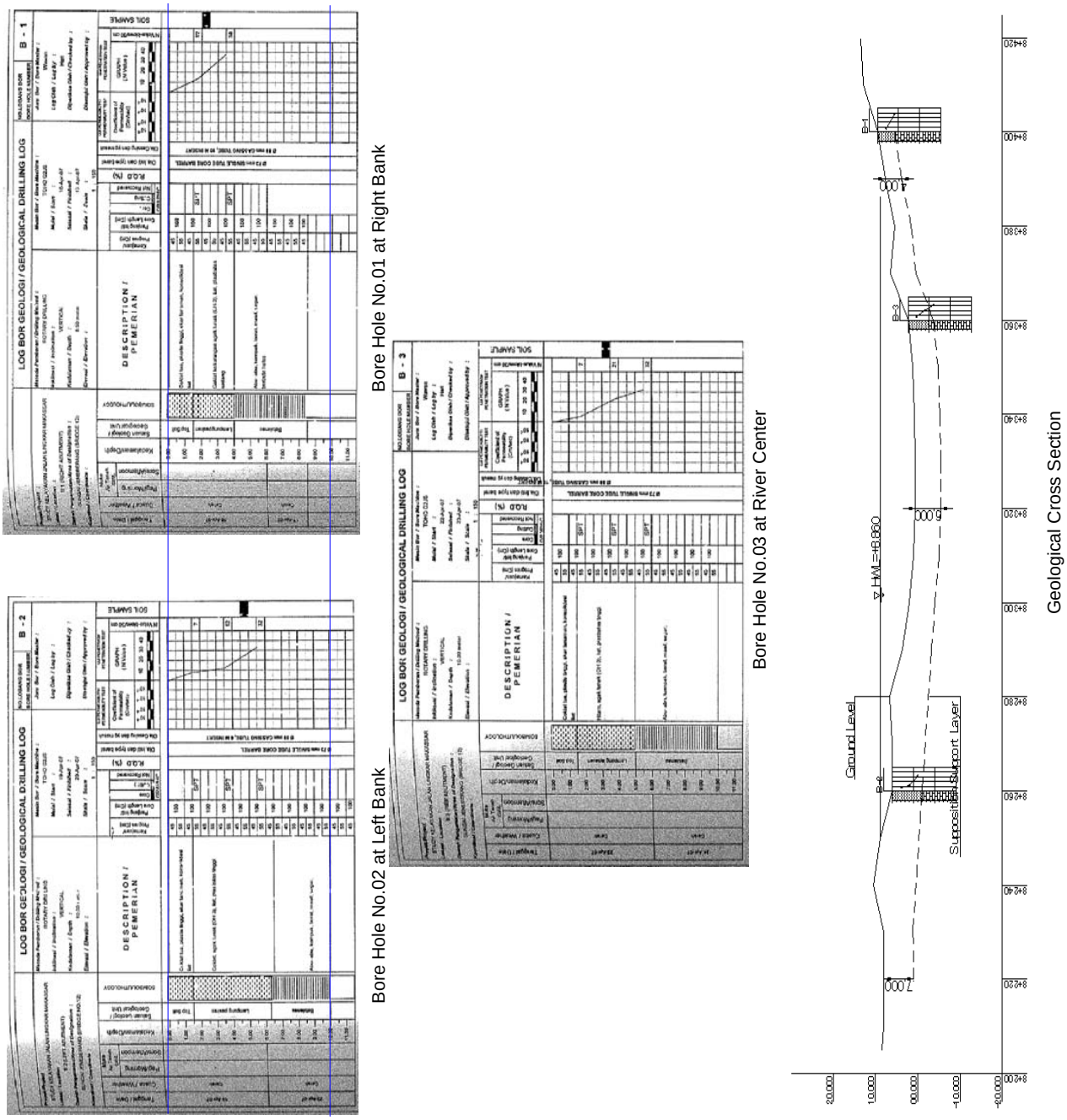



**Figure6.2.3 Boring Logs and Geological Cross Section**
**For Jeneberang No.1 Bridge on Mamminasa Bypass**

3) Bridge Number 2-6 (Tallo Bridge) on Trans-Sulawesi Mamminasata Road

i) Bore Hole 13 at Left Bank

- In depth 0 – 4.0 m, represented of top soil, clay sand, dark brown reddish, soft, plastic, cohesive, and loose. SPT Value 4.0 m from ground surface is 40 blows/foot.
- In depth 5.7 -10.0 m, represented of clay stone, dark gray, compact, soft to hard and uniform. SPT Value on 6 meter from ground surface is 50 blows/foot.

ii) Bore Hole 14 at River Bed

- In depth 0 – 3.0 m, represented of top soil and clay sand, dark brown reddish, soft, plastic, cohesive, loose. SPT Value on 3 m from ground surface is 50 blows/foot.
- In depth > 3.0 m, represented of clay stone, dark gray, compact, soft to hard and uniform. SPT Value on 4 m is 50 blows/foot.

iii) Bore Hole 15 at Right Bank

- In depth 0 – 7.5 m, represented of top soil, clay sand, dark brown reddish, soft, plastic, cohesive, loose. SPT Value on 5.0 m from ground surface is 20 blows/foot.
- In depth 7.5 -10.0 m, represented of clay stone, dark gray, compact, soft to hard and uniform. SPT Value on 7.5 m is 50 blows/foot.

Figure 6.2.4 shows boring logs for the above three investigations and a geological cross section for the Tallo Bridge site.

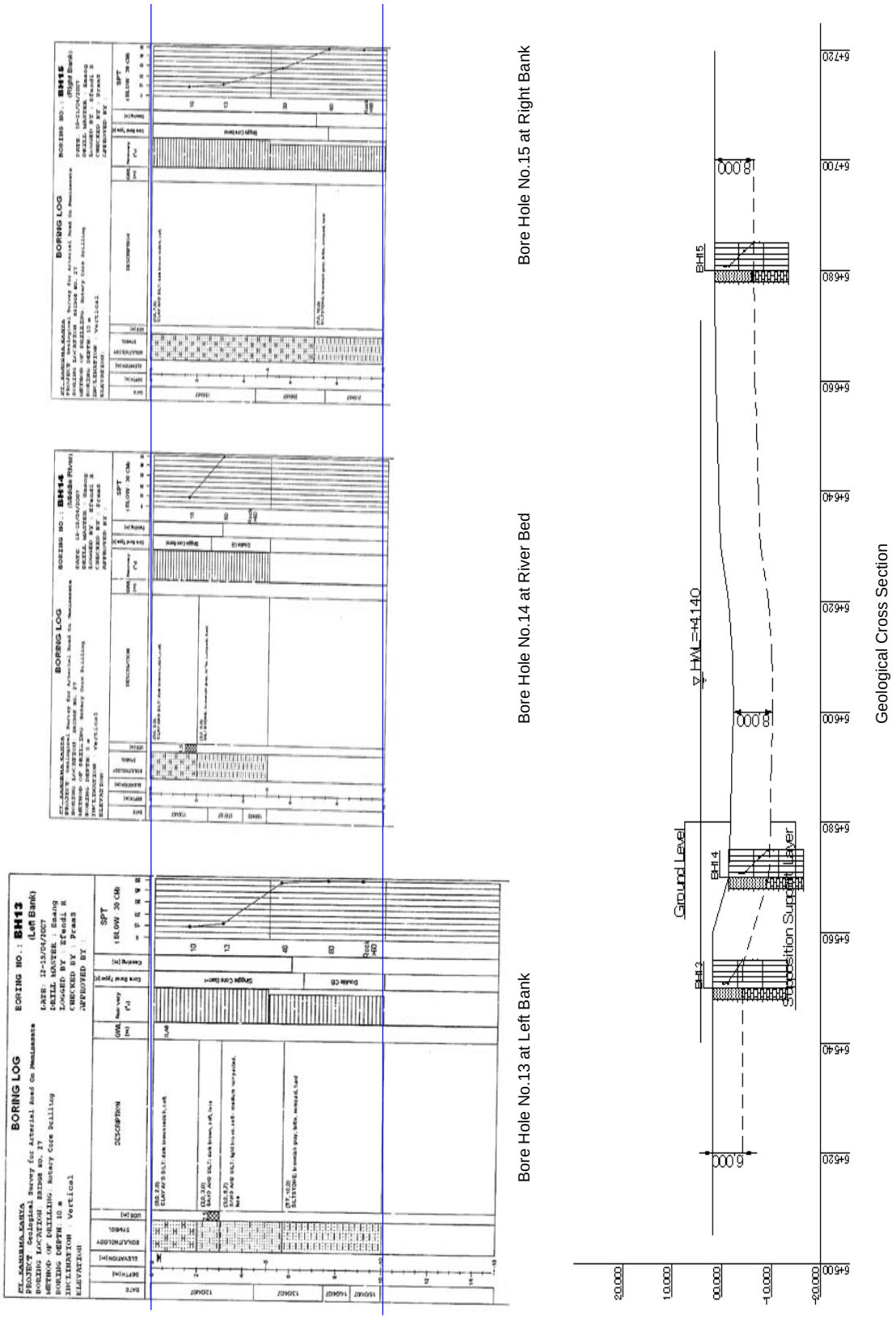



**Figure 6.2.4 Boring Logs and Geological Cross Section for Tallo Bridge on Trans-Sulawesi Mamminasata Road**

4) Bridge Number 2-11 (Jeneberang No.2 Bridge) on Trans-Sulawesi Mamminasata Road

i) Bore Hole 1 at Right Bank

- In depth 0 – 1.5 m, represented of top soil, high plasticity, dark brown color, many crop roots, and high consolidation. SPT Value on 1.5 m from ground surface is 10 blows/foot.
- In depth 1.5 – 6.0 m, represented of clay silt, black color, clay, and high plasticity. SPT Value on this layer is 15 blows/foot.
- In depth 6.0 - 14.0 m, represented of soft to hard soil consist of Pebble stone, dark grey color, compact and uniform. SPT Value on this layer is 41 blows/foot.
- In depth 14.0 m – 23.5 m, represented of soft to hard soil consist of Pebble stone, grey color, compact and uniform. SPT Value on this layer is 50 blows/foot.
- In depth >23.5 m, represented of hard, black, compact and uniform. SPT Value on this layer is 60 blows/foot.

