APPENDICES FOR CHAPTER 12

APPENDIX 12.1 PRESENT CONDITION AND PROPOSED COUNTERMEASURES OF FLOOD SECTIONS

FLOOD SECTION NO. 1

1. Nature of Flood and Damage to the Road

1. Location : Alipao, Surigao del Norte
2. Length : 1,000m (1160+700 ~ 1161+700)
3. Depth : 60cm
4. Duration : 6 hrs.
5. Frequency : 3 times/year
6. Traffic : Impassable to all types of vehicle
7. Damage to the Road : Mud/debris deposit on the road surface
8. Topography : Mountain slope side
9. Road side Development : Low. Rice field both side
   Several residential houses at 1161+500 ~ 700
10. Flood Type : I
11. Cause of Flood : Flood water from mountain slope
    No marked water channel is present

2. Existing Drainage Facilities

Location	Type of Facilities	Condition
1160 + 700	1 - 0.6 dia. RCPC	Totally clogged
+ 800	1 - 0.6 dia. RCPC	Totally clogged
+ 925	1 - 0.6 dia. RCPC	Totally clogged
1161 + 082	1 - 4.0x4.0 RCBC	1/2 clogged
+ 223	1 - 0.6 dia. RCPC	Functioning, overflow
+ 312	1 - 0.6 dia. RCPC	1/4 clogged
+ 472	1 - 0.6 dia. RCPC	Functioning, overflow
+ 567	1 - 0.6 dia. RCPC	Functioning
+ 673	1 - 1.5x2.0 RCBC	Functioning
1160 + 700		
1161 + 082	Side Ditch Left side	
	L = 382m	Totally silted

3. Past/present Flood Control/protection Measures

1. Shoulder pavement L = 1,000m (1160+700 ~ 1161+900)
   (W = 2.0m t = 10cm)

4. Proposed Countermeasures

1. Raising the Road L = 1,200m (1160+600 ~ 1161+800)
   H = 1.5m

2. Embankment slope protection with grouted riprap (upstream side)
   L = 1,200m (1160+600 ~ 1161+800)
3. Construction of RCBC 1 - 3.0 x 2.0 at 1160+700

4. Installation of RCPC

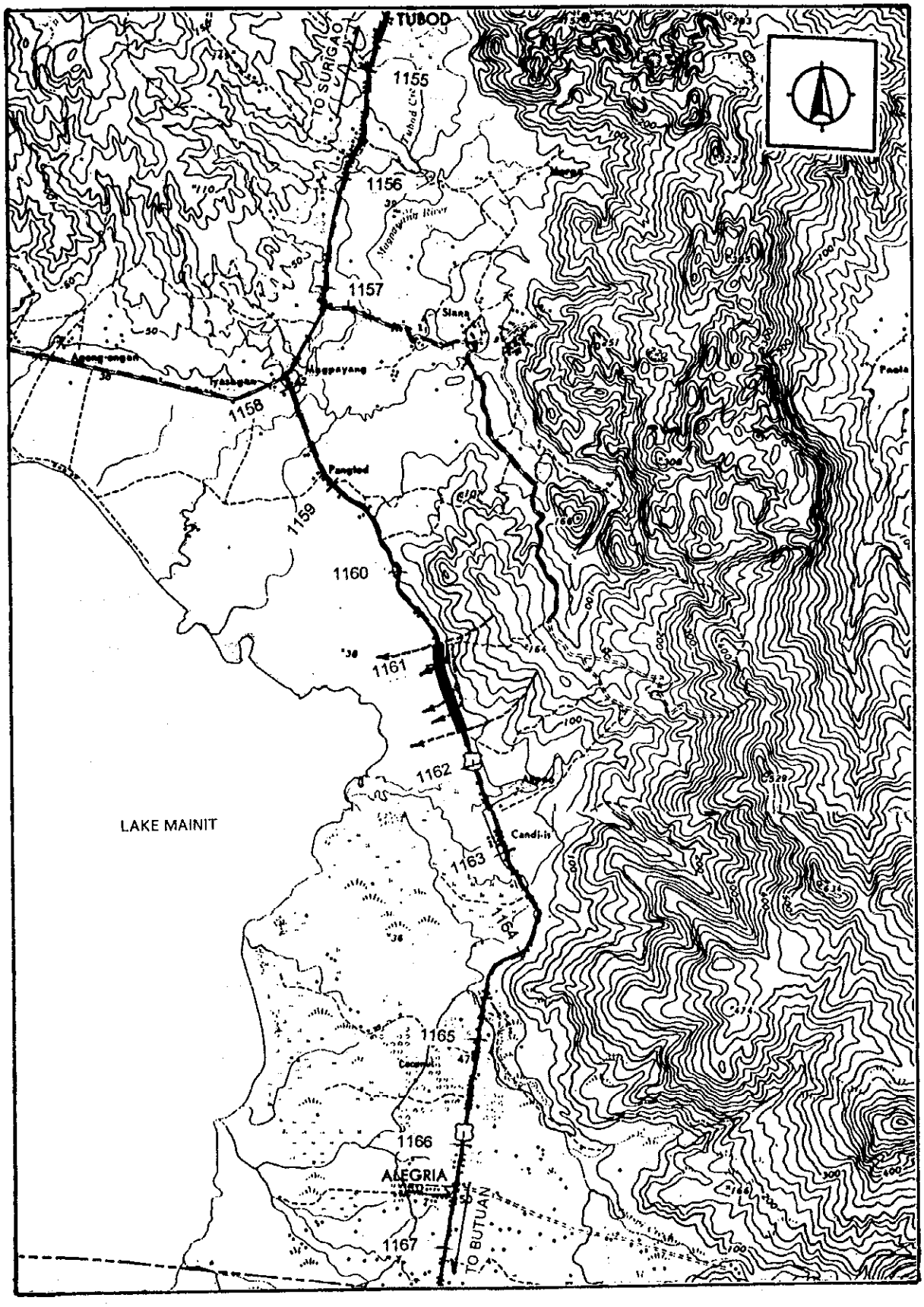
1 - 1.22 dia. 1160+800
1 - 1.22 dia. 1160+900
1 - 1.22 dia. 1161+000
1 - 1.22 dia. 1161+223
2 - 1.22 dia. 1161+312
1 - 1.22 dia. 1161+400
1 - 1.22 dia. 1161+472
1 - 1.22 dia. 1161+567

5. Installation of Side Ditch Type A (upstream side)
L = 1,200m (1160+600 ~ 1161+800)

6. Excavation of Drainage Canal
L = 40m at 1160 + 700
L = 20m at 1161 + 082

5. Discharge Estimate

Area No.	D.A. (km2)	L (m)	H (m)	C	Tc (min)	I10	I25 (mm/hr)	I50	Q10	Q25 (m^3/s)	Q50
1	0.2250	750	131	0.5	6.1	345	430	485	10.78	13.43	15.16
2	0.1572	400	77	0.5	3.6	400	500	535	8.73	10.92	11.68
3	0.2848	865	131	0.5	7.2	320	400	446	12.65	15.82	17.64



FLOOD SECTION 1 Alipao, Surigao del Norte

FLOOD SECTION NO. 2

1. Nature of Flood and Damage to the Road

1. Location : Candi-is, Surigao del Norte
2. Length : L = 500m (1163+600 ~ 1164+100)
3. Depth : 30cm
4. Duration : 4 hrs.
5. Frequency : 3 times/year
6. Traffic : Passable only to buses and trucks
7. Damage to the Road : Mud deposits on the road
8. Topography : Mountain slope side
9. Road side Development : Low. Rice field both side
10. Flood Type : I
11. Cause of Flood : Flood water from mountain slope
    No marked water channel is present

2. Existing Drainage Facilities and Condition

Location	Type of Facilities	Condition
1163 + 900	0.6 dia. RCPC	Functioning, Insufficient capacity
1163 + 600~900	Earth Canal L = 300m (W = 1.0m H = 0.7m)	Insufficient capacity

3. Past/present Flood Protection & Mitigation Measures

No action has been taken.

4. Proposed Countermeasures

1) Shoulder pavement (Both side) (W = 2.5m t = 18cm)
L = 2 x 500m (1163+600 ~ 1164+100)

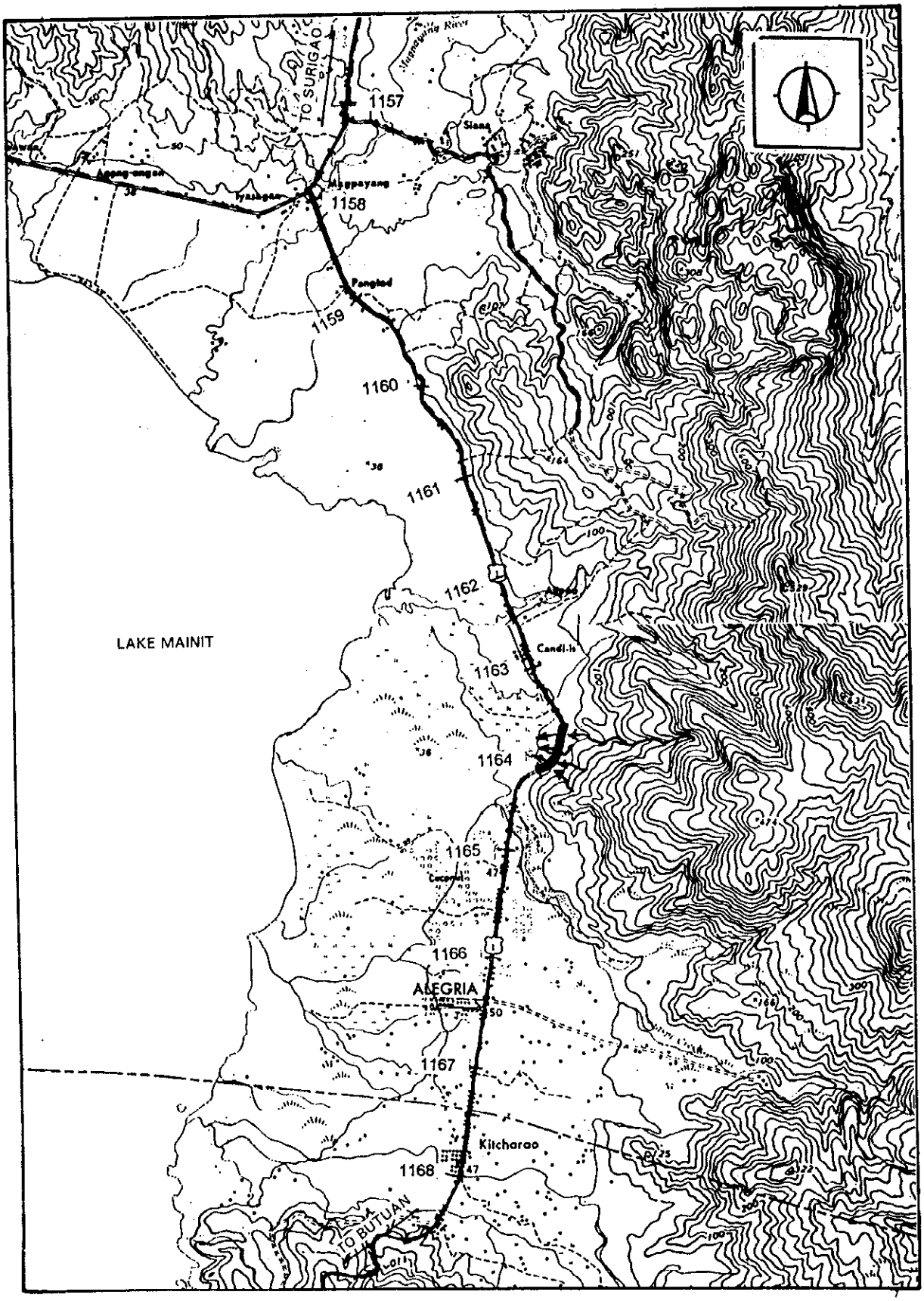
2) Installation of Side Ditch Type C (upstream side)
L = 590m (1163+510 ~ 1164+100)

3) Installation of RCPC

1 - 1.22 dia.1163+600
1 - 1.22 dia. +700
1 - 1.22 dia. +800
1 - 1.22 dia. +900
1 - 1.22 dia.1164+000

5. Discharge Estimate

Area (km2)	L (m)	H (m)	C	Tc (min)	I10 (mm/hr)	I25 (mm/hr)	I50 (mm/hr)	Q10	Q25 (m^3/s)	Q50
1.1596	1915	420	0.5	11.4	270	335	380	52.18	64.74	73.44



FLOOD SECTION 2 Candiis, Surigao del Norte

FLOOD SECTION NO. 3

1. Nature of Flood and Damage to the Road

1. Location : Magtiaco, Surigao del Norte
2. Length : L = 350m (1164+750 ~ 1165+100)
3. Depth : 35cm
4. Duration : 12 hrs.
5. Frequency : 2 times/year
6. Traffic : Passable only to buses and trucks
7. Damage to the Road : Not significant
   Residentiaal houses along the road are inundated
8. Topography : Alluvial fan
9. Road side Development : Medium. Residential houses along the road (both side)
10. Flood Type : III
11. Cause of Flood : Overflow from Legaspi river

2. Existing Drainage Facilities

No drainage facilities

3. Past/present Flood Control/protection Measures

Flood protection dike	H = 1.8m W = 2.5	L = 80m
	partially collapsed	L = 5.0m

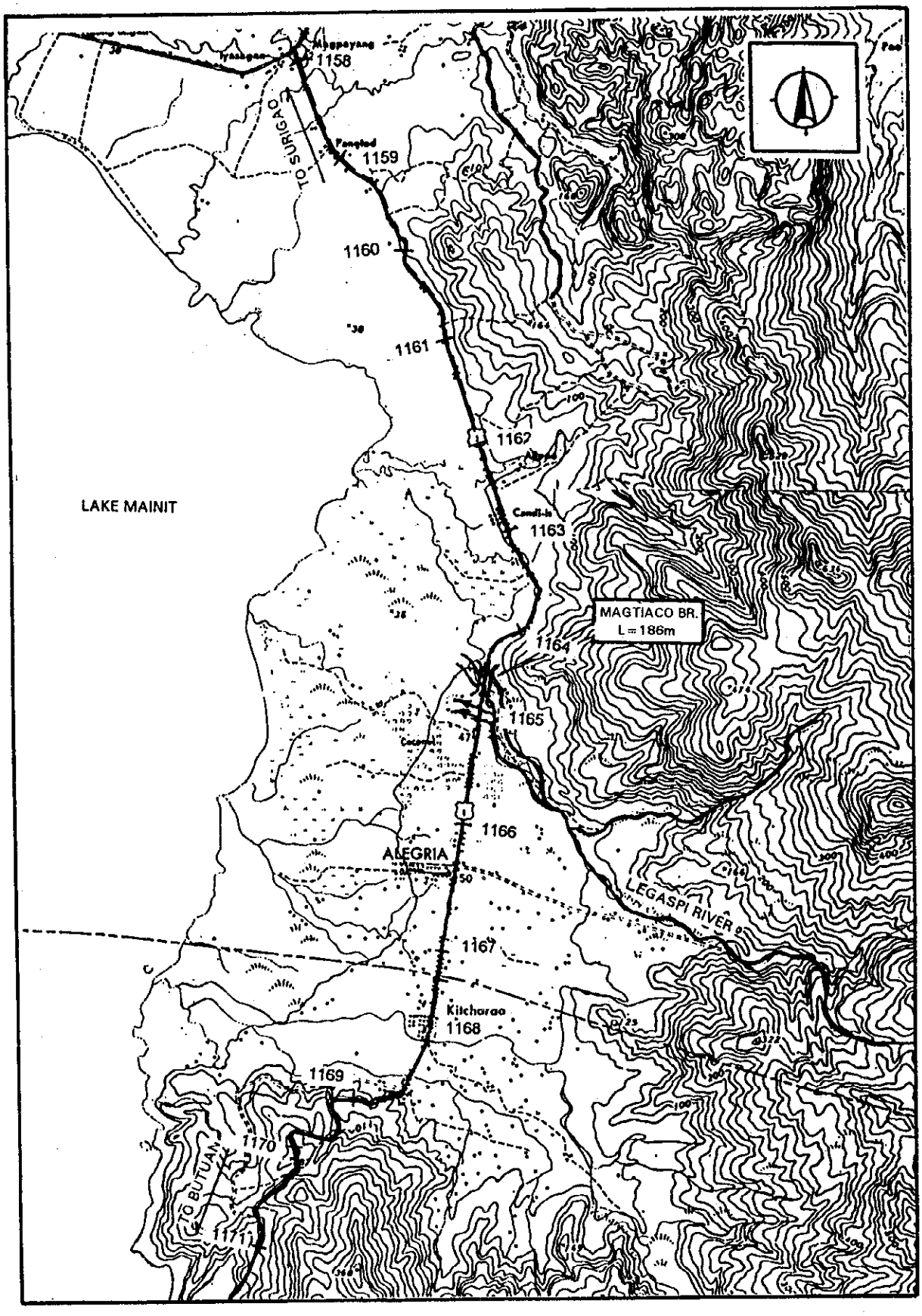
4. Proposed Countermeasures

1. Construction of flood protection dike.

Flood protection dike (Stone Masonry)
H = 2.5m W = 2.0m L = 580m

5. Basin characteristics

Drainage Are	22.76 km^2
Longest water course	9.29 km
Distance to Basin Control	4.15 km
Average Riverbed Slope	0.09849
Discharge (50 years return period)	171 m^3/s



FLOOD SECTION 3 Magtiaco, Surigao del Norte

FLOOD SECTION NO. 4

1. Nature of Flood and Damage to the Road

1. Location	:	San Pedro, Surigao del Norte
2. Length	:	L = 80m (1165+800 ~ 1165+880)
3. Depth	:	Road not flooded
4. Duration	:	N/A
5. Frequency	:	N/A
6. Traffic	:	N/A
7. Damage to the Road	:	Approach dike is severely scoured for about 80m. The road may be washed out if appropriate protection work is not taken.
8. Topography	:	Alluvial Fan
9. Roadside Development	:	Medium. Several residential houses along the road.
10. Flood Type	:	III
11. Cause of Road Damage	:	Flood water of San Pedro River directly hit appproach dike of San Pedro Bridge. Clearance below of San Pedro Bridge is only 1.3m.

2. Existing Drainage Facilities

Location	Type of Facilities	Condition
1165 + 868 ~ 1166 + 090	NIA irrigation canal (W = 1.1 H = 0.6 L = 222m)	No outlet protection at the end of canal

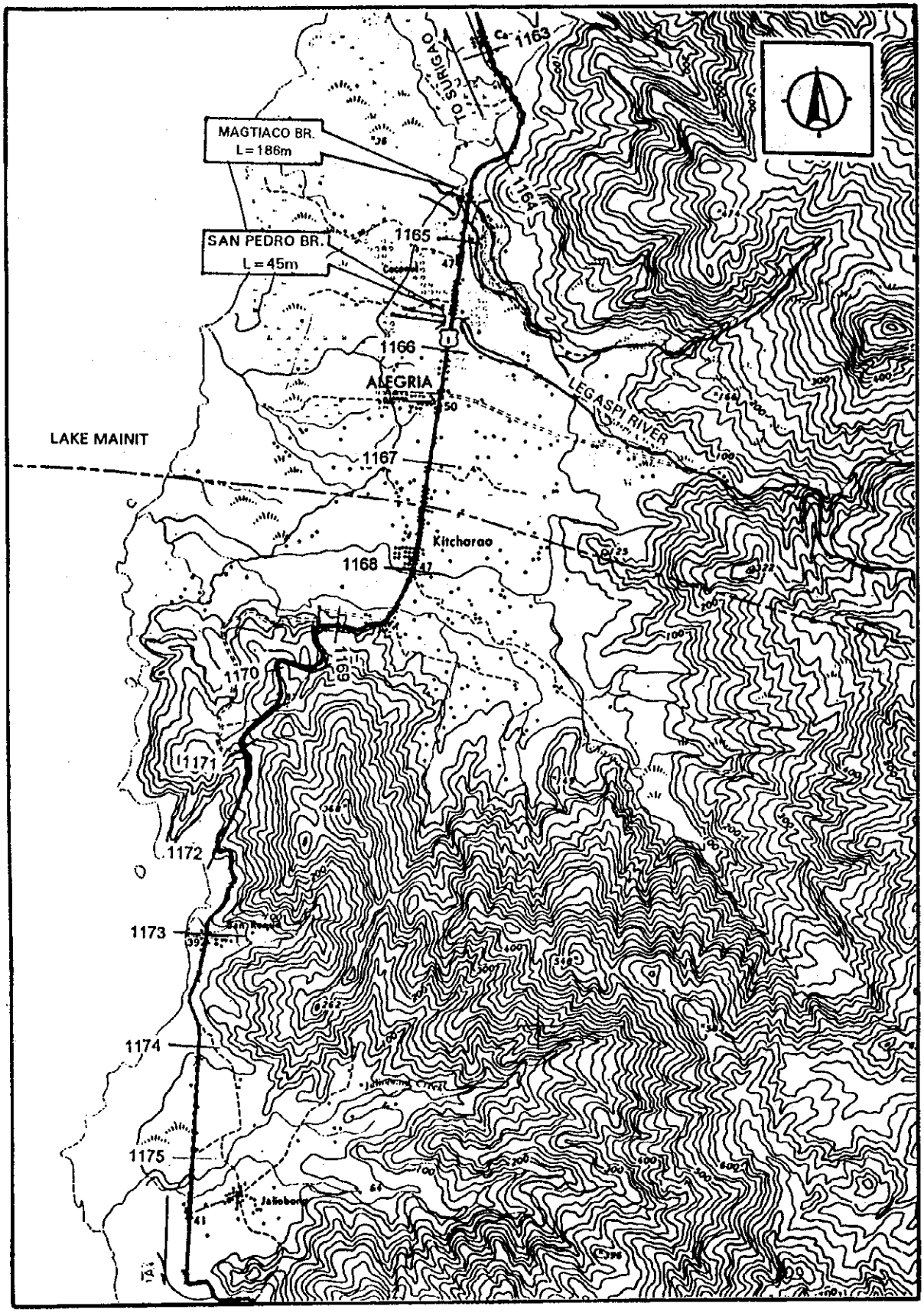
3. Past/present Flood Protection & Mitigation Measures

Embankment slope protection with grouted riprap L = 55m (1165 + 745 ~ 1165 + 800)	stable condition
Embankment slope protection with grouted riprap L = 80m (1165 + 800 ~ 11165 + 880)	washed out

Flood protection dike at 1.0 km upstream from the bridge to divert flood water to Magtiaco Bridge is totally collapsed.

4. Proposed Countermeasures

1. Dredging San Pedro River	L = 400m
2. Embankment Slope Protection with concrete pitching and sheet pile	L = 132m (1165+800 ~ 1165+902)
3. Concrete Dike	L = 85m
4. Stone pitching	L = 30m



FLOOD SECTION 4 San Pedro, Surigao del Norte

FLOOD SECTION NO. 5

1. Nature of Flood and Damage to the Road

1. Location : Alegria, Kitcharao, Surigao del Norte/Agusan del Norte
2. Length : L = 1,300m (1166+600~1167+900)
3. Depth : 50cm
4. Duration : 12 hrs.
5. Frequency : 2 times/year
6. Traffic : Impassable to all types of vehicle for 6 hrs.
7. Damage to the Road :

1166 + 600	Overflow always occurs Shoulder totally washed out L = 6.0m Pavement partially collapsed 5m x 2.0m
1166 + 800	Shoulder washed out
1167 + 200 ~ 250	Shoulder washed out
1167 + 450 ~ 500	Overflow always occurs Shoulder washed out

8. Topography : Alluvial Fan
9. Road Side Development: High. There are municipal centers of Alegria & Kitcharao along the road.
10. Flood Type : III
11. Cause of Flood : Overflow from Legaspi river

2. Existing Drainage Facilities and Conditions

Location	Type of Facilities	Condition
1166 + 611	2 - 0.6 dia. RCPC 1 - 0.9 dia. RCPC	Insufficient capacity Overflow always occur Bailey bridge was installed before.
1166 + 800	1 - 0.6 dia. RCPC	Functioning
1167 + 200	2 - 0.9 dia. RCPC 1 - 1.5 dia. RCPC	Insufficient capacity Overflow always occur
1167 + 300 ~ 1167 + 500	1.5 x 1.5 Drainage Canal L = 200m	Functioning

3. Past/present Flood Control/protection Measures

No specific work has been done.

4. Proposed Countermeasures

1. Shoulder pavement (Bothside)

   W = 3.0m L = 1,400m (1166+600 ~ 1168+000)

2. Installation of Flood Interception Canal

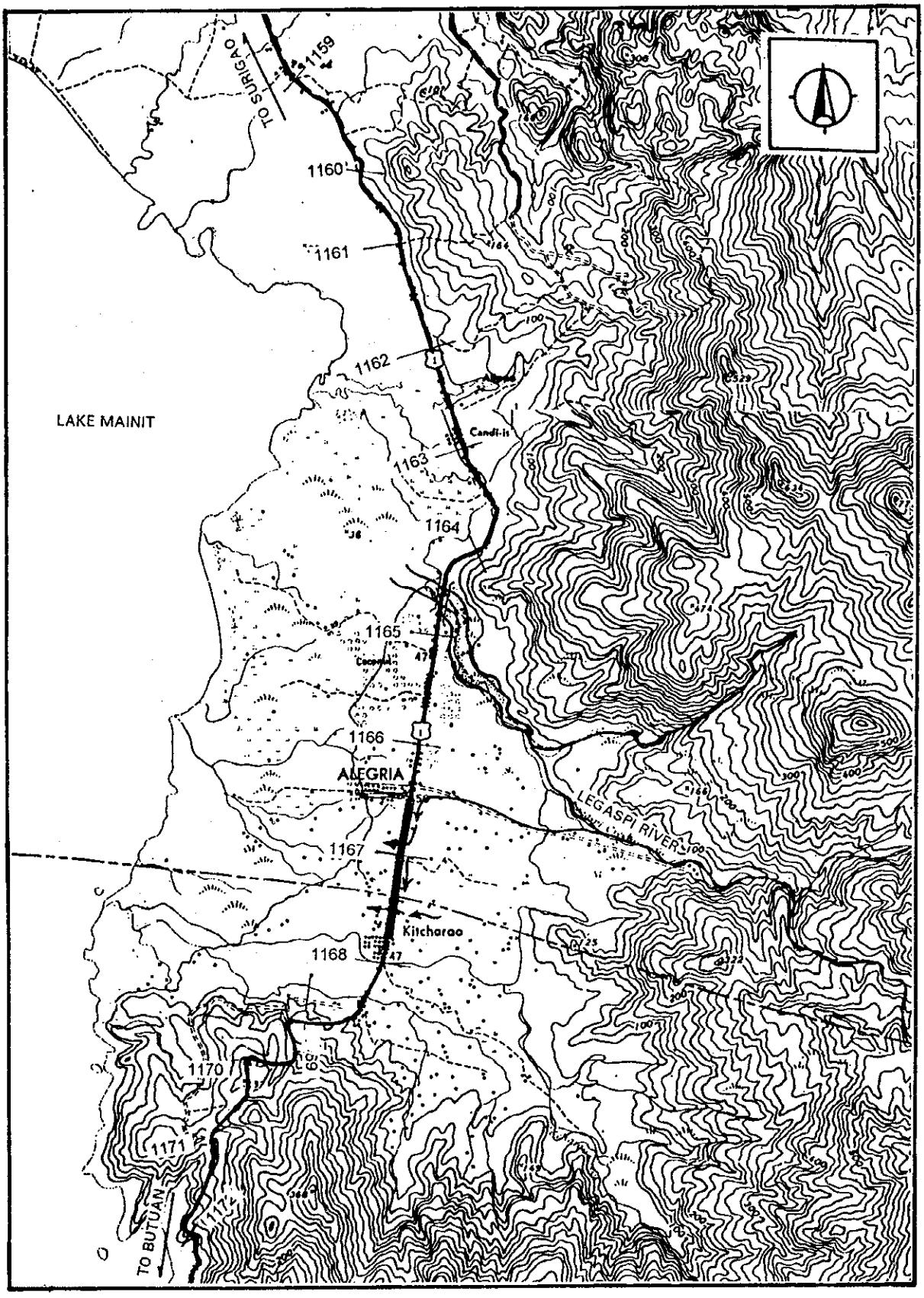
Type E	L = 1,300m	(1166+600 ~ 1167+900) Upstream
	L = 500m	(1167+200 ~ 1167+700) Downstream

3. Construction of box culvert

2 - 3.0 x 2.0	1166 + 611
2 - 3.0 x 2.0	1167 + 500

4. Installtion of pipe culvert

1 - 1.2 dia. RCPC	1166 + 800
1 - 1.2 dia. RCPC	1167 + 000
1 - 1.2 dia. RCPC	1167 + 200
1 - 1.2 dia. RCPC	1167 + 700



FLOOD SECTION 5 Alegria, Surigao del Norte

FLOOD SECTION NO. 6

1. Nature of Flood and Damage to the Road

1. Location : Baliguian, Agusan del Norte
2. Length : 490m (1182+100 ~ 1182+590)
3. Depth : 30cm
4. Duration : 4 hrs.
5. Frequency : 2 times/year
6. Traffic : Passable only to buses and trucks
7. Damage to the Road : Shoulder scoured L = 50m (1182+350 ~ 1182+400)
   Existing drainage pipes are crammed with clay by the residents who annoyed with the flood water discharged from the pipes.
8. Topography : Mountain slope side
9. Roadside Development : High. There are so many residential houses along the road.
10. Flood Type : III
11. Cause of Flood : Overflow from Baliguian river

2. Existing Drainage Facilities

Location	Type of Facilities	Condition
1182 + 213	1 - 0.6 dia. RCPC	Totally clogged
+ 230	1 - 0.6 dia. RCPC	Totally clogged
+ 247	1 - 0.6 dia. RCPC	Totally clogged
+ 476	1 - 0.6 dia. RCPC	Totally clogged
+ 590	0.5 x 0.8 RCBC	NIA irrigation canal
1181 + 910 ~ 1182 + 450	Earth side canal W = 1.5m H = 1.8m L = 540m	Functioning, canal width is narrowed where the canal crosses the road

3. Past/present Flood Control/protection Measures

Earth drainage canal is provided to drain flood water to Baliguian river.

