6.4 Water Quality

6.4.1 Present Condition

(1) River system

The rivers in the project area are divided into ten river systems, i.e. Rio Las Eramadas, Rio Mocuana, Rio Tipitapa, Rio La Mula, Rio Agua Agria, Rio Telica, San Isidro Sur, Rio Meseales, Rio Cinecapa and Rio Tomalapa as shown in Figure 6-20 and Table 6-14.

Swamps are located at the west of Tipitapa along the Lake Tipitapa. And many water springs are also distributed around swampy zone between San Cristobal and Tipitapa.

Many digged and drilled Water wells exist in the project area. Partiqularly, in the section between Telica and San Isidro, many digged wells are used for drinking and agricultural water. The depth of water level of the wells are mostly deeper than 30 meters.

(2) Field investigation

a. Components of investigation

24 water samples were collected and physical and chemical analyses were done. The location of samples consists of major rivers and water wells as shown in Figure 6-20. Most of rivers have not parmanent current except near Tipitapa and La Jicaral.

The components of physical and chemical anlyses are shown as follows:

- Physical components : Temperature, pH, Electric conductivity, Suspended solid (SS), Turbidity
- Chemical analysis : Ca, Mg, Na, K, HCO3, SO4, Cl, Pb, Cr, As, Hg, Mn, Fe, B, SiO2, PO4, NO3N, NH4N,

b. Results of analyses

Results of physical and chemical analyses are shown in Table 6-15 and Figure 6-22. "Hexa-diagram" and "Key-diagram" of major components are shown in Figure 6-23 and 6-24 respectively.

The water in whole area is classified into Type I (Ca(HCO3)2) to Type II (NaHCO3) by Key-diagram (Figure 6-24) and contains generally high quantity of HCO3, Ca and Na, particularly Road Section between Tipitapa and San Benito. (around Lago de Managua). There is not differency in water quality between Masaya - Tipitapa, Nandaime and Telica - San Isidro.

Components of surface water in San Benito and Tipitapa

contains much HCO3, Na + K, Mg and Mn (see Figure 6-22), but the surface water of other areas including Nandaime, San Cristobal and between Telica and San Isidro, are containing less concentration of total ions than San Benito and Tipitapa. Because the rivers between Tipitapa and San Benito have not parmanent current and the water of temporary current is assumed to dissolve much ions. The surface water of Rio Mocuana is parmanent current from water springs distributed at south of San Cristobal, so that it is better quality of water than that of the water at Benito and Tipitapa. The water between Telica and San Isidro contains relatively small quantity of ions.

NO3N, NH4 and NO2N are rich in WQ-3, 8, 20, 21 and 24 (Tipitapa, Nandaime, La Cruz De La India and near Las Mangas. It indicates the contamination due to the domestic waste. In addition, results of Jar Test for suspended solid (ss) are shown in Table 6-20 (See Section 6.6).