ii) Bore Hole 2 at River Basin

- In depth 0 – 1.5 m, represented of top soil, high plasticity, dark brown color, many crop roots, and high consolidation. SPT Value on 1.5 m from ground surface is 5 blows/foot.
- In depth 1.5 – 6.0 m, represented of clay silt, black color, clay, and high plasticity. SPT Value on this layer is 15 blows/foot.
- In depth 6.0 - 10.0 m, represented of soft to medium hard soil consist of Pebble stone, dark grey color, compact and uniform. SPT Value on this layer is 17 blows/foot.
- In depth 10.0 m – 18.5 m, represented of soft to medium hard soil consist of Pebble stone, grey color, compact and uniform. SPT Value on this layer is 25 blows/foot.
- In depth >27.0 m, represented of hard, black, compact and uniform layer. SPT Value on this layer is 50 blows/foot.

iii) Bore Hole 3 at Left Bank

- In depth 0 – 1.5 m, represented of top soil, high plasticity, dark brown color, many crop roots, and high consolidation. SPT Value on 1.5 m from ground surface is 13 blows/foot.
- In depth 1.5 – 6.5 m, represented of clay silt, black color, clay, and high plasticity. SPT Value on this layer is 13 blows/foot.
- In depth 6.5 - 18.0 m, represented of soft to medium hard soil consist of Pebble stone, dark grey color, compact and massive. SPT Value on this layer is 25 blows/foot.
- In depth 18.0 – 24.0 m, represented of soft to hard soil consist of Pebble stone, grey color, compact and uniform. SPT Value on this layer is 30 blows/foot.
- In depth > 26.0 m, represented of hard, black, compact and uniform layer. SPT Value on this layer is 50 blows/foot.

Figure 6.2.5 shows boring logs for the above three investigations and a geological cross section for the Jeneberang No.2 Bridge site.

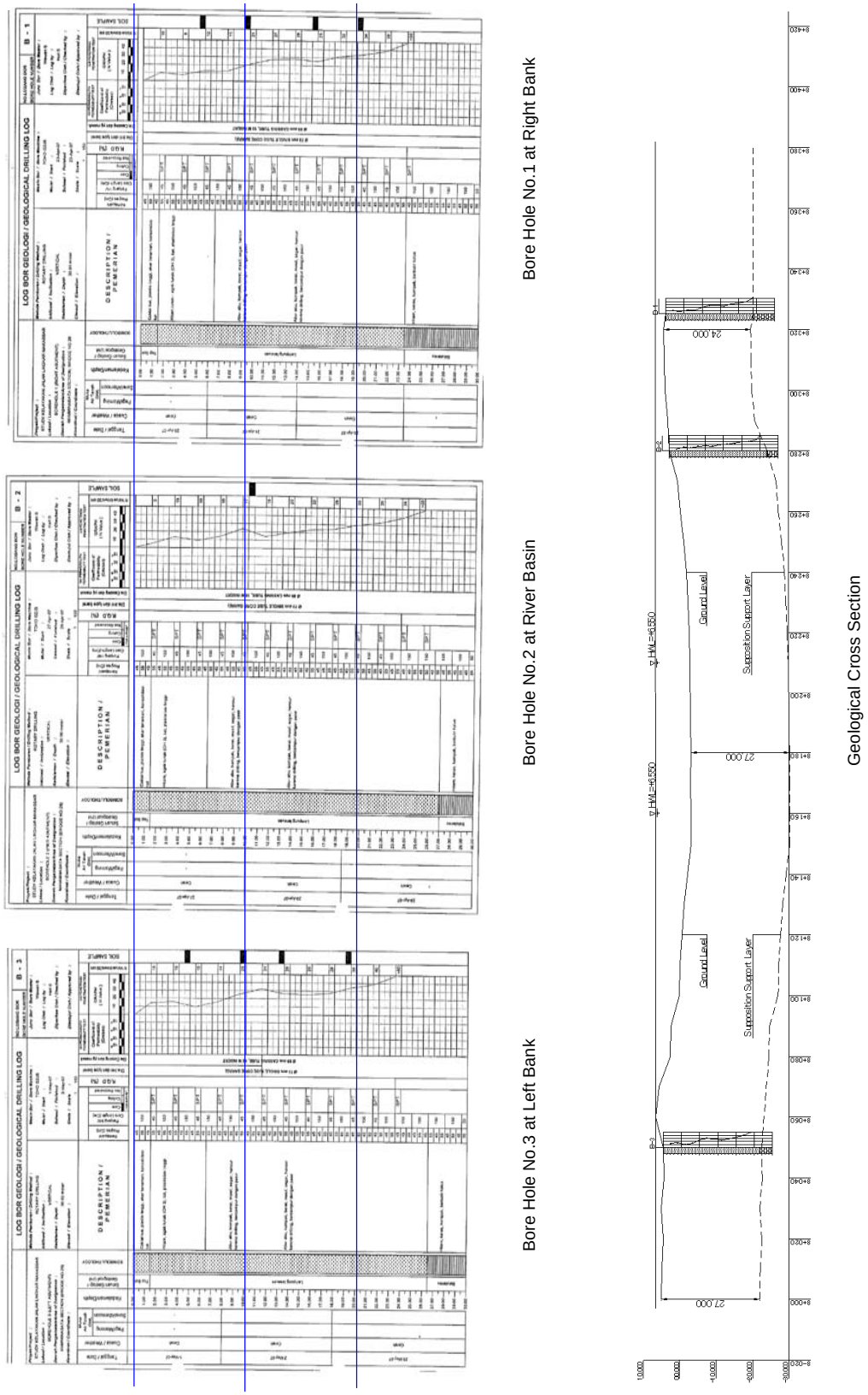



**Figure 6.2.5 Boring Logs and Geological Cross Section for Jeneberang No.2 Bridge on Trans-Sulawesi Mamminasata Road**

**(2) Other Bridges 20 – 100 m in Length**

Refer to Appendix E as to the geotechnical investigation results of bridges of which length is 20 – 100 m.

### 6.2.2 Road Alignment Soil Survey

**(1) Location and Methodology**

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.

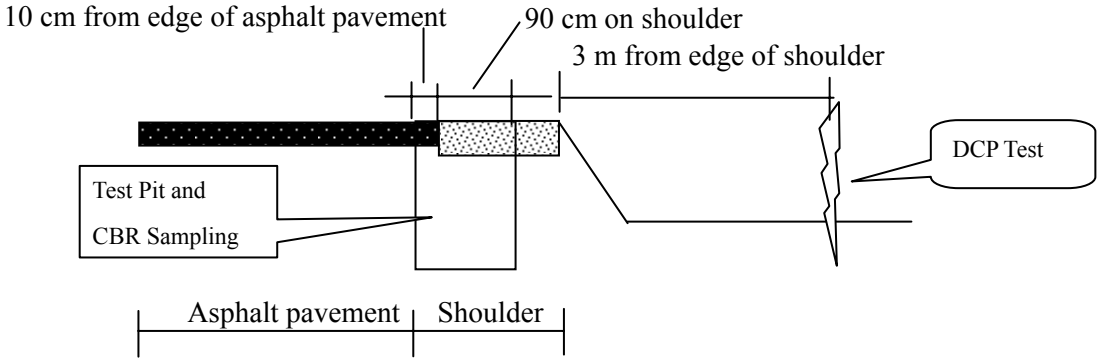
**Table 6.2.2 List of Soil Survey for the F/S Roads**

| 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 |

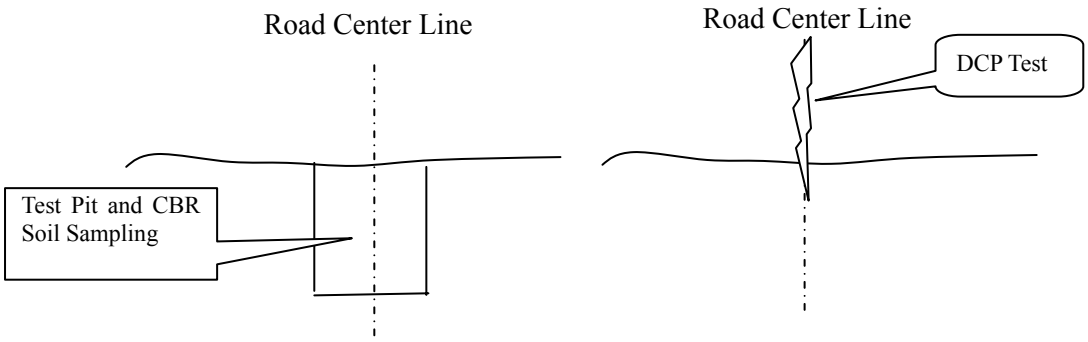
The subgrade survey, including CBR test, DCP test and laboratory test, was carried out to obtain the data of sub-soil conditions of the study routes. The test pits were excavated at 2 km along the study routes and the DCP tests were carried out 3 points per 1 km.