W = 1.5m H = 1.8m L = 540m (1181+910 ~ 1182+450)

4. Proposed Countermeasures

1. Paving the shoulder (Both side)
   L = 2 x 490m (1182+100 ~ 1182+590)

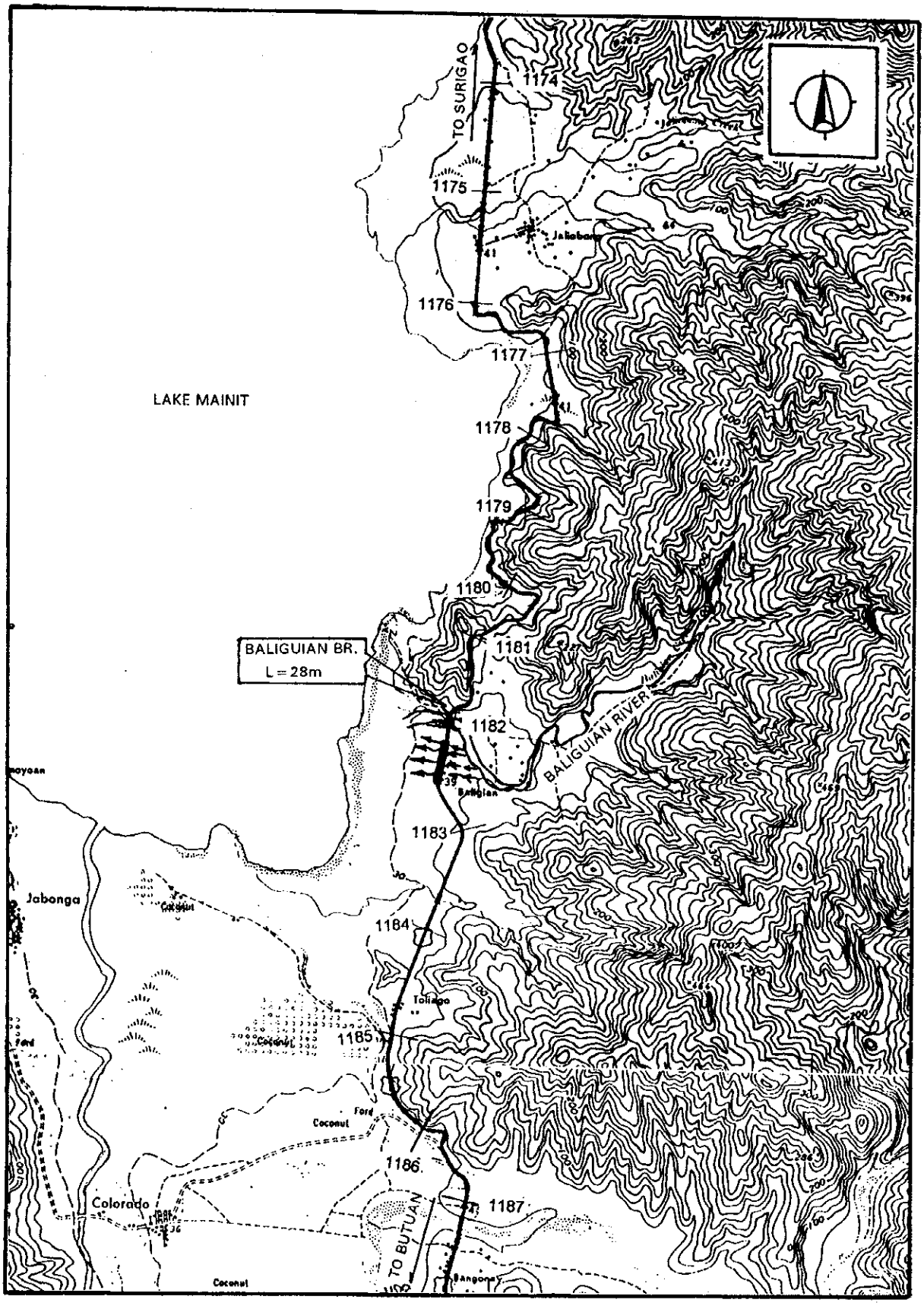
2. Installation of Flood Interception Canal (Both side)
   Side Ditch Type E L = 630m x 2 (1181+920 ~ 1182+550)

3. Installation of RCPC

1.07 dia.	at	1182 + 080
		1182 + 160
		1182 + 247
		1182 + 350
		1182 + 475

5. **Basin Characteristics (Baliguian River)**

Drainage Area	13.95 km^2
Longest water course	7.35 km
Distance to Basin Centroid	2.15 km
Average riverbed slope	0.0898
Discharge	100.6 m^3/s



FLOOD SECTION 6 Baliguian, Agusan del Norte

FLOOD SECTION NO. 7

1. Nature of Flood and Damage to the Road

1. Location : Baliguian, Agusan del Norte
2. Length : 160m (1183+100 ~ 1183+260)
3. Depth : 10cm
4. Duration : 3 hrs.
5. Frequency : Once/2 year
6. Traffic : Passable with care
7. Damage to the Road : Mudflow L = 50m (1183+100 ~ 1183+150)
   Overflow pipe at 1183 + 150
   Overflow box and
   Shoulder scoured at 1183 + 240
8. Topography : Alluvial Fan
9. Roadside Development : Low. Rice field both side
10. Flood Type : III
11. Cause of Flood : Overflow from Sayadion river

2. Existing Drainage Facilities and their Condition

Location	Type of Facilities	Condition
1183 + 149	1 - 0.6 dia. RCPC	Totally clogged Overflow always occur
1183 + 240	2 - 1.5 x 1.5 RCBC	Insufficient capacity 1/2 silted 60cm subsided
1183 + 533	1 - 0.6 dia. RCPC	1/2 clogged.

3. Past/present Flood Control/protection Measures

Declogging the pipe whenever overflow occurs at 1183 + 149.

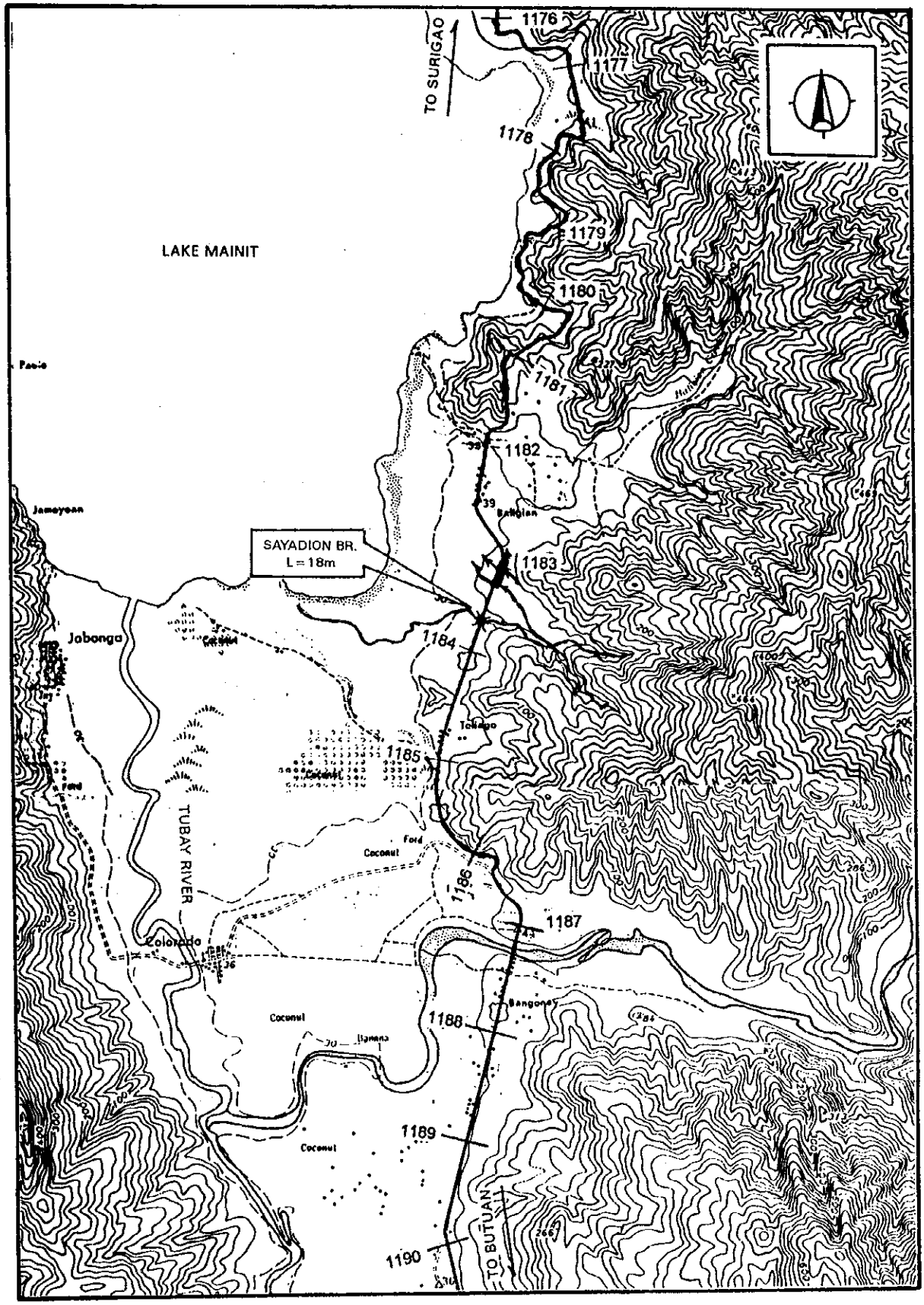
4. Proposed Countermeasures

1. Construction of new box culvert
   2 - 3.0 x 2.0 1183 + 240

2. Installation of new pipe with catch basin
   1 - 1.2 dia. RCPC 1183 + 150

5. Discharge Estimate

Drainage Area	L	H	C	Tc	I10	I25	I50	Q10	Q15	Q50
	(m)	(m)		(min)	(mm/hr)			(m^3/s)		
3.0	2,800	425	0.5	17.6	230	280	320	95.8	116.7	133.3



FLOOD SECTION 7 Baliguian, Agusan del Norte

FLOOD SECTION NO. 8

1. Nature of Flood and Damage to the Road

1. Location : Toliago, Agusan del Norte
2. Length : 950m (1184+250 ~ 1185+200)
3. Depth : 60cm (Max. 1.0m)
4. Duration : 6 hrs.
5. Frequency : 2 times/year
6. Traffic : Impassable to all types of vehicle
7. Damage to the Road : Mud and debris deposit on the road surface
   Shoulder heavily scoured (Both side)
   L = 90m (1184+360 ~ 1184+450)
8. Topography : Mountain slope side
   There is no marked water cause
9. Roadside Development : Low. No residential houses. Rice Field both side.
10. Flood Type : I
11. Cause of Flood : Flood water from mountain slope

2. Existing Drainage Facilities

Location	Type of Facilities	Condition
1184 + 510	1 - 0.6 dia. RCPC	Insufficient Capacity, Functioning
1184 + 688	1 - 0.6 dia. RCPC	Insufficient Capacity, Functioning
1184 + 716	1 - 0.6 dia. RCPC	Water surface elevation at inlet and outlet of the pipe is higher than road surface

3. Past/present Flood Control/protection Measures

1. Shoulder pavement (both side)
   W = 1.5m L = 105m (1184+345 ~ 1184+450)

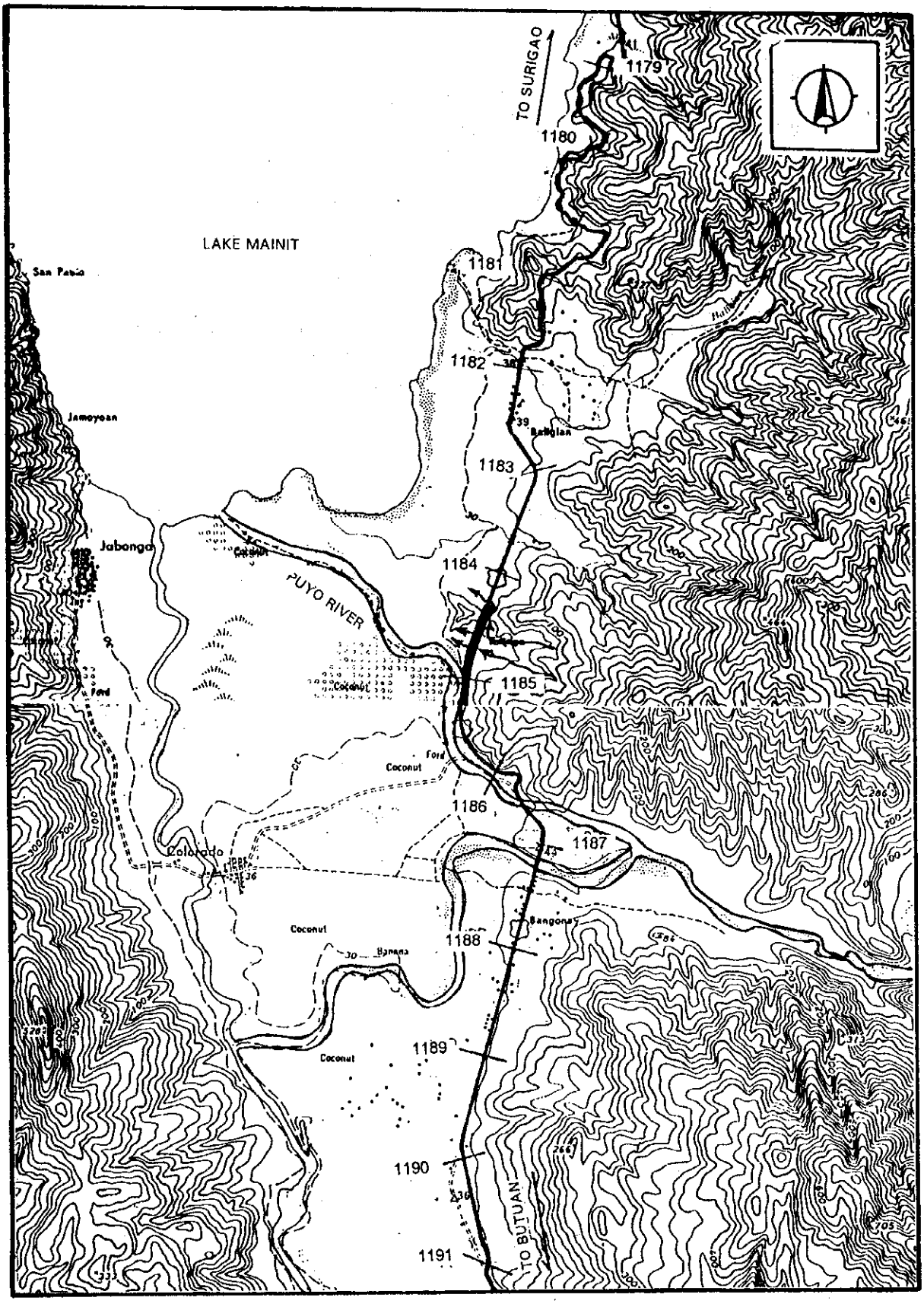
2. Embankment slope protection with grouted riprap (upstream side)
   H = 1.5m L = 105m (1184+345 ~ 1184+450)

4. Proposed Countermeasures

1. Raising the road by average 1.5m
   L = 1,000m (1184+200 ~ 1185+200)
2. Embankment slope protection with grouted riprap (Both side)
   L = 1,000m (1184+200 ~ 1185+200)
3. Shoulder pavement (Both side)
   W = 2.5m L = 1,000m (1184+200 ~ 1185+200)
4. Installation of Side Ditch Type C
   L = 1,000m (1184+200 ~ 1185+200)
5. Construction of box culvert 1 - 3.0 x 3.0 at 184+300
6. Installation of RCPC
   1.07 dia. 1184+350, 400, 450, 510, 560, 600, 688, 716
   1184+760, 800, 850, 900, 950
   1185+000, 050, 100, 150

5. Basin Characteristics

Area	L	H	C	Tc	I10	I25	I50	Q10	Q25	Q50
(km2)	(m)	(m)		(min)	(mm/hr)				(m^3/s)	
1.024	1,550	265	0.5	8.6	302	380	420	46.92	58.86	67.39



FLOOD SECTION 8 Toliago, Agusan del Norte

FLOOD SECTION NO. 9

1. Nature of Flood and Damage to the Road

1. Location : Bangonay, Agusan del Norte
2. Length : 1,600m (1187+600 ~ 1189+200)
3. Depth : 30cm
4. Duration : 6 hrs.
5. Frequency : Once/year
6. Traffic : Passable only to buses and trucks
7. Damage to the Road : Not significant
8. Topography : Alluvial Fan
9. Roadside Development : Low, coconut plantatioin (both side)
10. Flood Type : III
11. Cause of Flood : Overflow from Puyo river
    Huge amount of drift woods got stuck at Bangonay bridge during heavy rains and narrowed the bridge opening.

2. Existing Drainage Facilities

Location	Type of Facilities	Condition
1188 + 037	1 - 0.9 dia. RCPC	Insufficient capacity Overflow always occur
+ 460	2 - 3.0x2.2 RCBC	Functioning
+ 909	2 - 0.6 dia. RCPC	1/2 clogged
1187 + 700 ~		
1188 + 037	Lined Canal	
	W1 = 0.8 W2 = 3.0	Fair Condition
	H = 1.2m L = 337m	

3. Past/present Flood Control/protection Measures

1. Lined Canal — L = 337m (1187+700 ~ 1188+037)
   W1 = 0.8m W2 = 3.0m H = 1.2m

4. Proposed Countermeasures

1. Raising the Road by average 2.0m
   L = 1,600m (1187+600 ~ 1189+200)

2. Embankment slope protection with grouted riprap (upstream)
   L = 1,600m (1187+600 ~ 1189+200)

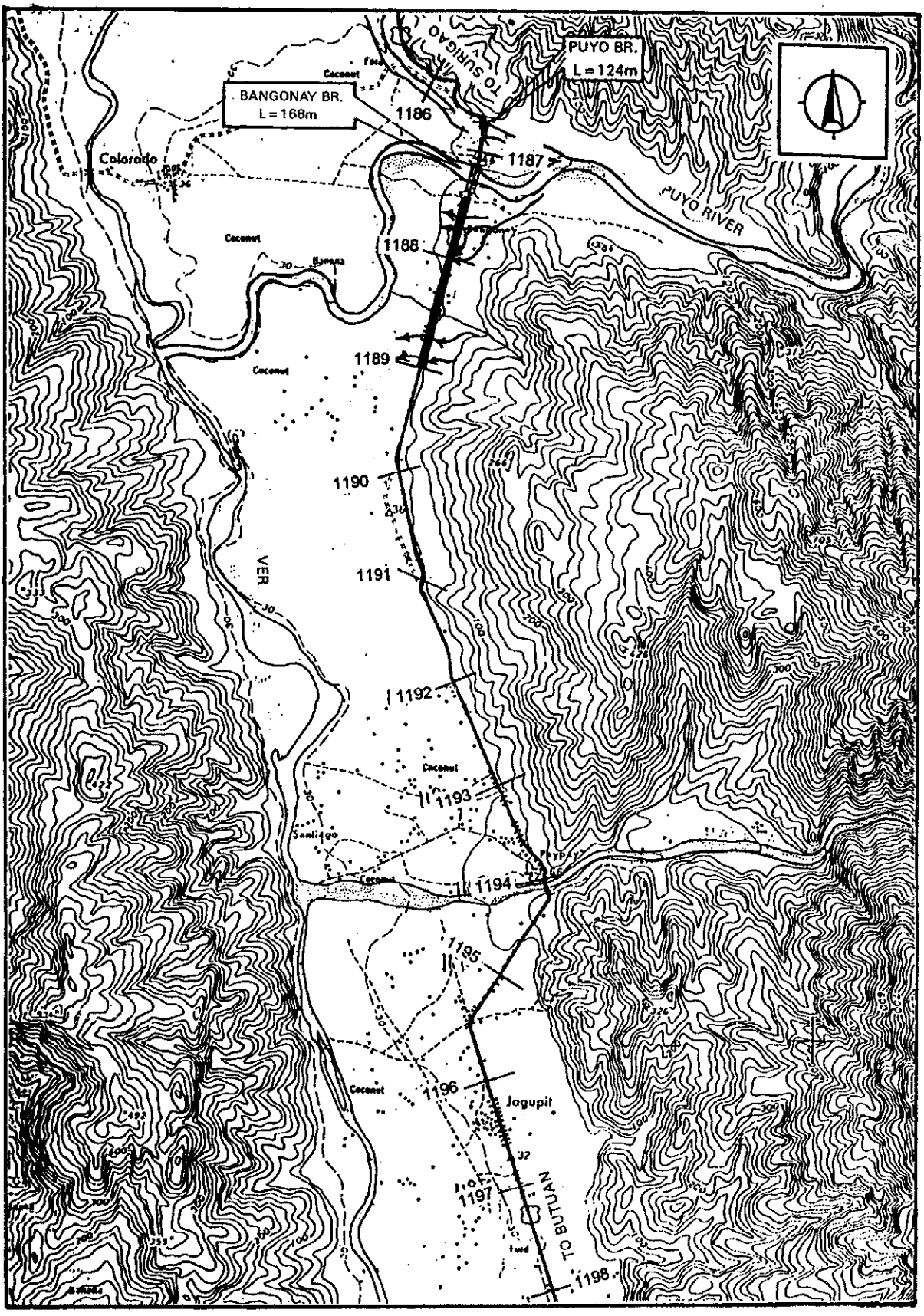
3. Installation of side ditch Type C
   L = 1,600m (1187+600 ~ 1189+200)

4. Construction of Box culvert
   1 - 3.0 x 2.0 at 1188+037

5. Installation of RCPC
   1 - 1.22 dia. 1187+700, 850, 950
   1188+200, 300, 400, 600, 700, 800, 900
   1189+000, 100

5. Basin Characteristics

Drainage Area	240.69 km^2
Longest water course	33.6 km
Distance to Basin Centroid	12.0 km
Average riverbed slope	0.02972
Probable Flood Discharge	1,123.1 m^3/s



FLOOD SECTION 9 Bangonay, Agusan del Norte

FLOOD SECTION NO. 10

1. Nature of Flood and Damage to the Road

1. Location : Santiago, Agusan del Norte
2. Length : L = 1,800m (1192+000 ~ 1193+800)
3. Depth : 40cm
4. Duration : 6 hrs.
5. Frequency : 2 times/year
6. Traffic : Impassable to all types of vehicle
7. Damage to the Road : Shoulder scoured L = 20m 1192+700~720
   Mud and debris deposit on the road surface.
   L = 200m 1192+700~900
   Overflow always occurs, shoulder scoured
   L = 20m 1193+100~120
   Overflow always occurs, shoulder and barangay road lead to the study road are heavily scoured
8. Topography : Mountain slope side
9. Road side Development : High. Municipal center at Santiago.
10. Flood Type : I
11. Cause of Flood : Flood water from mountain slope
    No marked water channel is present

2. Existing Drainage Facilities

Location	Type of Facilities	Condition
1192 + 382	1 - 0.6 dia. RCPC	Totally clogged
+ 492	1 - 0.6 dia. RCPC	Totally clogged
+ 682	1 - 0.9 dia. RCPC	3/4 clogged
+ 992	1 - 0.9 dia. RCPC	Totally clogged
1193 + 100	1 - 1.2 dia. RCPC	Newly installed
+ 234	1 - 0.6 dia. RCPC	1/2 clogged
+ 438	1 - 0.6 dia. RCPC	3/4 clogged
+ 711	1 - 0.6 dia. RCPC	1/2 clogged
1193+100~550	1.5 x 1.5 Earth canal (upstream)	Canal width is narrow at some sections

3. Past/present Flood Control/protection Measures

1. Mudflow catch wall L = 80m (1192+710 ~ 1192+790)
   (H = 1.5m) L = 20m (1193+980 ~ 1193+000)

2. Replacement of RCPC pipe at 1193+100 with New catch basin

4. Proposed Countermeasures

1. Shoulder pavement

W = 2.5m L = 1,320m (1192+680 ~ 1194+000)

2. Installation of Flood Interception Canal

Side Ditch Type A	L = 300m	(1193+700 ~ 1194+000)
Side Ditch Type C	L = 780m	(1191+900 ~ 1192+680)
Side Ditch Type E	L = 420m	(1192+680 ~ 1193+100)
Side Ditch Type E	L = 600m	(1193+100 ~ 1193+700) Bothside

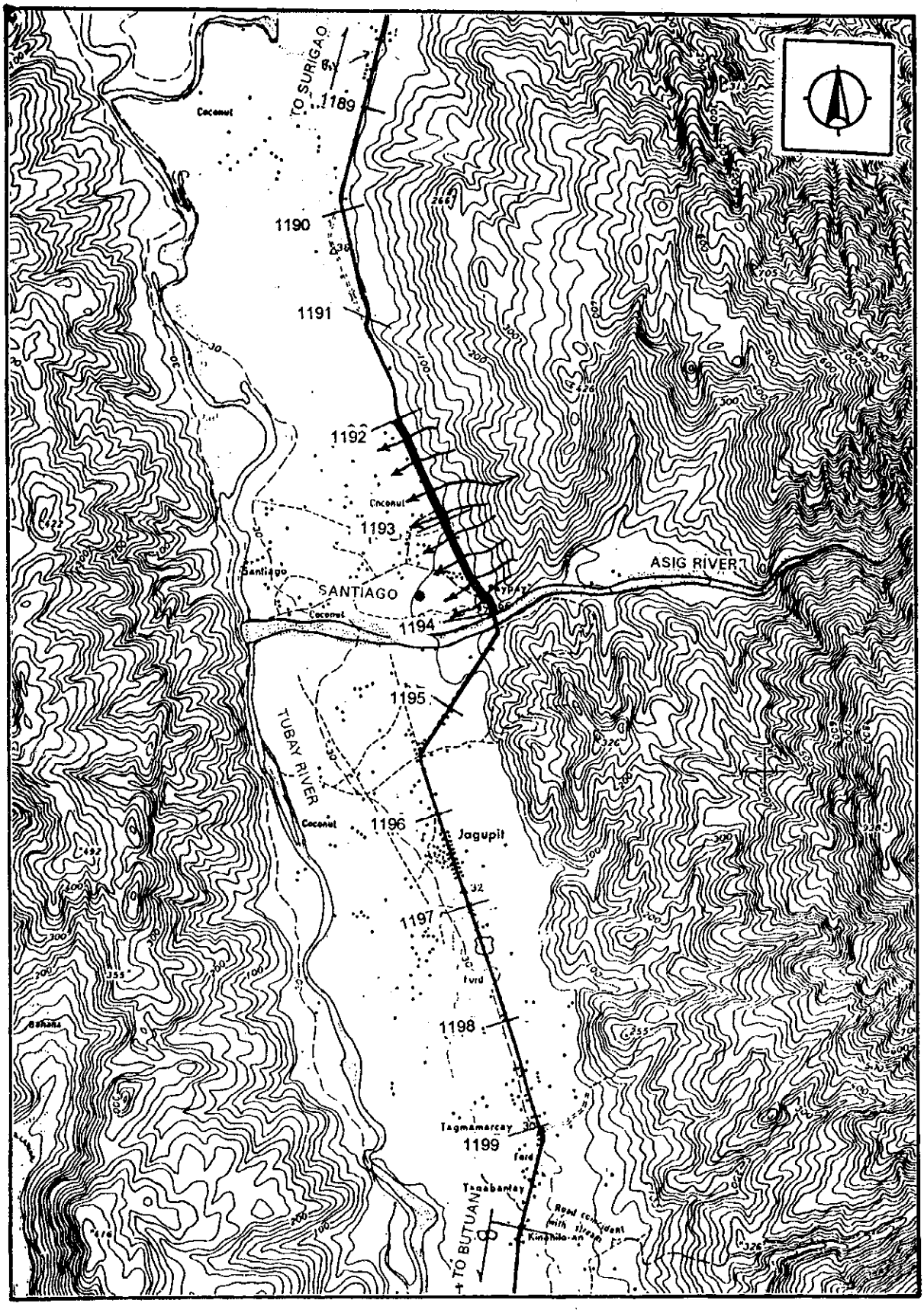
3. Installation of Drainage Pipes

1 - 1.2 dia. RCPC	1192+100
1 - 1.2 dia. RCPC	+200
1 - 1.2 dia. RCPC	+300
1 - 1.2 dia. RCPC	+382
1 - 1.2 dia. RCPC	+492
1 - 1.2 dia. RCPC	+600
2 - 1.2 dia. RCPC	+682
2 - 1.2 dia. RCPC	1193+100
1 - 1.2 dia. RCPC	+200
1 - 1.2 dia. RCPC	+300
1 - 1.2 dia. RCPC	+400
1 - 1.2 dia. RCPC	+500
2 - 1.2 dia. RCPC	+550
1 - 1.2 dia. RCPC	+711
1 - 0.9 dia. RCPC	+850

4. Drainage Canal

H = 1.5 W = 3.0 with Cover L = 1,500m

Drain flood water to outside urbanized area.