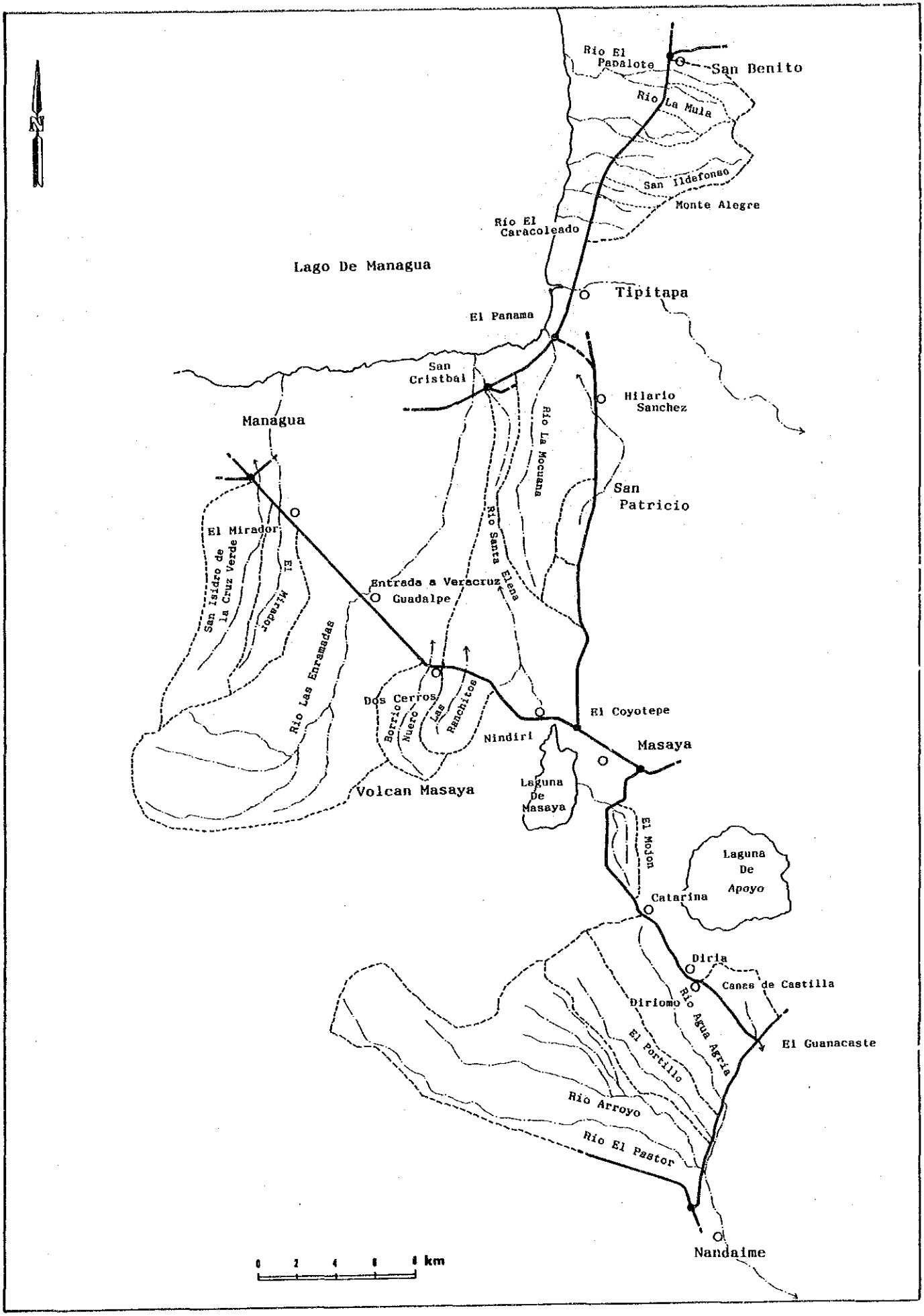


Figure 6-20(1) River System in the Project Area

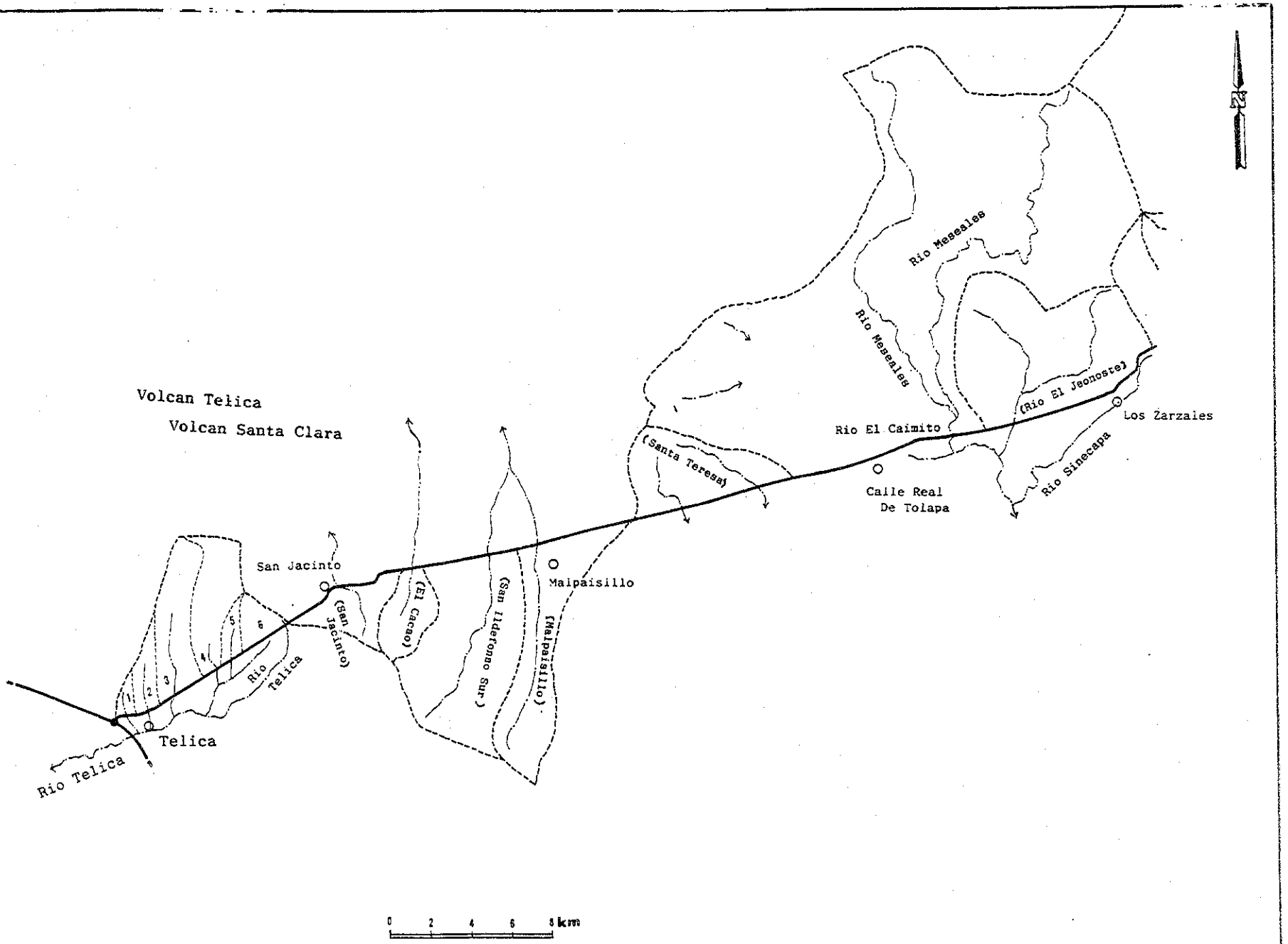


Figure 6-20(2) River System in the Project Area

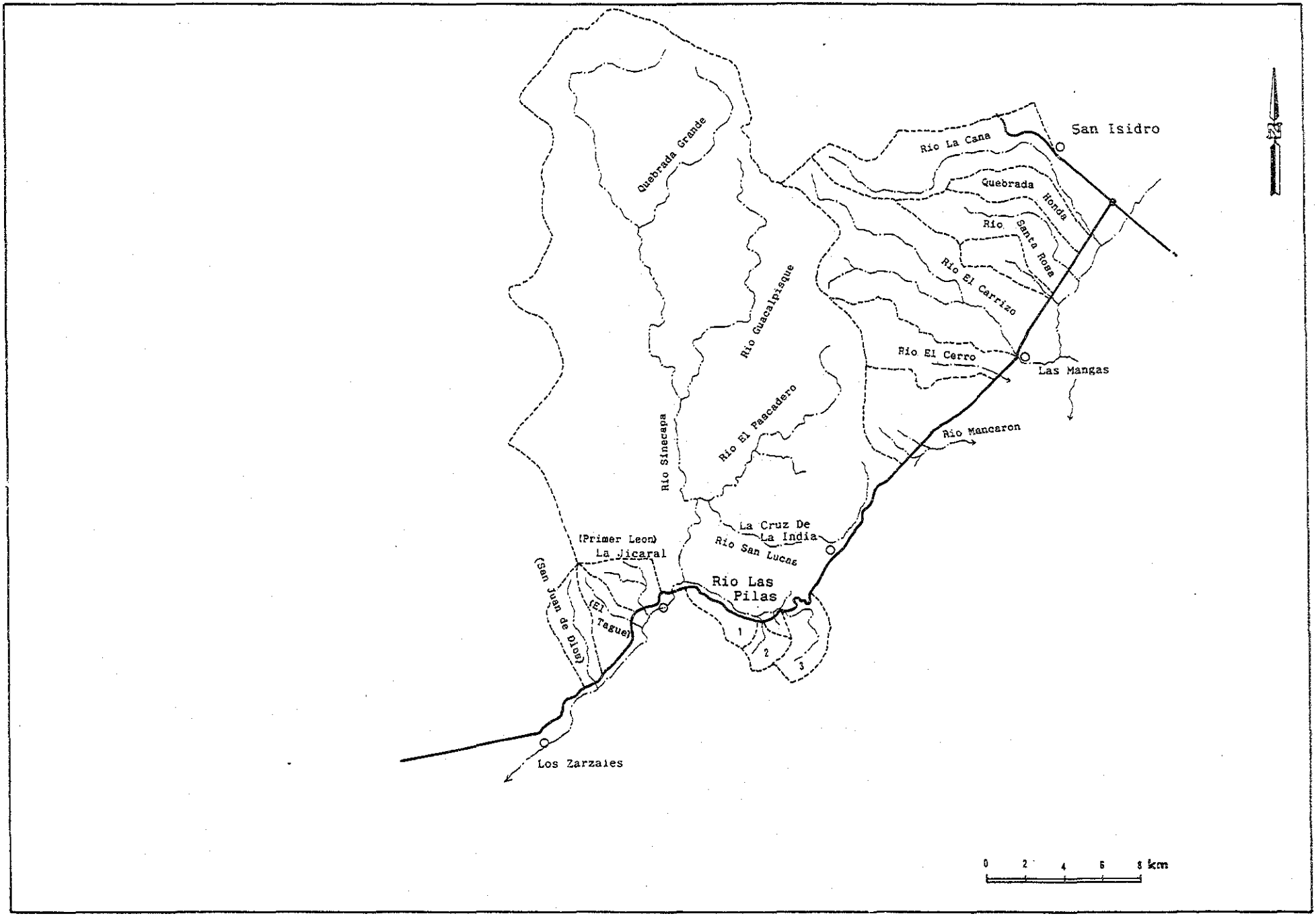


Figure 6-20(3) River System in the Project Area

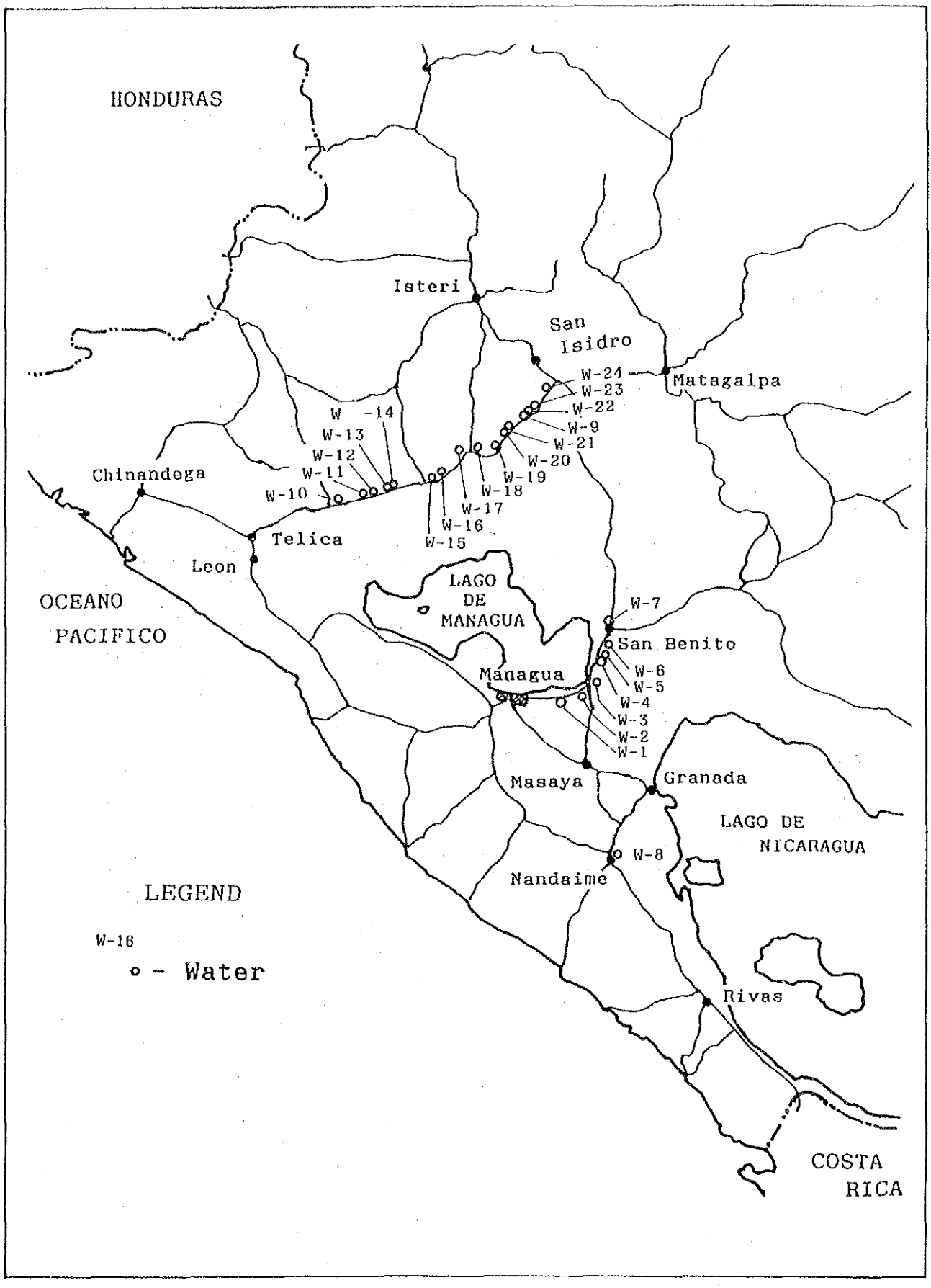


Figure 6-21 Sampling Points of Water Quality in the Project Area

Table 6-14(1) Results of Physical and Chemical Analyses of Water Quality in the Project Area

ITEMS	UNITS	SAMPLE NUMBER W-1	W-2	W-3	W-4
PHYSICAL PARAMETER					
pH	-	7.94	6.78	7.58	8.45
C	uS/cm	1416.00	67.00	881.00	2300.00
T	UNT	0.80	140.00	0.65	0.92
ST	mg/l	1501.04	87.20	751.37	2404.00
STD	mg/l	1406.04	68.30	718.37	2251.00
STS	mg/l	95.00	18.90	33.00	153.00
CHEMICAL PARAMETER					
"Cations"					
Ca	mg/l	41.90	5.53	56.93	75.90
Mg	mg/l	75.26	2.16	13.42	77.66
Na	mg/l	240.00	8.00	136.00	450.00
K	mg/l	31.50	3.40	16.50	65.00
Fe	mg/l	0.58	4.92	0.29	0.21
Hg	ug/l	*	<L.D	<L.D	<L.D
Cr	ug/l	*	<L.D	<L.D	1.52
Mn	ug/l	*	24.06	331.11	303.07
As	ug/l	*	4.69	4.87	1.62
Pb	ug/l	*	7.44	<L.D	2.43
"Anions"					
NO3N	mg/l	1.03	<0.05	2.66	133.12
SO4	mg/l	95.00	1.10	68.24	199.74
Cl	mg/l	47.18	3.93	82.21	86.88
HCO3	mg/l	874.17	44.22	342.44	1070.70
P	mg/l	0.206	0.096	0.397	0.333
NH4	mg/l	-	<0.01	0.360	0.063
NO2N	mg/l	<0.05	0.06	1.51	0.10
F	mg/l	0.47	<0.05	0.75	2.14
B	mg/l	0.90	<0.02	0.90	1.05
T.H	mg/l	414.20	22.65	197.20	508.85
F.A	mg/l	0.00	0.00	0.00	77.36
T.A	mg/l	716.87	36.23	280.82	1032.64
SiO2	mg/l	72.47	24.40	45.98	48.57

ST :Total solid
STD :Total Dissolved Solid
STS :Total Suspension Solid
T :Turbidity
L.D.:Under Permissive Limite

T.H :Total Hardness
F.A :Phenol. Alkalinity
A :Total Alkalinity
C :Coductividity

Table 6-14(2) Results of Physical and Chemical Analyses of Water Quality in the Project Area

ITEMS	UNITS	SAMPLE NUMBER W-5	W-6	W-7	W-8
PHYSICAL PARAMETER					
pH	-	7.86	7.06	7.06	7.52
C	uS/cm	793.00	105.00	94.00	151.00
T	UNT	0.70	120.00	120.00	1800.00
ST	mg/l	902.15	134.68	116.50	1426.00
STD	mg/l	777.15	98.68	88.50	134.04
STS	mg/l	125.00	36.00	28.00	1290.00
CHEMICAL PARAMETER					
"Cations"					
Ca	mg/l	21.74	9.37	7.90	10.56
Mg	mg/l	22.29	3.02	3.12	5.31
Na	mg/l	158.00	11.00	9.00	14.00
K	mg/l	19.25	5.75	4.25	11.30
Fe	mg/l	0.71	7.52	8.06	75.69
Hg	ug/l	*	<L.D	<L.D	<L.D
Cr	ug/l	*	0.16	<L.D	<L.D
Mn	ug/l	*	175.40	74.51	283.81
As	ug/l	*	<L.D	0.73	1.33
Pb	ug/l	*	7.62	<L.D	<L.D
"Anions"					
NO3N	mg/l	1.75	0.27	0.40	14.00
SO4	mg/l	35.18	2.47	1.85	7.11
Cl	mg/l	20.65	4.68	3.75	12.39
HCO3	mg/l	498.29	62.12	58.27	59.37
P	mg/l	0.114	0.214	0.124	1.163
NH4	mg/l	-	0.196	0.033	0.036
NO2N	mg/l	<0.05	0.29	0.14	0.05
F	mg/l	0.44	0.09	<0.05	<0.05
B	mg/l	0.53	<0.02	<0.02	0.04
T.H	mg/l	145.95	35.85	32.50	48.20
F.A	mg/l	0.00	0.00	0.00	0.00
T.A	mg/l	408.63	50.94	47.79	48.69
SiO2	mg/l	65.09	35.73	29.45	27.95

Table 6-14(3) Results of Physical and Chemical Analyses of Water Quality in the Project Area

Items	UNITS	SAMPLE NUMBER W-9	W-11	W-12
PHYSICAL PARAMETERS:				
pH	-	7.88	7.38	7.09
C	uS/cm	232.00	527.00	109.00
T	UNT	100.00	0.56	1400.00
ST	mg/l	241.73	466.37	326.45
STD	mg/l	196.73	459.87	101.45
STS	mg/l	45.00	6.50	225.00
CHEMICAL PARAMETERS "Cations"				
Ca	mg/l	22.97	40.67	8.77
Mg	mg/l	4.84	20.31	3.86
Na	mg/l	20.00	47.00	9.00
K	mg/l	4.25	8.75	8.25
Fe	mg/l	0.65	0.13	26.21
Hg	ug/l	0.21	<L.D	<L.D
Cr	ug/l	1.28	<L.D	0.15
Mn	ug/l	1.09	11.64	82.19
As	ug/l	3.58	<L.D	<L.D
Pb	ug/l	<L.D	0.60	2.46
"Anions"				
NO3N	mg/l	0.10	21.82	0.18
SO4	mg/l	1.52	41.84	1.75
Cl	mg/l	11.22	20.56	4.78
HCO3	mg/l	125.34	258.92	64.86
P	mg/l	0.16	0.15	0.81
NH4	mg/l	0.02	0.11	0.21
NO2N	mg/l	<0.05	0.11	<0.05
F	mg/l	<0.05	0.42	<0.05
B	mg/l	0.03	0.24	0.10
T.H	mg/l	77.15	185.00	37.70
F.A	mg/l	5.40	0 00	0.00
T.A	mg/l	113.59	212.15	53.15
SiO2	mg/l	42.69	94.74	28.28