Psitions of the test pit excavation and DCP tests are as follows:

i). For road widening section



ii). For new road section




Location of the test pit is 10 cm outside from the edge of asphalt pavement and dimension is 90 cm square on shoulder for road widening. For new road, test pit is excavated at the centre line of the study road. Minimum size of test pit is 1.0 m x 1.0 m and 1.0 m depth. The test pit is excavated up to subgrade layer. Thickness, type and condition of existing pavement layers and subgrade soil layers were observed and recorded.

Undisturbed soil was sampled for the CBR test. The CBR mould was pushed into test pit base, and then brought them to Laboratory for testing. Sampling for physical soil test is carried out for disturbed soil. The sample is kept in plastic bags, and then brought to laboratory for testing.

Laboratory tests consist of:

- Soaked CBR Test (AASHTO T.193 - 00 )
- Specific Gravity Test ( AASHTO T.100 – 03 )
- Moisture Content ( AASHTO T.101 – 00 )
- Grain Size Analysis (AASHTO T. 88 – 00 )
- Atterberg Limit Test ( AASHTO T.89 – 02 )

Dynamic Cone Penetrometer (DCP) tests were carried out to know CBR value of subgrade required for pavement design. The test covers up to 100 cm depth of subgrade. Investigation interval is at 300 meters.

**(2) Survey Results**

1) Trans-Sulawesi Mamminasata Road

The existing pavement layer thickness of Perintis Kemerdekaan Road and Sungguminasa (Boka) – Takalar road are as shown in Table 6.2.3. 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.

**Table 6.2.3 Existing Pavement Thickness of Perintis Kemerdekaan Road and Sungguminasa (Boka) – Takalar Road**

Section A, Perintis Kemerdekaan Road

| No | Station Point | Layer Thickness (cm) | | |
|---|---|---|---|---|
| | | Asphalt | Base | Subgrade |
| 1 | 0+000 | 20 | 45 | 35 |
| 2 | 2+000 | 18 | 62 | 20 |
| 3 | 4+000 | 18 | 52 | 32 |
| 4 | 6+000 | 18 | 52 | 30 |
| 5 | 8+000 | 20 | 50 | 30 |
| 6 | 10+000 | 15 | 45 | 40 |
| 7 | 12+000 | 18 | 52 | 30 |
| 8 | 14+000 | 15 | 55 | 30 |
| 9 | 16+000 | 18 | 52 | 30 |
| 10 | 18+000 | 15 | 45 | 40 |
| 12 | 20+000 | 15 | 45 | 40 |
| 13 | 22+000 | 15 | 45 | 40 |
| Average | | 17 | 50 | 33 |

Source: JICA Study Team

Section C, Sungguminasa - Takalar Road

| No | Station Point | Layer Thickness (cm) | | |
|---|---|---|---|---|
| | | Asphalt | Base | Subgrade |
| 1 | 0+000 | 20 | 40 | 40 |
| 2 | 2+000 | 20 | 40 | 40 |
| 3 | 4+000 | 10 | 35 | 55 |
| 4 | 6+000 | 10 | 20 | 70 |
| 5 | 8+000 | 10 | 20 | 70 |
| 6 | 10+000 | 10 | 20 | 70 |
| 7 | 12+000 | 12 | 20 | 68 |
| 8 | 14+000 | 20 | 20 | 60 |
| 9 | 16+000 | 20 | 20 | 60 |
| 10 | 18+000 | 15 | 20 | 65 |
| Average | | 15 | 26 | 60 |

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 as indicated in Table 6.2.4.

**Table 6.2.4 Subgrade Soil Characteristics for Trans-Sulawesi Mamminasata Road**

| Item | | Section A | Section B | Section C | Section D | Average |
|---|---|---|---|---|---|---|
| CBR | % | 6.8 | 3.1 | 2.7 | 0.9 | 3.4 |
| Liquid Limit | LL (%) | 53.8 | 41.5 | 56.2 | 41.1 | 48.2 |
| Plastic Limit | PL (%) | 40.0 | 29.1 | 38.6 | 27.8 | 33.9 |
| Plasticity Index | PI | 13.8 | 12.5 | 17.0 | 13.3 | 14.1 |
| CBR by DCP | % | 2.3 | 2.0 | 2.2 | 2.1 | 2.2 |

Source: JICA Study Team

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 as indicated in Table 6.2.5.

**Table 6.2.5 Subgrade Soil Characteristics for Mamminasa Bypass**

| Item | | North | South | Average |
|---|---|---|---|---|
| CBR | % | 3.2 | 6.0 | 4.6 |
| Liquid Limit | LL (%) | 50.5 | 54.6 | 52.5 |
| Plastic Limit | PL (%) | 31.8 | 30.4 | 31.1 |
| Plasticity Index | PI | 18.7 | 24.5 | 21.6 |
| CBR by DCP | % | 2.3 | 2.2 | 2.2 |

Source: JICA Study Team

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).

Tables 6.2.6 and 6.2.7 show the pavement composition of the existing Hertasning Road and Abdullah Daeng Sirua Road.

**Table 6.2.6 Existing Pavement Layers for Hertasning Road**

| No | Station Point | Layer Thickness (cm) | | |
|---|---|---|---|---|
| | | Layer I | Layer II | Layer III |
| 1 | 2+000 | Asphalt : 20 cm | Base : 30 cm | Gravel : 50 cm |
| 2 | 4+000 | Asphalt : 15 cm | Base : 15 cm | Gravel : 70 cm |
| 3 | 6+000 | Asphalt : 15 cm | Base : 50 cm | Clay : 40 cm |

**Table 6.2.7 Existing Pavement Layers for Abdullah Daeng Sirua Road**

| No | Station Point | Layer Thickness (cm) | | |
|---|---|---|---|---|
| | | Layer I | Layer II | Layer III |
| 1 | 0+000 | Asphalt : 20 cm | Base : 30 cm | Gravel : 50 cm |
| 2 | 6+000 | Asphalt : 10 cm | Base : 30 cm | Gravel : 60 cm |
| 3 | 8+000 | Asphalt : 10 cm | Base : 30 cm | Silt : 60 cm |
| 4 | 10+000 | Sandy gravel : 20 cm | Sandy silt : 80 cm | |
| 5 | 12+000 | Sandy gravel : 20 cm | Clay : 20 cm | Sandy silt : 60 cm |
| 6 | 14+000 | Top soil 20 cm | Clayey silt : 80 cm | |
| 7 | 16+000 | Top soil 20 cm | Clayey silt : 80 cm | |
| 8 | 18+000 | Top soil 20 cm | Clayey silt : 80 cm | |

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% as indicated in Table 6.2.8.

**Table 6.2.8 Subgrade Soil Characteristics for Hertasning Road and Abdullah Daeng Sirua Road**

| Item | | Hertasning Road | AD Sirua Road |
|---|---|---|---|
| CBR | % | 1.7 | - |
| Liquid Limit | LL (%) | 44.3 | 55.6 |
| Plastic Limit | PL (%) | 29.7 | 36.5 |
| Plasticity Index | PI | 14.6 | 19.2 |
| CBR by DCP | % | 3.4 | 2.3 |

Source: JICA Study Team

### 6.2.3 Road Construction Material Investigation

#### (1) Investigation for Material Sources

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.

#### (2) Laboratory Tests of Materials

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 laboratory tests were conducted:

i) Coarse Aggregate

- Sieve Analysis (AASHTO T27 – 99)
- Specific Gravity and Absorption (AASHTO T85 – 91)
- Los Angeles Aberration Test (AASHTO T96 – 02)
- Sodium Soleplate Soundness (AASHTO T 104 – 99)
- Flakiness Index (BS 812 Section 105.1 - 1989)
- Potential Alkali-Silica Reactivity (ASTM C – 289)

ii) Fine Aggregate

- Sieve Analysis (AASHTO T27 – 99)
- Specific Gravity and Absorption (AASHTO T84 – 00)
- Organic impurities (AASHTO T21 – 00)
- Sand Equivalent (AASHTO T 176 – 02)
- Sodium Soleplate Soundness (AASHTO T 104 – 99)
- Potential Alkali-Silica Reactivity (ASTM C – 289)