FLOOD SECTION 10 Santiago, Agusan del Norte

FLOOD SECTION NO. 11

1. Nature of Flood and Damage to the Road

1. Location : Jagupit, Agusan del Norte
2. Length : L = 320m (1196+400 ~ 1196+720)
3. Depth : 25cm
4. Duration : 4 hrs.
5. Frequency : 3 times/year
6. Traffic : Passable only to buses and trucks
7. Damage to the Road : Not significant
8. Topography : Alluvial Fan
9. Road side Development : Low. Corn field, coconut plantation
10. Flood Type : III
11. Cause of Flood : Overflow from Jagupit river
    Jagupit river is heavily silted, no clearance below Jagupit bridge. Flood water drain to the road

2. Existing Drainage Facilities

No drainage facilities

3. Past/present Flood Protection Measures

No action has been taken.

4. Proposed Countermeasures

1. Raising the road surface L = 320m (1196+400 ~ 1196+720)

2. Installation of RCPC

   1 - 1.22 dia. at 1196+605

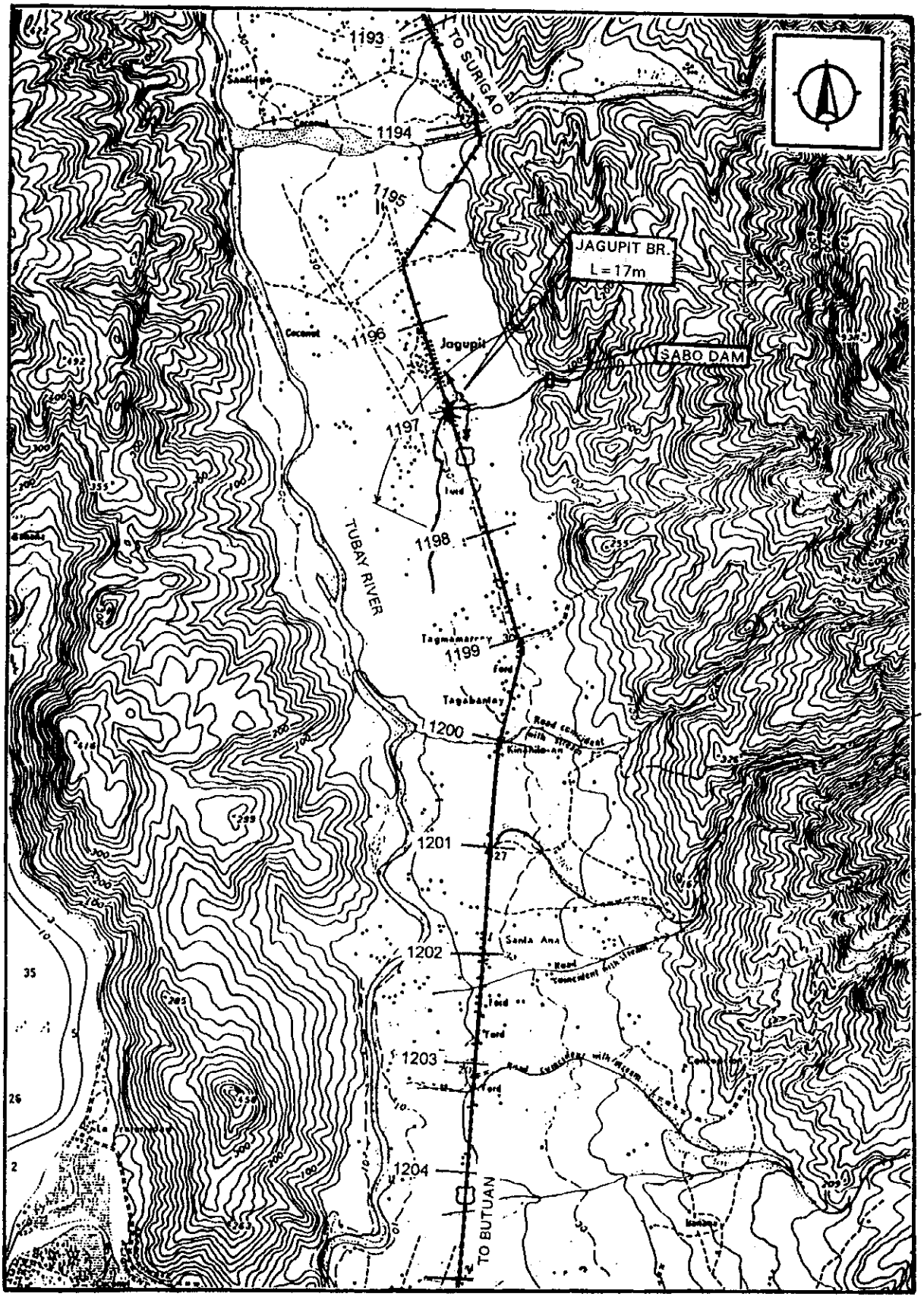
3. River dredging

Upstream of Jagupit Bridge		1,110m
Downstream of Jagupit Bridge		1,150m
	Total	2,260m

4. Construction of Sabo dam

5. Discharge Estimate

Area (km2)	L (km)	H (m)	C	Tc (min)	I10 (mm/hr)	I25 (mm/hr)	I50 (mm/hr)	Q10	Q25 (m^3/s)	Q50
2.60	4500	903	0.5	22.68	200	250	290	72.22	90.28	104.72



FLOOD SECTION 11 Jagupit, Agusan del Norte

FLOOD SECTION NO. 12

1. Nature of Flood and Damage to the Road

1. Location : Santiago, Agusan del Norte
2. Length : L = 15m (1197+556 ~ 1197+571)
3. Depth : No flood
4. Duration : No flood
5. Frequency : 3 times/year (Frequency of storm)
6. Traffic : One lane is closed due to pavement failure
7. Damage to the Road : Embankment of the bridge approach scoured heavily L = 15m
   Pavement is destroyed (one lane) L = 10m
8. Topography : Alluvial fan
9. Road side Development : Low, coconut plantation both side
10. Flood Type : III
11. Cause of Flood : Sedimentation and resulted aggradation of riverbed infront of Guinoyoran Bridge lead the river stream to distant its waterway to Northward by 30m, while another minor stream branch out to southward by 10m and directly hit the bridge approach.

2. Existing Drainage Facilities

No drainage facilities

3. Past/present Flood Control/protection Measures

1994 -Slope protection with grouted riprap L = 15m
Replacement of pavement slab L = 12m (two ways)

4. Proposed Countermeasures

River Dredging

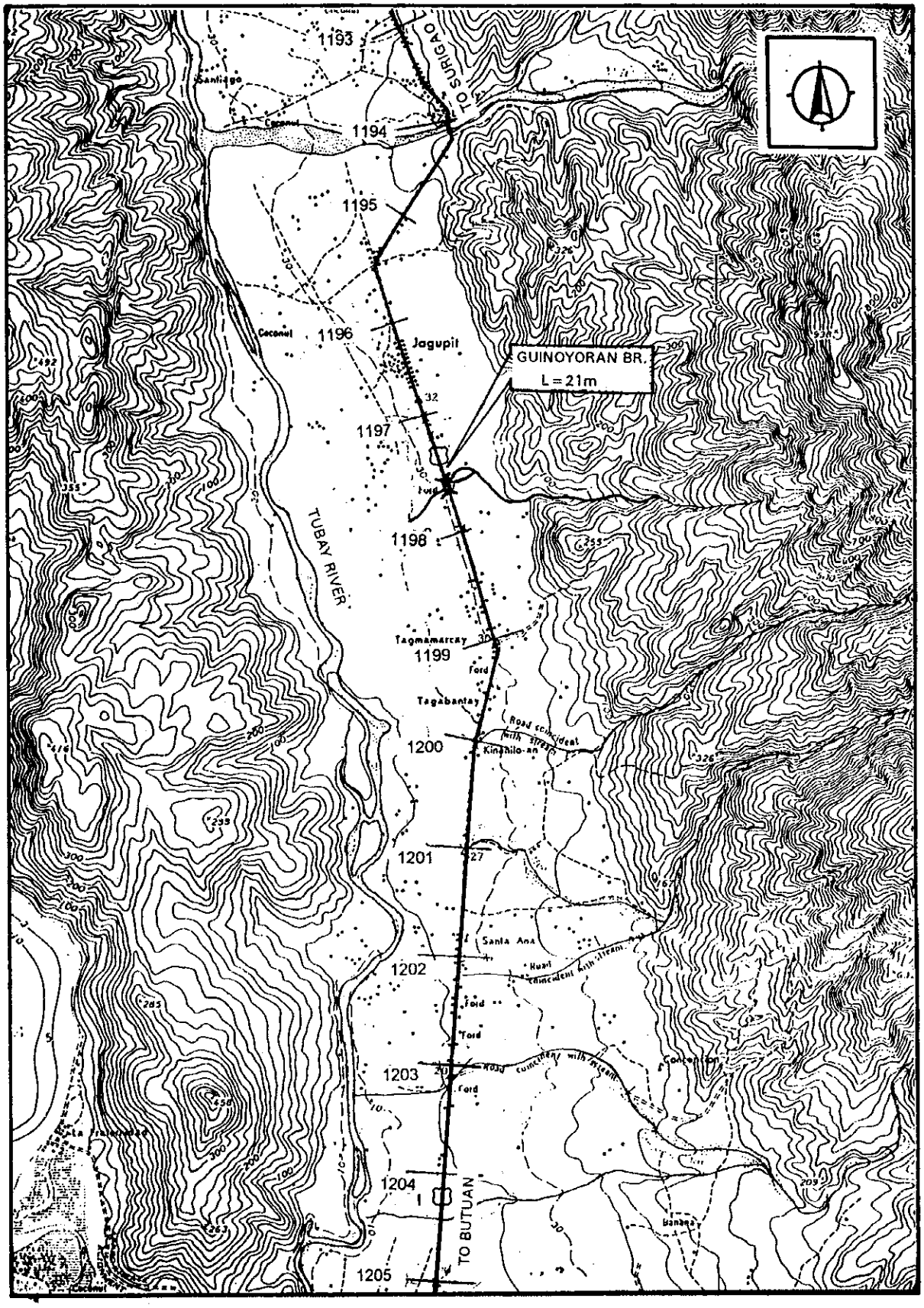
upstream of Guinoyoran Bridge
L = 150m
B1 = 8.0m
B2 = 16.0m
H = 2.0m

Downstream of Guinoyoran Bridge
L = 500m
B1 = 10.0
B2 = 14m
H = 1.0m

5. Basin characteristics

Guinoyoran River

Drainage Area	4.305 km^2
Longest water course	4.65 km
Distance to Basin Centroid	2.5 km
Average slope of water course	0.1957
Probable Flood Discharge	50.62 m^3/s



FLOOD SECTION 12 Guinoyoran, Agusan del Norte

FLOOD SECTION NO. 13

1. Nature of Flood and Damage to the Road

1. Location : Sta. Ana, Agusan del Norte
2. Length : 4,270m (1199+600 ~ 1203+870)
3. Depth : 20cm ~ 60cm Average 40cm
4. Duration : 2 ~ 8 hrs. Average 6 hrs.
5. Frequency : 2 times/year
6. Traffic : Impassable to all types of vehicle
7. Damage to the Road :

1199+820 ~ 850	(L = 30m)	Shoulder scoured
1200 + 000	(L = 20m)	Shoulder scoured, subbase washed out, pavement partly collapsed
1200+200	(L = 20m)	Shoulder scoured, subbase washed out, pavement partly collapsed
1200+790	(L = 10m)	Shoulder scoured, subbase washed out, pavement partly collapsed
1201+060	(L = 10m)	Shoulder scoured, subbase washed out, pavement partly collapsed
1202+230 ~ 260	(L = 30m)	Shoulder scoured, subbase washed out, pavement partly collapsed
1203+210 ~ 300	(L = 90m)	Shoulder washed out subbase washed out, pavement collapsed

8. Topography : Alluvial Fan
9. Road side Development: Medium, Barangay Center at 1199+600, and 1201+800 Rest area is coconut plantation both side.
10. Flood Type : III
11. Cause of Flood : Overflow from Kinahiloan River, Maniswang River and Tagmamarkay River.

2. Existing Drainage Facilities

Location	Type of Facilities	Condition
1199 + 309	RCDG bridge L = 26m (Tagmamarkay Bridge)	Stable
1199 + 645	1 - 1.2 dia. RCPC	1/2 clogged
+ 729	1 - 0.9 dia. RCPC	Functioning
+ 850	1 - 0.9 dia. RCPC	Totally clogged

1200 + 005	2 - 1.0 dia. RCPC	Insufficient capacity
	1 - 1.2 dia. RCPC	Overflow always occurs
		Shoulders damaged
+ 200	2 - 0.9 dia. RCPC	Insufficient capacity
		Overflow always occurs
		Shoulder damaged
+ 350	1 - 0.6 dia. RCPC	Totally clogged
+ 792	2 - 0.6 dia. RCPC	Totally clogged
		Overflow occurs
		Shoulder scoured
1201 + 066	1 - 0.6 dia. RCPC	1/4 silted
		Overflow occurs
		Shoulder scoured
+ 250	1 - 0.6 dia. RCPC	3/4 clogged
+ 413	1 - 0.6 dia. RCPC	Functioning
+ 975	1 - 0.6 dia. RCPC	Functioning
1202 + 124	1 - 0.6 dia. RCPC	Functioning
+ 251	2 - 0.6 dia. RCPC	Insufficient capacity
		Overflow occurs
		Shoulder scoured
		Pavement collapsed
+ 569	1 - 0.6 dia. RCPC	Functioning
+ 825	Steel I Beam Bridge (Sta. Ana Bridge) L = 99.0m	Stable
1203 + 218	2 - 3.05 x 2.1 RCBC	Insufficient capacity
+ 293	1 - 1.8 x 2.1 RCBC	Overflow always occur
		Shoulder scoured
+ 406	1 - 0.6 dia. RCPC	Functioning
+ 417	1 - 0.6 dia. RCPC	Functioning
+ 433	1 - 0.9 dia. RCPC	Functioning
+ 532	1 - 0.6 dia. RCPC	Functioning
+ 572	1 - 0.6 dia. RCPC	Functioning
+ 592	1 - 0.6 dia. RCPC	Functioning
+ 618	1 - 0.6 dia. RCPC	Functioning
+ 660	1 - 0.6 dia. RCPC	Functioning
+ 871	2 - 1.5 dia. RCPC	Functioning

3. Past/present Flood Control/protection Measures

1. 2 - 0.6 dia. RCPC at 1202 + 251
2. 2 - 3.0 x 2.0 RCBC at 1203 + 218
3. 1 - 1.8 x 2.0 RCBC at 1203 + 293
4. Embankment slope protection with grouted riprap L = 90m 1203+210~300

4. Proposed Countermeasures

ALTERNATIVE - 1 (Protection of Road)

1. Shoulder pavement (Bothside) W = 3.0 L = 4,300m
   (1199+500 ~ 1203+900)
2. Embankment slope protection with grouted riprap (Both side)

L = 4,300m (1199+500 ~ 1203+900)

3. Side Ditch Type C L = 4,271m (1199+500 ~ 1203+900)
4. Constructoin of box culvert
   2 - 3.0 x 2.0 at 1199 + 850
   1200 + 000
   1200 + 800
   1202 + 250
5. Installation of RCPC
   2 - 1.22 dia. at 1200 + 200
   1201 + 250
   1201 + 415
   1201 + 975
   1202 + 570

ALTERNATIVE - 2 (Raising the Road)

1. Raise the road by average 1.5m L =4.300m (1199+500 ~ 1203+900)
2. Embankment slope protection with grouted riprap (upstream)
   L = 4,300m (1199+500 ~ 1203+950)
3. Side ditch Type C L = 4,271m (1199+500 ~ 1203+900)
4. Construction of box culvert
   2 - 3.0 x 2.0 at 1199 + 850
   1200 + 000
   1200 + 800
   1202 + 250

5. Installation of RCPC
   2 - 1.22 dia. at 1200 + 200
   1201 + 250
   1201 + 415
   1201 + 975
   1202 + 570

ALTERNATIVE - 3

1. River Dredging
   L = 2,380m (Kinahiloan River)
   L = 3,400m (Maniswang River)
   L = 1,960m (Tagmamarkay River)
   Total L = 7,740m

2. Flood protection dike
   L = 2,380m (Kinahiloan River)
   L = 3,400m (Maniswang River)
   L = 2,100m (Tagmamarkay River)
   Total L = 7,880m

3. Sabo dam
   Type A 1 location at Kinahiloan River
   2 locations at Maniswang River
   1 location at Tagmamarkay River
   Total 4 locations

Type B	1 location at Kinahiloan River	
	1 location at Maniswang River	
	1 location at Tagmamarkay River	
Total	3 locations	

4. Groundsill — 2 Locations at Maniswang River

5. Installation of RCPC

2 - 1.22 dia.	at	1200 + 200
		1201 + 250
		1201 + 415
		1201 + 975
		1202 + 570

5. River Basin Characteristics of the area

Kinahiloan River

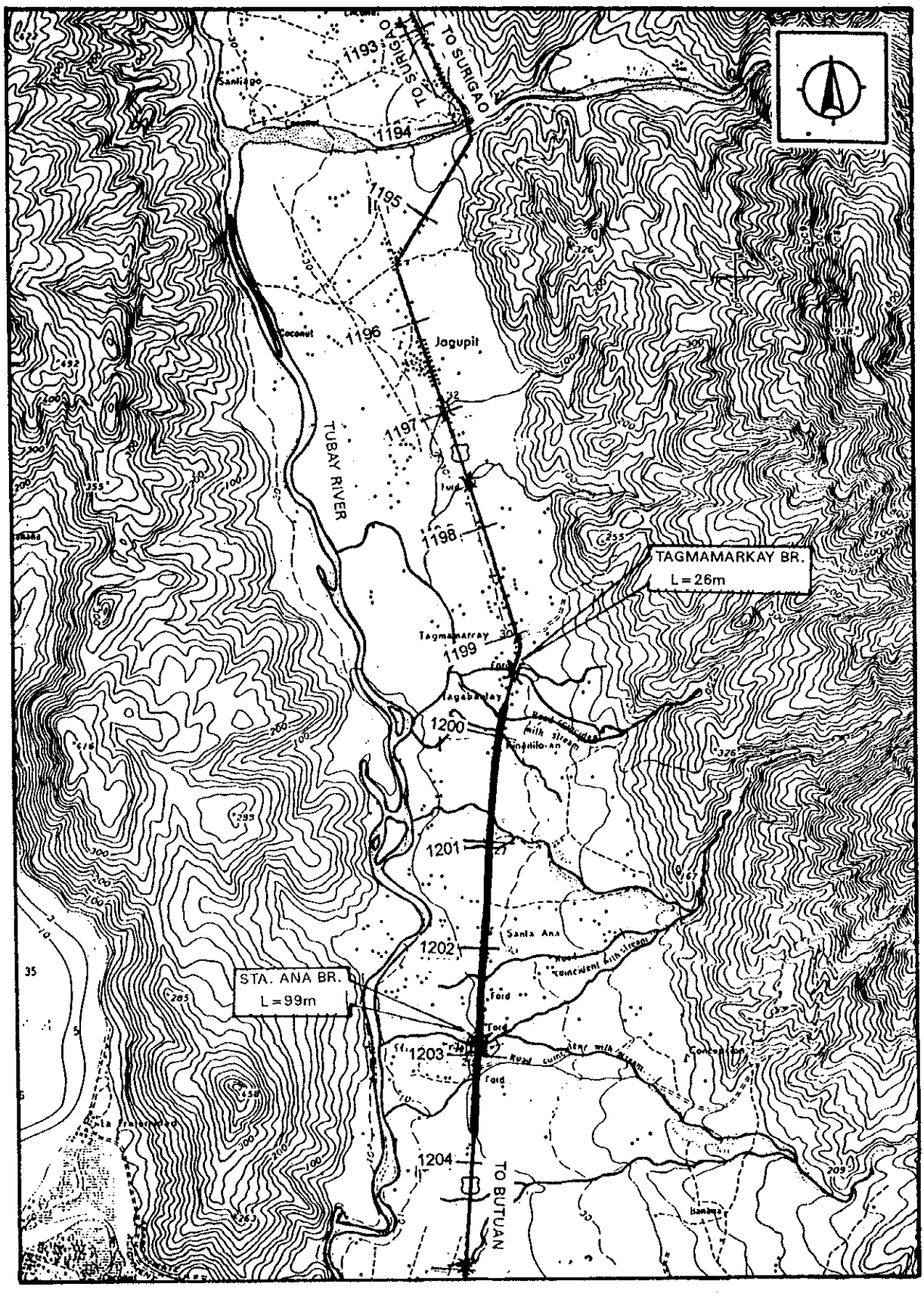
Drainage Area	16.94 km^2
Longest Water Course	10.94 km
Distance to Basin Centroid	6.0 km
Average Slope of Water Course	0.14607
Probable Flood Discharge	130.3 m^3/s

Maniswang River

Drainage Area	18.64 km^2
Longest Water Course	10.70 km
Distance to Basin Centroid	5.3 km
Average Slope of Water Course	0.14084
Probable Flood Discharge	140.1 m^3/s

Tagmamarkay River

Drainage Area	5.66 km^2
Longest Water Course	5.55 km
Distance to Basin Centroid	2.6 km
Average Slope of Water Course	0.1643
Probable Flood Discharge	44.9 m^3/s



FLOOD SECTION 13 Sta. Ana, Agusan del Norte

FLOOD SECTION NO. 14

1. Nature of Flood and Damage to the Road

1. Location : Agay, Agusan del Norte
2. Length : 400m (1219+700 ~ 1220+100)
3. Depth : 15cm
4. Duration : 6 hrs.
5. Frequency : 3 times/year
6. Traffic : Passable with care
7. Damage to the Road : Box and pipe culverts frequently overflowed. Shoulder washed out, pavement frequently collapsed at overflow sections (1220+000)
8. Topography : Lowland area, Flood plain
9. Road side Development : Medium, several residential houses along the road, rice field (bothside)
10. Flood Type : II
11. Cause of Flood : Lowland area. Water level goes up at entire surrounding area.

2. Existing Drainage Facilities

Location	Type of Facilities	Condition
1219 + 789	3.0 x 2.7 RCBC	Overflow always occurs
1219 + 850	2.35 x 1.9 RCBC	Overflow always occurs
1219 + 967	2 - 1.5 dia. RCPC	1/4 clogged, overflow always occurs
1220 + 125	0.9 dia. RCPC	1/4 clogged
1220 + 210	0.8 x 0.8 RCBC	NIA culvert

3. Past/present Flood Control/protection Measures

1. Shoulder material is refilled whenever shoulder is washed out.
2. Concrete slab is replaced whenever pavement collapsed.

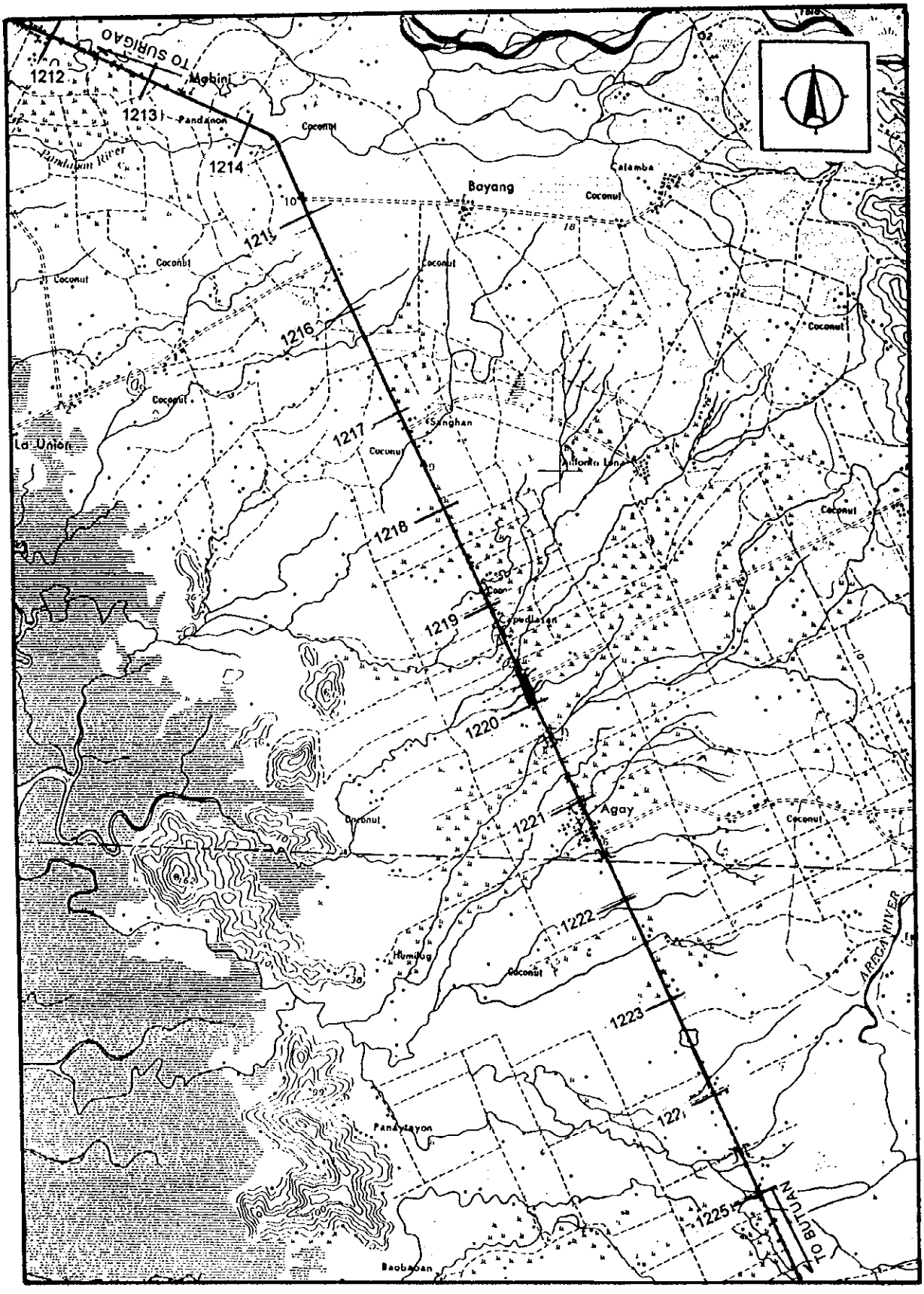
4. Proposed Countermeasures

1. Raise the road surface by 50cm
   L = 400m (1219+700 ~ 1220+100)

2. Shoulder pavement (Bothside) W = 2.5m
   L = 400m (1219+700 ~ 1220+100)

3. Embankment slope protection with grouted riprap (Bothside)
   L = 400m (1219+700 ~ 1220+100)

4. Installation at RCBC 2 - 3.0 x 2.0 at 1219+967



FLOOD SECTION 14 Agay, Agusan del Norte

FLOOD SECTION NO. 15

1. Nature of Flood and Damage to the Road

1. Location : Los Angeles, Butuan City
2. Length : 440m (1224+200 ~ 1224+640)
3. Depth : 30cm
4. Duration : 10 hrs.
5. Frequency : 2 times/year
6. Traffic : Passable only to buses and trucks
7. Damage to the Road : Not significant
8. Topography : Lowland area, Flood plain
9. Road side Development : Medium, several residential houses along the road, rice field (bothside)
10. Flood Type : II
11. Cause of Flood : Lowland area. Agay river is heavily silted, no clearance below Agay bridge.