Table 6-14(4) Results of Physical and Chemical Analyses of Water Quality in the Project Area

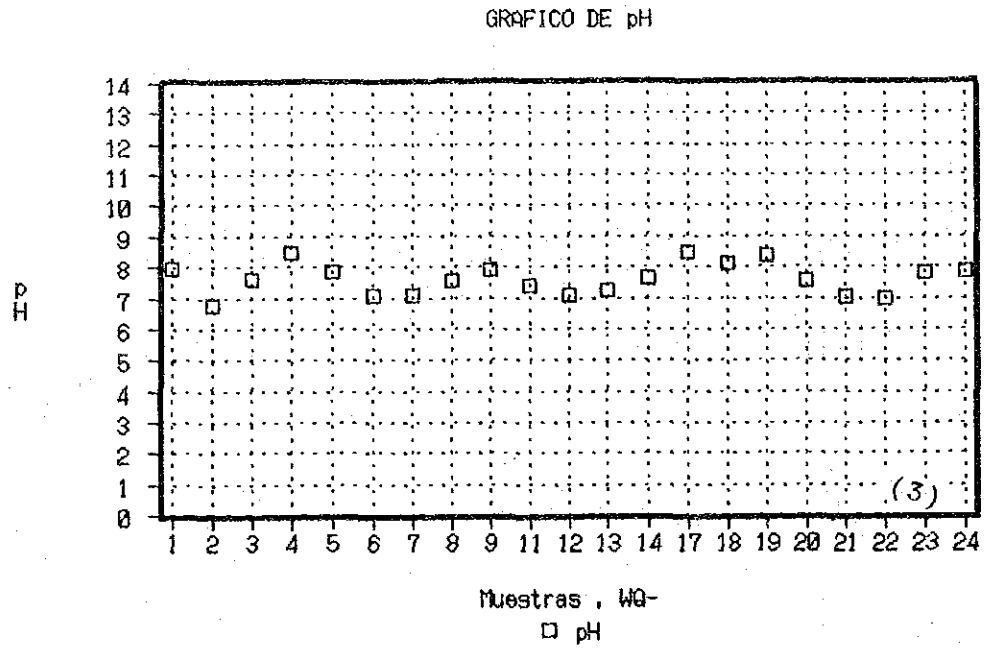
ITEMS	UNITS	SAMPLE NUMBER W-13	W-14
PHYSICAL PARAMETER			
pH	-	7.25	7.62
C	uS/cm	189.00	380.00
T	UNT	550.00	0.90
ST	mg/l	281.90	396.85
STD	mg/l	184.90	320.85
STS	mg/l	97.00	76.00
CHEMICAL PARAMETER			
"Cations"			
Ca	mg/l	15.95	35.49
Mg	mg/l	4.96	7.97
Na	mg/l	17.00	36.50
K	mg/l	18.25	8.10
Fe	mg/l	6.65	0.63
Hg	ug/l	<L.D	0.18
Cr	ug/l	<L.D	0.66
Mn	ug/l	75.21	25.24
As	ug/l	1.87	8.54
Pb	ug/l	0.33	0.09
"Anions"			
NO3N	mg/l	0.52	1.12
SO4	mg/l	4.06	23.29
Cl	mg/l	14.35	15.43
HCO3	mg/l	109.95	192.95
P	mg/l	0.65	0.31
NH4	mg/l	1.08	0.11
NO2N	mg/l	0.18	0.06
F	mg/l	<0.05	0.23
B	mg/l	0.04	0.04
T.H	mg/l	61.65	121.30
F.A	mg/l	0.00	0.00
T.A	mg/l	90.16	158.23
SiO2	mg/l	21.01	42.91

Table 6-14(5) Results of Physical and Chemical Analyses of Water Quality in the Project Area

Items	UNITS	SAMPLE NUMBER W-17	W-18	W-19	W-20
PHYSICAL PARAMETERS:					
pH	-	8.49	8.12	8.38	7.52
C	uS/cm	412.00	322.00	368.00	774.00
T	UNT	0.90	110.00	0.92	0.63
ST	mg/l	392.83	330.34	363.00	729.33
STD	mg/l	347.83	262.34	323.00	685.33
STS	mg/l	45.00	68.00	40.00	44.00
CHEMICAL PARAMETERS "Cations"					
Ca	mg/l	47.85	36.68	43.07	43.46
Mg	mg/l	9.67	7.50	9.18	24.42
Na	mg/l	31.00	17.00	23.00	100.00
K	mg/l	4.00	3.10	6.00	5.75
Fe	mg/l	0.13	1.08	0.16	0.13
Hg	ug/l	0.21	0.10	0.19	<L.D
Cr	ug/l	0.54	0.89	0.52	<L.D
Mn	ug/l	8.16	14.20	1.38	13.52
As	ug/l	2.17	8.54	2.53	0.25
Pb	ug/l	3.69	4.38	2.91	<L.D
"Anions"					
NO3N	mg/l	<0.05	0.45	0.42	103.92
SO4	mg/l	4.69	31.80	5.35	13.12
Cl	mg/l	12.63	7.01	10.76	25.80
HCO3	mg/l	203.94	154.75	214.41	368.86
P	mg/l	0.18	0.14	0.24	0.16
NH4	mg/l	0.02	0.03	0.02	0.15
NO2N	mg/l	<0.05	<0.05	<0.05	2.80
F	mg/l	0.17	0.11	0.23	2.22
B	mg/l	0.13	0.02	0.05	<0.01
T.H	mg/l	159.15	122.30	145.25	208.45
F.A	mg/l	28.40	3.38	9.01	0.00
T.A	mg/l	224.03	133.66	193.60	302.25
SiO2	mg/l	60.13	36.57	55.83	52.54

Table 6-14(6) Results of Physical and Chemical Analyses of Water Quality in the Project Area

Items	UNITS	SAMPLE NUMBER W-21	W-22	W-23	W-24
PHYSICAL PARAMETERS:					
pH	-	7.02	7.00	7.81	7.86
C	uS/cm	296.00	83.0	326.00	600.00
T	UNT	0.56	110.00	180.00	110.00
ST	mg/l	373.39	93.86	328.65	590.65
STD	mg/l	269.39	72.86	287.65	518.65
STS	mg/l	104.00	21.00	41.00	72.00
CHEMICAL PARAMETERS "Cations"					
Ca	mg/l	18.34	7.18	31.90	58.62
Mg	mg/l	8.94	1.45	6.35	6.53
Na	mg/l	36.00	11.00	32.00	59.00
K	mg/l	0.90	3.25	10.00	10.60
Fe	mg/l	0.07	1.95	0.80	0.53
Hg	ug/l	<L.D	0.21	0.11	0.13
Cr	ug/l	<L.D	1.28	0.68	0.82
Mn	ug/l	31.83	1.09	16.12	48.18
As	ug/l	<L.D	3.58	3.17	3.21
Pb	ug/l	0.66	<L.D	3.57	8.52
"Anions"					
NO3N	mg/l	6.26	<0.05	<0.05	12.45
SO4	mg/l	4.47	0.44	3.77	25.06
Cl	mg/l	8.13	12.16	12.15	17.77
HCO3	mg/l	186.35	37.38	186.91	322.14
P	mg/l	0.18	0.05	0.53	0.40
NH4	mg/l	0.02	0.03	0.02	0.07
NO2N	mg/l	<0.05	<0.05	<0.05	0.36
F	mg/l	<0.05	<0.05	0.21	0.24
B	mg/l	<0.01	<0.02	0.04	0.08
T.H	mg/l	82.55	23.85	106.45	173.10
F.A	mg/l	0.00	0.00	2.70	5.40
T.A.	mg/l	152.70	30.62	158.55	270.82
SiO2	mg/l	46.88	45.41	40.76	52.20



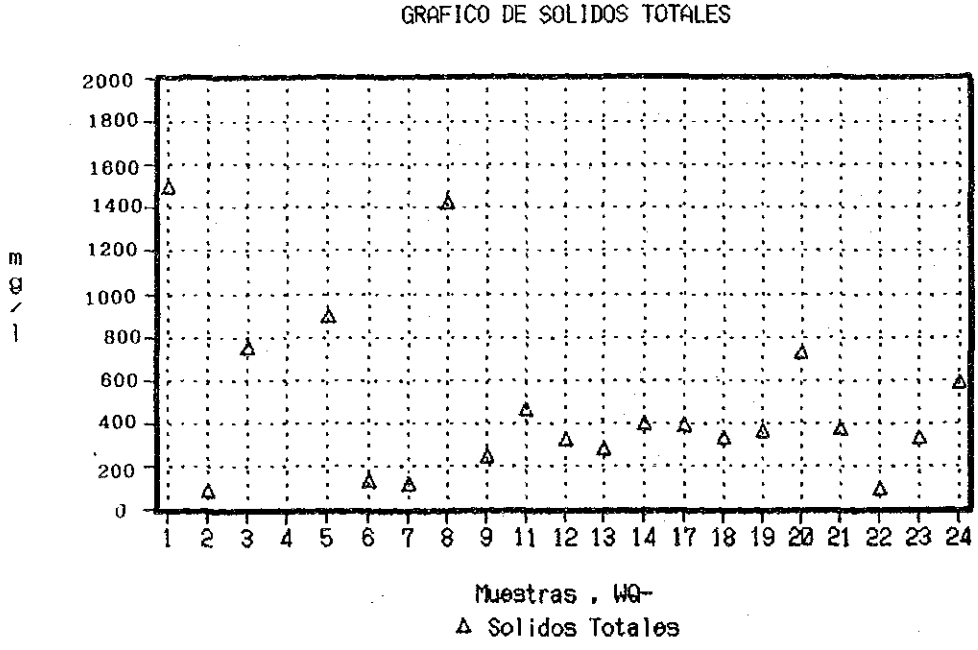
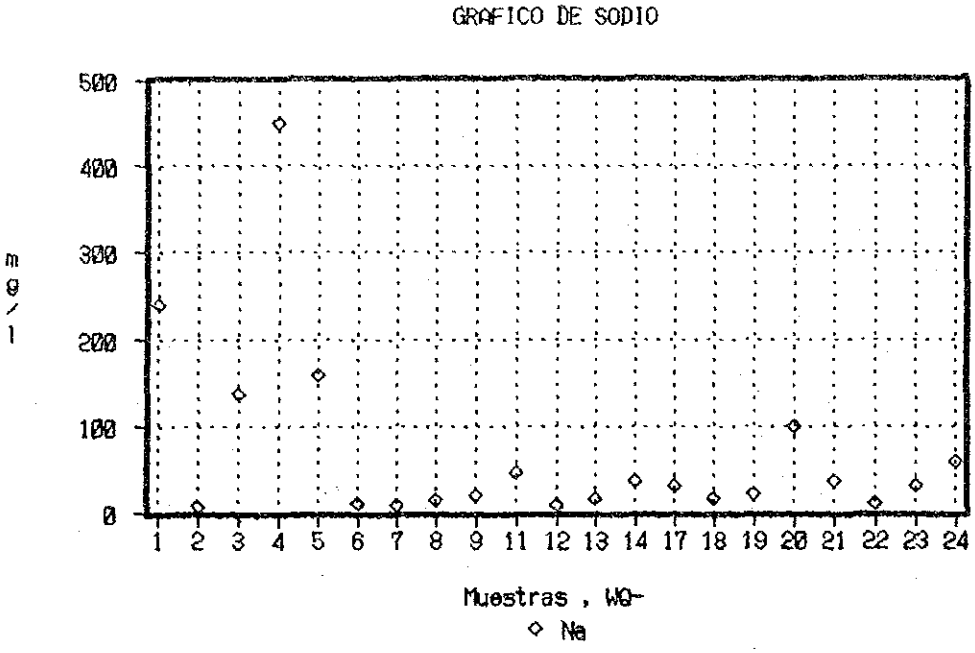