iii) Borrow Soils

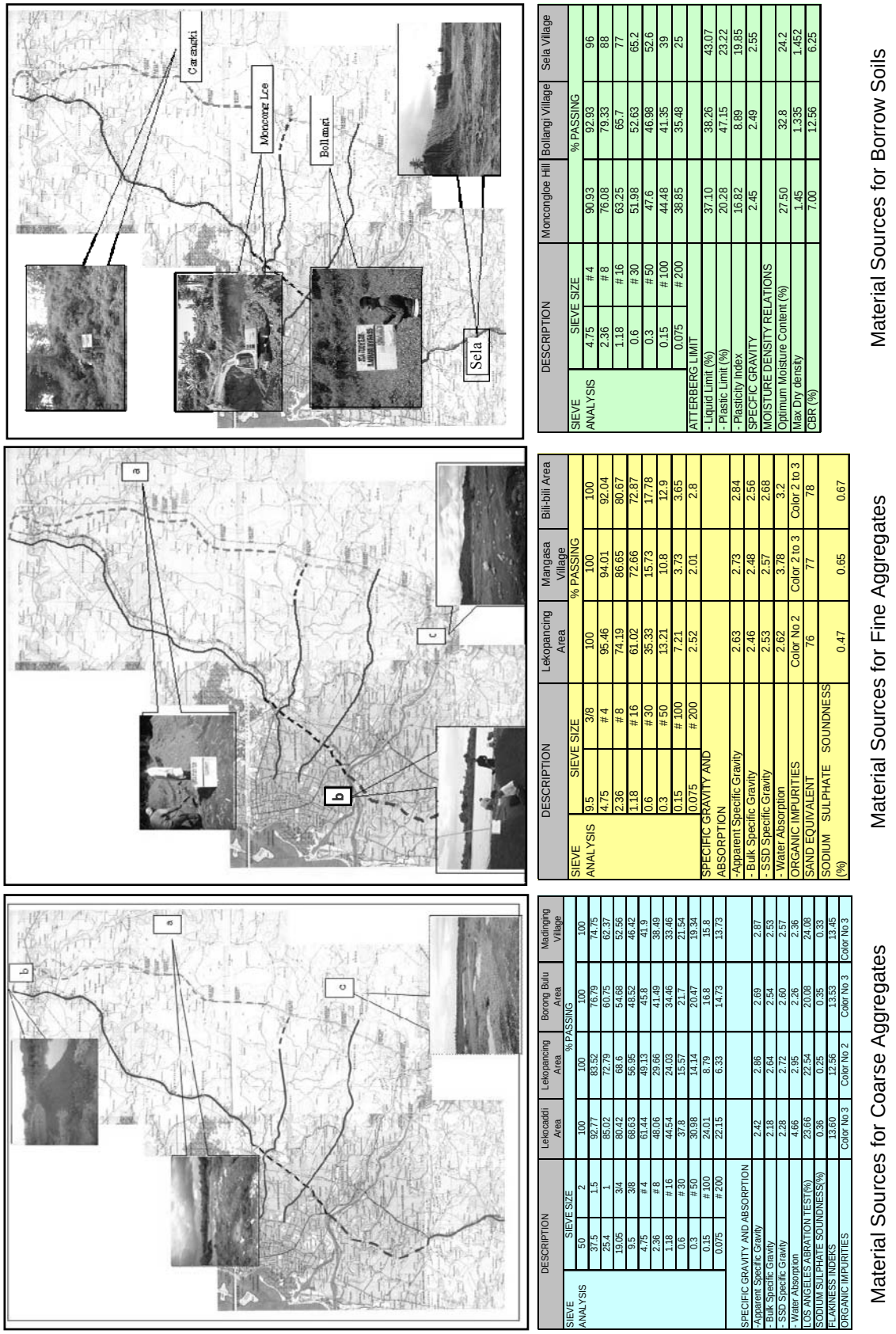
- Sieve Analysis (AASHTO T88 – 00)
- Atterberg Limit (AASHTO T89 – 02)
- Moisture Density Relations (AASHTO T99 – 01)
- Specific Gravity (AASHTO T100 – 03)
- CBR Test (AASHTO T 193 – 99)

### (3) Location and Estimated Quantity of Materials

The following Table 6.2.9 and Figure 6.2.6 show material sources, distance from Makassar and estimated quantities available for the F/S road construction. Refer to Appendix E as to the laboratory tests results of these materials.

**Table 6.2.9 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 |




| DESCRIPTION | | Lekocaddi Area | Lekopancing Area | Borong Bulu Area | Madinging Village |
|---|---|---|---|---|---|
| | SIEVE SIZE | | % PASSING | | |
| SIEVE ANALYSIS | 50 2 | 100 | 100 | 100 | 100 |
| | 37.5 1.5 | 92.77 | 83.52 | 76.79 | 74.75 |
| | 25.4 1 | 85.02 | 72.79 | 60.75 | 62.37 |
| | 19.05 3/4 | 80.42 | 68.6 | 54.68 | 52.56 |
| | 9.5 3/8 | 68.63 | 56.95 | 48.52 | 46.42 |
| | 4.75 # 4 | 61.44 | 49.13 | 45.8 | 41.9 |
| | 2.36 # 8 | 48.06 | 29.66 | 41.49 | 38.49 |
| | 1.18 # 16 | 44.54 | 24.03 | 34.46 | 33.46 |
| | 0.6 # 30 | 37.8 | 15.57 | 21.7 | 21.54 |
| | 0.3 # 50 | 30.98 | 14.14 | 20.47 | 19.34 |
| | 0.15 # 100 | 24.01 | 8.79 | 16.8 | 15.8 |
| | 0.075 # 200 | 22.15 | 6.33 | 14.73 | 13.73 |
| SPECIFIC GRAVITY AND ABSORPTION | | | | | |
| -Apparent Specific Gravity | | 2.42 | 2.86 | 2.69 | 2.87 |
| - Bulk Specific Gravity | | 2.18 | 2.64 | 2.54 | 2.53 |
| - SSD Specific Gravity | | 2.28 | 2.72 | 2.60 | 2.57 |
| - Water Absorption | | 4.66 | 2.95 | 2.26 | 2.36 |
| LOS ANGELES ABRATION TEST(%) | | 23.66 | 22.54 | 20.08 | 24.08 |
| SODIUM SULPHATE SOUNDNESS(%) | | 0.36 | 0.25 | 0.35 | 0.33 |
| FLAKINESS INDEKS | | 13.60 | 12.56 | 13.53 | 13.45 |
| ORGANIC IMPURITIES | | Color No.3 | Color No.2 | Color No.3 | Color No.3 |

| DESCRIPTION | | Lekopancing Area | Mangasa Village | Bili-bili Area |
|---|---|---|---|---|
| | SIEVE SIZE | | % PASSING | |
| SIEVE ANALYSIS | 9.5 3/8 | 100 | 100 | 100 |
| | 4.75 # 4 | 95.46 | 94.01 | 92.04 |
| | 2.36 # 8 | 74.19 | 86.65 | 80.67 |
| | 1.18 # 16 | 61.02 | 72.66 | 72.87 |
| | 0.6 # 30 | 35.33 | 15.73 | 17.78 |
| | 0.3 # 50 | 13.21 | 10.8 | 12.9 |
| | 0.15 # 100 | 7.21 | 3.73 | 3.65 |
| | 0.075 # 200 | 2.52 | 2.01 | 2.8 |
| SPECIFIC GRAVITY AND ABSORPTION | | | | |
| -Apparent Specific Gravity | | 2.63 | 2.73 | 2.84 |
| - Bulk Specific Gravity | | 2.46 | 2.48 | 2.56 |
| - SSD Specific Gravity | | 2.53 | 2.57 | 2.68 |
| - Water Absorption | | 2.62 | 3.78 | 3.2 |
| ORGANIC IMPURITIES | | Color No 2 | Color 2 to 3 | Color 2 to 3 |
| SAND EQUIVALENT | | 76 | 77 | 78 |
| SODIUM SULPHATE SOUNDNESS (%) | | 0.47 | 0.65 | 0.67 |

| DESCRIPTION | | Monconglоe Hill | Bollangi Village | Sela Village |
|---|---|---|---|---|
| | SIEVE SIZE | | % PASSING | |
| SIEVE ANALYSIS | 4.75 # 4 | 90.93 | 92.93 | 96 |
| | 2.36 # 8 | 76.08 | 79.33 | 88 |
| | 1.18 # 16 | 63.25 | 65.7 | 77 |
| | 0.6 # 30 | 51.98 | 52.63 | 65.2 |
| | 0.3 # 50 | 47.6 | 46.98 | 52.6 |
| | 0.15 # 100 | 44.48 | 41.35 | 39 |
| | 0.075 # 200 | 38.85 | 35.48 | 25 |
| ATTERBERG LIMIT | | | | |
| - Liquid Limit (%) | | 37.10 | 38.26 | 43.07 |
| - Plastic Limit (%) | | 20.28 | 47.15 | 23.22 |
| - Plasticity Index | | 16.82 | 8.89 | 19.85 |
| SPECIFIC GRAVITY | | 2.45 | 2.49 | 2.55 |
| MOISTURE DENSITY RELATIONS | | | | |
| Optimum Moisture Content (%) | | 27.50 | 32.8 | 24.2 |
| Max Dry density | | 1.45 | 1.335 | 1.452 |
| CBR (%) | | 7.00 | 12.56 | 6.25 |

**Figure 6.2.6 Location and Characteristics of Construction Material Sources**

## 6.3 Topographic Survey and Mapping

### (1) Objective

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.

### (2) Location of Survey Works

The locations of the survey works (for existing roads and proposed roads) are shown in **Table 6.3.1**.

**Table 6.3.1 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** |

### (3) Scope of Works

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

### (4) Aerial Photography

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 as shown in **Figure 6.3.1**.