2. Existing Drainage Facilities

Location	Type of Facilities	Condition
1223 + 071	0.6 dia. RCPC	Functioning
1223 + 386	0.6 dia. RCPC	1/2 clogging
1223 + 704	0.6 dia. RCPC	Functioning
1223 + 701	1.5 dia. RCPC	Functioning
1224 + 180	0.9 x 1.0 RCBC	Functioning, NIA canal
1224 + 257	5.0 x 2.5 RCBC	Functioning
1224 + 300	5.0 x 2.5 RCBC	Functioning
1224 + 636	1.2 dia. RCPC	Not functioning
1224 + 716	1.5 dia. RCPC	Wrong location

3. Past/present Flood Control/protection Measures

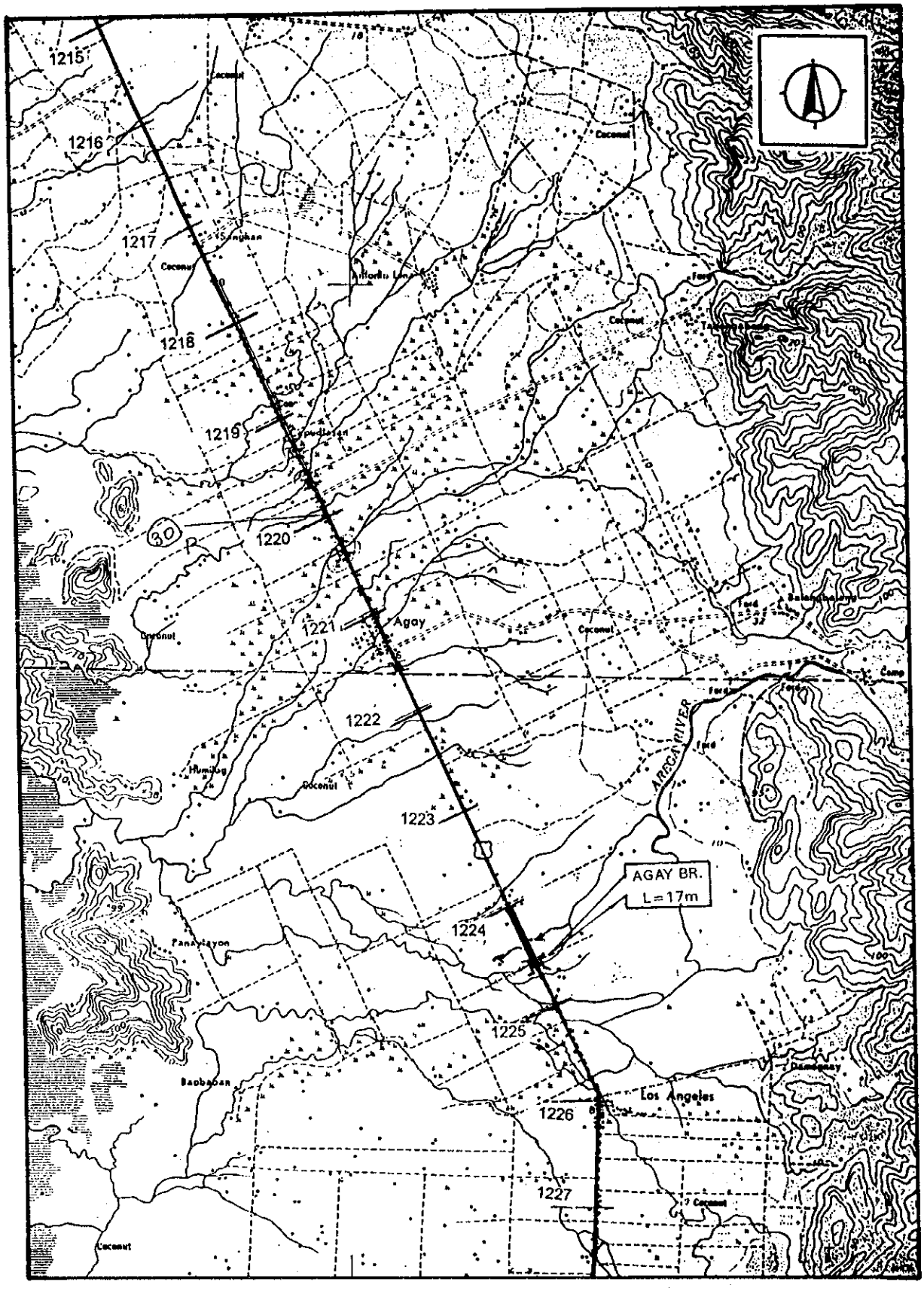
1. Shoulder pavement Rightside W = 2.0m L = 60m
   Leftside W = 2.0m L = 30m

4. Proposed Countermeasures

1. Raising Road Elevation by 1.5m (max.)
   L = 1,450m (1224+000 ~ 1225+470)

2. Dredging of Agay River
   L = 500m

3. Installation of RCPC
   1.22 dia. at 1224 + 636,
   1224 + 820



FLOOD SECTION 15 Los Angeles, Butuan City

FLOOD SECTION NO. 16

1. Nature of Flood and Damage to the Road

1. Location : Trento, Agusan del Sur
2. Length : 9,000m (1355+200 ~ 1364+200)
3. Depth : 30cm ~ 50cm Max. 60cm at 1356 + 450
4. Duration : 1 ~ 2 days
5. Frequency : Every 5 years, 1981, 1993 are most critical
6. Traffic : Impassable to all types of vehicle at station 1356+450
7. Damage to the Road : Not significant
8. Topography : Flood plain
9. Roadside Development : High. There are several barangay centers along the road. Remaining areas are rice field.
10. Flood Type : IV
11. Cause of Flood : Overflow from Simulao river
    NIA irrigation canal which is higher than road surface blocks the flood water to drain. This further aggravates flood along the road.

2. Existing Drainage Facilities

Location	Type of Facilities	Condition
1355 + 600	1.2 dia. RCPC	Not functioning
1355 + 700	1.2 dia. RCPC	Not functioning
1356 + 150	0.6 dia. RCPC	Not functioning
1356 + 450	2.6 x 2.35 RCBC	Overflow always occur
1356 + 900	1.2 dia. RCPC	1/4 clogged, Functioning
1357 + 350	1.2 dia. RCPC	1/4 clogged, Functioning
1358 + 050	0.6 dia. RCPC	1/4 clogged, Functioning
1359 + 150	1.5 dia. RCPC	Functioning
1359 + 700	2.5 x 1.7 RCBC	Functioning
1360 + 550	3.0 x 2.5 RCBC	Functioning
1360 + 900	1.2 dia. RCPC	1/2 clogged, Functioning
1361 + 150	2.25 x 2.2 RCBC	Functioning
1361 + 200	2.6 x 2.5 RCBC	Functioning
1362 + 700	0.6 dia. RCPC	Functioning
1363 + 050	0.6 dia. RCPC	Not functioning
1363 + 280	3.0 x 2.4 RCBC	Functioning
1363 + 500	3.5 x 2.0 RCBC	Functioning
1363 + 650	3.0 x 3.0 RCBC	Functioning
1363 + 800	3.55 x 2.6 RCBC	Functioning
1364 + 100	1.90 x 1.50 RCBC	Functioning
1364 + 200	3.10 x 3.10 RCBC	1/4 clogged Functioning

3. Past/present Flood Control/protection Measures

Simulao Bridge whose piers and abutments are seriously scoured was reconstructed in 1990.

4. Proposed Countermeasures

1. Raise the road by 1.0m
   L = 9,000m (1355 + 200 ~ 1364 + 200)

2. Protect Embankment Slope with Grouted Riprap (Bothside)
   L = 9,000m (1355 + 200 ~ 1364 + 200)

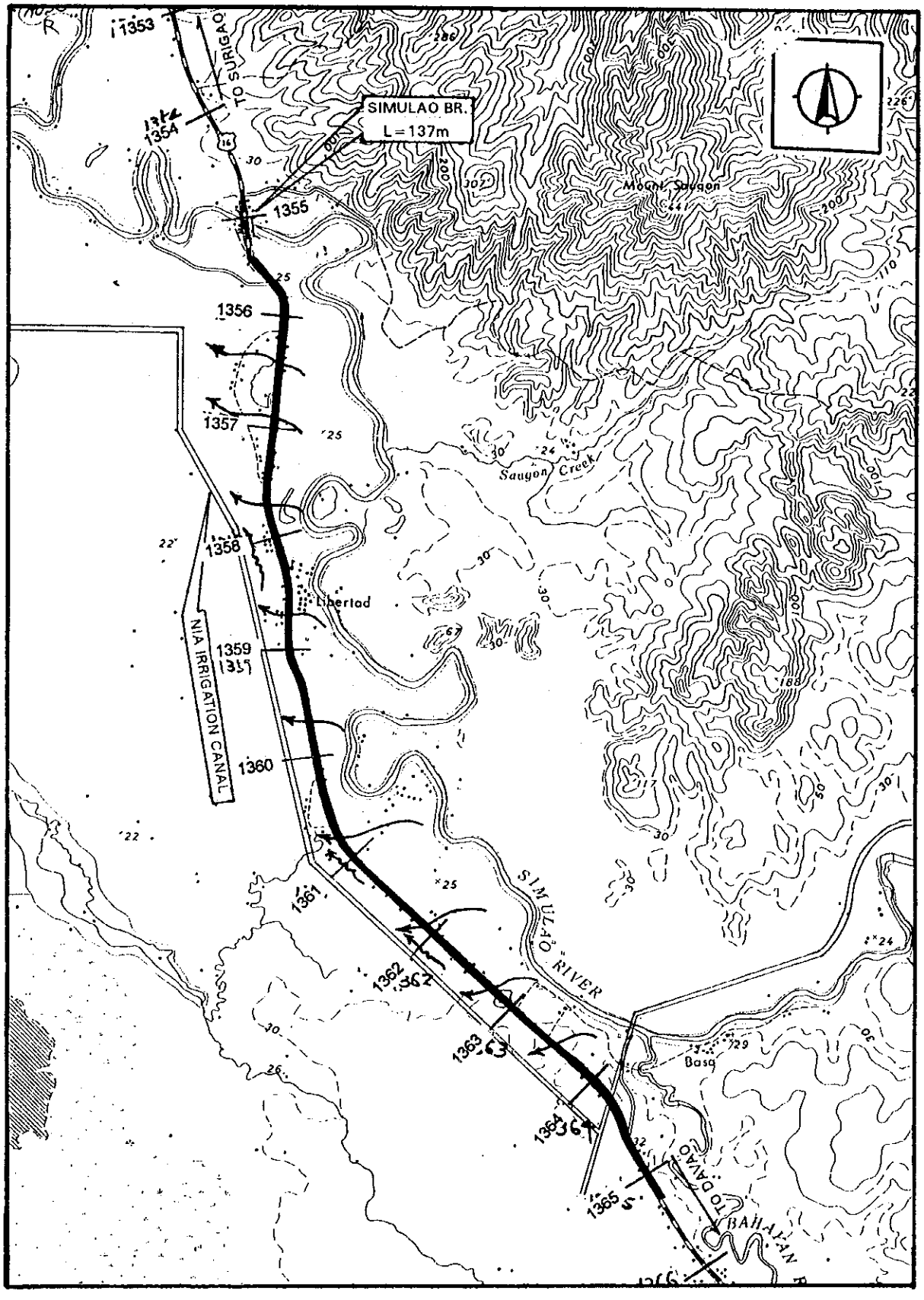
3. Construct RCBC
   2 - 3.0 x 3.0 at 1356 + 450

4. Install RCPC

   1.22 dia. every 100m 62 locations

5. River Basin Characteristics

Drainage Area	515.44 km^2
Longest water course	51.15 km
Distance to Basin Centroid	18.8 km
Average Slope of Water Course	0.01818
Probable Flood Discharge	
Unit Hydrograph Method	1,064.5 m^3/s



FLOOD SECTION 16 Trento, Agusan del Norte

FLOOD SECTION NO. 17

1. Nature of Flood and Damage to the Road

1. Location : Monkayo, Davao del Norte
2. Length : 1,950m (1393+400 ~ 1395+350 including Kalaw Bridge)
   150m (1397+300 ~ 1397+450 including Tina Bridge)
   300m (1398+000 ~ 1398+300 including Banlag Bridge)
3. Depth : Max. 2.0cm (Monkayo town proper)
4. Duration : 3 ~ 5 days
5. Frequency : Once/5 years
6. Traffic : Impassable to all types of vehicle for 3~5 days
7. Damage to the Road : Not significant due to slow velocity of flood water
8. Topography : Flood plain
9. Roadside Development : High. Municipal center of Monkayo at 1394+500
10. Flood Type : IV
11. Cause of Flood : Monkayo town proper is underwater by 2.0m. Kalaw bridge, Tina bridge and Banlag bridge over topped by flood water by 1.0m.

    The causes of flood may be:
    1) Backwater induced at sharp bend of the stream channel 2.1 km downstream of Kalaw bridge.
    2) Mild riverbed slope (0.026%) and ensuing excessive sedimentation.
    3) Contraction of streamflow at Kalaw bridge.

2. Existing Drainage Facilities

Location	Type of Facilities	Condition
1393+490	1 - 0.6 dia. RCPC	1/2 clogged
1393+590	2 - 0.9 dia. RCPC	Functioning
1393+850	1 - 0.6 dia. RCPC	Needs Wingwall
1394+090	2 - 3.0x2.1 RCBC	Functioning
1394+450	1 - 3.7x2.3 RCBC	Functioning
1394+850	1 - 3.7x2.9 RCBC	Functioning
1394+900	2 - 3.0x3.0 RCBC	Functioning
1394+970	2 - 0.9 dia RCPC	Functioning
1394+970	1 - 1.2 dia RCPC	Functioning

3. Past/on-going Flood Control/protection Measures

1984: Master Planning and Detailed Engineering Flood Control and Drainage of the Upper Agusan Development Project (CARBDP)

Phase I

Stage 1: Monkayo Cut-off Channel - 1	L = 60m
Dredging Agusan River	L = 2104m
Stage 2: Monkayo Cut-off Channel - 2	L = 615m
Stage 3: Monkayo Cut-off Channel - 3	L = 260m

Phase II

Flood Interception Dike	L = 317m

None of them has been implemented yet.

4. Proposed Countermeasures

ALTERNATIVE - 1

1. Construction of Monkayo Cut-off Channel	L = 1,020m
2. Dredging of Agusan River	L = 2,100m
3. Construction of flood protection dike H=25m	L = 317m
4. Reconstruction of Kalaw Bridge	L = 120m

ALTERNATIVE - 2

1. Construction of Flood protection dike H = 80m	L = 2,000m
2. Reconstruction of Kalaw Bridge	L = 180m
3. Reconstruction of Tina Bridge	L = 32m
4. Reconstruction of Banlag Bridge	L = 27m
5. Raising the Road Max. 3m	L = 791m (1397+200 ~ 1398+400)

ALTERNATIVE - 3

1. Construction of New Bypass Road	L = 2,400m (including New Kalaw Bridge)
2. Construction of New Kalaw Bridge	L = 200m
3. Reconstruction of Tina Bridge	L = 32m
4. Reconstruction of Banlag Bridge	L = 27m
5. Raising the Road Max. 3m	L = 791m (1397+200 ~ 1398+400)

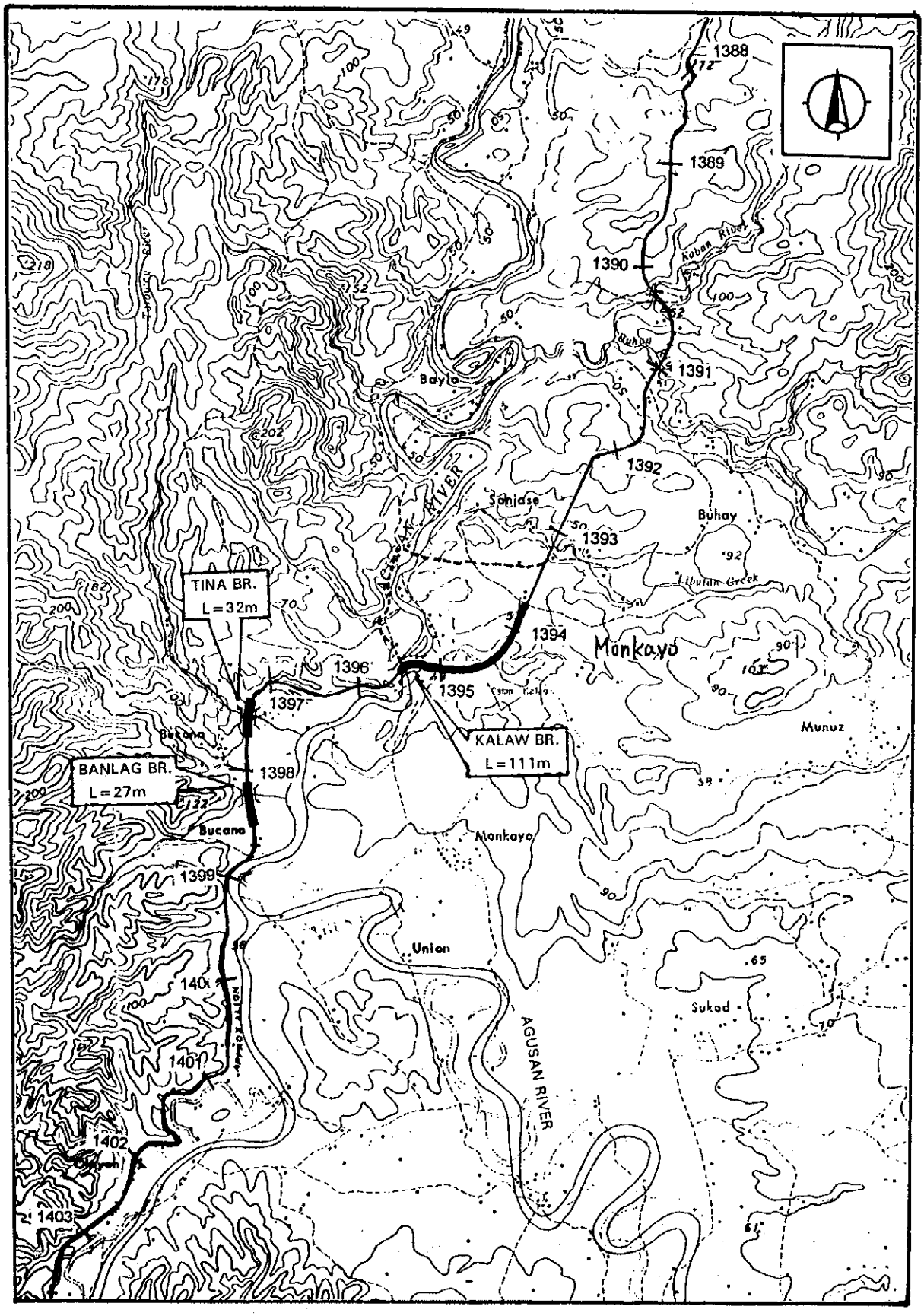
5. Drainage Basin Characteristics

Drainage Area	1,355 km^2
Longest water course	105 km
Distance to Basin Centroid	50.85 km
Average Slope of Water Course	0.0314

Probable Flood Discharge

Year	Peak Discharge (m^3/s)	Log(Q)
1958	75.0	1.8751
1959	210.8	2.3239
1960	617.4	2.7906
1961	552.8	2.7426
1962	1,811.4	3.2580
1963	2,114.0	3.3251
1964	220.2	2.3428
1965	942.2	2.9741
1966	326.0	2.5132
1967	549.9	2.7403
1968	220.2	2.3428
1969	171.0	2.2330
1970	108.5	2.0354
Mean	609.18	2.5767
Std.	651.173	0.4438
Skew	1.642	0.2288

Extreme Value Type I	2,297.2	m^3/s for 50 years flood
Log Person Type III	3,478.6	m^3/s for 50 years flood
Unit Hydrograph Method	2,354.0	m^3/s for 50 years flood



FLOOD SECTION 17 Monkayo, Davao del Norte

FLOOD SECTION NO. 18

1. Nature of Flood and Damage to the Road

1. Location : Tagum, Davao del Norte
2. Length : 7,500m (1460+500 ~ 1468+000)
3. Depth : 60cm
4. Duration : 24 hrs.
5. Frequency : 2 times/year
6. Traffic : Impassable to all types of vehicle for 12 hrs.
   Passable only to buses and trucks for 24 hrs.
7. Damage to the Road : Leftside shoulder is heavily scoured
   L = 2,300m (1462+900 ~ 1465+200)
8. Topography : Flood plain
9. Road side Development: Medium. There are several residential houses and, one school along the road, primarily coconut plantation.
10. Flood Type : IV
11. Cause of Flood : Overflow from Liboganon river.

2. Existing Drainage Facilities

Location	Type of Facilities	Condition
1462 + 305	0.9 dia. RCPC	Good
1462 + 900	0.6 dia. RCPC	1/3 clogged
1463 + 098	0.9 dia. RCPC	1/3 clogged
1463 + 200	0.9 dia. RCPC	1/3 clogged
1463 + 310	0.9 dia. RCPC	1/3 clogged
1463 + 600	0.9 dia. RCPC	1/3 clogged
1463 + 700	0.9 dia. RCPC	1/3 clogged
1464 + 300	0.9 dia. RCPC	1/3 clogged
1464 + 500	0.9 dia. RCPC	1/3 clogged
1464 + 700	0.9 dia. RCPC	1/3 clogged
1464 + 743	0.9 dia. RCPC	Good
1465 + 285	Liboganon Bridge L=32m	RCDG damaged,
1465 + 514	0.9 dia. RCPC	1/3 clogged
1466 + 566	0.9 dia. RCPC	Good
1466 + 828	Gov. Miranda Br. L=146m	Stable

3. Past/present Flood Control/protection Measures

1987 Cut-off channel No. 5 & No. 6
1988 Cut-off channel No. 4
1989 NIA Flood protection dike (Western Side of Liboganon River)
1989 Embankment protection along Pan-Philippine Highway L = 326m (1464+960 ~ 1465+286)

1990 Cut-off channel No. 1, 2, 3
Diversion channel between Taganay River ~ Liboganon River

1994 Embankment protection along Pan-Philippine Highway
Right L = 1,060m (1462+900 ~ 1464+960)
Left L = 40m (1464+920 ~ 1464+960)
Construction of Box Culvert
at 1464+600
1464+500

1993~1994 DPWH flood proteciton dike, Eastern side of Liboganon River
L = 16,000m

4. Proposed Countermeasures

ALTERNATIVE - 1

1. Shoulder pavement	W = 3.0	L = 5,800	(1460+500 ~ 1466+400)
2. Embankment slope protection		L = 2,320m	(1462+600 ~ 1464+920)
3. Dredging creek		L = 3,800m	(1460+500 ~ 1464+300)

ALTERNATIVE - 2

1. Flood protection dike (DPWH dike upstream)	L = 6,200m
2. Flood protection dike (DPWH dike downstream)	L = 7,300m
3. Flood protection dike (NIA dike downstream)	L = 7,200m
4. Bridge between dikes	L = 500m
5. Cut-off Channel	L = 650m
6. Approach Embankment	L = 1,050m

5. Drainage Basin Characteristics

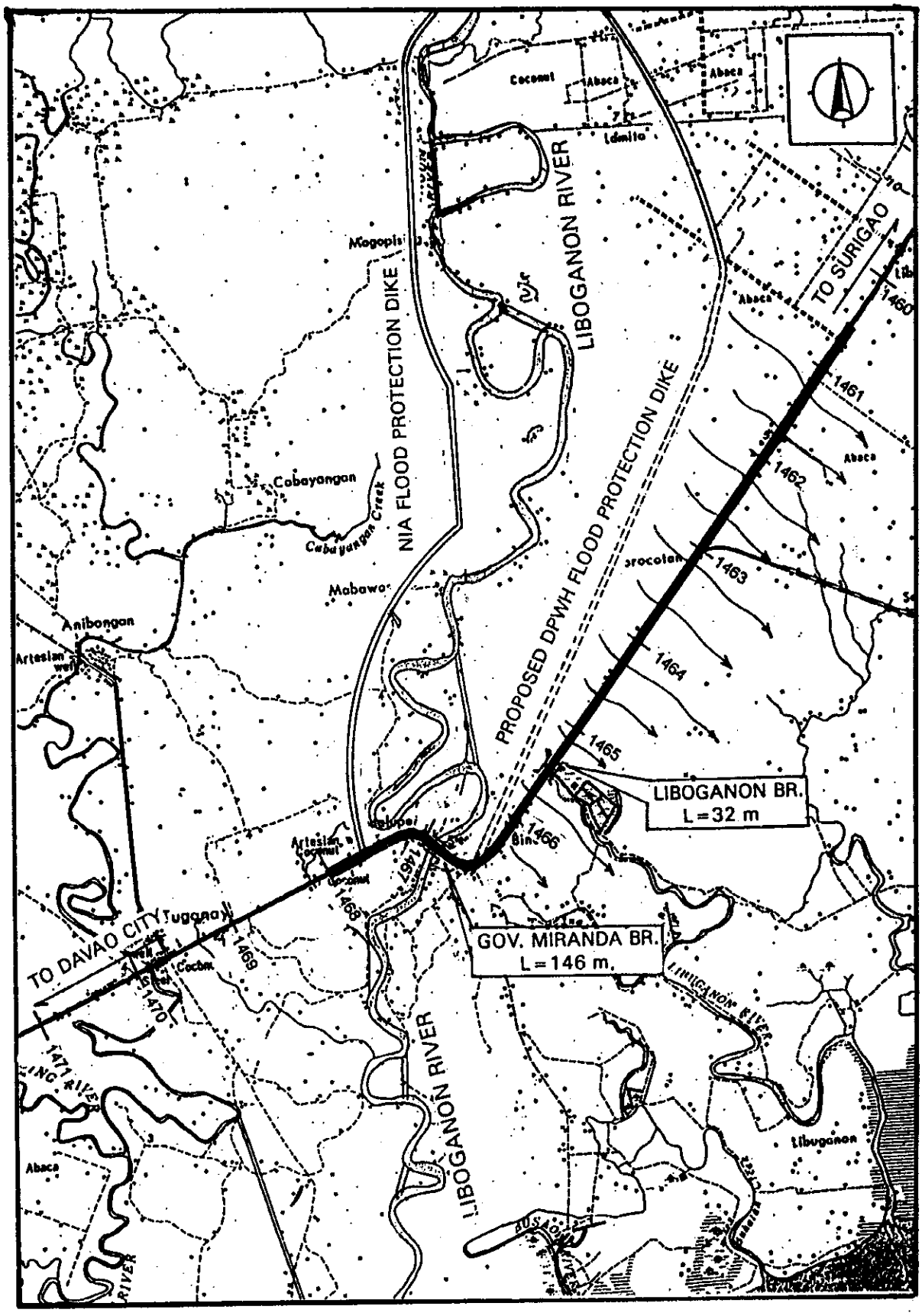
Drainage Area	2,024 km^2
Longest Water Course	122 km
Distance to Basin Centroid	36.4 km
Average Slope of Water Course	0.00861

Probable Flood Discharge

Year	Peak Q	LOG
1949	834.0	2.921166
1950	771.0	2.887054
1951	789.0	2.897077
1952	729.0	2.862728
1953	624.0	2.795185
1954	405.7	2.608205
1955	702.0	2.846337
1956	837.0	2.922725
1957	777.0	2.890421
1958	570.0	2.755875
1959	540.0	2.732394
1960	592.4	2.772615
1961	607.8	2.783761
1963	766.0	2.884229
1964	682.0	2.833784
1965	488.0	2.688420
1966	391.0	2.592177
1967	571.4	2.756940
1968	782.8	2.893651
1969	634.4	2.802363
MEAN	654.725	2.806355
STD	134.406	0.097073
SKEW	-	-0.802466

	Gumbel	Log-P.III
K(50-year)	2.590	1.606
LOG(X)	-	2.9622552174
X(50-year)	1,002.8	916.8

Extreme Value Type I	1,002.8 M^3/s
Log-Person Type III	916.8 m^3/s
Unit Hydrograph Method	1,927.3 m^3/s
Design Discharge (1.25 x UHM)	2,409.0 m^3/s



FLOOD SECTION 18 **Tagum, Davao del Norte**

APPENDICES FOR CHAPTER 16

APPENDIX 16.1

Vehicle Operating Costs Calculation System on Actual Roads by ECOVAL-S

1. Basic Input Data

Below is presented a summary list of items required as basic input data to ECOVAL system.