Figure 6-22(1) Water Quality in the Project Area



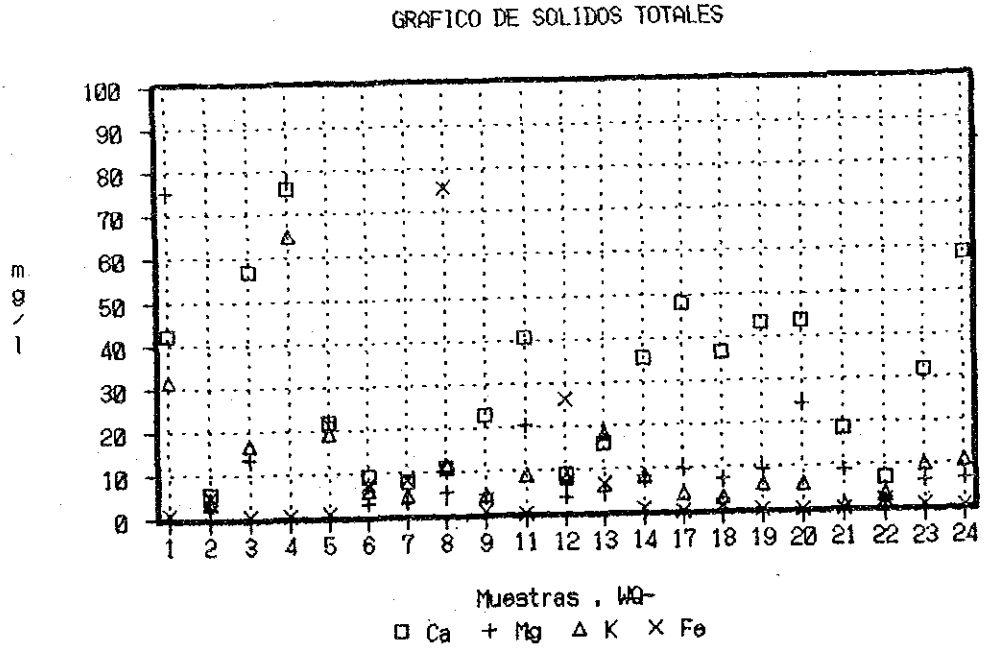
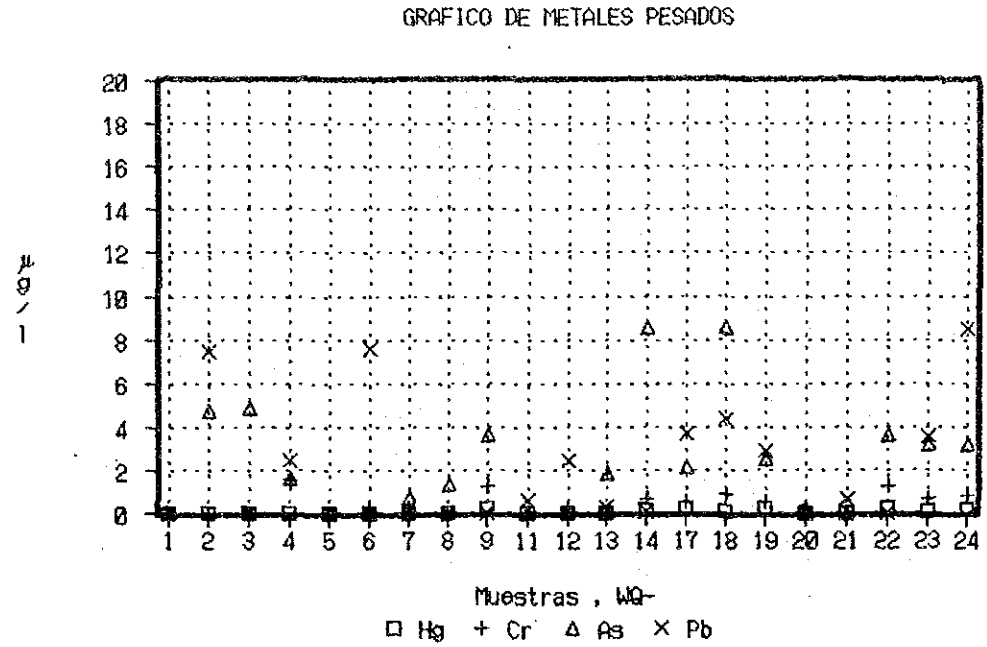


Figure 6-22(2) Water Quality in the Project Area



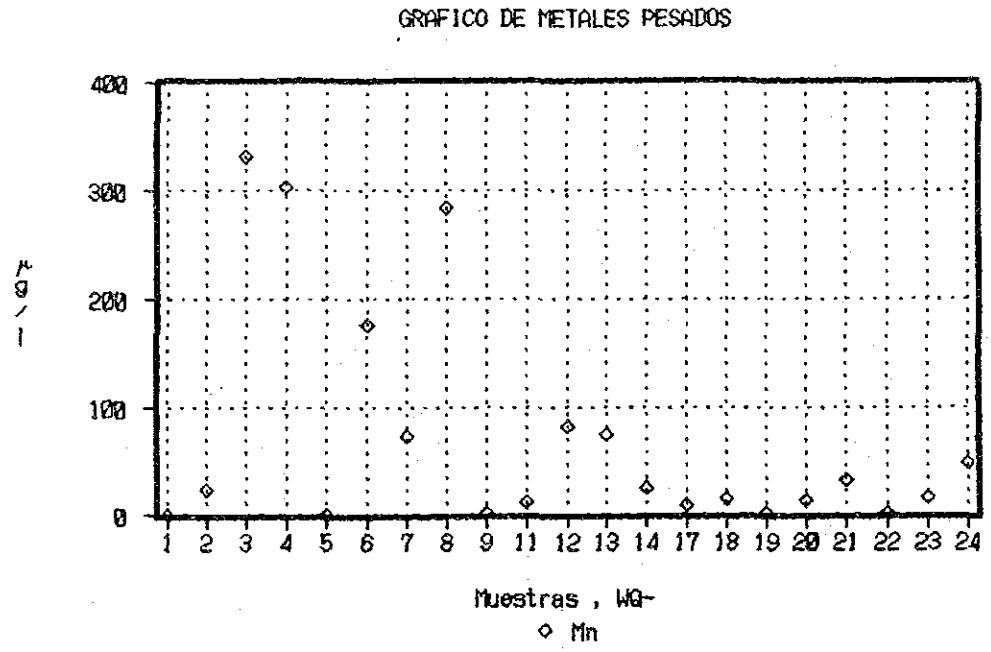
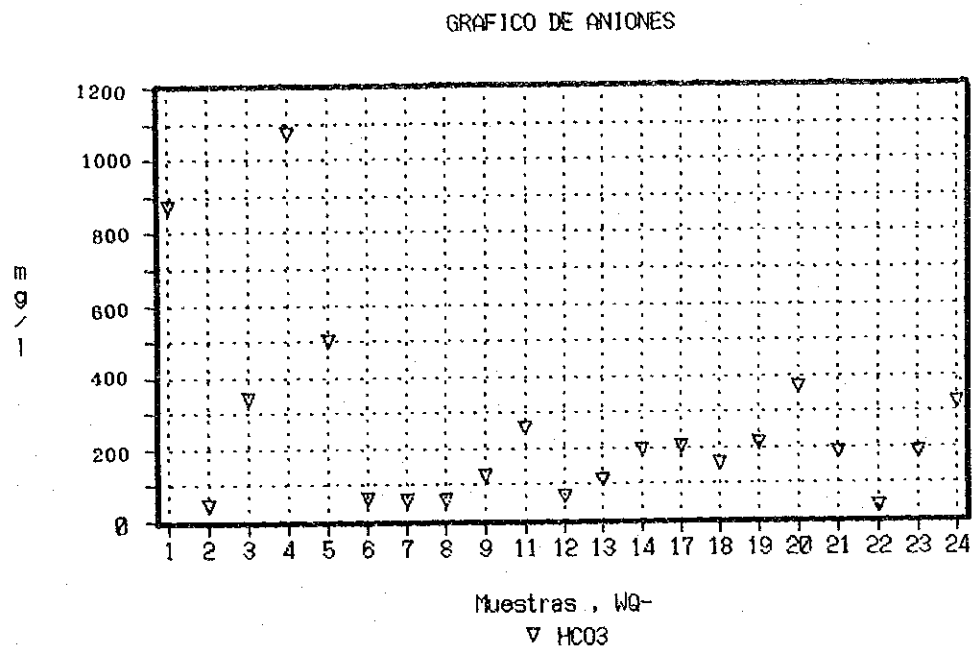


Figure 6-22(3) Water Quality in the Project Area



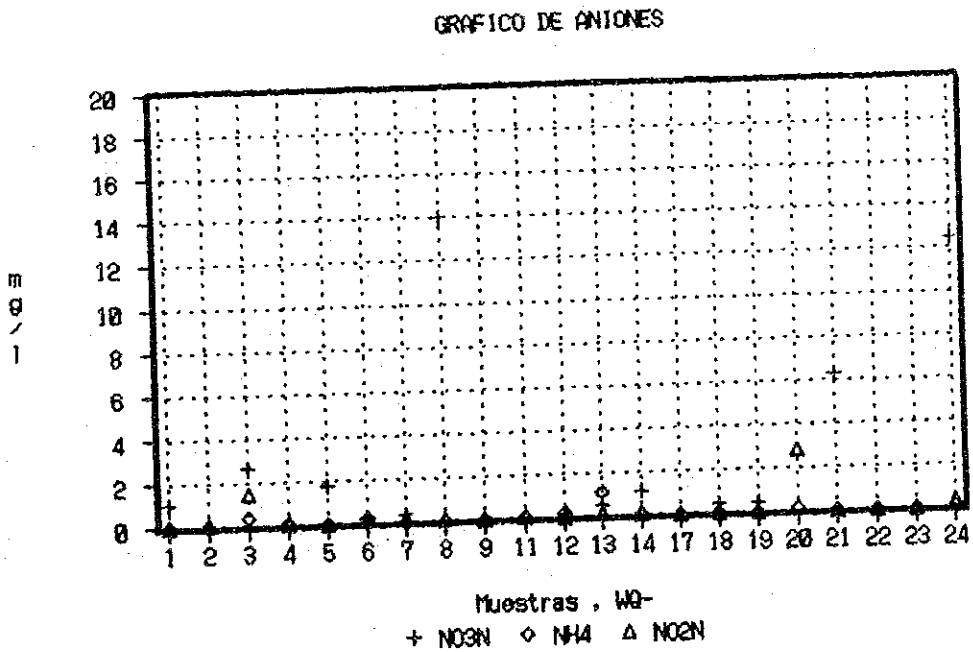
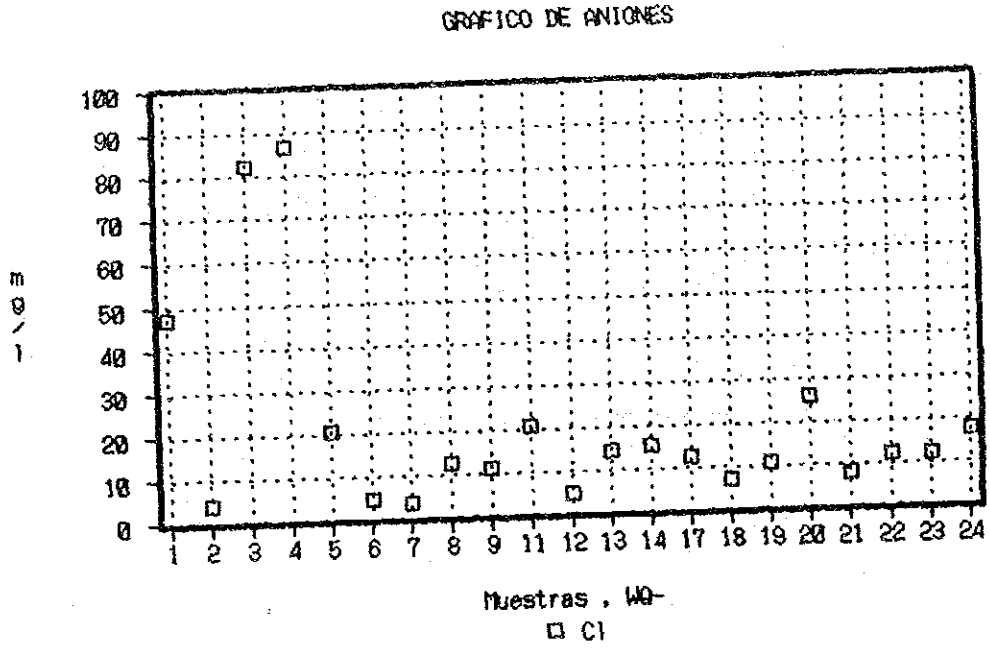