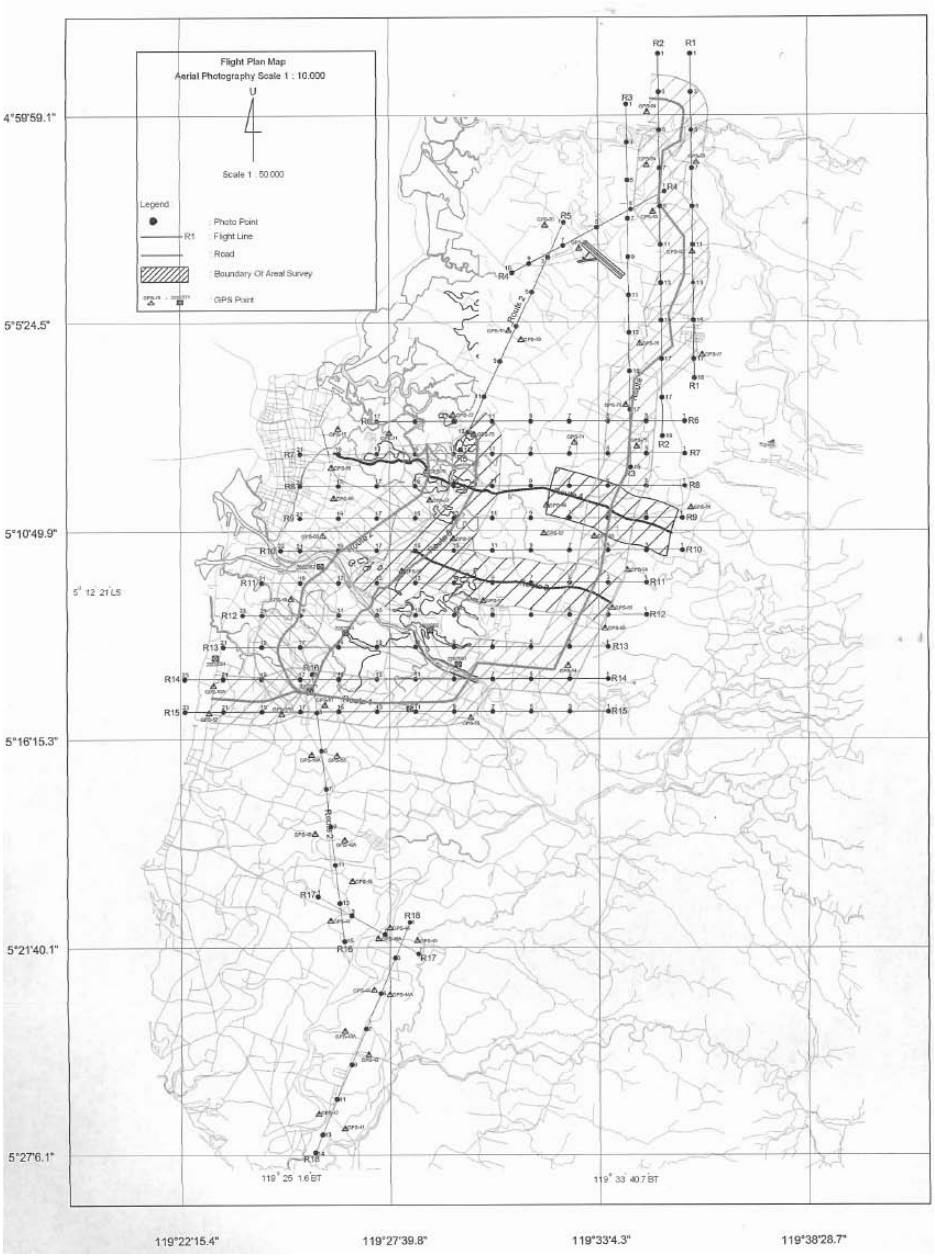



**Figure 6.3.1 Flight Map of Aerial Photography**

### (5) Ground Control Survey

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.

1) GPS Survey

GPS survey was carried out to determine X and Y coordinates of the control points. A list of Coordinates by GPS UTM projection is shown in **Table 6.3.2** and **Figures 6.3.2 – 6.3.6**.

**Table 6.3.2 List of Coordinates by GPS UTM Projection**

Central Meridian = 117°; Zone = 50 (Longitude 114°-120°)

| No. | Point | Point of Coordinate | | Convergensi Grid | | | Scale Factor | Hight Ellipsoide (meter) | Zone |
|---|---|---|---|---|---|---|---|---|---|
| | | North | East | | | | | | |
| | | Y (meter) | X (meter) | ° | ' | " | | | |
| 1 | AZ-1 | 9,398,845.057 | 770,062.148 | 0 | -13 | 51.32907 | 1.00050285 | 55.688 | 50 |
| 2 | AZ-2 | 9,407,881.966 | 772,987.202 | 0 | -13 | 47.61720 | 1.00052252 | 66.915 | 50 |
| 3 | AZ-3 | 9,418,159.815 | 764,238.120 | 0 | -13 | 7.14021 | 1.00046433 | 55.050 | 50 |
| 4 | AZ-4 | 9,423,055.927 | 783,568.893 | 0 | -13 | 57.50492 | 1.00059544 | 68.164 | 50 |
| 5 | AZ-6 | 9,431,823.206 | 770,493.620 | 0 | -13 | 6.73019 | 1.00050575 | 56.194 | 50 |
| 6 | AZ-7 | 9,431,433.325 | 777,022.161 | 0 | -13 | 26.25059 | 1.00055000 | 59.451 | 50 |
| 7 | BP-01 | 9,447,718.226 | 785,432.051 | 0 | -13 | 26.78174 | 1.00060858 | 57.081 | 50 |
| 8 | BP-01B | 9,418,707.306 | 764,392.690 | 0 | -13 | 6.85494 | 1.00046534 | 55.098 | 50 |
| 9 | BP-02 | 9,445,644.201 | 785,263.074 | 0 | -13 | 29.34789 | 1.00060738 | 59.447 | 50 |
| 10 | BP-02A | 9,419,111.093 | 769,040.660 | 0 | -13 | 20.11216 | 1.00049604 | 61.345 | 50 |
| 11 | BP-02B | 9,426,071.983 | 770,625.987 | 0 | -13 | 15.12470 | 1.00050663 | 57.768 | 50 |
| 12 | BP-04 | 9,430,426.768 | 770,275.301 | 0 | -13 | 8.03822 | 1.00050429 | 56.463 | 50 |
| 13 | EP-04 | 9,426,841.935 | 786,396.003 | 0 | -14 | 0.26302 | 1.00061539 | 87.148 | 50 |
| 14 | GPS-10 | 9,436,481.871 | 778,620.115 | 0 | -13 | 23.65764 | 1.00056100 | 75.722 | 50 |
| 15 | GPS-41 | 9,398,139.212 | 770,736.886 | 0 | -13 | 54.38794 | 1.00050737 | 54.933 | 50 |
| 16 | GPS-42 | 9,398,834.178 | 769,478.035 | 0 | -13 | 49.54825 | 1.00049895 | 55.854 | 50 |
| 17 | GPS-43 | 9,401,725.905 | 771,880.621 | 0 | -13 | 52.88591 | 1.00051505 | 59.513 | 50 |
| 18 | GPS-43A | 9,402,849.794 | 770,732.663 | 0 | -13 | 47.80637 | 1.00050734 | 60.536 | 50 |
| 19 | GPS-44 | 9,404,836.804 | 772,130.396 | 0 | -13 | 49.29021 | 1.00051674 | 62.941 | 50 |
| 20 | GPS-44A | 9,404,625.437 | 772,877.680 | 0 | -13 | 51.86173 | 1.00052178 | 62.079 | 50 |
| 21 | GPS-45 | 9,407,216.644 | 774,195.401 | 0 | -13 | 52.21500 | 1.00053070 | 67.166 | 50 |
| 22 | GPS-46 | 9,407,826.205 | 772,898.846 | 0 | -13 | 47.42802 | 1.00052192 | 66.781 | 50 |
| 23 | GPS-46A | 9,407,303.333 | 772,343.290 | 0 | -13 | 46.47892 | 1.00051817 | 66.304 | 50 |
| 24 | GPS-47 | 9,408,160.683 | 770,065.490 | 0 | -13 | 38.38248 | 1.00050287 | 64.451 | 50 |
| 25 | GPS-48 | 9,409,848.091 | 770,987.595 | 0 | -13 | 38.81879 | 1.00050905 | 68.132 | 50 |
| 26 | GPS-49 | 9,412,355.684 | 769,333.151 | 0 | -13 | 30.34814 | 1.00049799 | 67.529 | 50 |
| 27 | GPS-49A | 9,412,037.151 | 770,749.702 | 0 | -13 | 35.04908 | 1.00050746 | 69.555 | 50 |
| 28 | GPS-50 | 9,416,104.719 | 770,366.487 | 0 | -13 | 28.23481 | 1.00050489 | 64.768 | 50 |
| 29 | GPS-50A | 9,416,130.916 | 769,173.758 | 0 | -13 | 24.63721 | 1.00049692 | 64.881 | 50 |
| 30 | GPS-51 | 9,418,510.500 | 769,813.534 | 0 | -13 | 23.24210 | 1.00050119 | 60.706 | 50 |
| 31 | GPS-51A | 9,418,077.414 | 767,745.158 | 0 | -13 | 17.68871 | 1.00048743 | 59.292 | 50 |
| 32 | GPS-52 | 9,418,126.822 | 764,355.448 | 0 | -13 | 7.53422 | 1.00046510 | 55.044 | 50 |
| 33 | GPS-52A | 9,419,433.336 | 764,483.334 | 0 | -13 | 6.13587 | 1.00046593 | 55.931 | 50 |
| 34 | GPS-53 | 9,417,903.992 | 776,788.022 | 0 | -13 | 44.84374 | 1.00054839 | 69.272 | 50 |
| 35 | GPS-54 | 9,420,386.458 | 781,426.566 | 0 | -13 | 55.05280 | 1.00058045 | 64.767 | 50 |
| 36 | GPS-55 | 9,422,189.351 | 783,204.379 | 0 | -13 | 57.69293 | 1.00059288 | 76.249 | 50 |
| 37 | GPS-56 | 9,423,168.036 | 783,557.306 | 0 | -13 | 57.30713 | 1.00059536 | 65.600 | 50 |
| 38 | GPS-57 | 9,423,515.008 | 777,390.254 | 0 | -13 | 38.62451 | 1.00055253 | 67.596 | 50 |
| 39 | GPS-58 | 9,424,957.981 | 773,505.711 | 0 | -13 | 25.14343 | 1.00052603 | 59.500 | 50 |
| 40 | GPS-59 | 9,423,627.683 | 768,199.745 | 0 | -13 | 11.37882 | 1.00049045 | 56.520 | 50 |
| 41 | GPS-60 | 9,426,590.711 | 769,638.802 | 0 | -13 | 11.50785 | 1.00050003 | 56.816 | 50 |
| 42 | GPS-61 | 9,426,487.776 | 775,942.121 | 0 | -13 | 30.13418 | 1.00054261 | 57.524 | 50 |
| 43 | GPS-62 | 9,426,766.376 | 780,273.220 | 0 | -13 | 42.43166 | 1.00057244 | 58.078 | 50 |
| 44 | GPS-63 | 9,426,616.811 | 782,695.470 | 0 | -13 | 49.74781 | 1.00058932 | 61.995 | 50 |
| 45 | GPS-64 | 9,424,986.700 | 784,279.147 | 0 | -13 | 56.77489 | 1.00060044 | 61.812 | 50 |
| 46 | GPS-65 | 9,428,001.138 | 787,312.438 | 0 | -14 | 1.23417 | 1.00062190 | 79.808 | 50 |
| 47 | GPS-66 | 9,428,106.319 | 780,402.165 | 0 | -13 | 40.87594 | 1.00057333 | 59.979 | 50 |
| 48 | GPS-67 | 9,428,353.068 | 774,841.413 | 0 | -13 | 24.26824 | 1.00053510 | 56.206 | 50 |
| 49 | GPS-68 | 9,428,448.379 | 770,251.948 | 0 | -13 | 10.72176 | 1.00050413 | 56.584 | 50 |
| 50 | GPS-69 | 9,429,924.219 | 770,145.551 | 0 | -13 | 8.35902 | 1.00050342 | 55.651 | 50 |
| 51 | GPS-70 | 9,429,764.887 | 774,680.939 | 0 | -13 | 21.80350 | 1.00053401 | 58.278 | 50 |
| 52 | GPS-71 | 9,431,558.177 | 772,951.691 | 0 | -13 | 14.24304 | 1.00052229 | 54.542 | 50 |
| 53 | GPS-72 | 9,432,441.723 | 775,947.011 | 0 | -13 | 21.69347 | 1.00054264 | 60.329 | 50 |