Item		Input Data
Traffic Condition		(1) AADT, VT(i) (2) HF (3) RFRIC
Road Condition	Cross-sectional Item	(4) NL (5) CWID (6) SWID
	Alignment	(7) GRA (8) GLTH (9) PSD (10) AOD (11) LOA
	Others	(12) STYP (13) SCON (14) LMAIN (15) SN (16) QMAT
Section		(17) SLENG

1) AADT, VT(i)

Annual average daily traffic, by vehicle type

Code		Code	
1	Car, Jeep	6	Bus
2	Jeepney	7	Truck
3	Pick-up, Van	8	Truck
4	Motorcycle	9	Truck
5	Tricycle		

2) Hourly Factor (HF)

The hourly factor can be input as observed.

3) Roadside Friction (RFRIC)

Code	1	2	3	4
RFRIC	None	Light	Medium	Heavy
Value	0	3	6	9

Roadside friction is defined as follows:

None : Few or no houses along the carriageway.

Light : Houses and/or intersections along and close to the carriageway. 100-200 meters between these objects. Pedestrians and other slow moving traffic observed occasionally.

Medium: Scattered roadside development, 50-100 meters between buildings and/or intersections. Pedestrians and other slow moving traffic tend to disrupt the motor vehicle traffic frequently and reduce travel speed to under 40 kph even at low traffic densities.

Heavy: Continuous roadside development. Less than 50m. between buildings and/or intersections. Pedestrians and other slow moving traffic tend to disrupt the motor vehicle traffic frequently and reduce travel speed to under 40 kph even at low traffic densities.

4) Number of Lanes (NL)

Number of lanes of both directions.

5) Carriageway Width (CWID)

CWID is input as actual width in meter. Gravel roads are assumed to have no shoulders, and their full width is coded into CWID.

Code		Value	Code		Value
0	4 m	4	5	7 m	7
1	5 m	5	6	2x7 m	7
2	5.5m	5.5	7	6.5 m urban	6.5
3	6 m	6	8	7 m urban	7
4	6.5 m	6.5	9	2x7 m urban	7

6) Shoulder Width (SWID)

Coded as a combination of width, surface type and surface condition. Gravel roads are assumed to have no shoulders.

Code		Value
0	Unpaved (good/bad) 0 - 0.5m	0
1	Unpaved, good 0.6 - 1.9m	1

2	Unpaved, good 2.0m & more	1.5
3	Paved, good 1.5m & more	4.0

7) Gradient (GRA)

In the highway inventory, the observed gradient is recorded continuously in per cent of rise or fall; corresponding lengths are recorded simultaneously. For a gradient of three (3) per cent and more, the average gradient in per cent is input and the average gradient length in meters (GLTH) is also an input variable.

GRADIENT			GRADIENT LENGTH <400m:			GRADIENT LENGTH >400m:		
Code		Value	Code		Value	Code		Value
0	<3%	1.0	4	3-4.9%	4	8	3-4.9%	4
1	0-0.9%	0.5	5	5-6.9%	6	9	5-6.9%	6
2	1-1.9%	1.5	6	7-8.9%	8	10	7-8.9%	8
3	2-2.9%	2.5	7	9%	10	11	9%	10

8) Gradient Length (GLTH)

When VOC analysis is conducted by each 100m section, GLTH is automatically set to be 100m.

9) Passing Sight Distance (PSD)

Passing Sight Distance is defined as the percentage oof total length of a Subsection with passing sight distance exceeding 450 meters. For instance, if the length of Subsection is 2 kilometers with PSD exceeding 450 meters over a length of 1.2 kilometers, the PSD percentage would be 60.

Code	Value
1	0%
2	20%
3	40%
4	60%
5	80%
6	100%

10) Angle of Direction (AOD)

Horizontal angle in degrees at curve.

11) Length of Arc (LOA)

Length of arc in meters at curve.

12) Surface Type (STYP)

Code	Surface Type
1	Gravel
2	Bituminous
3	AC
4	PCC

13) Surface Condition (SCON)

The surface condition (SCON) is given in the form of a number that relates to the measured roughness (R.) of the surface. R. is expressed in terms of inches of movement of the rear axle of the test vehicle relative to its chassis per kilometer of running of the test vehicle. In the case of existing cement surface (CC) the input SCON is the R. measured by the test vehicle. In other studies, new (Project) CC is given a roughness of R.50, new (Project) AC is given a roughness of R.40, respectively.

Roughness of gravel surfaces, both existing and new, is calculated on the basis of the following formula:

$$SCON = 430 + \frac{400}{1 + LMAIN}\left(1 - \frac{3000\ LMAIN}{3000 + ADTU}\right) - 20\ SN - 20\ QMAT + GRA^2$$

14) Level of Maintenance (LMAIN)

Normal range 1.0 to 0.3; 1.0 is the level to which the unit maintenance costs apply.

very good	= 1.0
good	= 0.8
fairly good	= 0.7
fair	= 0.6
poor	= 0.4
bad	= 0.3

15) Strength or Shape (SN)

Shape is an input parameter which applies only to gravel roads and affects roughness (SCON). It ranges from a value of 0 for a very badly shaped road to a value of 5 for a well-shaped road.

16) Quality of Material (QMAT)

This parameter is used in the formula for calculating the SCON value (surface roughness) of gravel roads. The guidelines used are:

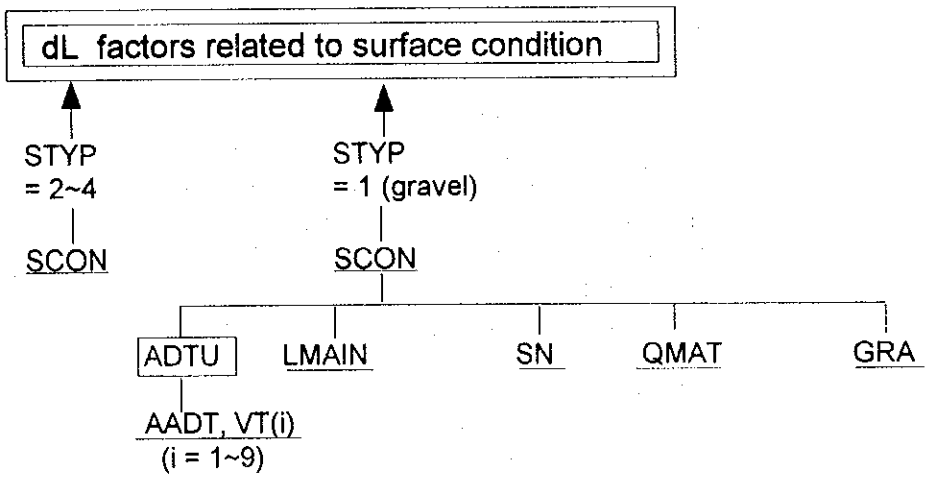
Input	Description
9	exceptionally good material
8	very good - good grading - good binder
7	good material - good grading - fair binder
6	good material - fair grading - some binder
5	fair material - some grading - little binder
4	fair material - some grading - no binder
3	poor material - little grading - no binder
2	poor material - no grading - no binder
1	bad material
0	completely unsuitable material

17) Length of Subsection (SLENG)

SLENG is length of subsection in km. as minimum unit of 100m.

2. Diagrams of Interrelation between Objective, Basic Parameters and Input Data

1) dL Factors related to surface condition



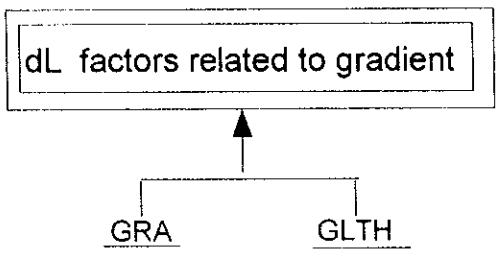
where;

: objective parameter

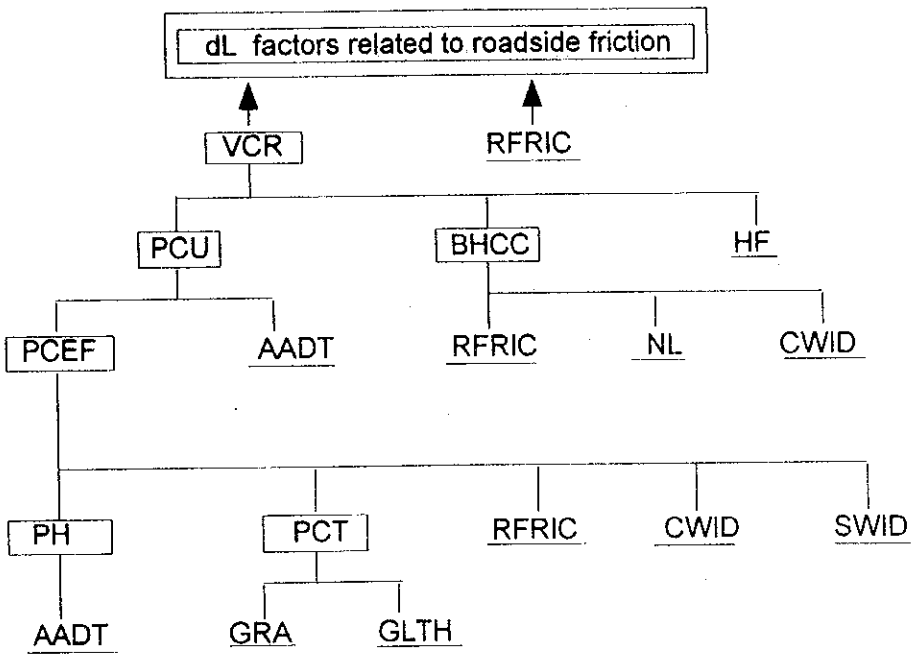
: basic parameter

: input data

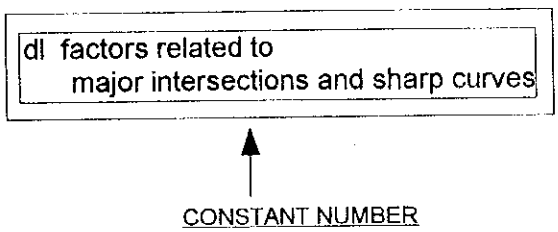
2) dL Factors related to gradient



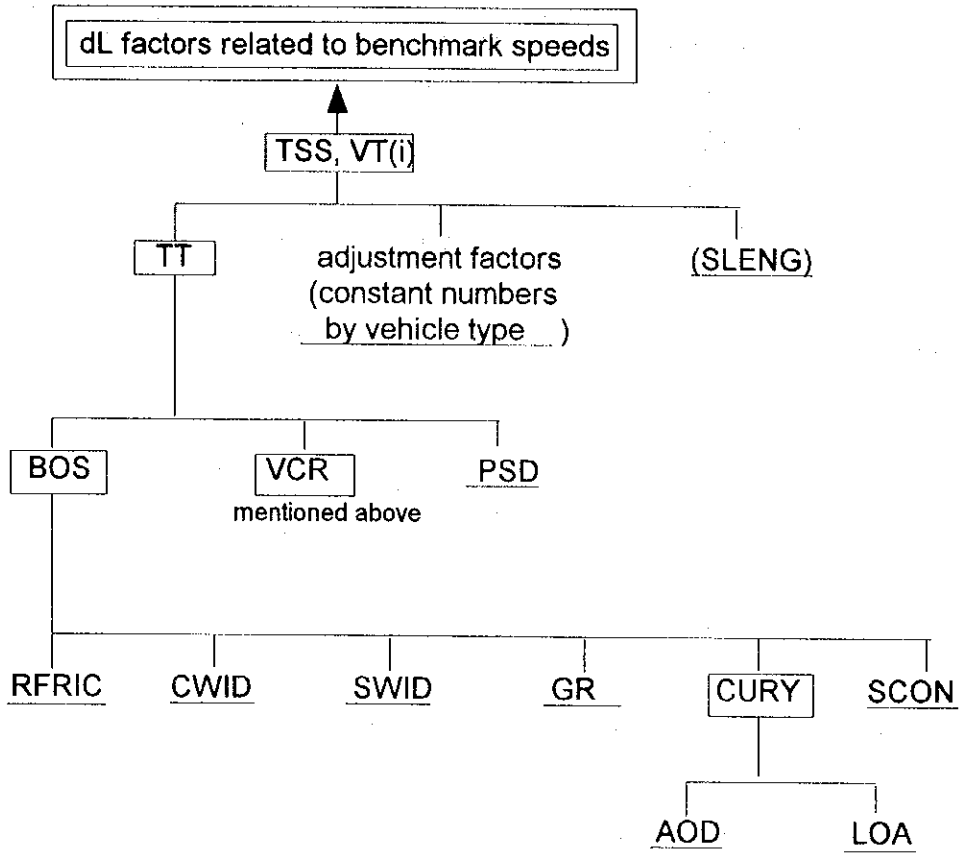
3) dL Factors related to roadside friction



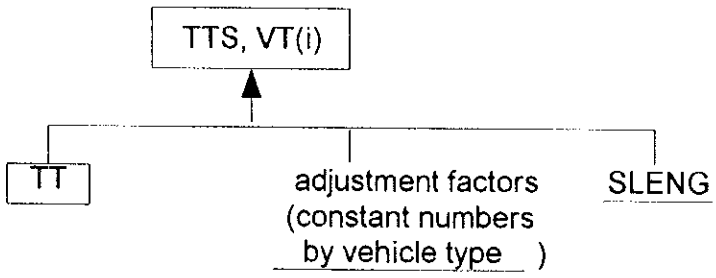
4) dL Factors related to major intersections and sharp curves



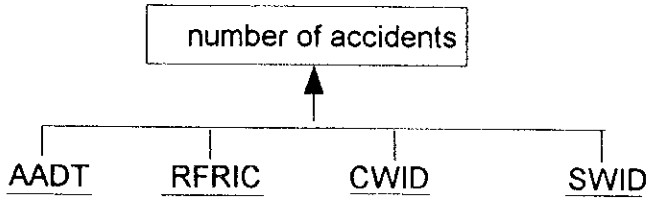
5) dL Factors related to benchmark speeds



6) Travel time by vehicle type (TTS, VT(i))



7) Number of accidents



3. Basic Parameters Calculation

3.1 List of Basic Parameters

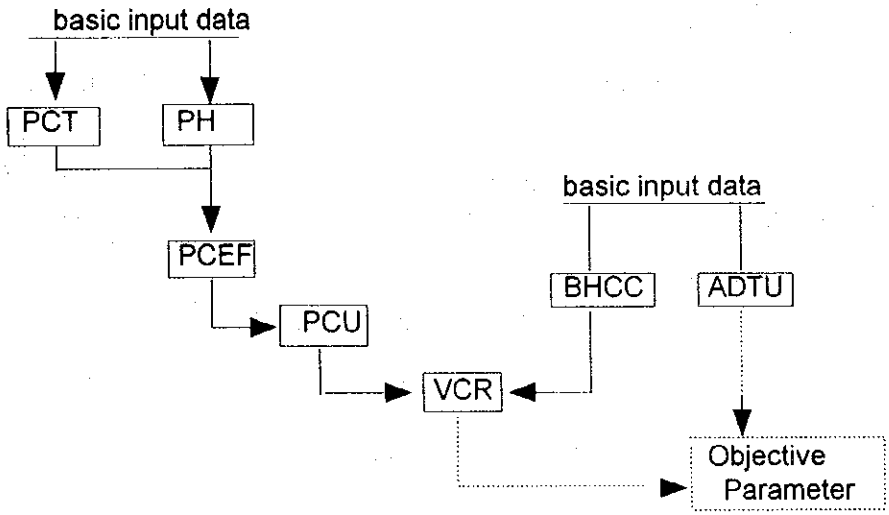
Below is presented a summary list of basic parameters. Basic parameters are output from basic input data, and also input for objective parameters, such as dL factors.

Items		Basic Parameters
Items for Traffic Volume	Characteristics of Traffic	PH
		PCT
		PCEF
	Traffic Volume related	PCV
		ADTV
	Capacity related	BHCC
	Traffic Congestion	VCR
Items for Travel Speed	Free Flow	BOS
		CURY
	Actual Travel Time	TT
		TTS, VT(i)
	Travel Speed	TSS, VT(i)

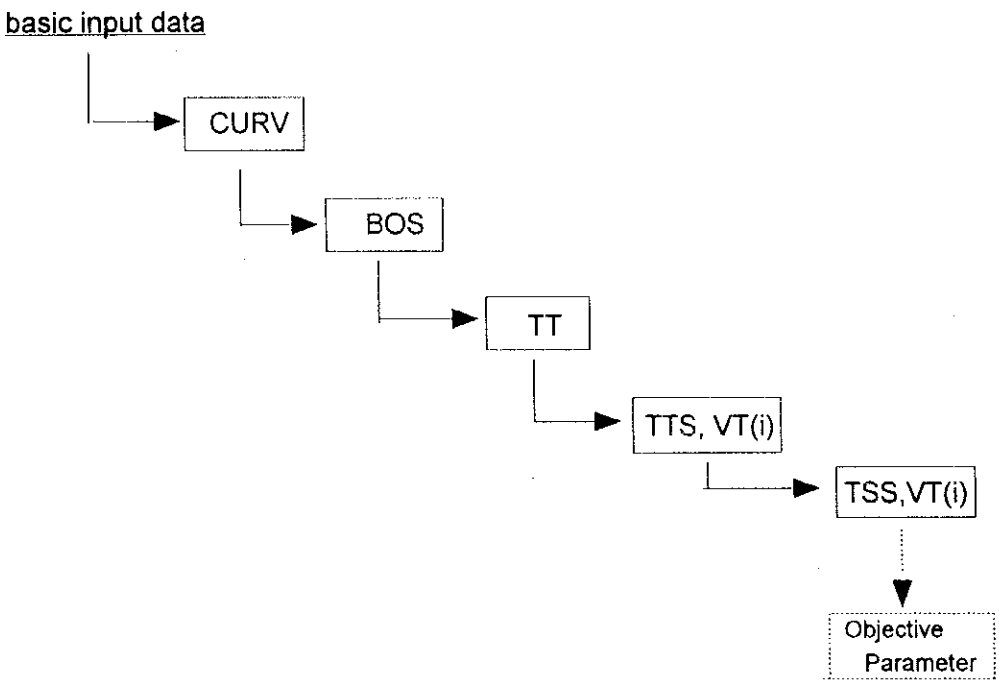
3.2 Calculation Order of Basic Parameter

Based on the discussion presented in Chapter 2, calculation order of basic parameters is illustrated below.

Traffic Volume Related



Travel Time Related



3.3 Calculation of Traffic Volume Related Parameters

1) Percentage of heavy vehicles (PH)

PH = 100(AADT,VT[6-9])/(AADT, VT[1-3 and 6-9])

2) Passenger car equivalent factors (PCEF)

The calculation of PCEF requires a gradient factor (PCT) which is computed as follows:

$$PCT = 0.0002\ GLTH \left[\frac{100\ GRA}{(100 + GRA^2)} \right]^2$$

- where GRA is input in per cent (max. 10), and GLTH is input in meters max. 800m.

The Passenger Car equivalent factors are calculated by vehicle by the formulae:

For vehicle type 1; VT 1 (cars and jeeps)

$$PCEF, VT\ (1) = 1.0$$

For vehicle type 2; VT 2 (jeepneys)

$$PCEF, VT\ (2) = (1.5 + 0.1 \cdot RFRIC + PCT) \cdot \frac{20}{20 + SWID}$$

For vehicle type 3; VT 3 (pick-ups, vans)

$$PCEF, VT\ (3) = 1.0$$

For vehicle type 4; VT 4 (motorcycles)

$$PCEF, VT\ (4) = \frac{30}{CWID \cdot (10 + SWID)}$$

For vehicle type 5; VT 5 (tricycles)

$$PCEF, VT\ (5) = (2.5 + 0.1\ RFRIC + PCT) \frac{15}{15 + SWID}$$

For vehicle type 6; VT 6 (buses)

$$PCEF, VT\ (6) = 2 + 0.1\ RFRIC + \frac{100 \cdot PCT}{10 + PH}$$

For vehicle type 7; VT 7 (trucks)

$$PCEF, VT\ (7) = 2 + \frac{100 \cdot PCT}{10 + PH}$$

For vehicle types 8 and 9: as vehicle type 7.

3) Passenger car unit (PCU)

Total PCU should not exceed four (4) times total AADT.

$$PCU = \sum_{i=1}^{9} AADT, VT\ (i) \times PCEF, VT\ (i)$$

$$\text{Condition: } \frac{PCU}{\sum_{i=1}^{9} AADT, VT\ (i)} \leq 4.0$$

$$\text{If } >4.00 \text{ set PCU at } 4.00 \times \sum_{i=1}^{9} AADT, VT(i)$$

4) Average daily traffic units (ADTU)

ADTU is used in the calculation of the value of the SCON parameter for gravel roads and the corresponding road maintenance costs.

$$\begin{aligned} AADTU = {} & 0.4\ (AADT, VT\ [1] + AADT, VT\ [3]) + \\ & 0.7\ (AADT, VT\ [2]) + \\ & 0.2\ (AADT, VT\ [5]) + \\ & 2.5\ (AADT, VT\ [6] + AADT, VT\ [7] + AADT, VT\ [8]) + \\ & 4.0\ (AADT, VT\ [9]) \end{aligned}$$

5) Basic hourly capacity in passenger car unit (BHCC)
In ECOVAL-S it is calculated as:

$$BHCC = \frac{CWID^2 \cdot (NL+3)^3 \cdot (100\text{-}RFRIC)}{230}$$

CWID CODE	PIRFS[1/] (PCU/H)	ECOVAL-S (PCU/H)	Calculation Condition		
			CWID(m)	NL	RFRIC
0	600	400 (800)	4.0	1 (2)	light
1	1,200	700 (1,300)	5.0	1 (2)	-do-
2	1,800	1,500	5.5	2	-do-
3	1,900	1,800	6.0	2	-do-
4	2,000	2,100	6.5	2	-do-
5	2,400	2,500	7.0	2	-do-
6	7,200	6,800	2x7.0	4	-do-

Note: 1/: Philippine Islands Road Feasibility Study (March, 1980)

6) Volume/capacity ratio (VCR)

$$VCR = \frac{PCU \cdot \frac{HF}{100}}{BHCC}$$

- where the hourly factor can be input as observed.

3.4 Calculation of Travel Speed Related Parameters

1) Basic operating speed (BOS)

The first step of travel time calculation is to make an estimate of the basic operating speed (BOS) which is the speed of a standard study vehicle running under conditions of low traffic.

$$BOS = \frac{150\ (5+CWID)\ (100+SWID)}{100\ RFRIC+100\ GRA-5\ RFRIC\ GRA+2000+0.007\ SCON^2+100\ CURV-0.05\ SCON\ CURV}$$

CWID is carriageway width (values in the range 4-7)
SWID is shoulder width/type (values in the range 0-4)
RFRIC is roadside friction
(nil = 0, light = 3, medium = 6, heavy = 9)
GRA is gradient, in per cent of rise or fall
(values in the range 0.0 to 10)
SCON is surface condition = roughness (R.)

Curvature is calculated from information extracted from the highway inventory on length of arc and angle of deflection of each individual curve. Curvature is a physical measure which indicates to what extent the horizontal alignment affects the basic operating speed.

$$CURV = \Sigma\ 0.5\ \frac{AOD}{LOA}$$

- where AOD/LOA is the angle of deflection measured in degrees divided by the length of arc measured in meters. Each curve may not contribute to the curvature by more than 1.5; for example with AOD = 180 and LOA = 45m, CURV = (180/45)/2 = 2.0, which is reduced to the maximum value of 1.5.

2) Travel time per kilometer (TT)

The travel time given by distance and basic operating speed is increased as traffic volume rises; passing sight distance also plays a role.

$$TT = \frac{60}{BOS}\left[1 + \frac{BOS}{70} \cdot VCR^3\right]\left[1 - (1.3 - VCR) \cdot VCR \cdot PSD \cdot BOS \cdot 0.00003\right]$$

where: TT is travel time per kilometer in minutes.
BOS is the basic operating speed in kph.
VCR is volume: capacity ratio (0 to 1.30)
PSD is passing sight distance (all of more than 450m = 100, none of more than 450m= 0; intermediate values of 80, 60, 40 and 20).

3) Travel time by vehicle type by subsection (TTS, VT(i))

The dimension of TTS is in minute.

For VT1 (car and jeep) $TTS, VT(1) = \frac{TT}{0.85} \cdot SLENG$

For VT2 (jeepney) $TTS, VT(2) = \frac{TT}{0.65} \cdot SLENG$

For VT3 (pick-up, van) $TTS, VT(3) = \frac{TT}{0.80} \cdot SLENG$

For VT4 (motorcycle) $TTS, VT(4) = \frac{TT}{0.70} \cdot SLENG$

For VT5 (tricycle) $TTS, VT(5) = \frac{TT}{0.55} \cdot SLENG$

For VT6 (bus) $TTS, VT(6) = \frac{TT}{0.80} \cdot SLENG$

For VT7.VT8 and VT9(truck) $TTS, VT(7) = TTS, VT(8) = TTS, VT(9) = \frac{TT}{0.70} \cdot SLENG$

4) Travel speed in kph by vehicle type by subsection (TSS, VT(i))

The dimension of TSS is in kilometer per hour.

$$TSS, VT(i) = \frac{60 \cdot SLENG}{TTS, VT(i)}$$

4. Calculation of dL Factors

The dL Factors which only affect the runing cost calculations, simulates the extra running costs incurred by vehicles operating on actual roads with substandard road surfaces and conditions, and/or substandard geometric characteristics or with other features. Such extra costs are transformed into imaginary road lengths called dL, which actually expresses the extra running costs as a per cent over the basic running costs. The imaginary lengths are added up after calculation of a dL-value for each substandard element. And the actual road length (L) and the dL-values over that road subsection are combined into the composite expression, L + dL (kms), which then simply is multiplied by the basic running costs to give actual running costs by various improvement levels, including the "do nothing" existing level.

The dL values are given or calculated for:

(a) surface condition
(b) gradient
(c) roadside friction/volume: capacity ratio
(d) major intersections, narrow structures and sharp curves
(e) speed above optimum (least cost) speed.

1) dL factor for surface condition

$$dL\ (LVEH) = dL\ (HVEH) = 0.0026 \cdot SCON - \frac{0.2 \cdot SCON}{SCON + 80} - 0.1$$

where: SCON is average annual roughness of the surface, as measured by the "bump integrator", per kilometer.

2) dL factor for gradient

$$dL\ (LVEH) = GRA^2\ (5 + GLTH/100)/1000$$
$$dL\ (HVEH) = GRA^2\ (2 + GLTH/100)/300$$

where: GLTH should not exceed 800m in above formula.

Calculation Example

GRA CODE	PIRFS[1/]		ECOVAL - S	
	LVEH	HVEH	LVEH	HVEH
0	0.00	0.00	0.01	0.02
1	0.00	0.00	0.00	0.01
2	0.03	0.05	0.02	0.05
3	0.06	0.10	0.06	0.13
4	0.10	0.25	0.11	0.21
5	0.25	0.50	0.25	0.48
6	0.50	0.80	0.45	0.85
7	0.75	1.10	0.70	1.33
8	0.10	0.75	0.14	0.32
9	0.30	1.50	0.32	0.72
10	0.60	2.00	0.58	1.28
11	0.90	2.40	0.90	2.00

Note 1/: Philippine Islands Road Feasibility Study (March, 1980)

- where GLTH in ECOVAL-S is assumed to be 400m for GRA CODE(°) to GRA CODE(3) and GRA CODE(8) to GRA CODE(11), also, 200m for GRA CODE(4) to GRA CODE(7).

3) dL factor for roadside friction and volume/capacity ratio

$$dL\ (LVEH) = 0.020\ (RFRIC + 20)\ VCR^2 + 0.001\ RFRIC^2$$
$$dL\ (HVEH) = 0.015\ (RFRIC + 30)\ VCR^2 + 0.002\ RFRIC^2$$

VCR is volume capacity ratio (0 to 1.30)
for VCR more than 1.30 use value VCR = 1.30

RFRIC is roadside friction (nil = 0, light = 3,
medium = 6, heavy = 9)

4) dL factor for major intersection and sharp curve

For dL factor, the constant value is applied per spot.

	dL (LVEH)	dL (HVEH)
MINT per no.	0.16	0.16
SCUR per no.	0.16	0.16

5) dL factor for benchmark speed

$$dL\ (LVEH) = \left[(TSS,\ VT(i)-60)^4 + 10 \cdot (TSS,\ VT(i)-60)^3\right]/10^7$$

$$dL\ (HVEH) = \left[(TSS,\ VT(i)-50)^4 + 10 \cdot (TSS,\ VT(i)-50)^3\right]/10^7$$

TTS, VT(i) is travel speed in kph by vehicle type by subsection.