Figure 6-22(4) Water Quality in the Project Area



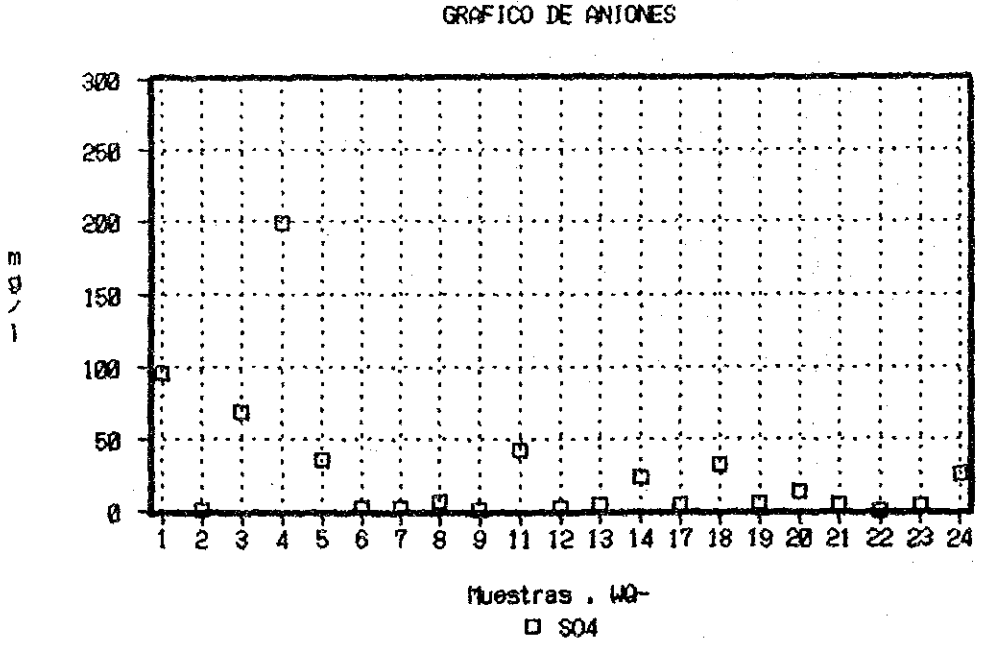
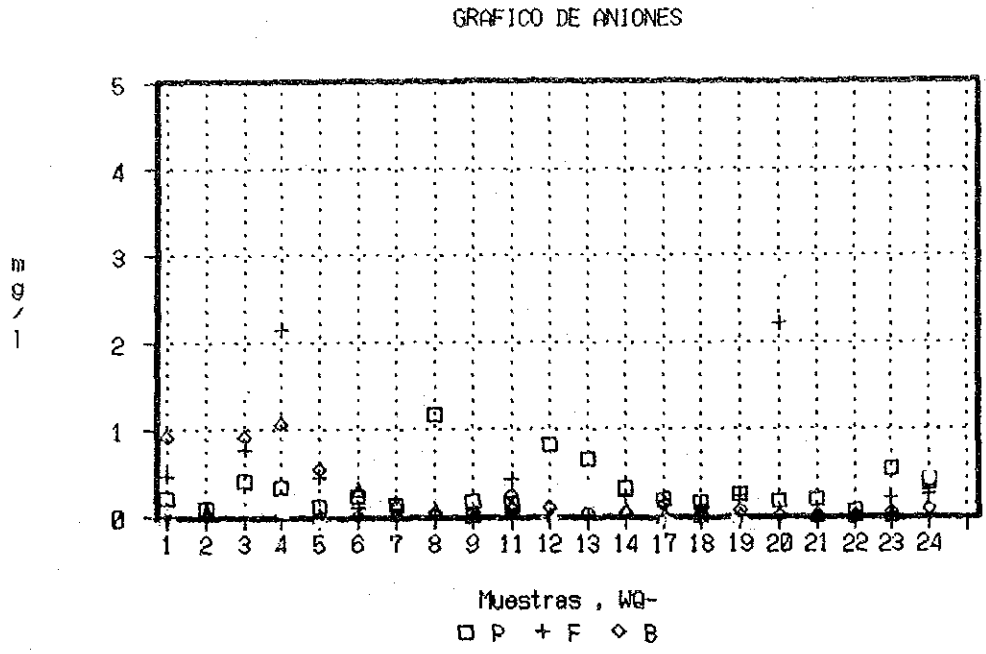