| No. | Point | Point of Coordinate | | Convergensi Grid | | | Scale Factor | Hight Ellipsoide (meter) | Zone |
|---|---|---|---|---|---|---|---|---|---|
| | | North | East | | | | | | |
| | | Y (meter) | X (meter) | ° | ' | " | | | |
| 54 | GPS-73 | 9,431,530.224 | 776,955.355 | 0 | -13 | 25.91831 | 1.00054955 | 60.882 | 50 |
| 55 | GPS-74 | 9,431,117.692 | 781,764.001 | 0 | -13 | 40.49115 | 1.00058281 | 61.509 | 50 |
| 56 | GPS-75 | 9,430,937.822 | 784,730.045 | 0 | -13 | 49.38031 | 1.00060362 | 97.096 | 50 |
| 57 | GPS-76 | 9,432,914.864 | 784,205.074 | 0 | -13 | 44.96192 | 1.00059992 | 77.693 | 50 |
| 58 | GPS-77 | 9,435,294.570 | 787,871.402 | 0 | -13 | 52.06505 | 1.00062589 | 74.213 | 50 |
| 59 | GPS-78 | 9,435,834.148 | 784,883.687 | 0 | -13 | 42.65001 | 1.00060470 | 63.748 | 50 |
| 60 | GPS-79 | 9,436,035.744 | 779,216.505 | 0 | -13 | 26.01659 | 1.00056512 | 69.070 | 50 |
| 61 | GPS-80 | 9,441,574.338 | 780,379.020 | 0 | -13 | 21.37881 | 1.00057318 | 68.125 | 50 |
| 62 | GPS-81 | 9,440,465.853 | 781,997.640 | 0 | -13 | 27.60721 | 1.00058445 | 60.389 | 50 |
| 63 | GPS-82 | 9,440,292.142 | 787,388.197 | 0 | -13 | 43.28122 | 1.00062245 | 61.517 | 50 |
| 64 | GPS-83 | 9,442,209.022 | 785,525.227 | 0 | -13 | 35.13597 | 1.00060923 | 59.253 | 50 |
| 65 | GPS-84 | 9,444,471.124 | 785,226.904 | 0 | -13 | 30.96647 | 1.00060713 | 59.276 | 50 |
| 66 | GPS-85 | 9,444,626.230 | 787,610.947 | 0 | -13 | 37.50624 | 1.00062404 | 59.851 | 50 |
| 67 | 2002064 | 9,421,985.329 | 770,801.086 | 0 | -13 | 21.33467 | 1.00050781 | 61.183 | 50 |
| 68 | 2002066 | 9,422,108.994 | 774,844.223 | 0 | -13 | 33.10915 | 1.00053512 | 63.627 | 50 |
| 69 | 2002067 | 9,420,480.342 | 776,181.583 | 0 | -13 | 39.37601 | 1.00054424 | 65.827 | 50 |
| 70 | 2002069 | 9,418,336.403 | 773,857.317 | 0 | -13 | 35.51128 | 1.00052841 | 67.620 | 50 |
| 71 | 2002071 | 9,419,178.407 | 769,088.944 | 0 | -13 | 20.16233 | 1.00049636 | 61.550 | 50 |
| 72 | 2003054 | 9,420,744.072 | 764,566.833 | 0 | -13 | 4.59863 | 1.00046648 | 55.718 | 50 |
| 73 | N.4009 | 9,440,155.650 | 782,608.759 | 0 | -13 | 29.80609 | 1.00058872 | 65.185 | 50 |
| 74 | N1.4030 | 9,398,841.799 | 770,106.353 | 0 | -13 | 51.46952 | 1.00050314 | 55.735 | 50 |
| 75 | N1.4028 | 9,419,205.723 | 816,517.661 | 0 | -15 | 40.93728 | 1.00084026 | 1094.425 | 50 |