APPENDIX 16.2

VEHICLE OPERATING COSTS ON SINGLE LANE

In the Study, "single lane" cases are seen in subsections involved a temporary bridge of which only one-lane is passable during the construction term of new permanent bridge after collapse of existing bridge, and in subsections involved a dangerous spot with steep slope or embankment failure in which a part of carriageway is covered with falling mad/rocks or is lost by scouring.

Vehicle encounters at a single-lane section cause a slowing or stopping of one or both of vehicles involved. The total speed change per vehicle is used as an input to calculate the additional vehicle operating costs.

1. Number of Encounters

1) Basic formula

The basic equation is taken to be:

$$E_{kmh} = \frac{T^2}{2V}$$

Where: E_{kmh} is the number of encounters per km per hour
T is the number of vehicles an hour
V is the average speed, in kph.

The basic equation is modified for application to single-lane.

$$E = \left[AADT \cdot \frac{PHR}{100} \right] 2 \cdot \frac{1}{2 \cdot TSS} \cdot \frac{EBL}{1000} \cdot \frac{100}{PHR}$$

Where: E is the number of encounters a day
AADT is the annual average daily traffic excluding motorcycles and tricycles

$$AADT = \sum_{i=1}^{3} AADT,VT(i) + \sum_{i=6}^{9} AADT,VT(i)$$

PHR is the factor which determines the hourly encounters.

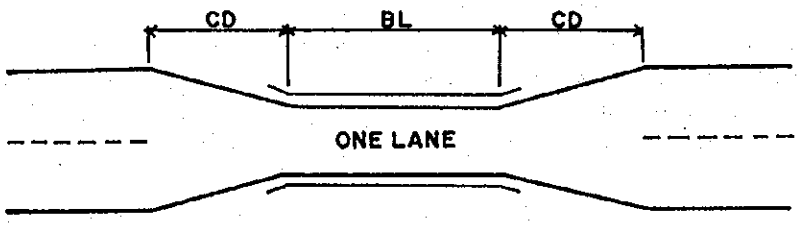
TSS is the average travel speed by subsection in kilometer per hour.

$$TSS = \frac{\sum_{i=1}^{3} AADT,VT(i) \cdot TSS,VT(i) + \sum_{i=6}^{9} AADT,VT(i) \cdot TSS,VT(i)}{\sum_{i=1}^{3} AADT,VT(i) + \sum_{i=6}^{9} AADT,VT(i)}$$

EBL is the "effective bridge length" in meters.

2) Effective bridge length

The "effective bridge length" in this study is taken to be: **2·CD + BL**



Where: CD is the clearance distance on the farther side of the bridge (in meters).
= 20m (in all cases)
BL is the length of the bridge (in meters).1/
1/: In case of embankment failure, dangerous spot length is assumed as BL.

3) Calculation results

The number of encounters shown in table below is calculated by the above formula.

Estimated Number of Encounters per Day

AADT	Bridge Length (in meter)			
	25	50	100	200
500	9	12	19	32
1,000	35	48	75	129
2,000	140	194	302	517
4,000	560	775	1,206	2,068
6,000	1,260	1,745	2,714	4,652

Note: In the calculation TSS and PHR as a basic parameter are simplified and set.
TSS = 65 km/hour
PHR = 7.°

2. Additional Running Cost at Single-Lane

1) Speed change cycle

We assume that "single-lane" cases are seen in subsections of a temporary bridge and a dangerous spot with steep slope or embankment failure.

Vehicle encounters at single-lane are taken to involve the slowing or stopping of one or both vehicles involved.

Furthermore, even vehicle no-encounters are forced to slow mainly due to a bad running condition of a temporary bridge or a dangerous spot.

Speed Change Cycle (in kph)

		Approach Speed	Crossing Speed: Temporary Bridge	Crossing Speed: Dangerous Spot	Speed Change Cycle: Temporary Bridge	Speed Change Cycle: Dangerous Spot
Encounters	Stopping	TSS	-	-	TSS	TSS
	Opposing	TSS	10	20	TSS-10	TSS-20
No-encounters		TSS	10	20	TSS-10	TSS-20

2) dL Values

For each 10kph speed change cycle, four (4) percent of basic running cost is additionally considered in ECOVAL-S.

Thus, additional vehicle operating costs by type are calculated by the formulas below. It is reminded that these additional costs are applied at each single-lane bridge or dangerous spot.

single-lane bridge

$$AC = \sum_{\substack{i=1 \\ (i\neq 4,5)}}^{9} 365 \cdot \frac{4}{100} \cdot BRC,Vt(i) \left[AADT,VT(i) \cdot \frac{NOE}{AADT} \cdot \frac{TSS,VT(i)}{10} + AADT,VT(i) \left[1 - \frac{NOE}{AADT} \right] \cdot \frac{TSS,VT(i)-10}{10} \right] + \sum_{i=4}^{5} 365 \cdot \frac{4}{100} \cdot BRC,Vt(i) \cdot AADT,VT(i) \cdot \frac{TSS,VT(i)-10}{10}$$

dangerous spot

$$AC = \sum_{\substack{i=1 \\ (i\neq 4,5)}}^{9} 365 \cdot \frac{4}{100} \cdot BRC,Vt(i) \left[AADT,VT(i) \cdot \frac{NOE}{AADT} \cdot \frac{TSS,VT(i)}{10} + AADT,VT(i) \left[1 - \frac{NOE}{AADT} \right] \cdot \frac{TSS,VT(i)-20}{10} \right] + \sum_{i=4}^{5} 365 \cdot \frac{4}{100} \cdot BRC,Vt(i) \cdot AADT,VT(i) \cdot \frac{TSS,VT(i)-20}{10}$$

Where: AC is additional cost per bridge or spot.

BRC,VT(i) is Basic Running Cost by vehicle type.

AADT,VT(i) is annual average daily traffic by vehicle type.

AADT is annual average daily traffic excluding motorcycles and tricycles.

$$AADT = \sum_{i=1}^{3} AADT,VT(i) + \sum_{i=6}^{9} AADT,VT(i)$$

NOE is number of encounters a day. If NOE exceeds AADT, set AADT.

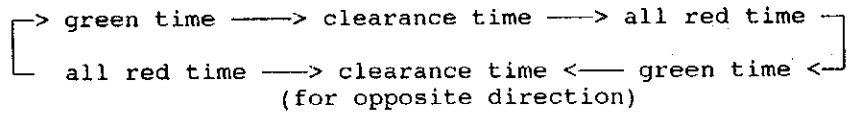
TSS,VT(i) is travel speed in kph by vehicle type. If TSS,VT(i)-10(or TSS,VT(i)-20)<0, set TSS,VT(i)-10(or TSS,VT(i)-20)=0.

3. Signalization

When number of encounters a day exceeds limits in line with AADT and/or bridge length increment, signalization will be introduced to control traffic. In the Study, we assume that limitation is >50 encounters a day (approximately one occurrence per minute).

1) Phases of signalization

Once cycle of signalization comprises each two (2) of green, clearance an red times for both direction.



$$SC = 2\ (GT + CT + RT)$$

Where: SC is cycle of signalization in second.

GT is green time for one direction. Here, 60 seconds of green time is set.

CT is clearance time in second.

$$CT = \frac{\frac{EBL}{CTS \cdot 1000}}{3600} = 3.6 \cdot \frac{BL + 2CD}{CTS}$$

EBL is effective brige length in meter.

BL is bridge length in meter.

CD is clearance distance in meter. CD = 20m

CTS is crossign travel spee in kph. CTS at single-lane bridge is 10 kph, and at dangerous spot, 20 kph, respectively.

RT is all red time. Here, 3 seconds is set.

2) Waiting vehicle

The formula below determines the number of waiting vehicles of one (1) direction per each signalization cycle.

$$WV = \frac{\frac{AADT}{2} \cdot \frac{HF}{100}}{\frac{3,600}{SC}} = \frac{AADT \cdot HF \cdot SC}{7.2 \times 10^5}$$

Where: WV is average number of waiting vehicles of one direction per each signalization cycle.

AADT includes motorcycles and tricycles in the formula.

$$AADT = \sum_{i=1}^{9} AADT,VT(i)$$

HF is hourly factor of which observed is input.

SC is cycle of signalization in second.

3) Probability of stopping

In signalized subsection, the majority of vehicles stop, and only vehicles are exempted from temporary stopping which happen to cross the signalized subsection at green time phase. The simplified formula can be adopted for calculation of probability of stopping.

$$PS = 100 \cdot \left[1 - \frac{GT}{SC} \right] = 100 \cdot \left[1 - \frac{60}{SC} \right]$$

Where: PS is probability of stopping in percent.

GT is green time (60 seconds).

The formula above assumes that full stretch of green time phase contributes non-stopping of vehicles, but practically, the vehicles approaching a signal inevitably stop as long as waiting vehicles exist. The modification of formula is considered on clearance duration of waiting vehicles which line up at a signal.

$$PS = 100 \cdot \left[1 - \frac{GT - HDT \cdot WV}{SC} \right]$$

Where: HDT is head way time between vehicles at signal in second. Here, 2 seconds is set.

WV is average number of waiting vehicles.

If $(GT-HDT \cdot WV) < 0$, $(GT-HDT \cdot WV) = 0$

4) Additional cost

The basic idea discussed in encounter models is adopted here in the same manner.

single-lane bridge

$$AC = \sum_{i=1}^{9} 365 \cdot \frac{4}{100} \cdot BRC,Vt(i) \left[AADT,VT(i) \cdot \frac{PS}{100} \cdot \frac{TSS,VT(i)}{10} + AADT,VT(i) \left[1 - \frac{PS}{100} \right] \cdot \frac{TSS,VT(i)-10}{10} \right]$$

dangerous spot

$$AC = \sum_{i=1}^{9} 365 \cdot \frac{4}{100} \cdot BRC,Vt(i) \left[AADT,VT(i) \cdot \frac{PS}{100} \cdot \frac{TSS,VT(i)}{10} + AADT,VT(i) \left[1 - \frac{PS}{100} \right] \cdot \frac{TSS,VT(i)-20}{10} \right]$$

APPENDICES FOR CHAPTER 17

APPENDIX 17.1

STANDARD TABLE OF CONTENTS IN ACCORDANCE WITH GUIDELINES FOR THE PREPARATION OF ENVIRONMENTAL IMPACT STATEMENT FOR MAJOR HIGHWAY PROJECTS

1. **Introduction**
   Statement on;
   - the name of the project
   - the project proponent and the lead agency

2. **Summary**
   - the project outline
   - unavoidable environmental impacts
   - alternatives
   - mitigating measures; and also
   - data gaps and deficiencies

3. **Project Goal, Objective and Purpose**
   - national goal (employment, economic development, environmental enhancement, social development)
   - project objectives

4. **Project Description**
   - proposed project location
   - alignment of the project with maps
   - relationship with other existing and proposed projects
   - all project activities
   - timing and duration of the project activities
   - use of heavy equipments

5. **Environment of the Project Area**

5.1 Physical Environment
   - geography
   - topography
   - geological condition
   - meteorological condition
     (temperature, humidity, wind, cyclones, rainfall)
   - utilities of physical services
     (garage, water and power supply, etc.)

5.2 Biological Environment
   - flora
     (vegetation types, abundance, diversity and importance of species)
   - fauna
     (fish, wildlife and domestic animals with abundance, seasonal distribution and importance)

5.3 Socio-Economic Environment

- existing life styles
  (culture, spiritual community patterns)
- population
  (densities, distribution, etc.)
- employment
  (unemployment ratios, occupational distribution, etc.)
- existing housing facilities, business establishments, hospitals, schools, etc.
- existing income of municipality
- existing transportation and communication facilities

5.4 Land Use

- existing land use
  (agricultural, residential, industrial, commercial, etc.)
- land values and ownership
- land use plans
- unique natural spots
  (scenic, religious, historic, cultural, scientific, etc.)

5.5 Pollution

(Existing pollutional conditions to facilitate the identification of critical areas and possible impacts of the project)

- air qualities
  - trends
  - composition of polluted air
  - pollution generators
  - quality standards
- noise qualities
  - noise level
  - noise standards
- water qualities
  - qualities of water bodies
  - basin of rivers, amount of flowing water
  - standards

5.6 Transportation Situation

- existing road network
- availability of public transport

6. Impact of the Project on Existing Environment

The change (beneficial and adverse effects) by the Project.
examples

- damages in air or noise quality levels
- possible extinction of any rare or endangered species
- increase or decrease in overall employment levels
- changes in land usage and income levels
- changes in lifestyle and activities of the people

7. **Alternatives and Valuation**
   - differences in environmental impacts among the alternatives considered
   - selection of alternatives

8. **Mitigating Measures**
   - measures and options to be undertaken to reduce the adverse impacts by the project

9. **Project Proponent, Address and Tel. No.**

10. **Lead Agency, Address and Tel. No.**

11. **Commenting Agencies, Address and Tel. No.**

12. **Reference Materials**

APPENDIX 17.2

TECHNICAL DEFINITIONS AND SCOPE OF THE ENVIRONMENTALLY CRITICAL PROJECTS AND AREAS ENUMERATED IN PROCLAMATION 2146

SOURCE: ENVIRONMENTAL MANAGEMENT BUREAU (EMB), DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES (DENR)

I. ENVIRONMENTALLY CRITICAL PROJECTS

A. Heavy Industries

1. Non-Ferrous Metal Industries

   a) Classified as large-scale industrial plants under the implementing rules and regulations of LOI No. 950;
   b) Having a designated rated capacity equally to or exceeding 3,000 metric tons product; and
   c) Will process toxic non-ferrous metals such as cadmium, chromium and lead.

2. Iron and Steel Mills

   a) Classified as a large-scale industrial plants under the implementing rules and regulations of LOI No. 950; and
   b) Having a designed annual rated capacity equal to or exceeding 30,000 metric tons products.

3. Petroleum and Petrochemical Industries

   a) Classified as large-scale industrial plants under the implementing rules and regulations of LOI No. 950;
   b) Refineries with designed capacities equal to or exceeding 30,000 barrels of petroleum per year; and
   c) Petrochemical industry projects with designed annual rated capacities of 30,000 tons.

4. Smelting Plants

   a) Classified as large-scale industrial plants under the implementing rules and regulations of LOI No. 950;
   b) Having a designed annual rated capacity equal to or exceeding 15,000 metric tons raw materials; and
   c) Will process toxic non-ferrous metals such as cadmium, chromium and lead.

B. Resource Extractive Industries

1. Major Mining and Quarrying Projects

   a) Ore-processing by cyanidization, flotation, mechanized grinding and/or crush-

ing, magnetic separation and or mechanized gravity concentration;
b) Utilization of the open-pit method with mechanical operations and/or blasting;
c) Underground mining using blasting and/or mechanized extraction;
d) Marine or off-shore mining; and
e) Extraction of oil and gas.

2. Forestry Projects

a) Logging Projects
b) Major Wood Processing Projects
c) Introduction of Fauna in Public/Private Forests
d) Forests Occupancy
e) Extraction of Mangrove Products
f) Grazing Projects

3. Dikes for/and Fishpond Development Projects

a) Dike construction for purposes of raising fries and harvesting the same at marketable size and quantities as specified by Fishery A.O. No. 60; and
b) Fishpond development equal to or greater than 25 hectares.

C. Infrastructure Projects

1. Major Dams

- Impoundment structures and appurtenances with storage volumes equal to or exceeding 20 million cubic meters.

2. Major Power Plants

a) All nuclear power plants, all geothermal power plants;
b) Thermal power plants with rated capacities equal to or exceeding 10 megawatts; and
c) Hydroelectric power plants with rated capacities equal to or exceeding 6 megawatts.

3. Major Reclamation Projects

- Filling or draining of areas equal to or exceeding one (1) hectare.

4. Major Roads and Bridge

a) Traverse any highly developed urban area(s);
b) Affect the hydrology of the traversed area(s); and
c) Substantially increase or impede traffic flow.

II. ENVIRONMENTALLY CRITICAL AREAS

A. All areas declared by law as national parks, watershed reserves, wildlife preserves and sanctuaries.

B. Areas set aside as aesthetic potential tourist spots.

C. Areas which constitute the habitat for any endangered or threatened species of indigenous Philippine wildlife (flora and fauna).
- Wilderness areas which are natural habitats of endangered or threatened, rare and interminate species of flora and fauna.

D. Areas of unique historic, archaeological, or scientific interests.

E. Areas which are traditionally occupied by cultural communities or tribes.

F. Areas frequently visited and or hard-hit by natural calamities (geologic hazards, floods, typhoons, volcanic activity, etc.)

a) Areas frequently visited or hard-hit by typhoons.
b) Areas frequently visited and hard-hit by tsunamis.
c) Areas frequently visited and/or hard-hit by earthquakes.
d) Storm surge-prone areas.
e) Flood-prone areas.

G. Areas with critical slope
- All lands with slope of 40% or more.

H. Areas classified as prime agricultural lands
- Lands of capability classes, A, B, Ce, De, as determined by the land Capability Classification Guide of the Bureau of Soils.

I. Recharged areas of aquifers

J. Waterbodies
- Waters for domestic purposes, within the controlled and/or protected areas declared by the appropriate authorities and which support wildlife and fishery activities.

K. Mangrove Areas
- Areas declared as mangrove swamp forest reserves by Proclamation No. 2152 and mangrove forests declared as wilderness areas by Proclamation No. 2151.

L. Coral Reefs
- Areas identified by local sources such as the Marine Sciences Center or UP-NSRC, MNR, NRMC, etc..

APPENDIX 17.3

LIST OF EXEMPTED PROJECTS IN THE PROCEDURE OF THE ENVIRONMENTAL IMPACT STATEMENT (EIS) SYSTEM

SOURCE: ENVIRONMENTAL MANAGEMENT BUREAU (EMB), DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES (DENR)

I. CATEGORY

A. Industry

1. Agro-Base

- Rice Mills
- Backyard animal farms
  1,000 poultry
  20 pigs

2. Service Sectors

- Restaurants
- Hotels/motels/inns/dormitories
- Vulcanizing shops/tire recapping
- Garment manufacturing
- Cottage industries (wood, working, handicrafts, furniture, shoe, tinsmiths, etc.) refer to Industry Classification of DTI
- Bakeries
- Sports Gyms/complex/recreation establishments
- Medical clinics
- Schools
- Churches
- Gasoline station

B. Mining

- Exploration activities, involving diamond drilling, trenching, test fitting except geothermal and oil exploration.

C. Foresty

- **INTEGRATED SOCIAL FORESTRY PROJECTS** shall refer to community based agroforestry projects designed to maximize upland productivity, enhance ecological stability, and to improve the socio-economic conditions of forest occupants and communities dependent on the forests for livelihood. These involve the provisions for security of tenure thru the issuance of Certificates of Stewardship Contracts (covering 25 years, renewable for another 25 years), extension services, infrastructure support, credit assistance, and appropriate technical assistance.

- **WATERSHED REHABILITATION PROJECTS** shall refer to project involving the institution of soil erosion control measures thru either vegetative (e.g. planting, bench - brush, fascine, etc.) or engineering/structural (e.g. check-dams, gabions, rip-rap/retaining rock walls) means.

D. Infrastructure

- Rehabilitation of existing structures (to cover the activity of maintenance and repair works).
- Construction Activities

a. Construction of single and two storey structures.
   i) 200 square meters or less in floor area;
   ii) designed or used for a total occupancy of forty (40) persons or less.

b. Operations, repair, maintenance or replacement of existing structures facilities and/or equipment, involving negligible or no expansion or change of land use beyond that previously existing. Provided, that in the case of replacement, all necessary permits applicable to the proposed action are secured from the appropriate government entities (e.g. building permit, and KV clearance). Specifically exempted are interior remodelling or alteration involving the following: roof, ceiling, floor, foundation, wall window, plumbing electrical, cooling/heating, ventilation, communication, elevator/escalator system and stairway.

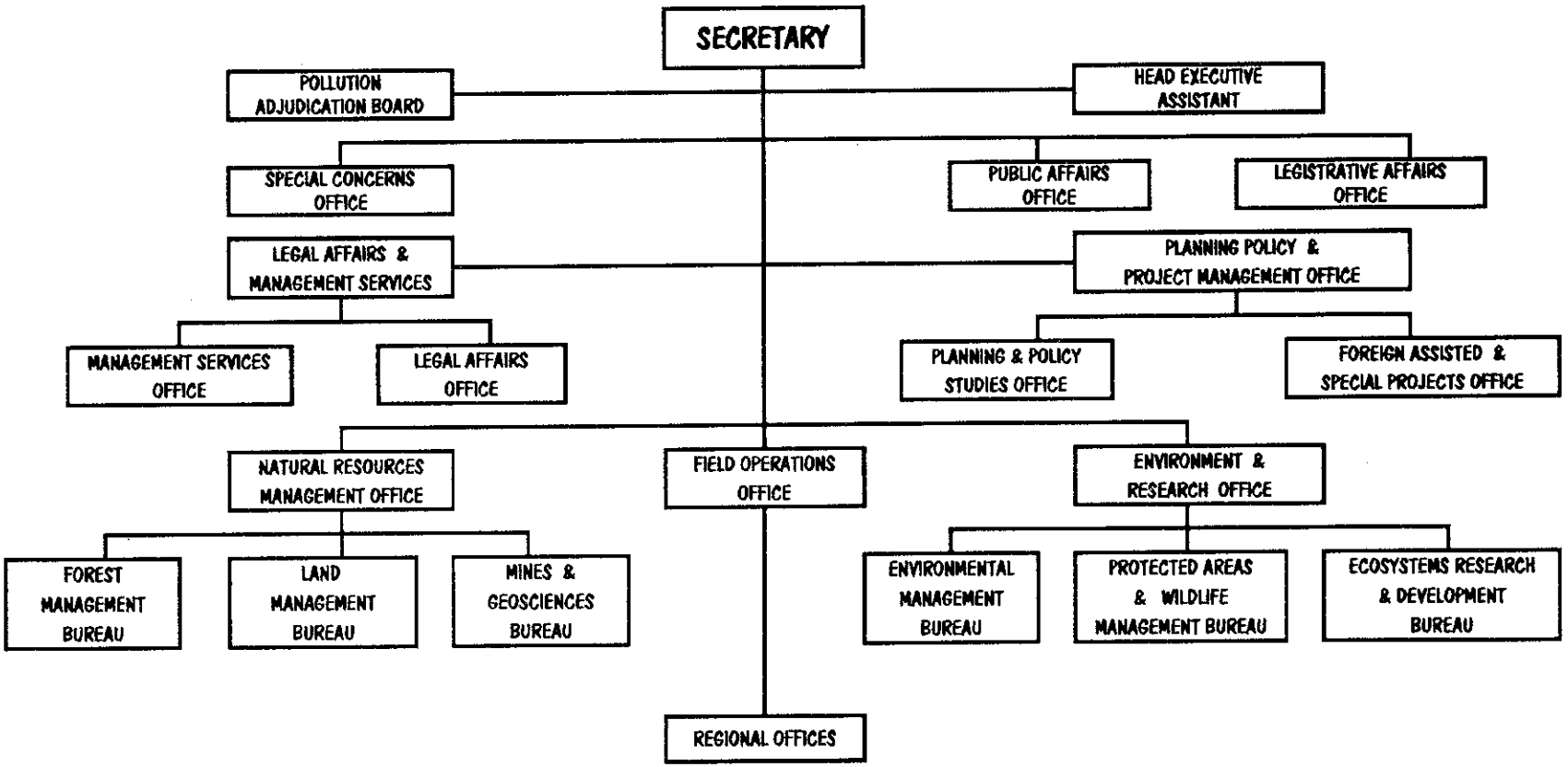
c. Demolition of abandoned, dangerous or condemned buildings or structures authorized by an appropriate government entity.

d. Construction, repair, replacement or maintenance of temporary or permanent, minor structures or facilities accessory to existing installations, provided, that such are allowable, conforming or in conformity with local zoning ordinances and/or the national building code, including the following:

   - signs
   - fences
   - utility or equipment storage sheds
   - automatic outdoor water sprinkling system
   - parking lots accommodating fifty (50) passenger cars or less
   - storm drainage, sewer and/or carpool
   - covered walks, patios for open space, loading and unloading ramps and bus, jeepney or minibus shelters.
   - guard houses or towers and installation of outdoor lighting system for security and safety purposes.
   - installation of water tanks less than 100,000 liters.
   - curbs, gutters, sidewalks and driveways abutting existing streets; and
   - interior or exterior remodelling or alteration or existing structures or facilities.