Figure 6-22(5) Water Quality in the Project Area



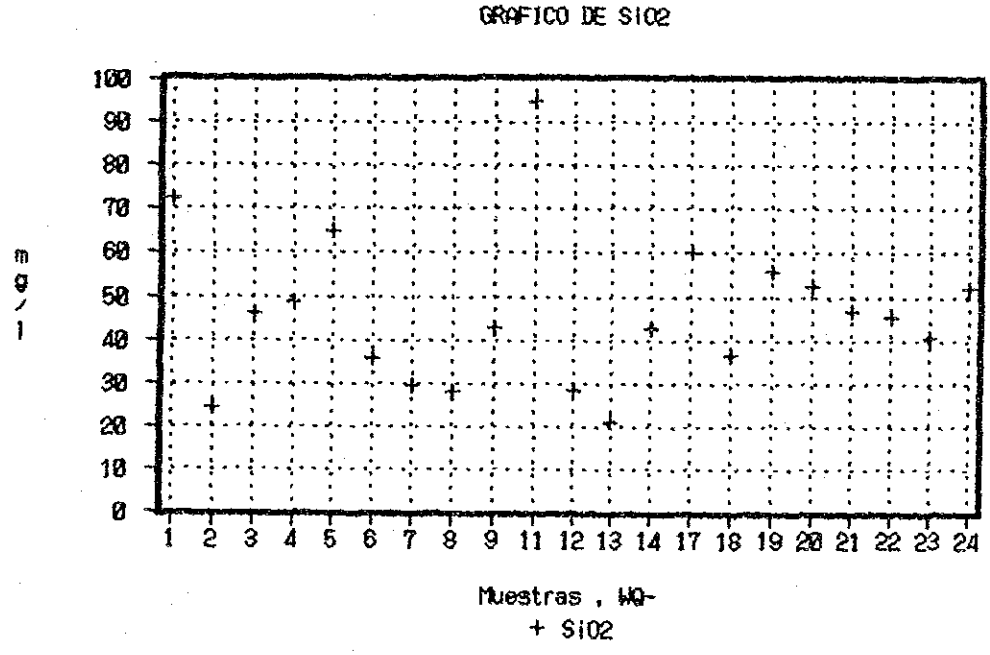


Figure 6-22(6) Water Quality in the Project Area

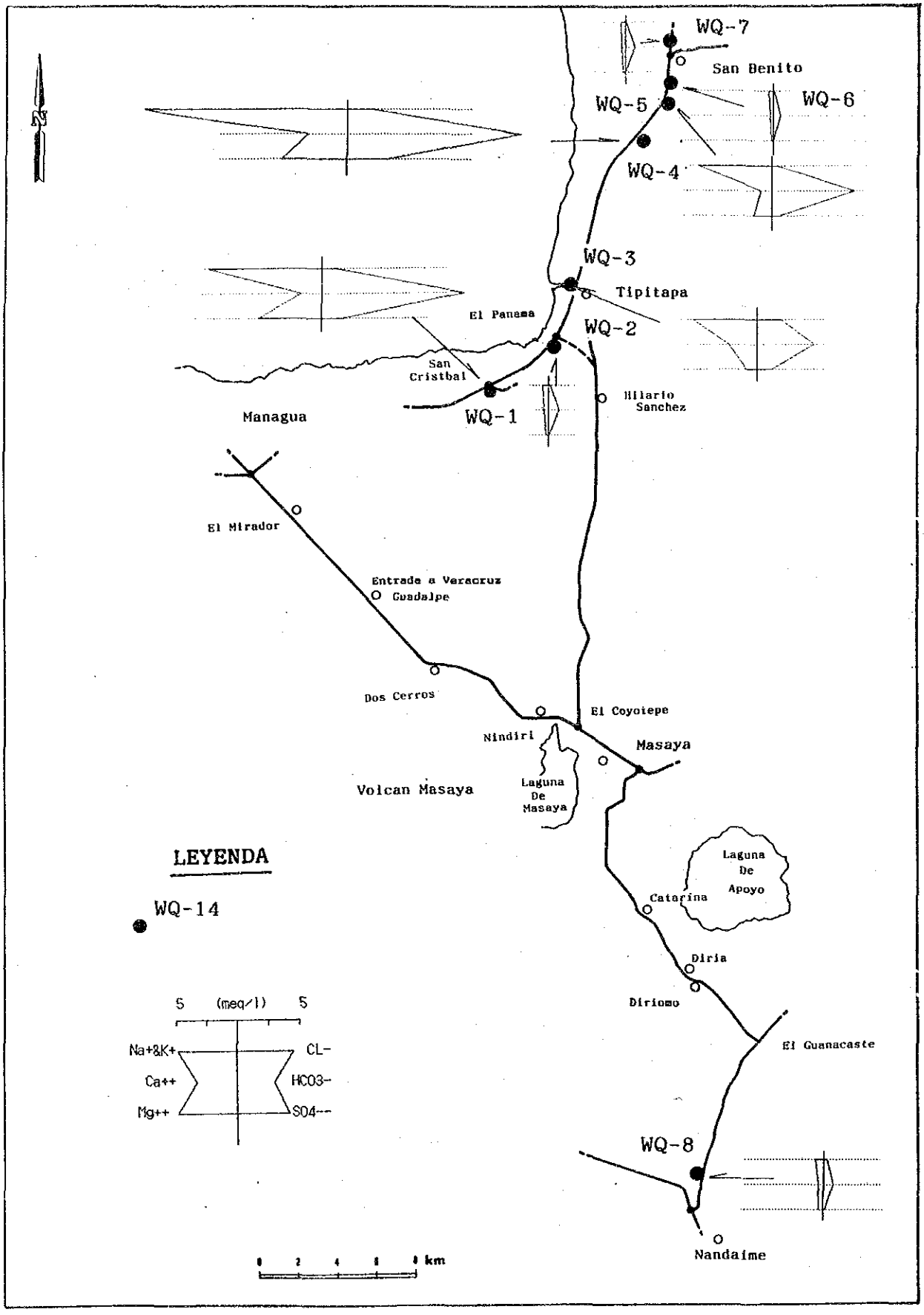


Figure 6-23(1) Hexa-Diagram of Water Qwality in the Project Area

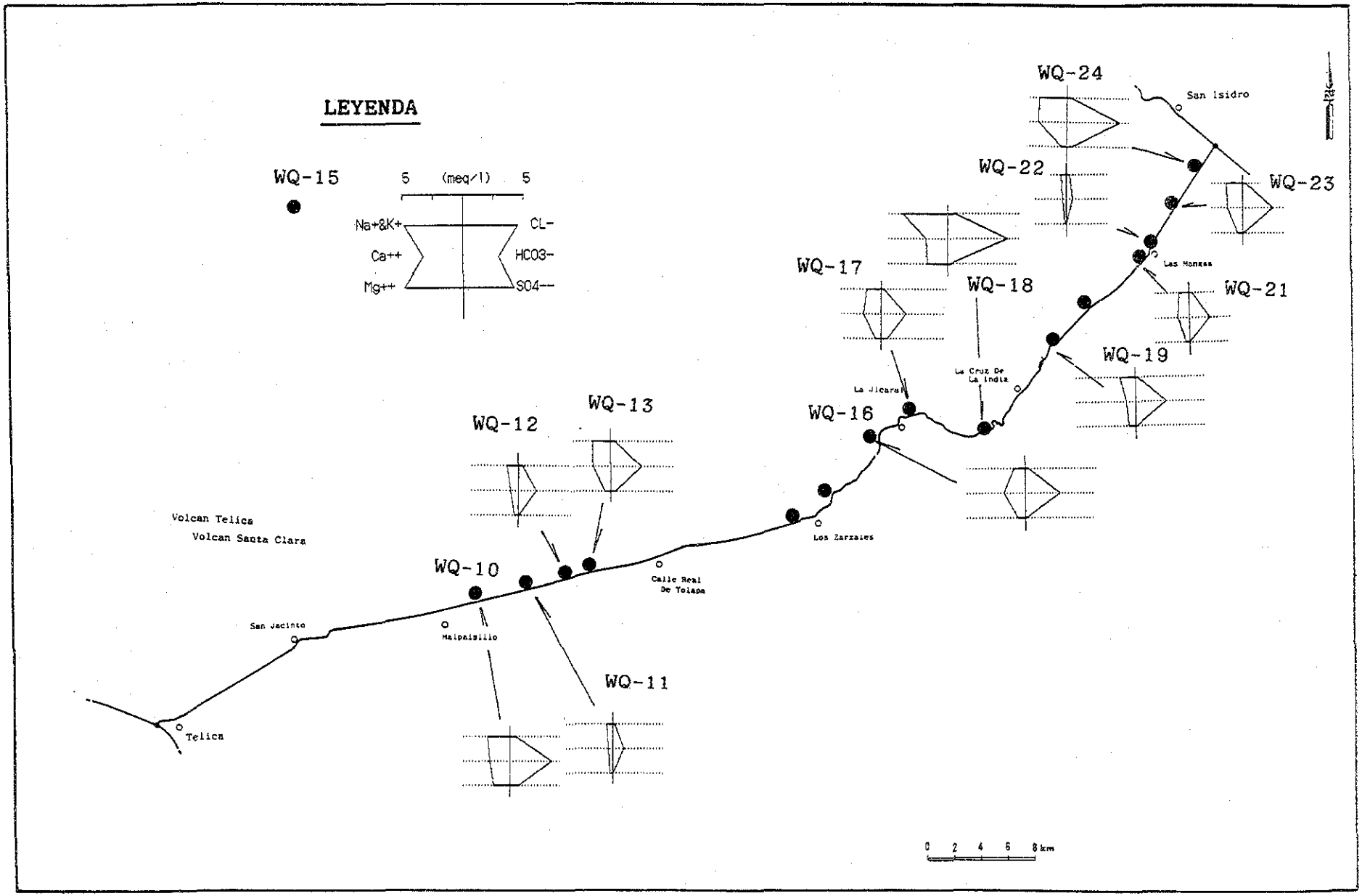
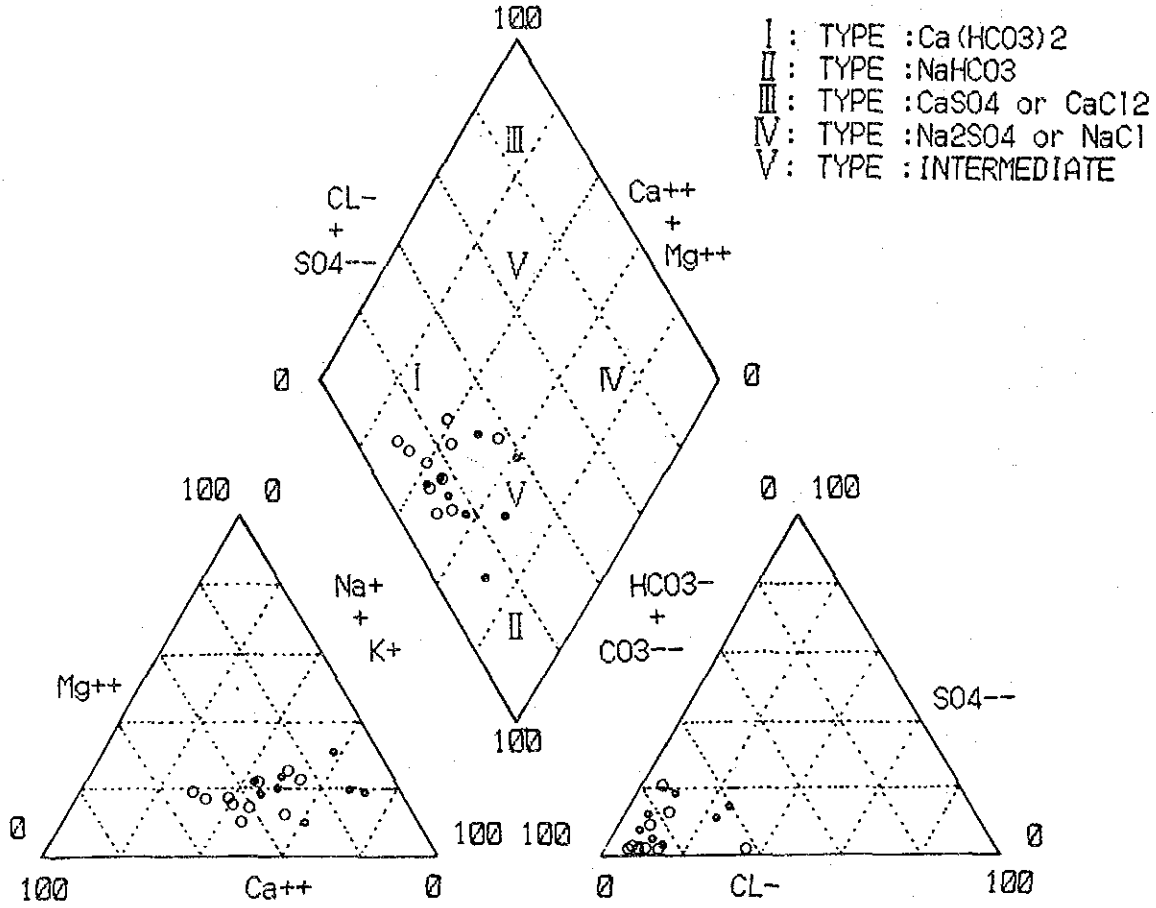


Figure 6-23(2) Hexa-Diagram of Water Qwality in the Project Area



-- KEY DIAGRAM --

O Telica -- San Isidro

o Tipitapa -- San Benito, Nandaime

Figure 6-24 Key Diagram of Water Quality in the Project Area

6.4.2 Examination of Water Quality

Influence on water quality by road is thought to be occurrence of suspended solid (SS) from bare ground at the stage of construction. The examination of SS is used results of Jar Test of soil in the project area. The examination area is whole of project area.

(1) Method of examination

The value of suspended solid discherged from bare ground is tentatively computed by Formula 6-2. The velosity of water at the work site is culculated by Formula 6-3.

$$S = So \times \frac{Q}{Q + A1*w} \qquad \text{(Formula 6-2)}$$

$$Q = (R*A2/3.6x10^5)*(1-I)$$

S : Suspended solid (SS) (ppm)
So : Amount of SS (mg/l), using result of Jar Test
Q : Inflow (m3/s)
R : Intensity of rain-fall (mm/hour)
A1 : Area of water course (m2)
A2 : Area of bare ground (m2)
w : Precipitation speed (intermediate grain size : < 5um : 0.018 mm/s)
I : Rate of Infiltration

$$V = 72\ (H/L)^{0.6} \qquad \text{(Formula 6-3)}$$

V : Flowing speed at the edge of bare ground (m/s)
H : Difference of height (m)
L : Length of water course (m)

(2) Condition of predicted site

The condition of predicted site is as follows:

Bare ground due to the construction :
- area : 10,000 m2 (500 m x 20 m)
- Gradient of water course : 1.0 %
- Period of probable intensity of rain-fall : 25 years
- Velosity of water at the edge of area : 4.54 m/s (110 min)
- Concentration of SS : refer to result of Jar Test
- Rate of Infiltration : 0.3
- Area of water course : 600 m2 (0.6 m x 500 m)

(3) Results of prediction

The results of simulation concerning SS are shown in Table 6-15. The prediction value of SS ranges 101 to 184 ppm,

which is less than environmental quality standard for water quality (< 200 ppm). The sections between Masaya and Nandaime and Managua and San Benito are slightly higher concentration than other road sections.

In addition, the water quality of rivers which have not parmanent current, will contain much dissolved components such as Na, K, Ca, HCO3, SO4, etc.

Table 6-15 Predicted Suspended Solid from Bare Ground

Section	Kind of Soil *1	SS *2 (g/l)	I.R. *3	Q.I. *4	SS *5 (ppm)
1. Managua - Masaya	I	1.08	60	1.17	106
2. Masaya - Tipitapa	I	1.94	56	1.09	101
3. Masaya - Nandaime	I	2.0	56	1.09	184
4. Managua - San Benito	V	1.7	60	1.09	156
5. Telica - Loz Zarzales	M	1.28	44	0.86	104
6. Los Zarzales San Isidro	V	1.83	44	0.86	148

* 1 : I :Inceptisol, M :Mollisol, V :Vertosol
* 2 : Average Suspended Solid measured by Jar Test
* 3 : Intensity of probable rain-fall (mm/h)
* 4 : Quantity of inflow (m3)
* 5 : Predicted concentration of suspended solid

6.4.3 Evaluation of Water Quality

The suspended solis (SS) will occur from bare ground during rain-fall at the stage of road construction. The predicted SS value will be 100 to 190 ppm which is less than environmental quality standard for water quality (200 ppm). But, it is necessary to prevent SS from bare ground by monitoring at the stage of road construction.

6.5 Noise and Vibration

6.5.1 Present Condition

(1) Source of Noise and Vibration

The source of Noise and Vibration is generally thought to be automobiles, train, factory, office, house, construction works, human activity, animals and natural phenomena. The basic data of Noise and Vibration in Nicaragua is not existed at present.

(2) Field investigation

The field investigation was carried out only measurement of noise. At present, the vibration pollution is thought to be nearly not existing, so that the field investigation of vibration was excluded.

a. Components of measurement

The number of field investigation of the Noise is 28 places (6 sections) as shown in Table 6-16 and Figure 6-25. Investigating places are limited at the urban areas and major intersections.

b. Method of noise measurement

Method of noise measurement is "Sound level measurement method" using Sound level meter (NA-20, JAPAN). The height of measurement is 1.2 m above from surface of the earth. The period and number of measurement are 24 hours and 24 times respectively. The measured time is 10 minutes for taking 100 samples (dB(A)) of noise being 5 seconds interval.

c. Result of measurement

Results of noise measurement were computed central value (L50) and 90 % range value (L5 and L95) and are shown in Figure 6-26 (refer to Appendix 10). All of data of noise are compiled to four division as follows:

Morning	:	5:00 - 8:00
Daytime	:	8:00 - 17:00
Evening	:	17:00 - 21:00
Night	:	21:00 - 5:00

The noise level in Managua, Masaya, Nandaime, Tipitapa and San Benito ranges 42 to 70 dB(A). These values except night in some places are beyond environmental quality standard for noise as shown in Table 4-3 (60, 55 and 50 dB(A)). The noise between Managua and Masaya is quite high, ranging 63 to 70 dB(A).