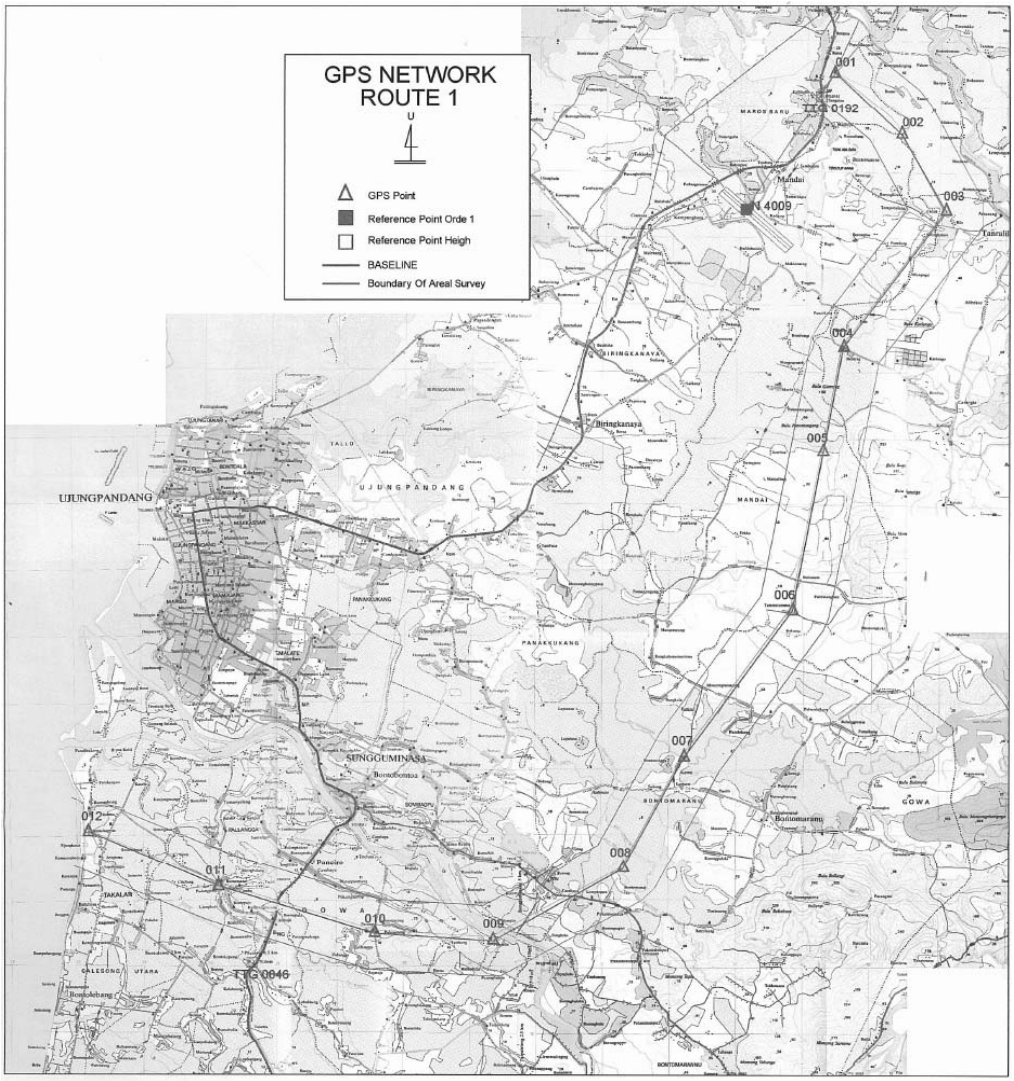



**Figure 6.3.2 GPS Network for Mamminasa Bypass**

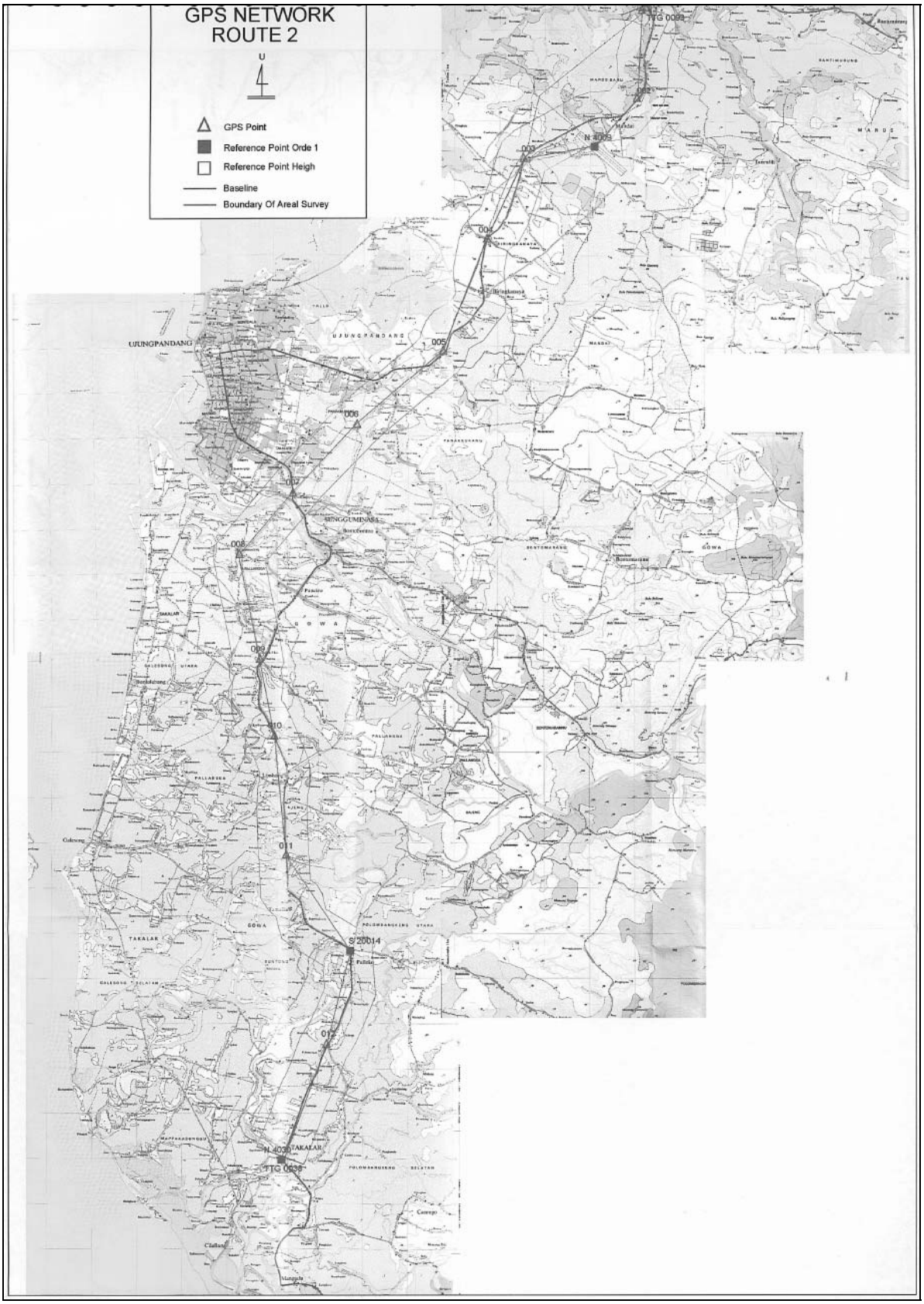



**Figure 6.3.3 GPS Network for Trans Sulawesi Mamminasata Road**

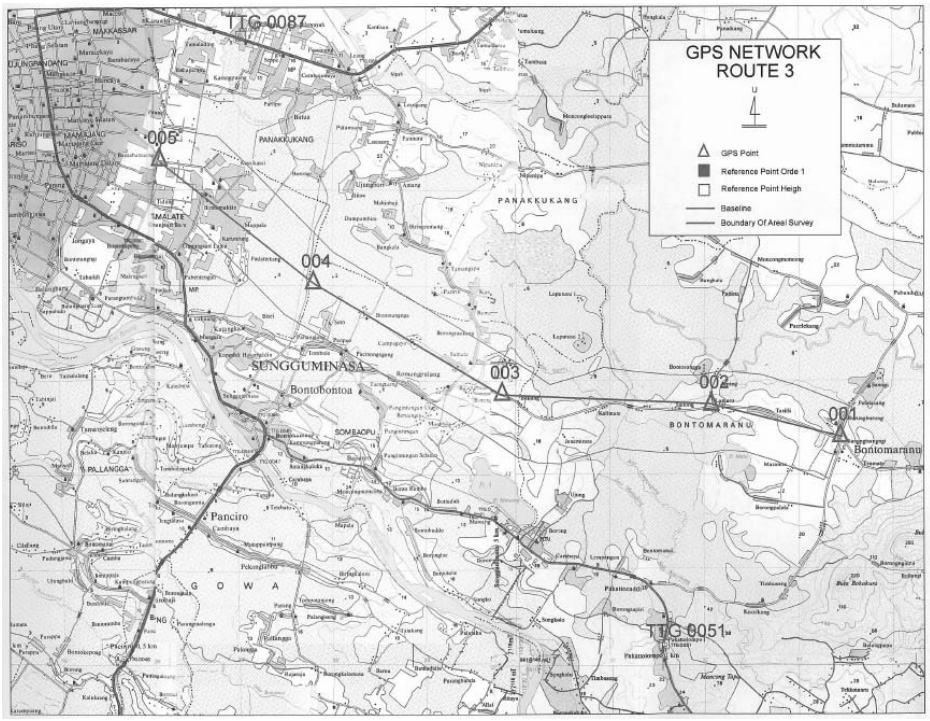



**Figure 6.3.4 GPS Network for Hertasning Road**

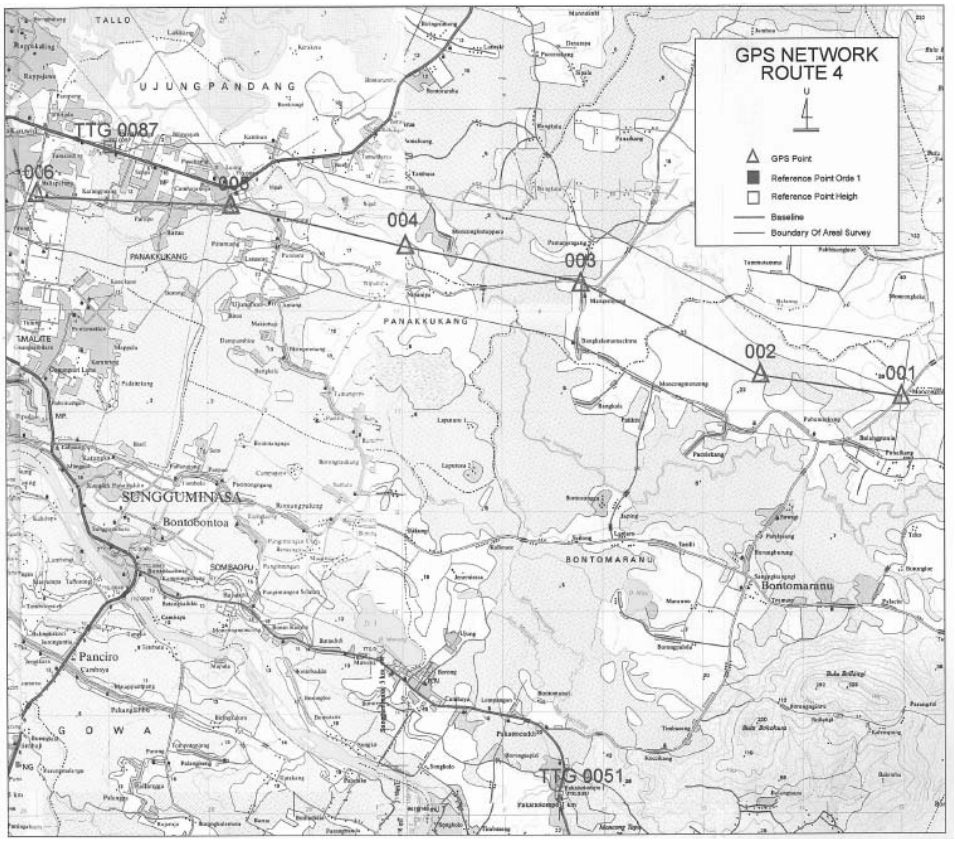



**Figure 6.3.5 GPS Network Route for Abdullah Daeng Sirua Road**

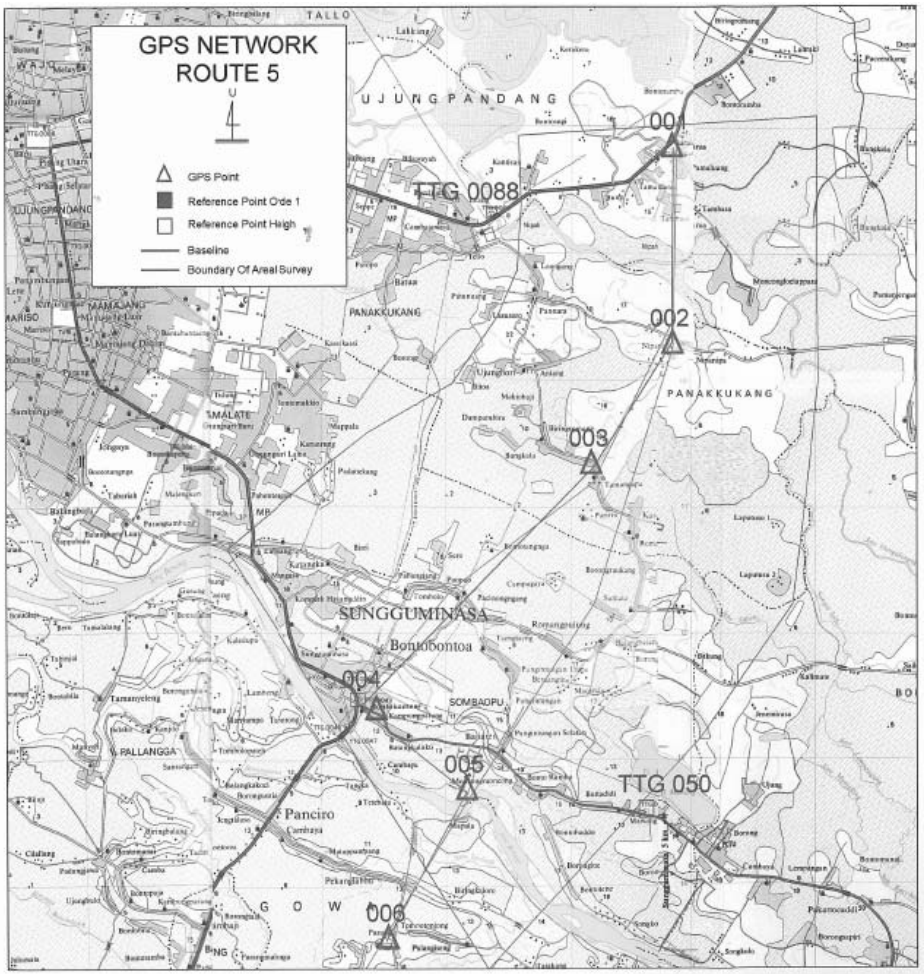



**Figure 6.3.6 GPS Network for Outer Ring Road**

2) Aerial Triangulation

Aerial triangulation was carried out based on the coordinates shown in **Table 6.3.3**.

**Table 6.3.3 List of Coordinate Scale of Aerial Photography**

| Run | Models | Number of Models | Line-Km | Number of Photograph | Flight Hight (m) | Coordinate | WGS 84 | | | | | | | | UTM 50S (WGS 84) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Latitude | | | | Longitude | | | | Y (m) | X (m) |
| 1 | 17.0 | 16997.5 | 15.64 | 18.0 | 1624.4 | Up | S | 4 | 58 | 19.93520 | BT | 119 | 35 | 27.55980 | 787,331.575 | 9,449,844.824 |
| | | | | | | Down | S | 5 | 6 | 48.73050 | BT | 119 | 35 | 34.56030 | 787,485.115 | 9,434,205.459 |
| 2 | 18.0 | 20000.1 | 18.40 | 19.0 | 1624.4 | Up | S | 4 | 58 | 20.21070 | BT | 119 | 34 | 37.56880 | 785,790.558 | 9,449,842.384 |
| | | | | | | Down | S | 5 | 8 | 18.60000 | BT | 119 | 35 | 34.92290 | 785,971.847 | 9,431,443.148 |
| 3 | 18.0 | 19000.2 | 17.48 | 19.0 | 1624.4 | Up | S | 4 | 59 | 39.10500 | BT | 119 | 33 | 48.36650 | 784,264.470 | 9,447,423.422 |
| | | | | | | Down | S | 5 | 9 | 7.77300 | BT | 119 | 33 | 56.20080 | 784,436.696 | 9,429,944.050 |
| 4 | 9.0 | 9001.7 | 8.28 | 10.0 | 1624.4 | Up | S | 5 | 1 | 55.88270 | BT | 119 | 34 | 48.21580 | 786,092.708 | 9,443,212.202 |
| | | | | | | Down | S | 5 | 4 | 3.91000 | BT | 119 | 30 | 51.78440 | 778,790.315 | 9,439,305.785 |
| 5 | 13.0 | 13036.6 | 11.99 | 14.0 | 1624.4 | Up | S | 5 | 2 | 44.62540 | BT | 119 | 32 | 11.77470 | 781,265.078 | 9,441,732.994 |
| | | | | | | Down | S | 5 | 8 | 40.66000 | BT | 119 | 29 | 32.45760 | 776,312.602 | 9,430,809.580 |
| 6 | 16.0 | 16001.8 | 14.72 | 17.0 | 1624.4 | Left | S | 5 | 7 | 57.39070 | BT | 119 | 27 | 22.36590 | 772,309.003 | 9,432,154.919 |
| | | | | | | Right | S | 5 | 7 | 55.51180 | BT | 119 | 35 | 20.08170 | 787,030.616 | 9,432,154.649 |
| 7 | 20.0 | 20000.0 | 18.40 | 21.0 | 1624.4 | Left | S | 5 | 8 | 48.29020 | BT | 119 | 25 | 23.18550 | 768,630.616 | 9,430,604.649 |
| | | | | | | Right | S | 5 | 8 | 45.93980 | BT | 119 | 35 | 20.28540 | 787,030.616 | 9,430,604.649 |
| 8 | 20.0 | 20000.0 | 18.40 | 21.0 | 1624.4 | Left | S | 5 | 9 | 38.72470 | BT | 119 | 25 | 23.37670 | 768,630.616 | 9,429,054.649 |