APPENDIX 17.4

ORGANIZATION CHART OF DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES (DENR)



APPENDIX 17.5

VEGETATION ALONG THE PROJECT ROAD (1)

Station	Side	Distribution Ratios by Classification (%)									Remarks
		0	1	2	3	4	5	6	7	4-7	
Sta. 1113	North Bound		75						25	25	• mangrove forest along Surigao Bay
	South Bound	10	55	20		15				15	
Sta. 1123	Average	5	65	10	0	7.5	0	0	12.5	20	
Sta. 1123	North Bound	20	50			30				30	• dominant of rice field
	South Bound	10	70	5		15				15	• poor secondary forest
Sta. 1133	Average	15	60	2.5	0	22.5	0	0	0	22.5	(sta. 1125 - 1127)
Sta. 1133	North Bound	5	25	70						0	• coconut and banana, plantation
	South Bound	15	20	60		5				5	
Sta. 1143	Average	10	22.5	65	0	2.5	0	0	0	2.5	
Sta. 1143	North Bound	45	5	50						0	• coconut plantation
	South Bound	30	10	60						0	
Sta. 1153	Average	37.5	7.5	55	0	0	0	0	0	0	
Sta. 1153	North Bound	45	30	25						0	• poor vegetation
	South Bound	50	30	15				5		5	
Sta. 1163	Average	47.5	30	20	0	0	0	2.5	0	2.5	
Sta. 1163	North Bound	30	25	30		15				15	
	South Bound	30	45	10		15				15	
Sta. 1173	Average	30	35	20	0	15	0	0	0	15	
Sta. 1173	North Bound	25	40	10		15	10			25	
	South Bound	25	40			25		10		35	• wet land near Lake Mainit
Sta. 1183	Average	25	40	5	0	20	5	5	0	30	
Sta. 1183	North Bound	10	20	45		10	15			25	• coconut plantation
	South Bound	35	50					15		15	• flood area
Sta. 1193	Average	22.5	35	22.5	0	5	7.5	7.5	0	20	
Sta. 1193	North Bound	20		80						0	• coconut plantation
	South Bound	25		75						0	
Sta. 1203	Average	22.5	0	77.5	0	0	0	0	0	0	
Sta. 1203	North Bound	20	25	55						0	• coconut plantation
	South Bound	20	30	50						0	• fine roadside trees near Cabadbaran
Sta. 1213	Average	20	27.5	52.5	0	0	0	0	0	0	

Classification

0. housing lot, factory and waste land
1. rice field, grassland
2. plantation (include small scale farm)
3. afforestration (plant with economic importance)
4. lower copse (lower than approx. 5m)
5. higher copse (higher than approx. 5 m)
6. wet land (aquatic plant)
7. mangrove forest (manglove, nipa)

4-7. total of 4.5.6 and 7

APPENDIX 17.5

VEGETATION ALONG THE PROJECT ROAD (2)

Station	Side	Distribution Ratios by Classification (%)									Remarks
		0	1	2	3	4	5	6	7	4-7	
Sta. 1213	North Bound	15	50	35						0	• coconut and banana plantation
	South Bound	15	50	35						0	• fine roadside trees near sta. 1214
Sta. 1223	Average	15	50	35	0	0	0	0	0	0	
Sta. 1223	North Bound	10	40	50						0	• coconut and banana plantation
	South Bound	10	40	50						0	
Sta. 1233	Average	10	40	50	0	0	0	0	0	0	
Sta. 1233	North Bound	40	20	30	10					0	• reforest near sta. 1239
	South Bound	50	25	25						0	
Sta. 1243	Average	45	22.5	27.5	5	0	0	0	0	0	
Sta. 1243	North Bound	65	5	15			15			15	• mountainous area
	South Bound	30	25	15			30			30	• secondary forest on the slope
Sta. 1253	Average	47.5	15	15	0	0	22.5	0	0	22.5	
Sta. 1253	North Bound	20	30	40		5	5			10	
	South Bound	15	15	50			20			20	• secondary forest with high
Sta. 1263	Average	17.5	22.5	45	0	2.5	12.5	0	0	15	naturalness
Sta. 1263	North Bound	40	20	35			5			5	• coconut and corn plantation
	South Bound	55	10	35						0	
Sta. 1273	Average	47.5	15	35	0	0	2.5	0	0	2.5	
Sta. 1273	North Bound	45		35	10		10			10	• secondary forest with low naturalness
	South Bound	50		35	5	5	5			10	
Sta. 1283	Average	47.5	0	35	7.5	2.5	7.5	0	0	10	
Sta. 1283	North Bound	35	20	20		10	15			25	• secondary forest with low naturalness
	South Bound	40		25		10	25			35	
Sta. 1293	Average	37.5	10	22.5	0	10	20	0	0	30	
Sta. 1293	North Bound	40	15	25	10	5	5			10	• rubber plantation near sta. 1297
	South Bound	60		10	5		20	5		25	• swampy area near sta. 1301
Sta. 1303	Average	50	7.5	17.5	7.5	2.5	12.5	2.5	0	17.5	
Sta. 1303	North Bound	55	20	15		10				10	• secondary forest with low naturalness
	South Bound	55	15	10		20				20	
Sta. 1313	Average	55	17.5	12.5	0	15	0	0	0	15	

APPENDIX 17.5

VEGETATION ALONG THE PROJECT ROAD (3)

Station	Side	Distribution Ratios by Classification (%)									Remarks
		0	1	2	3	4	5	6	7	4-7	
Sta. 1313	North Bound	30	25	45						0	• palm oil plantation
	South Bound	30	25	45						0	
Sta. 1323	Average	30	25	45	0	0	0	0	0	0	
Sta. 1323	North Bound	35	40	25						0	
	South Bound	35	45	15				5		5	• wet land with very low naturalness
Sta. 1333	Average	35	42.5	20	0	0	0	2.5	0	2.5	
Sta. 1333	North Bound	45	10	10			35			35	• the secondary forest with variation
	South Bound	20	15	15	5		30	15		45	
Sta. 1343	Average	32.5	12.5	12.5	2.5	0	32.5	7.5	0	40	
Sta. 1343	North Bound	45	10	10			35			35	• the secondary forest as pasture
	South Bound	20	20	15			30	15		45	
Sta.1353	Average	32.5	15	12.5	0	0	32.5	7.5	0	40	
Sta. 1353	North Bound	15	85							0	• wet rice field
	South Bound		95					5		5	
Sta. 1363	Average	7.5	90	0	0	0	0	2.5	0	2.5	
Sta. 1363	North Bound	25	30	25			20			20	• rice field (sta. 1363-sta. 1368)
	South Bound	35	25	20			20			20	• secondary forest with high
Sta.1373	Average	30	27.5	22.5	0	0	20	0	0	20	naturalness after sta. 1368
Sta. 1373	North Bound	15	10	20		10	45			55	• mountainous area of the second
	South Bound	30	15	10			45			45	forest
Sta. 1383	Average	22.5	12.5	15	0	5	45	0	0	50	• rather stable slope
Sta. 1383	North Bound	20	5	40		5	30			35	• fine roadside trees near sta. 1384
	South Bound	30	10	40	5		15			15	and sta. 1392
Sta.1393	Average	25	7.5	40	2.5	2.5	22.5	0	0	25	
Sta. 1393	North Bound	45	25	30						0	• poor vegetation
	South Bound	55	35	10						0	• occasional observation of arable by
Sta.1403	Average	50	30	20	0	0	0	0	0	0	slash and burn method
Sta. 1403	North Bound	30	35	20			15			15	
	South Bound	30	30	15		5	20			25	• the secondary forest on the slope
Sta. 1413	Average	30	32.5	17.5	0	2.5	17.5	0	0	20	

APPENDIX 17.5

VEGETATION ALONG THE PROJECT ROAD (4)

Station	Side	Distribution Ratios by Classification (%)									Remarks
		0	1	2	3	4	5	6	7	4-7	
Sta. 1413	North Bound	10	65		10	5	10			15	• dominant of rice field
	South Bound	45	20	25	5	5				5	• noticeable roadside trees
Sta. 1423	Average	27.5	42.5	12.5	7.5	5	5	0	0	10	
Sta. 1423	North Bound	35	20	5			40			40	• dominant of secondary forest after
	South Bound	30	25				45			45	sta. 1428
Sta. 1433	Average	32.5	22.5	2.5	0	0	42.5	0	0	42.5	
Sta. 1433	North Bound	30	25	10		10	25			35	• rice field (sta. 1433-sta. 1440)
	South Bound	30	25	10			35			35	• secondary forest on slope after
Sta.1443	Average	30	25	10	0	5	30	0	0	35	sta. 1440
Sta.1443	North Bound		10	20		15	55			70	• steep mountainous area
	South Bound		10	35		35	20			55	• the secondary forest with high
Sta. 1453	Average	0	10	27.5	0	25	37.5	0	0	62.5	naturalness
Sta. 1453	North Bound	55	15	30						0	• poor vegetation
	South Bound	70	10	20						0	• coconut plantation on wet land after
Sta. 1463	Average	62.5	12.5	25	0	0	0	0	0	0	sta. 1459
Sta. 1463	North Bound	20	15	45		5			15	20	• low land with mixture of fresh and
	South Bound	20	25	40					15	15	sea water
Sta. 1473	Average	20	20	42.5	0	2.5	0	0	15	17.5	• nipa forest near Tagum river
Sta. 1473	North Bound	40		50		10				10	• flood area
	South Bound	35		55		10				10	• poor vegetation with high occupancy
Sta. 1483	Average	37.5	0	52.5	0	10	0	0	0	10	of housing lot
Sta. 1483	North Bound	40		55					5	5	• high occupancy of housing lot
	South Bound	25		75						0	• coconut plantation
Sta. 1493	Average	32.5	0	65	0	0	0	0	2.5	2.5	
Sta. 1493	North Bound	75		15		10				10	• town area with some factories
	South Bound	65		30		5				5	
Sta. 1503	Average	70	0	22.5	0	7.5	0	0	0	7.5	
Sta. 1503	North Bound	30	20	25		15	10			25	• coconut and banana plantation
	South Bound	35	20	25		20				20	• dumping garbage site along the road
Sta. 1513	Average	32.5	20	25	0	17.5	5	0	0	22.5	
Whole	North Bound	30.6	24	28.6	1	4.6	10	0	1.1	15.8	
Section	South Bound	31.8	24.5	27.1	0.6	4.8	9	1.9	0.4	16.0	
	Average	31.2	24.3	27.9	0.8	4.7	9.5	0.9	0.8	15.9	

APPENDIX 17.6

SCREENING/SCOPING FORMAT

Environmental Factor			Explanation	Possibility of Impact	Remarks
Social Environment	1	Resettlement	Resettlement due to land occupation		
	2	Economical activity	Lost of land productivity, change of economical structures		
	3	Traffic, life facilities	Traffic congestion, accident, impact on accessibility to school, hospital, etc.		
	4	Community disruption	Disruption of community due to obstruction of traffic		
	5	Historic spot, cultural assets	Loss or decrease of value of cultural assets		
	6	Water right, common right	Obstructions to water right, fishing right, common right, etc.		
	7	Sanitation	Aggravation of public sanitation, e.g. generation of refuse and vermin		
	8	Waste	Generation of construction scrap, surplus soil and other wastes		
	9	Disaster	Increase in potential of occurrence of disaster such as slope failure and cave-in		
Natural Environment	10	Topography/ geology	Change in valuable topography or geology due to excavation or embankment		
	11	Soil erosion	Washout of surface soil by rainwater due to deforestation		
	12	Ground water	Drying up of ground water due to drainage in excavated land		
	13	Lake/river	Change in water volume or bottom elevation due to reclamation or inflow of drainage		
	14	Coast/sea	Coastal erosion or sedimentation due to change of coastal condition or reclamation		
	15	Animals and plants	Obstruction to propagation or extinction due to change in growing condition		
	16	Meteorology	Change in temperature or wind due to land development or big building		
	17	Landscape	Deterioration of landscape due to land development or structure		
Pollution	18	Air pollution	Pollution due to exhaust gas from vehicle or factory		
	19	Water pollution	Pollution due to inflow of soil or drainage from factory		
	20	Soil pollution	Pollution due to dust, agricultural chemicals or asphalt emulsion		
	21	Noise/ Vibration	Noise/vibration due to passage of vehicles		
	22	Land subsidence	Subsidence due to land alteration or lowering of ground water		
	23	Nasty smell	Generation of exhaust gas or other source of nasty smell		
Conclusion: Necessity of IEE or EIA					

TABLE 17.6-1 SCREENING FORMAT (JICA MODEL)

Environmental Factor			Explanation	Possibility of Impact	Remarks
Social Environment	1	Resettlement	Resettlement due to land occupation		
	2	Economical activity	Lost of land productivity, change of economical structures		
	3	Traffic, life facilities	Traffic congestion, accident, impact on accessibility to school, hospital, etc.		
	4	Community disruption	Disruption of community due to obstruction of traffic		
	5	Historic spot, cultural assets	Loss or decrease of value of cultural assets		
	6	Water right, common right	Obstructions to water right, fishing right, common right, etc.		
	7	Sanitation	Aggravation of public sanitation, e.g. generation of refuse and vermin		
	8	Waste	Generation of construction scrap, surplus soil and other wastes		
	9	Disaster	Increase in potential of occurrence of disaster such as slope failure and cave-in		
Natural Environment	10	Topography/ geology	Change in valuable topography or geology due to excavation or embankment		
	11	Soil erosion	Washout of surface soil by rainwater due to deforestation		
	12	Ground water	Drying up of ground water due to drainage in excavated land		
	13	Lake/river	Change in water volume or bottom elevation due to reclamation or inflow of drainage		
	14	Coast/sea	Coastal erosion or sedimentation due to change of coastal condition or reclamation		
	15	Animals and plants	Obstruction to propagation or extinction due to change in growing condition		
	16	Meteorology	Change in temperature or wind due to land development or big building		
	17	Landscape	Deterioration of landscape due to land development or structure		
Pollution	18	Air pollution	Pollution due to exhaust gas from vehicle or factory		
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	20	Soil pollution	Pollution due to dust, agricultural chemicals or asphalt emulsion		
	21	Noise/ Vibration	Noise/vibration due to passage of vehicles		
	22	Land subsidence	Subsidence due to land alteration or lowering of ground water		
	23	Nasty smell	Generation of exhaust gas or other source of nasty smell		
Conclusion: Necessity of IEE or EIA					

TABLE 17.6-2 SCOPING FORMAT (JICA MODEL)

Environmental Factor			Evaluation	Remarks
Social Environment	1	Resettlement		
	2	Economical activity		
	3	Traffic, life facilities		
	4	Community disruption		
	5	Historic spot, cultural assets		
	6	Water right, common right		
	7	Sanitation		
	8	Waste		
	9	Disaster		
Natural Environment	10	Topography/ geology		
	11	Soil erosion		
	12	Ground water		
	13	Lake/river		
	14	Coast/sea		
	15	Animals and plants		
	16	Meteorology		
	17	Landscape		
Pollution	18	Air pollution		
	19	Water Pollution		
	20	Soil Pollution		
	21	Noise/vibration		
	22	Land subsidence		
	23	Nasty smell		

Note: Evaluation

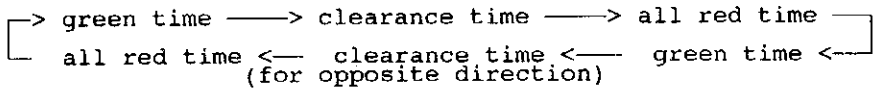
A : Significant impact
B : Slight impact
C : Unclear (needing further study to clarify)
D : None or negligibly small impact (no need to discuss in IEE/EIA)

APPENDIX 17.7

ONE-WAY OPERATION ROAD CAPACITY IN PAVEMENT AND BRIDGE REHABILITATION SECTION

In principle, roadway rehabilitation works are executed side by side. And in some bridges which require major repair, rehabilitation works is done in same manner. During the construction of one side, the other side is open to traffic in one-way operation controlled by signed (by traffic signal or manually).

One cycle of signalization comprises each two (2) of green, clearance a red times for both direction.



$$SC = 2\ (GT + CT + RT)$$

Where:

- SC is cycle of signalization in second.
- GT is green time for one direction. Here, 60 seconds of green time is set.
- CT is clearance time in second.

$$CT = \frac{\frac{EL}{CT \cdot 1000}}{3600} = 3.6 \cdot \frac{RL + 2CD}{CTS}$$

- EL is effective length in meter.
- RL is rehabilitation length in meter.
- CD is clearance distance in meter. CD = 20m
- CTS is crossing travel speed in kph. CTS at roadway rehabilitation is 20 kph, and at bridge rehabilitation, 10 kph, respectively.
- RT is all red time. Here, 3 seconds is set.

$$ORC = \frac{3,600}{SC} \cdot \frac{120}{HW} \cdot \frac{100}{HF}$$

where;

- ORC is one-way operation road capacity in vehicle per day.
- HW is headway of proceeding vehicles at signalized section in second. Here, 2.5 seconds is set (Under ideal road condition, HW is about 2.0 seconds at intersection).
- HF is hourly factor to daily traffic in percent. 8.32% i set based on traffic count survey along the Project Road.

TABLE 17.7-1 RESULTS OF CALCULATION

Rehabilitation Length (meters)	Cycle of Signalization (seconds)		One-Way Operation	
	Roadway Rehabilitation	Bridge Rehabilitation	Roadway Rehabilitation	Bridge Rehabilitation
20	147.6	169.2	14,100	12,300
40	154.8	183.6	13,400	11,300
60	162.0	198.0	12,800	10,500
80	169.2	212.4	12,300	9,800
100	176.4	226.8	11,800	9,200
150	194.4	262.8	10,700	7,900
200	212.4	298.8	9,800	7,000
250	230.4	334.8	9,000	6,200
300	248.4	370.8	8,400	5,600
400	284.4	442.8	7,300	4,700
500	320.4	514.8	6,500	4,000

APPENDIX 17.8

METHODOLOGY FOR PREDICTION OF AIR QUALITY LEVEL

The Puff Model simulates diffusion of exhaust gas from a pollutant by every short range of time. In this model, exhaust gas is recognized as a cluster of smoke and its diffusion area is calculated and measured by three dimensions of x, y and z as indices shown in Figure 17.8-1. The diffusion of air pollutants emitted by vehicles on the road is assumed as shown in Figure 17.8-2.

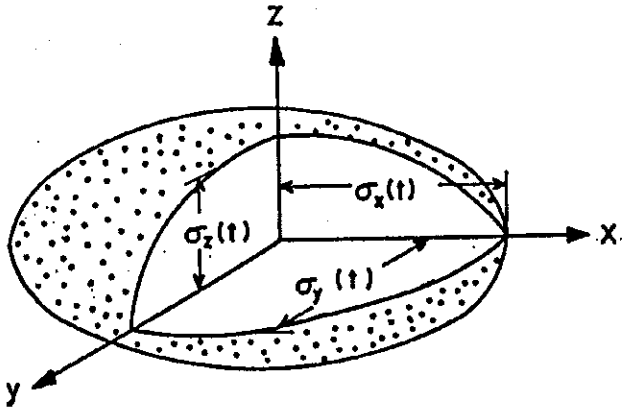


FIGURE 17.8-1 GENERAL IDEA OF PUFF MODEL

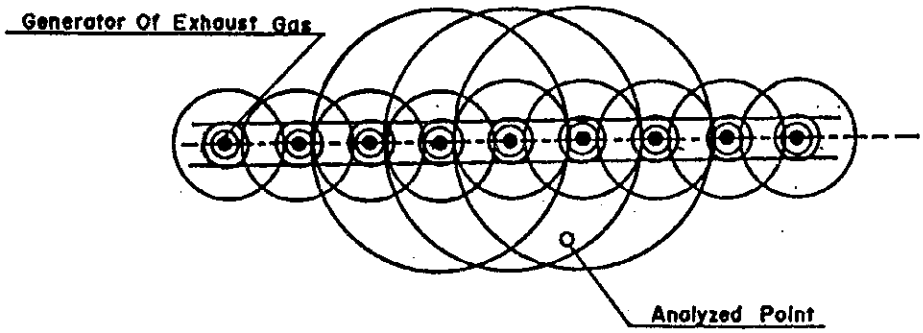


FIGURE 17.8-2 MODEL APPLICATION FOR VEHICLES ON THE ROAD

The Puff Model was developed in Japan and commonly used as a model to assess an air quality level in both of government and private sectors. The formula is as follows:

$$c(x,y,z) = \frac{Q}{(2z)^3/2 \cdot \delta^2 \cdot \tau} \cdot \left[\frac{1-\exp(-to^{\frac{1}{2}})}{2l} + \frac{1-\exp(-to^{\frac{m}{2}})}{2m} \right]$$

where;

$$l = \frac{1}{2}\left[\frac{x^2+y^2}{\delta^2} + \frac{(Z-H)^2}{\tau^2}\right]$$

$$m = \frac{1}{2}\left[\frac{x^2+y^2}{\delta^2} + \frac{(Z+H)^2}{\tau^2}\right]$$

C (x, y, z)	is density level in ppm.
Q	is emission strength by pollutant in ml per second.
H	is effective height of emisison of source.
to	is corresponding time to initial diffusion width as set.
δ, τ	are factors regarding to width of diffusion.

APPENDIX 17.9

REHABILITATION WORKS POTENTIALLY AFFECTING WATER QUALITY AND ITS CLASSIFICATION BY RIVER

Station	Bridge Name	No. of Spans	Countermeasures	Branch Stream at Bridge Site	Main River	Water Classification by Standards
1162.292	Alimpatayan	3-Span	• Dredging	Alimpatayan	No	No Classification
1165.700	San Pedro	1-Span	• Provision of Spurdike • Dredging	Legaspi Creek	No	No Classification
1196.733	Jagupit	1-Span	• Dredging	Jagupit	Tubay River	A
1197.535	Guinoyoran	1-Span	• Dredging	Guinoyoran	-do-	A
1202.825	Sta. Ana	4-Span	• Dredging	Sta. Ana	-do-	A
1224.722	Agay	1-Span	• Dredging	Agay	Magallanes River	C
1225.050	Ngilan	3-Span	• Dredging	Ngilan	-do-	C
1225.862	Los Angeles	2-Span	• Dredging	Los Angeles	-do-	C
1229.929	Taguibo	4-Span	• Provision of Spurdike	Taguibo	-do-	C
1255.196	Hupas	1-Span	• Dredging	Hupas	Agusan River	C
1269.766	Taglatawan	3-Span	• Widening of Carriageway or Construction of Additional Bridge	Taglatawan	-do-	C
1390.242	Gabanan	3-Span	• Total Reconstruction of Bridge	Gabanan	-do-	C
1402.218	Olaycon	2-Span	• Reinforcement of Foundation	Olaycon	-do-	C
1466.749	Gov. Miranda	10-Span	• Total Reconstruction of Bridge	Liboganon	Tagum River	D
1487.404	Bunawan	3-Span	• Dredging	Bunawan	Bunawan River	No Classification

APPENDIX 17.10

METHODOLOGY FOR PREDICTION OF NOISE LEVEL

To predict noise level along the Project Road, the acoustical model was used which was developed by Nihon Onkyo Gakkai, the authoritative academic society on acoustics in Japan. In the Model, it is assumed that vehicles as a generator of noise are running with same speed and same headway. The strength of noise generated by vehicles is given based on classified noise strength by vehicle type and their actual componential ratio on a road when a traffic count data is available. The noise level at each analyzed spot is calculated by accumulating the noise from all vehicles lined up. The formula is as follows.

$$L50 = Lw - 8 - 20\log_{10} l + 10\log_{10}\left(\pi \cdot \frac{l}{d} \cdot \tanh\left(2t \frac{l}{d}\right)\right) + \alpha_d + \alpha i$$

where; $Lw = 87 + 0.2\,V + 10\log_{10}(a_1 + 10a2)$

L50 is middle value of noise generated by vehicles in dB(A).

Lw is average noise level generated by one vehicle in dB(A).

V is average speed of vehicles in km per hour.

a_1 is componential ratio of light vehicle.

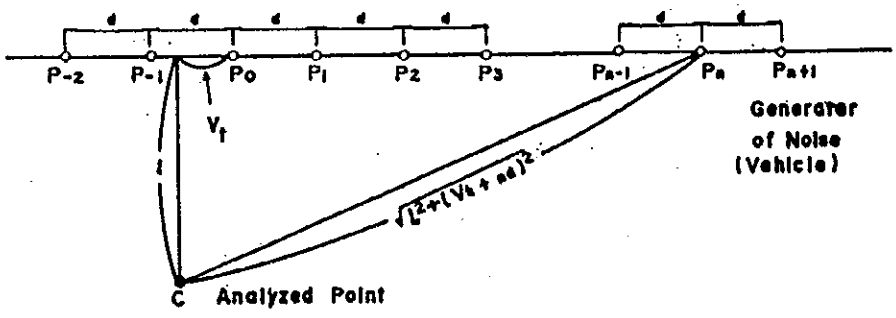
a_2 is componential ratio of heavy vehicle.
Here, $a_1 + a_2 = 1.0$

l is distance from vehicle to analyzed point in meter.

d is average headway of vehicle in meter.
Here, d = 1000V/N

N is hourly traffic volume in vehicle per hour in both direction.

α_d, α_i are adjustment factors as to road cross-sectional features and land use along a road.



GENERAL IDEA OF THE MODEL

APPENDICES FOR CHAPTER 19

APPENDIX 19.1 FUNCTIONS OF AGENCIES RELATED TO ROAD/BRIDGE MAINTENANCE

APPENDIX 19-1

FUNCTIONS OF AGENCIES RELATED TO ROAD/BRIDGE MAINTENANCE

Agencies in DPWH related to road/bridge maintenance are as follows:

- Bureau of Maintenance
- Maintenance Division of Regional Offices
- Maintenance Section of District Offices
- Bureau of Equipment
- Regional Equipment Services
- Area Equipment Service

1) Bureau of Maintenance (BOM)

The Bureau of Maintenance (BOM) provides the DEO/CEO technical assistance and guidance in the efficient and economical implementation of the maintenance functions. The Bureau is composed of five (5) Divisions: Planning and Programming Division, Inspectorate Division, Inventory and Statistics Division, Monitoring and Methods Division and Building Services Division.

i) Planning and Programming Division

The Division performs the following: prepares the national consolidated annual highway maintenance program and performance budget (the annual work program expressed in Pesos required for the resource needed to accomplish the program), update maintenance activities/performance standards, review of the regional annual road/bridge restoration priority project listings and so on.

ii) Inspectorate Division

The Division among others conducts field inspection to evaluate the progress of maintenance and repair work, assesses the conditions of national roads and bridges and so on. The Division also conducts nationwide road condition inspection to assess conditions of national roads on a semi-annual basis (once in a dry season and once in a rainy season). Inspectorates from the Division are joined by representatives from the Regional Maintenance Division and District/City Maintenance Section concerned.

The inspection is made on the basis of physical condition and maintenance effort. The criteria for measuring maintenance effort is rather a subjective one but it is designed to incorporate "efforts" by Regional Offices and DEO/CEO into the overall rating. The check points of the physical condition are broken down into carriageway and roadside (shoulder, vegetation and drainage). The overall rating expressed in percentage is obtained by taking the average of the percentage rating of the physical conditions and maintenance efforts.

The range of the overall rating is as follows:

	Overall Rating
4 (Good)	88% - 100%
3 (Fair)	75% - 87%
2 (Poor)	< 75%
1 (Beyond Repair)	

The results of the inspection are summarized into a nationwide national roads condition rating.

If the rating of a road section is found to be low (75% and below), the District/City maintenance engineers through the Regional Director is instructed to upgrade the level of maintenance in the section. If the low rating continues for the two consecutive years, they are directed to determine the cause of damage and necessary measures to remedy such situations.

iii) Inventory and Statistics Division

The Division checks, reviews, verifies and compiles inventory reports received from the field engineering office, prepares EMK of districts and sub-districts, and so on. EMK is calculated based on width of road surface or pavement, surface type and average annual daily traffic flow.

iv) Monitoring and Methods Division

The Division checks, reviews, evaluates and compiles the progress reports submitted by the field engineering offices on maintenance and repair of infrastructure projects and facilities.

2) Maintenance Division of Regional Offices

The Maintenance Division of Regional Offices have two (2) sections: Building Section and Roads and Bridges Section.

The Roads and Bridges section undertakes monitoring and supervision of roads/bridges maintenance operations which one done by DEO/CEO.

3) Maintenance Section of DEO/CEO

The maintenance section of DEO/CEO is the implementing arm of actual maintenance works. It is headed by a Maintenance Engineer who is responsible for the planning, management and operation of maintenance activities within the district. He has Area Engineers and Foremen who will supervise all maintenance activities undertaken both by MBA and MBC.

4) Bureau of Equipment

The Bureau of Equipment (BOE) provides technical services on the management of construction and maintenance equipment and ancillary facilities. The BOE consists of five divisions: Equipment Planning Division, Equipment Utilization Division, Equipment Maintenance Division, Central Equipment and Spare Parts Division and Marine Equipment Division.

i) Equipment Planning Division

The Division, formulates policies and programs governing equipment acquisition, operation, maintenance and disposal. It personally undertakes the procurement of equipment.

ii) Equipment Utilization Division

The Division formulates guidelines, policies, rules and regulations with regards to nationwide allocation and utilization of equipment required by projects and equipment leasing.

To serve this purpose, field offices are requested to submit to BOE reports such as Fleet Demand/Availability Report and Equipment Preventive Maintenance/Consumption and Utilization Report.

Fleet Demand/Availability Survey is conducted on a quarterly basis. District Engineering Offices are requested to submit equipment demand for the next quarter. The report is prepared by Equipment Engineer seconded to DEO/CEO from RES. The report shows the deficiency/excess of equipment arrived at by comparing the number of units by type with availability/utilization status.

iii) Equipment Maintenance Division

The Division provides technical supervision over the maintenance, operations and repairs of equipment. Inspectorate Section under the division takes charge of inspection on all equipment in the field in collaboration with RES. However, due to budgetary constraints, it has been unable to cover all fifteen RES's to inspect the equipment.

iv) Central Equipment and Spare Parts Division

In 1990, the purchase of spare parts was centralized at Central Equipment and Spare Parts Division (CESPD). The orders for purchase of bulky spare parts were made to dealers through CESPD. However, the process has been changed. Funds for procurement of spare parts are now given to RES. At present, the purchase of spare parts is normally done through public bidding at Regional and DEO/CEO level. There are cases when RES consults Centralized Depot, in case when there are no stocks available, with distributors of equipment for spare parts. To overcome shortage of funds for spare parts, usable spare parts from unserviceable equipment are removed and stored for future usage.

5) Regional and Area Equipment Service

Road maintenance equipment is provided to DEO/CEO by Regional Equipment Services (RES). The RES are administratively under Regional Offices of DPWH and receive technical instruction from the Bureau of Equipment (BOE).

A RES has a base shop and a number of area shops under its command. Major repair of equipment is done at base shops and minor repair is done at area shops. RES also have mobile repair vehicles. High priority repair work is given to equipment with high demand such as dump trucks. According to interviews at BOE, no repair work will be conducted, if the cost of repair work is found to exceed 50% of average acquisition costs.

RES provides/assigns its minimum fleet of Basic Highway Maintenance Equipment (BHME: bulldozers, dumptrucks, loaders, road rollers, service vehicles, etc.) for road maintenance activities by Administration to calamity-related emergency highway repair and rehabilitation projects.

The equipments categorized under BHME is assigned to DEO/CEO free of rental charge as stipulated in Department Order No. 54, series of 1991. However, in lieu of charging equipment rentals, the amount equivalent to 15% of EMK funds, which had been previously authorized to be retained with the Regional Office, shall be automatically released to the DEO/CEO who shall administer and control the disbursement of such funds exclusively for equipment maintenance services including the procurement of preventive maintenance parts.