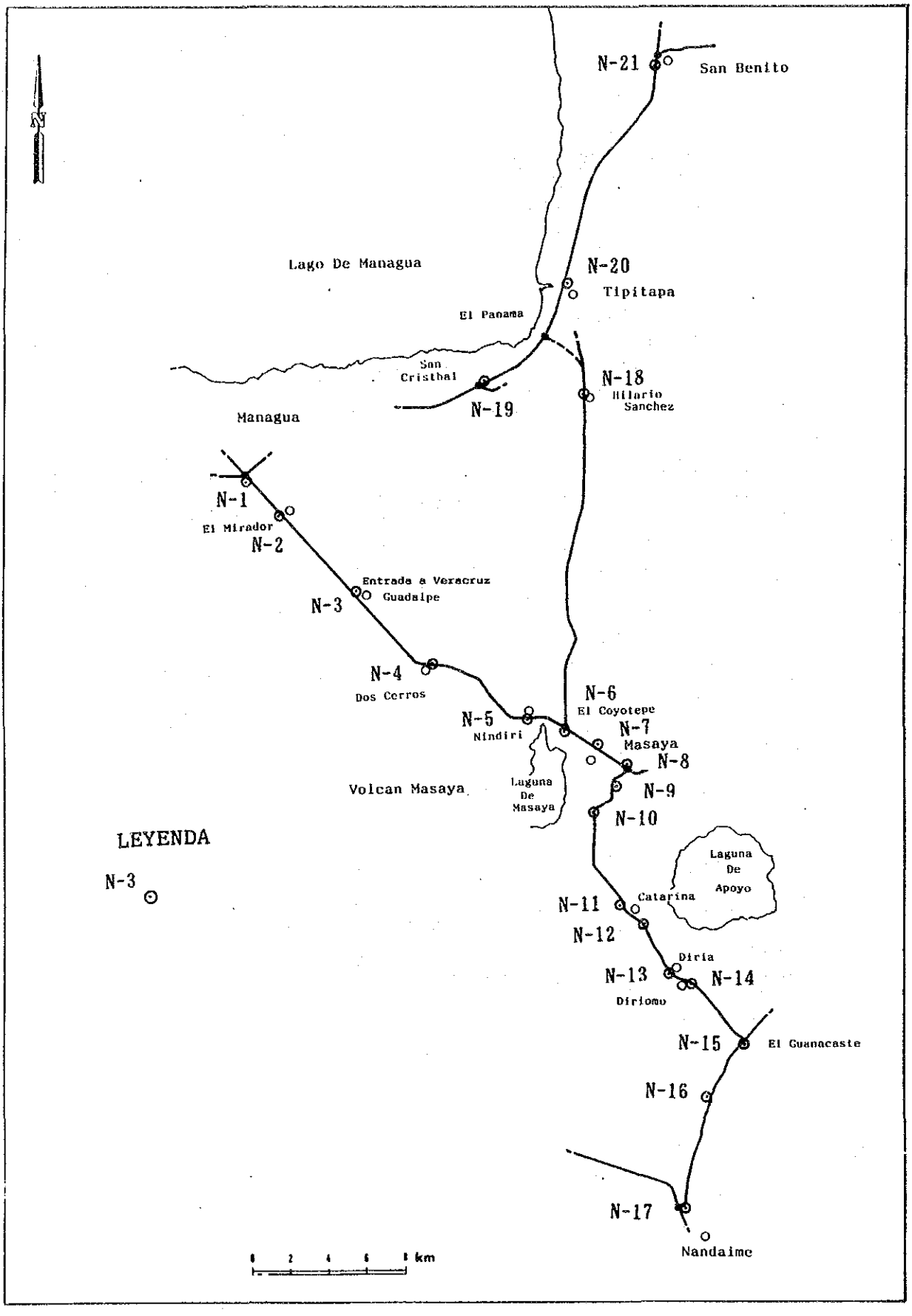


Figure 6-25(1) Location Map of Noise Measurement

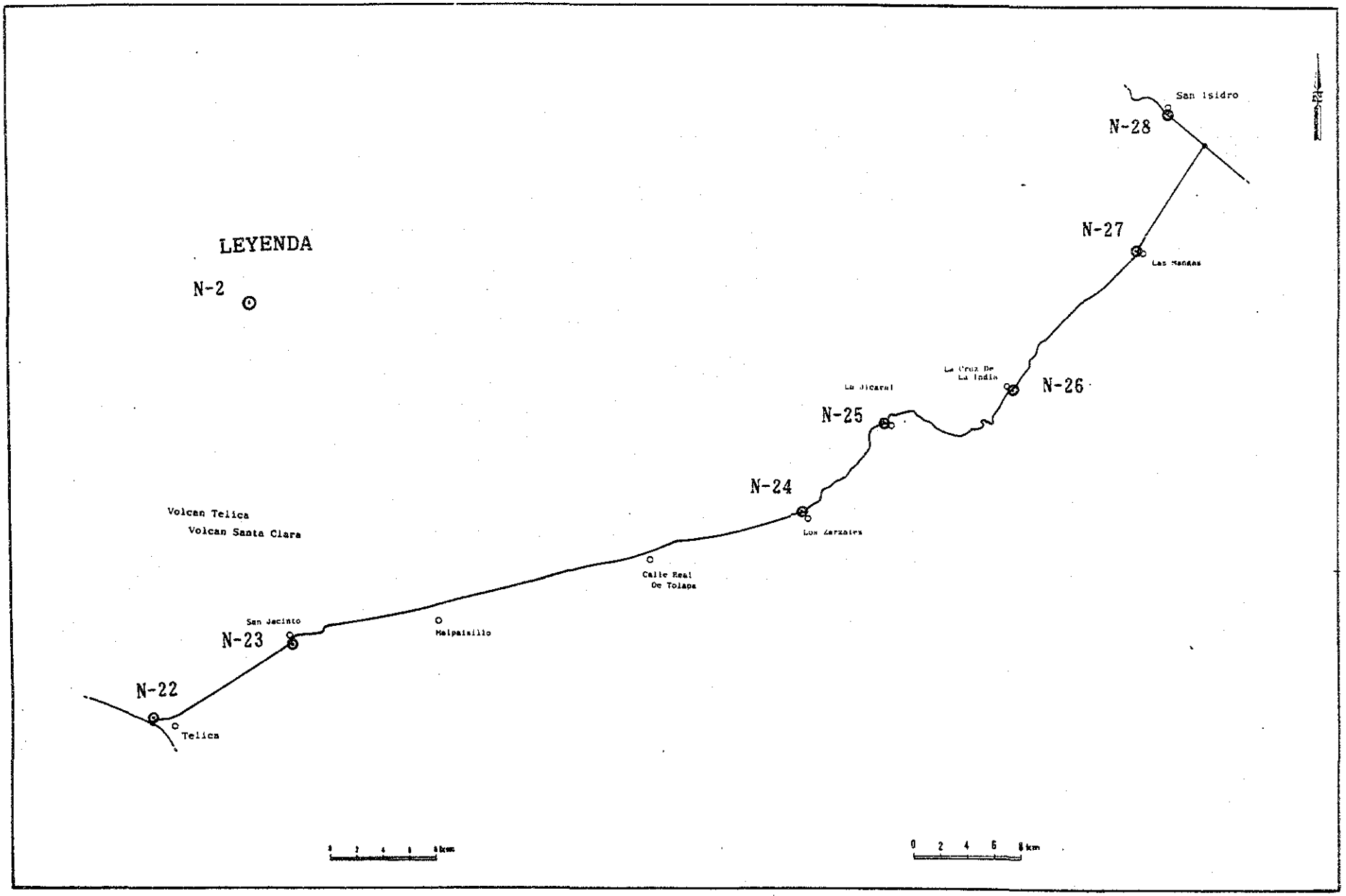


Figure 6-25(2) Location Map of Noise Measurement

Table 6-16(1) Present Condition of Noise in the Project Area

(1) Sound level at the boundary of the roads

Ubicacion (Fecha)	dB(A)	Hora																						
		8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	1	2	3	4	5	6	7
N-1	L(50)	71	69	71	71	71	69	70	68	67	68	68	70	64	65	64	61	55	49	52	46	59	60	67	72
N-2	L(50)	69	69	73	69	70	57	70	71	69	71	71	67	62	74	64	71	44	44	44	46	52	61	69	71
N-3	L(50)	67	67	64	63	63	71	65	64	66	65	65	64	64	55	54	54	49	46	47	45	44	47	49	62
N-4	L(50)	69	60	64	63	59	62	64	64	69	70	74	69	59	60	59	54	57	58	58	55	56	56	60	78
N-5	L(50)	73	69	55	59	66	69	71	55	58	69	-	63	64	60	61	48	34	44	40	35	43	56	55	62
N-6	L(50)	69	65	69	70	69	70	69	82	66	67	65	65	60	59	57	44	48	32	35	37	38	50	61	69
N-7	L(50)	70	70	68	67	68	66	70	67	65	68	67	64	59	60	53	49	52	-	-	-	47	58	58	67
N-8	L(50)	62	57	58	69	65	59	60	55	53	55	55	55	52	50	40	40	-	-	-	-	50	49	55	64
N-9	L(50)	51	50	57	52	50	50	49	48	56	64	63	54	49	55	48	44	46	44	37	35	36	46	46	46
N-10	L(50)	64	55	61	63	59	60	62	57	67	66	66	51	56	55	59	52	44	41	36	38	34	45	45	56
N-11	L(50)	62	53	54	58	49	55	54	52	58	55	52	46	54	46	45	40	46	46	44	44	--	-	-	58
N-12	L(50)	60	56	58	56	60	56	52	59	57	55	58	48	49	47	52	48	42	40	44	47	-	-	-	55
N-13	L(50)	44	49	44	46	51	51	55	50	51	59	62	51	55	55	45	48	-	-	47	54	47	49	52	54
N-14	L(50)	53	46	49	46	56	45	51	45	43	57	53	55	46	43	45	45	-	-	41	41	38	47	53	54
N-15	L(50)	52	50	56	49	46	58	51	57	52	57	53	58	50	53	50	53	50	49	51	48	48	45	46	55
N-16	L(50)	52	53	62	55	62	52	54	55	62	47	61	59	57	50	51	49	42	35	36	39	37	32	45	45
N-17	L(50)	63	63	59	55	59	-	61	65	63	65	67	58	61	49	41	53	46	47	47	50	53	57	63	64
N-18	L(50)	36	62	57	62	39	47	37	55	54	58	64	61	57	49	51	52	45	45	43	41	51	51	59	48
N-19	L(50)	65	62	65	60	60	62	57	67	66	69	67	66	63	63	51	53	51	51	50	48	47	55	62	67
N-20	L(50)	62	62	66	51	61	60	-	63	67	62	68	62	63	63	58	60	39	49	43	45	51	44	51	57
N-21	L(50)	65	62	65	59	61	62	63	61	66	63	61	59	59	60	57	53	32	37	42	40	39	46	48	57
N-22	L(50)	52	48	50	45	48	43	48	51	57	57	57	47	45	36	38	48	51	43	47	47	40	42	46	59
N-23	L(50)	47	41	47	46	33	43	41	41	45	51	45	45	44	42	38	41	45	41	46	35	42	45	53	48
N-24	L(50)	44	42	47	45	50	44	38	43	44	50	49	44	38	37	48	36	46	46	46	47	46	45	45	34
N-25	L(50)	36	33	37	40	29	33	43	37	42	43	48	50	47	46	45	44	39	38	37	34	33	35	46	52
N-26	L(50)	40	44	37	34	35	38	41	28	47	34	48	50	45	41	50	45	38	38	36	34	34	42	39	45
N-27	L(50)	44	44	48	47	46	37	40	34	40	32	44	41	50	43	41	43	45	41	40	43	43	44	47	46
N-28	L(50)	63	63	59	59	59	63	58	55	54	55	53	52	58	41	37	37	40	39	35	38	38	52	57	58