| | | | | | | Right | S | 5 | 9 | 36.36790 | BT | 119 | 35 | 20.48960 | 787,030.616 | 9,429,054.649 |
| 9 | 20.0 | 19866.9 | 18.28 | 21.0 | 1624.4 | Left | S | 5 | 10 | 29.15910 | BT | 119 | 25 | 23.56840 | 768,630.616 | 9,427,504.649 |
| | | | | | | Right | S | 5 | 10 | 26.81220 | BT | 119 | 35 | 16.72020 | 786,908.144 | 9,427,504.649 |
| 10 | 21.0 | 20866.4 | 19.20 | 22.0 | 1624.4 | Left | S | 5 | 11 | 19.70790 | BT | 119 | 24 | 53.91630 | 767,711.065 | 9,425,954.649 |
| | | | | | | Right | S | 5 | 11 | 17.24020 | BT | 119 | 35 | 16.92550 | 786,908.144 | 9,425,954.649 |
| 11 | 20.0 | 20000.0 | 18.40 | 21.0 | 1624.4 | Left | S | 5 | 12 | 10.25690 | BT | 119 | 24 | 24.23410 | 766,790.616 | 9,424,404.649 |
| | | | | | | Right | S | 5 | 12 | 7.89660 | BT | 119 | 34 | 21.39410 | 785,190.616 | 9,424,404.649 |
| 12 | 21.0 | 21000.0 | 19.32 | 22.0 | 1624.4 | Left | S | 5 | 13 | 0.80620 | BT | 119 | 23 | 54.56540 | 765,870.616 | 9,422,854.649 |
| | | | | | | Right | S | 5 | 12 | 58.32520 | BT | 119 | 34 | 21.59930 | 785,190.616 | 9,422,854.649 |
| 13 | 20.0 | 20000.0 | 18.40 | 21.0 | 1624.4 | Left | S | 5 | 13 | 51.35560 | BT | 119 | 23 | 24.89580 | 764,950.616 | 9,421,304.649 |
| | | | | | | Right | S | 5 | 13 | 48.99820 | BT | 119 | 33 | 22.08990 | 783,350.616 | 9,421,304.649 |
| 14 | 22.0 | 21999.5 | 20.24 | 23.0 | 1624.4 | Left | S | 5 | 14 | 42.01880 | BT | 119 | 22 | 25.37730 | 763,111.065 | 9,419,754.649 |
| | | | | | | Right | S | 5 | 14 | 39.42740 | BT | 119 | 33 | 22.29490 | 783,350.616 | 9,419,754.649 |
| 15 | 22.0 | 21999.5 | 20.24 | 23.0 | 1624.4 | Left | S | 5 | 15 | 32.45500 | BT | 119 | 22 | 25.55360 | 763,110.615 | 9,418,204.649 |
| | | | | | | Right | S | 5 | 15 | 29.85660 | BT | 119 | 33 | 22.50040 | 783,350.616 | 9,418,204.649 |
| 16 | 14.0 | 14003.8 | 12.88 | 15.0 | 1624.4 | Up | S | 5 | 14 | 33.60130 | BT | 119 | 25 | 43.32020 | 769,210.280 | 9,419,989.965 |
| | | | | | | Down | S | 5 | 21 | 29.69230 | BT | 119 | 26 | 34.17370 | 770,726.618 | 9,407,196.126 |
| 17 | 6.0 | 6015.3 | 5.53 | 7.0 | 1624.4 | Up | S | 5 | 20 | 19.94930 | BT | 119 | 25 | 52.67370 | 769,456.775 | 9,409,344.607 |
| | | | | | | Down | S | 5 | 21 | 48.78730 | BT | 119 | 28 | 28.93950 | 774,259.450 | 9,406,595.086 |
| 18 | 13.0 | 13018.3 | 11.98 | 14.0 | 1624.4 | Up | S | 5 | 20 | 59.82720 | BT | 119 | 28 | 15.29630 | 773,845.249 | 9,408,101.509 |
| | | | | | | Down | S | 5 | 27 | 1.21740 | BT | 119 | 25 | 49.80330 | 769,319.142 | 9,397,012.839 |
| | | | | | | | | | | | | | | | | |
| Total | 310 | 312807.55 | 287.8 | 328 | | | | | | | | | | | | |