APPENDIX 19.2 ORGANIZATIONAL CHART OF DEO/CEO MAINTENANCE SECTION

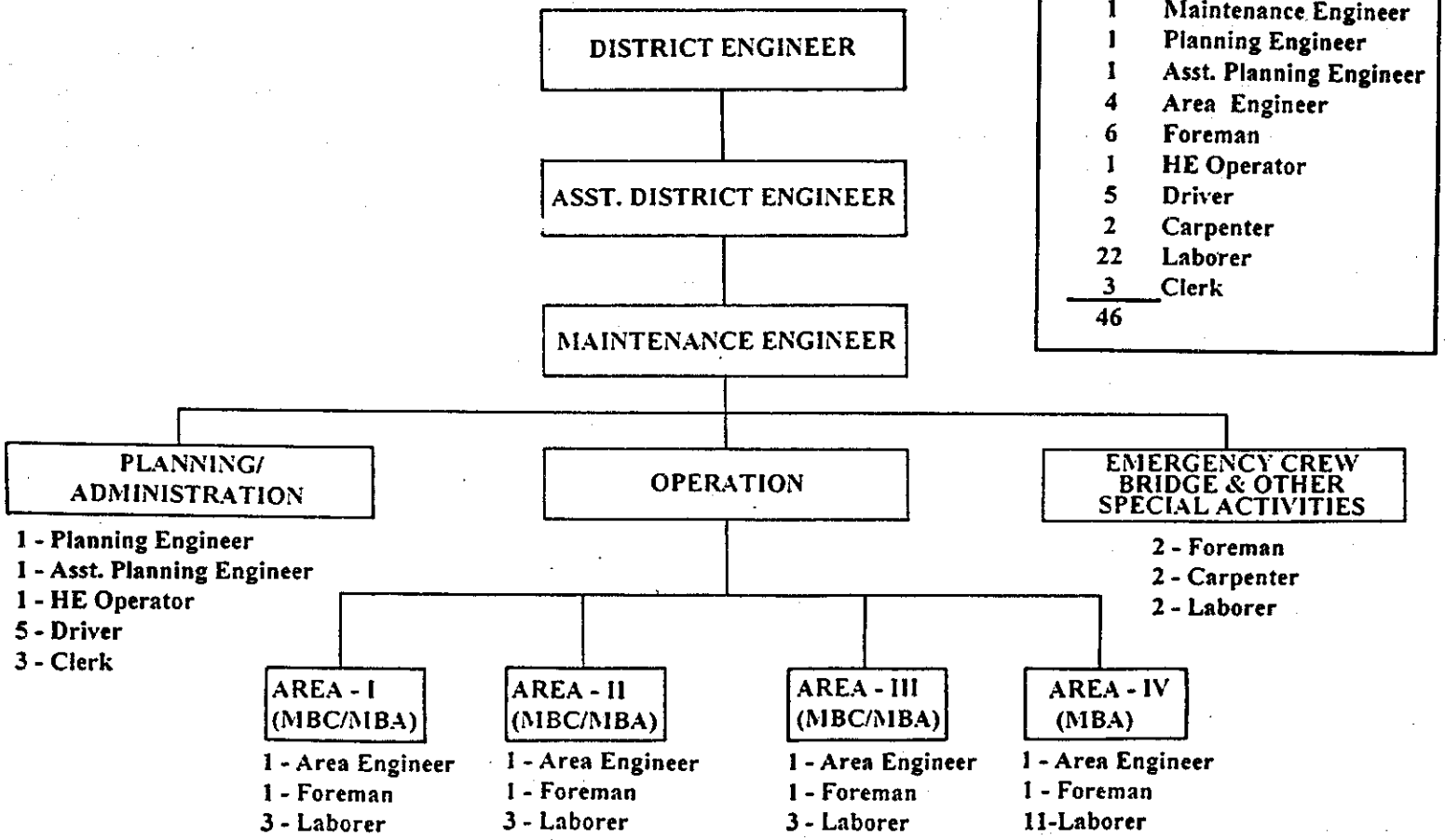
App. 19.2-1

SURIGAO DEL NORTE 1st ENGINEERING DISTRICT

ORGANIZATIONAL CHART

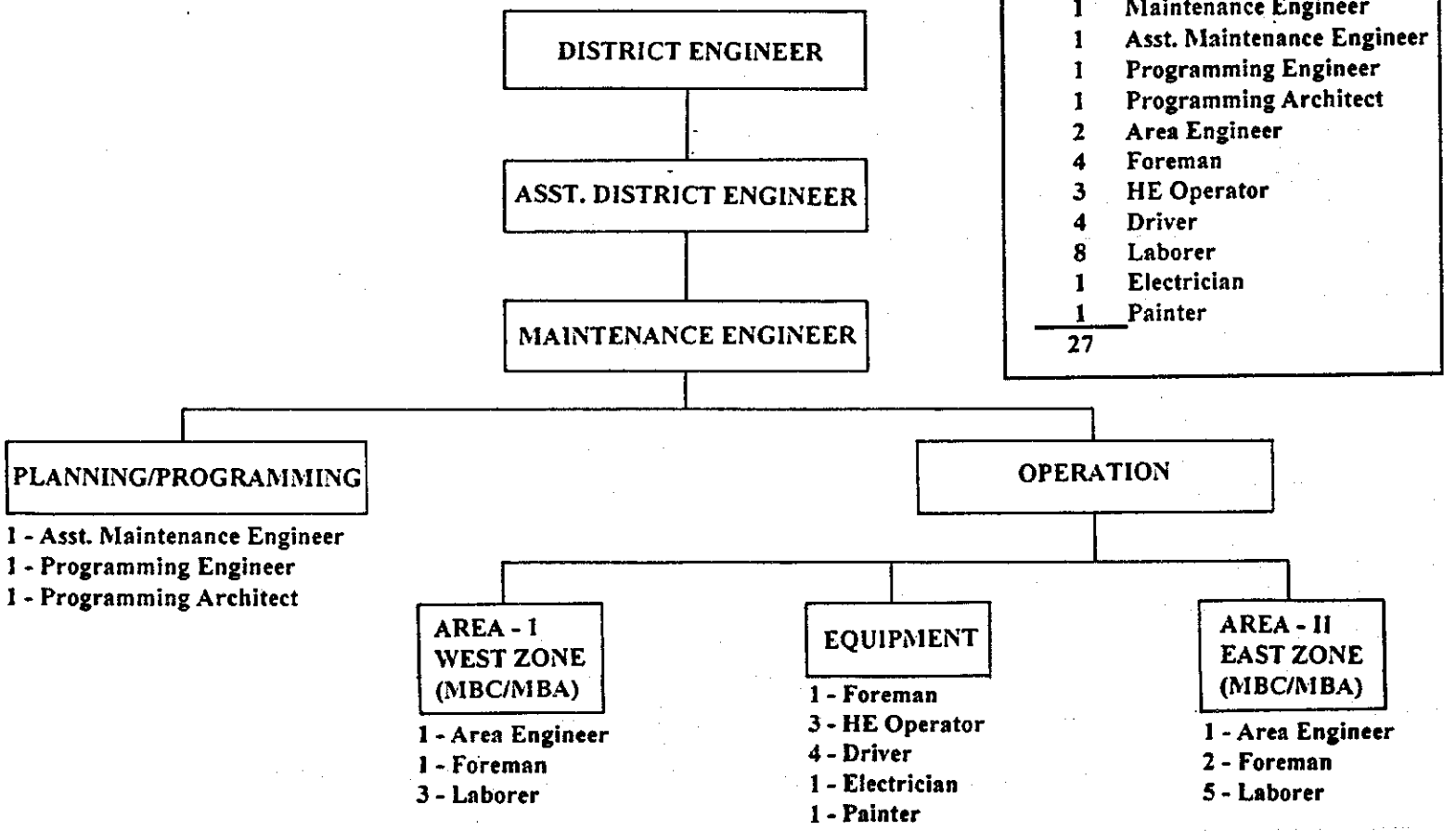
MAINTENANCE SECTION

MAINTENANCE PERSONNEL	
No.	Position
1	Maintenance Engineer
1	Planning Engineer
1	Asst. Planning Engineer
4	Area Engineer
6	Foreman
1	HE Operator
5	Driver
2	Carpenter
22	Laborer
3	Clerk
46	



AGUSAN DEL NORTE ENGINEERING DISTRICT

ORGANIZATIONAL CHART
MAINTENANCE SECTION



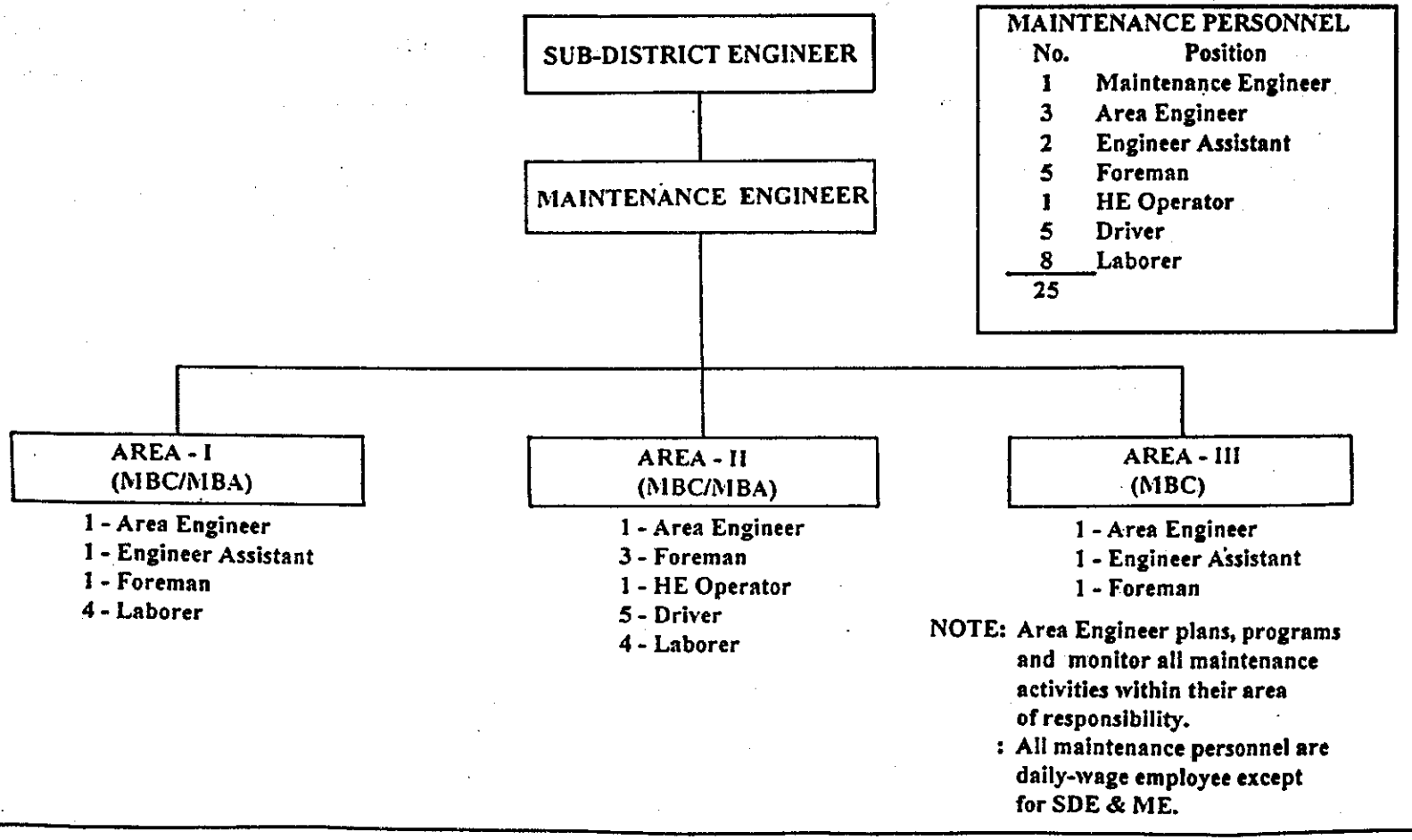
MAINTENANCE PERSONNEL

No.	Position
1	Maintenance Engineer
1	Asst. Maintenance Engineer
1	Programming Engineer
1	Programming Architect
2	Area Engineer
4	Foreman
3	HE Operator
4	Driver
8	Laborer
1	Electrician
1	Painter
27	

BUTUAN CITY SUB-ENGINEERING DISTRICT

ORGANIZATIONAL CHART

MAINTENANCE SECTION



MAINTENANCE PERSONNEL

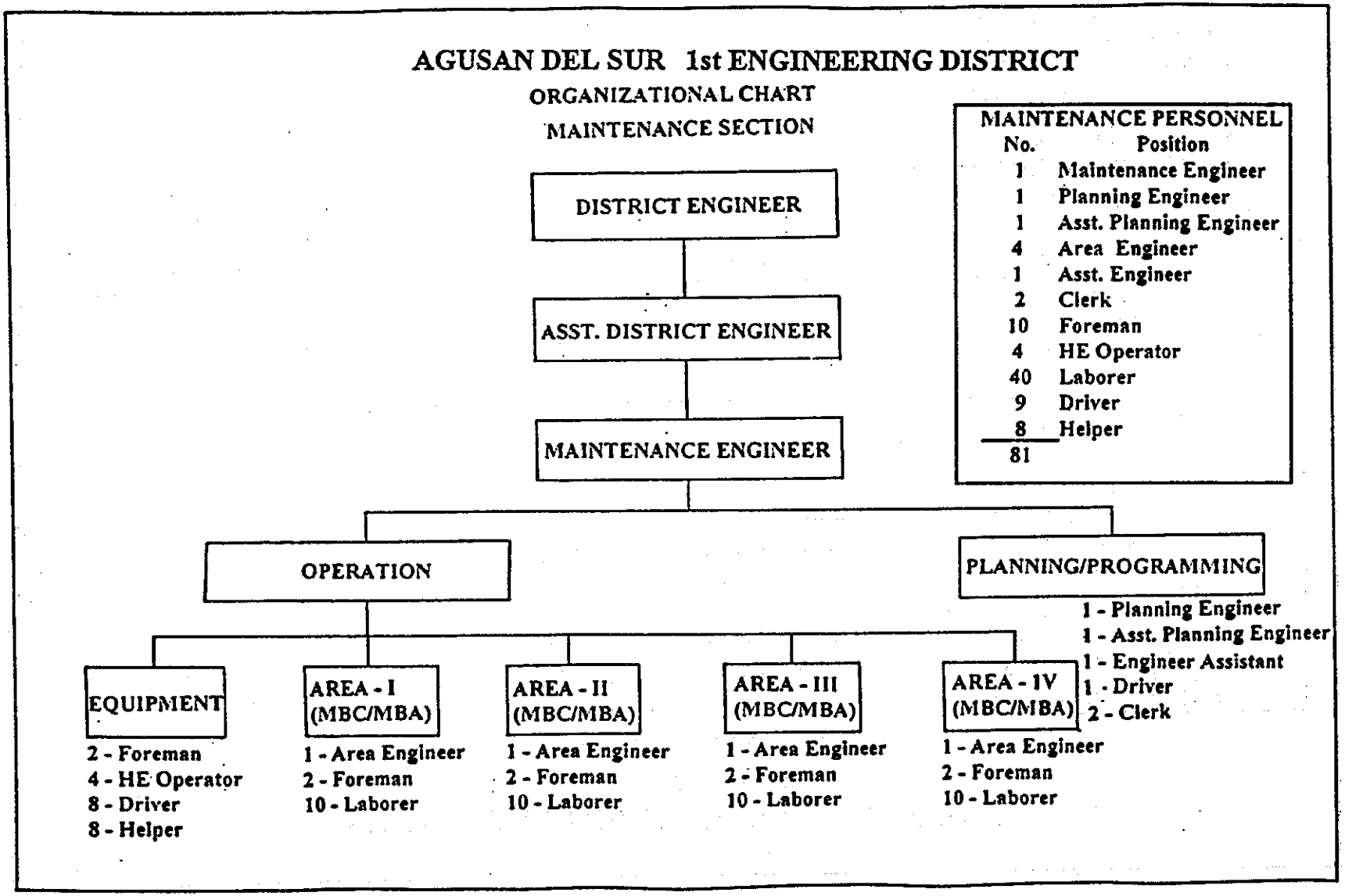
No.	Position
1	Maintenance Engineer
3	Area Engineer
2	Engineer Assistant
5	Foreman
1	HE Operator
5	Driver
8	Laborer
25	

NOTE: Area Engineer plans, programs and monitor all maintenance activities within their area of responsibility.

: All maintenance personnel are daily-wage employee except for SDE & ME.

AGUSAN DEL SUR 1st ENGINEERING DISTRICT

ORGANIZATIONAL CHART
MAINTENANCE SECTION

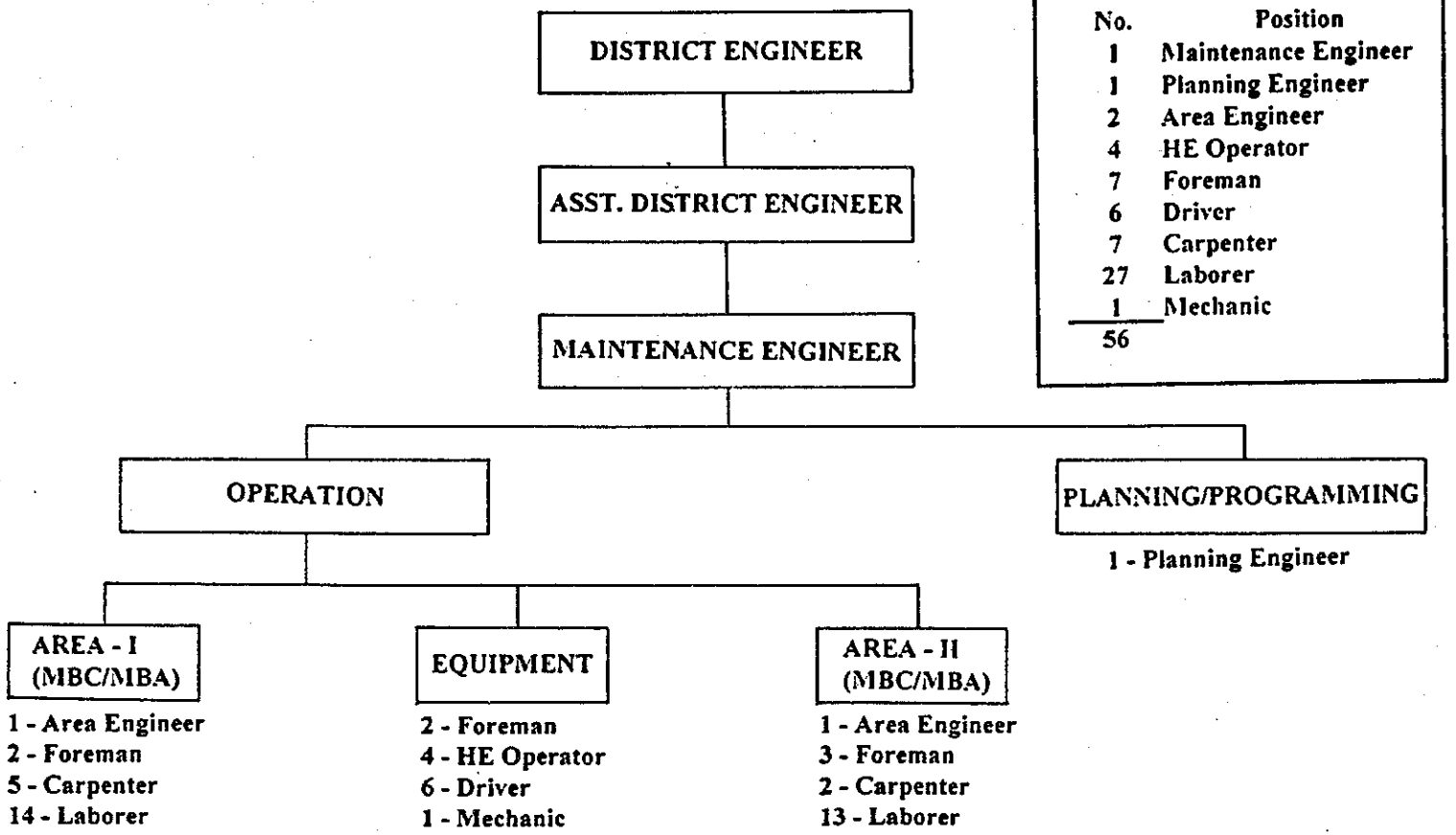


MAINTENANCE PERSONNEL	
No.	Position
1	Maintenance Engineer
1	Planning Engineer
1	Asst. Planning Engineer
4	Area Engineer
1	Asst. Engineer
2	Clerk
10	Foreman
4	HE Operator
40	Laborer
9	Driver
8	Helper
81	

DAVAO DEL NORTE 2nd ENGINEERING DISTRICT

ORGANIZATIONAL CHART

MAINTENANCE SECTION

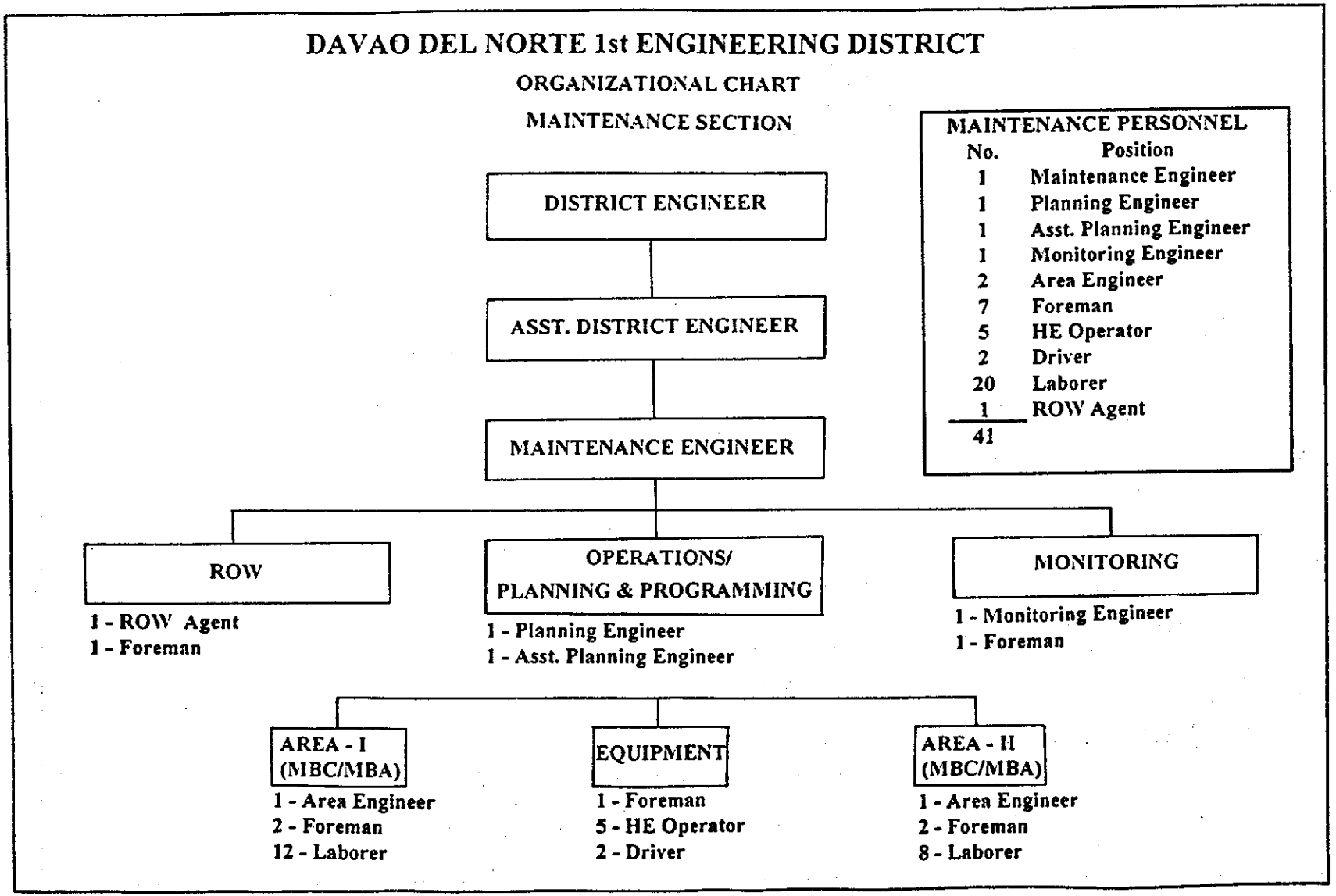


MAINTENANCE PERSONNEL	
No.	Position
1	Maintenance Engineer
1	Planning Engineer
2	Area Engineer
4	HE Operator
7	Foreman
6	Driver
7	Carpenter
27	Laborer
1	Mechanic
56	

DAVAO DEL NORTE 1st ENGINEERING DISTRICT

ORGANIZATIONAL CHART

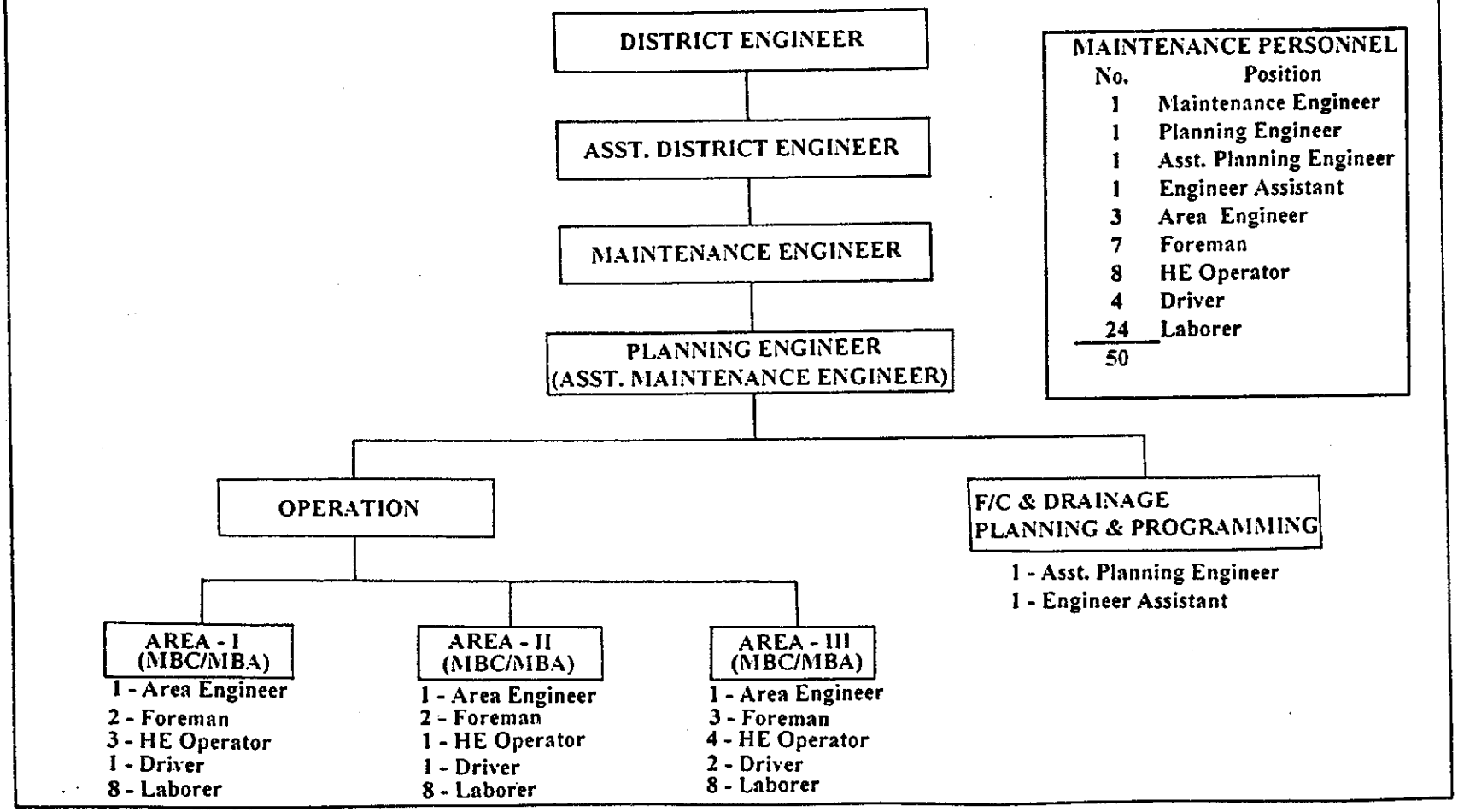
MAINTENANCE SECTION



MAINTENANCE PERSONNEL	
No.	Position
1	Maintenance Engineer
1	Planning Engineer
1	Asst. Planning Engineer
1	Monitoring Engineer
2	Area Engineer
7	Foreman
5	HE Operator
2	Driver
20	Laborer
1	ROW Agent
41	

DAVAO CITY ENGINEERING DISTRICT

ORGANIZATIONAL CHART
MAINTENANCE SECTION



MAINTENANCE PERSONNEL	
No.	Position
1	Maintenance Engineer
1	Planning Engineer
1	Asst. Planning Engineer
1	Engineer Assistant
3	Area Engineer
7	Foreman
8	HE Operator
4	Driver
24	Laborer
50