Table 6-16(2) Present Condition of Noise in the Project Area

(2) Traffic volume

Ubicacion (Fecha)		Hora																							
		8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	1	2	3	4	5	6	7
N-1	Small V.	192	199	205	202	200	201	213	212	191	216	222	119	135	113	62	47	27	27	18	1	4	14	33	185
	Large V.	18	15	25	18	21	32	20	15	19	12	13	11	3	6	4	2	2	4	2	12	14	11	22	34
N-2	Small V.	139	128	127	125	187	120	135	141	152	148	148	118	75	81	35	17	9	11	4	5	10	17	47	265
	Large V.	11	20	16	13	18	13	16	17	13	22	14	9	1	6	3	0	0	0	0	1	3	12	18	18
N-3	Small V.	137	87	100	60	53	43	72	72	89	97	128	90	50	35	10	15	2	2	3	2	2	7	17	58
	Large V.	15	17	21	11	13	10	11	17	19	16	13	5	3	1	4	3	1	2	3	1	1	4	5	8
N-4	Small V.	65	55	55	49	46	77	66	56	104	100	98	65	32	43	20	7	3	2	2	3	5	11	30	79
	Large V.	13	13	15	11	11	11	14	15	18	12	9	10	8	4	4	3	3	1	0	3	5	6	7	12
N-5	Small V.	71	96	57	76	54	60	85	63	81	68	-	82	50	45	30	12	6	11	3	4	7	11	6	57
	Large V.	9	9	7	15	10	13	9	18	13	12	-	8	3	3	1	0	0	0	2	0	1	5	9	6
N-6	Small V.	115	87	102	83	85	86	80	210	90	109	110	81	35	26	26	7	12	2	3	1	2	14	37	100
	Large V.	15	17	17	23	7	19	20	50	18	22	10	10	5	3	2	2	0	1	1	2	7	4	7	17
N-7	Small V.	52	56	54	42	38	47	54	55	57	44	64	58	43	32	10	8	3	-	-	-	2	5	8	34
	Large V.	11	15	7	9	13	7	12	9	8	14	18	12	4	0	5	3	5	-	-	-	3	5	7	8
N-8	Small V.	20	13	18	19	22	18	21	26	22	14	23	17	18	11	5	2	-	-	-	-	15	2	6	20
	Large V.	9	5	4	8	5	10	7	4	5	8	9	2	4	0	0	0	-	-	-	-	9	3	6	7
N-9	Small V.	18	16	34	25	24	15	23	29	37	22	20	21	18	12	2	12	1	0	0	1	3	3	3	4
	Large V.	4	5	8	1	5	8	7	4	5	8	11	6	3	2	1	3	0	0	0	0	0	0	1	0
N-10	Small V.	32	29	42	35	37	37	31	36	50	44	40	32	10	13	15	11	0	0	0	1	0	2	2	23
	Large V.	13	2	9	15	5	6	9	5	20	13	5	10	3	0	6	4	0	0	0	0	0	0	0	5
N-11	Small V.	15	8	14	22	21	19	11	31	25	40	33	15	13	8	8	8	3	2	1	2	-	-	-	10
	Large V.	5	3	3	6	5	4	6	3	1	3	5	3	4	3	1	2	1	0	0	0	-	-	-	9
N-12	Small V.	13	17	20	14	11	10	9	15	22	23	26	14	13	9	7	6	1	0	0	2	-	-	-	13
	Large V.	3	3	4	8	2	6	4	7	6	4	6	3	5	3	1	2	0	0	0	1	-	-	-	0
N-13	Small V.	11	15	10	12	10	12	10	12	12	12	29	13	4	8	2	2	-	-	3	2	1	4	9	11
	Large V.	9	6	4	3	2	6	3	7	6	6	13	7	2	2	0	0	-	-	1	0	2	1	8	13
N-14	Small V.	12	10	9	15	15	7	9	18	4	13	15	9	7	2	1	1	-	-	3	3	3	4	7	10
	Large V.	2	2	4	2	4	2	2	7	3	1	3	1	4	2	0	0	-	-	2	0	1	3	3	8
N-15	Small V.	18	19	11	10	14	18	14	11	8	20	15	14	5	10	5	3	8	6	7	6	3	9	7	5
	Large V.	3	7	6	4	6	6	6	9	5	6	3	5	3	4	1	0	1	1	1	1	3	3	2	8
N-16	Small V.	16	23	13	14	1	9	22	15	20	15	15	8	5	5	7	4	6	4	8	5	5	8	6	9
	Large V.	2	2	5	6	2	6	14	4	6	12	11	4	4	0	0	0	1	0	2	0	1	2	2	1
N-17	Small V.	10	15	24	21	19	-	32	14	11	21	15	14	8	1	5	0	0	2	1	1	1	8	9	9
	Large V.	5	7	6	7	9	-	9	12	8	6	11	4	2	1	2	4	0	0	0	0	2	6	12	8
N-18	Small V.	8	20	14	16	9	15	12	19	12	17	19	19	8	3	4	2	0	0	5	0	5	5	11	8
	Large V.	0	3	3	3	7	3	1	3	11	8	12	3	2	3	1	1	0	0	3	0	4	3	3	5
N-19	Small V.	47	26	31	14	16	29	34	43	42	40	43	46	22	12	5	8	4	5	4	2	7	9	15	29
	Large V.	13	11	10	4	10	8	14	9	13	19	8	7	5	7	2	0	2	1	4	1	0	6	9	14
N-20	Small V.	34	31	38	29	25	33	-	42	70	36	35	30	18	35	9	10	3	1	2	3	2	1	13	9
	Large V.	10	9	13	7	7	7	-	15	15	7	12	19	7	11	4	5	0	0	0	1	2	0	3	5
N-21	Small V.	23	21	30	13	20	22	24	33	60	33	21	15	10	15	5	6	1	1	1	2	2	6	12	9
	Large V.	9	7	9	10	14	8	7	8	15	8	10	7	11	8	6	5	1	0	1	1	0	4	4	4
N-22	Small V.	6	10	6	7	11	1	5	7	11	19	5	12	6	4	3	1	0	0	1	2	2	1	3	6
	Large V.	2	2	2	1	0	1	2	2	4	4	1	4	3	1	0	0	0	0	0	0	1	0	0	1
N-23	Small V.	4	8	4	8	5	6	6	6	8	9	6	7	5	2	2	3	0	0	2	0	0	2	3	10
	Large V.	0	1	2	2	1	2	2	4	1	3	1	3	1	1	0	0	0	0	0	0	0	0	1	1
N-24	Small V.	2	1	5	4	5	1	1	0	3	3	4	2	2	1	0	0	0	1	0	0	0	0	2	1
	Large V.	1	4	1	0	2	2	1	1	3	5	3	0	1	1	0	0	0	0	0	0	1	0	2	1
N-25	Small V.	2	1	1	3	1	1	3	4	2	0	2	5	0	2	1	0	0	0	0	0	0	0	0	6
	Large V.	2	1	1	1	3	1	3	1	0	1	1	1	0	1	0	0	0	1	0	0	0	0	1	4
N-26	Small V.	3	3	1	2	2	1	2	1	5	0	2	2	2	0	2	2	0	0	0	0	0	0	3	4
	Large V.	1	2	2	1	2	2	3	1	3	1	3	1	0	0	0	0	1	0	0	0	0	0	1	3
N-27	Small V.	3	2	2	3	1	2	4	2	2	3	5	1	1	2	1	0	1	0	0	1	0	1	2	3
	Large V.	1	1	0	2	2	0	1	0	0	0	1	0	1	1	0	1	0	0	0	0	0	2	0	3
N-28	Small V.	22	18	21	16	14	15	13	16	17	10	19	10	4	2	0	1	0	0	2	1	3	6	12	19
	Large V.	4	11	7	9	6	3	6	4	2	4	1	3	5	0	0	0	0	0	0	0	0	3	3	5

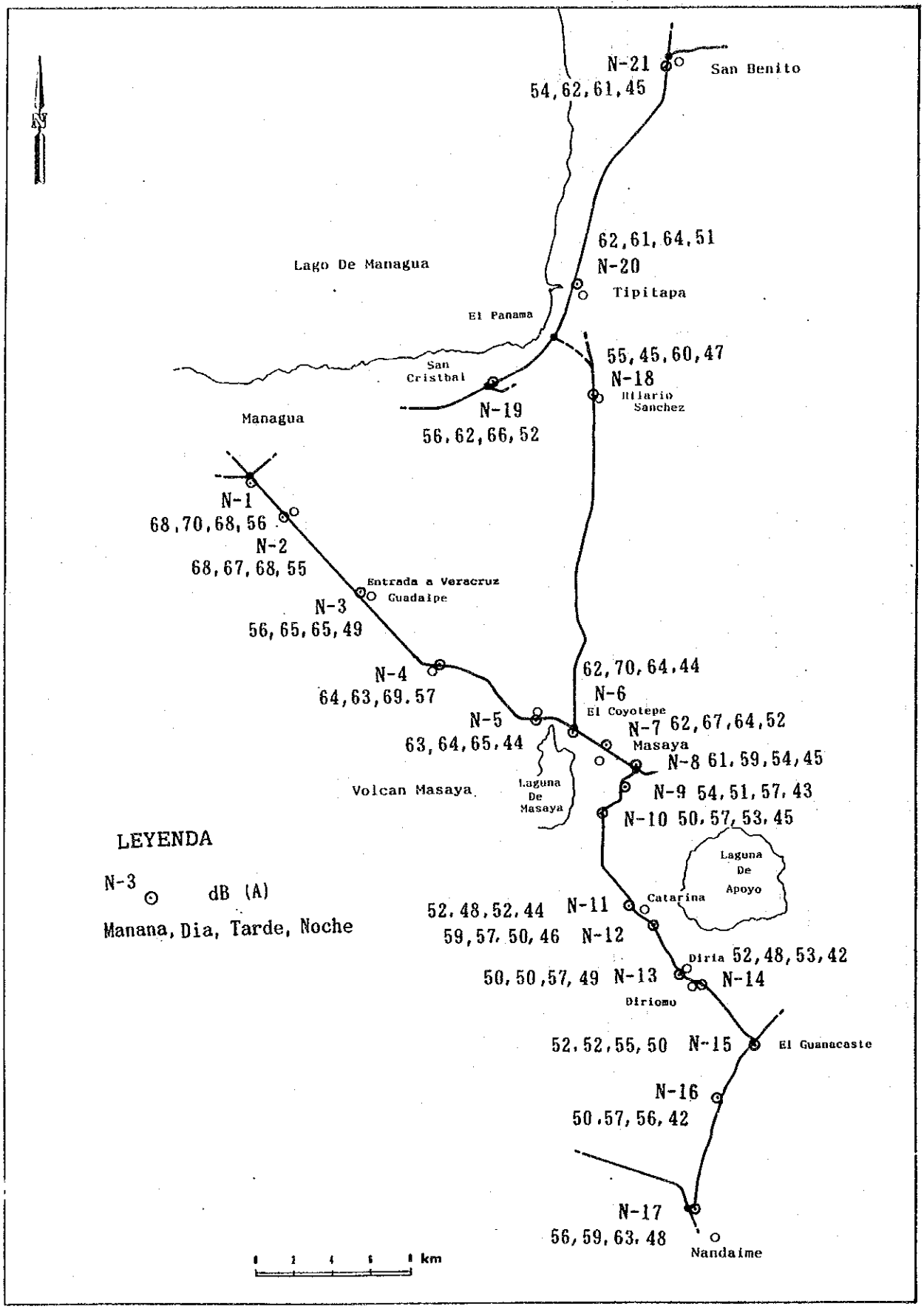
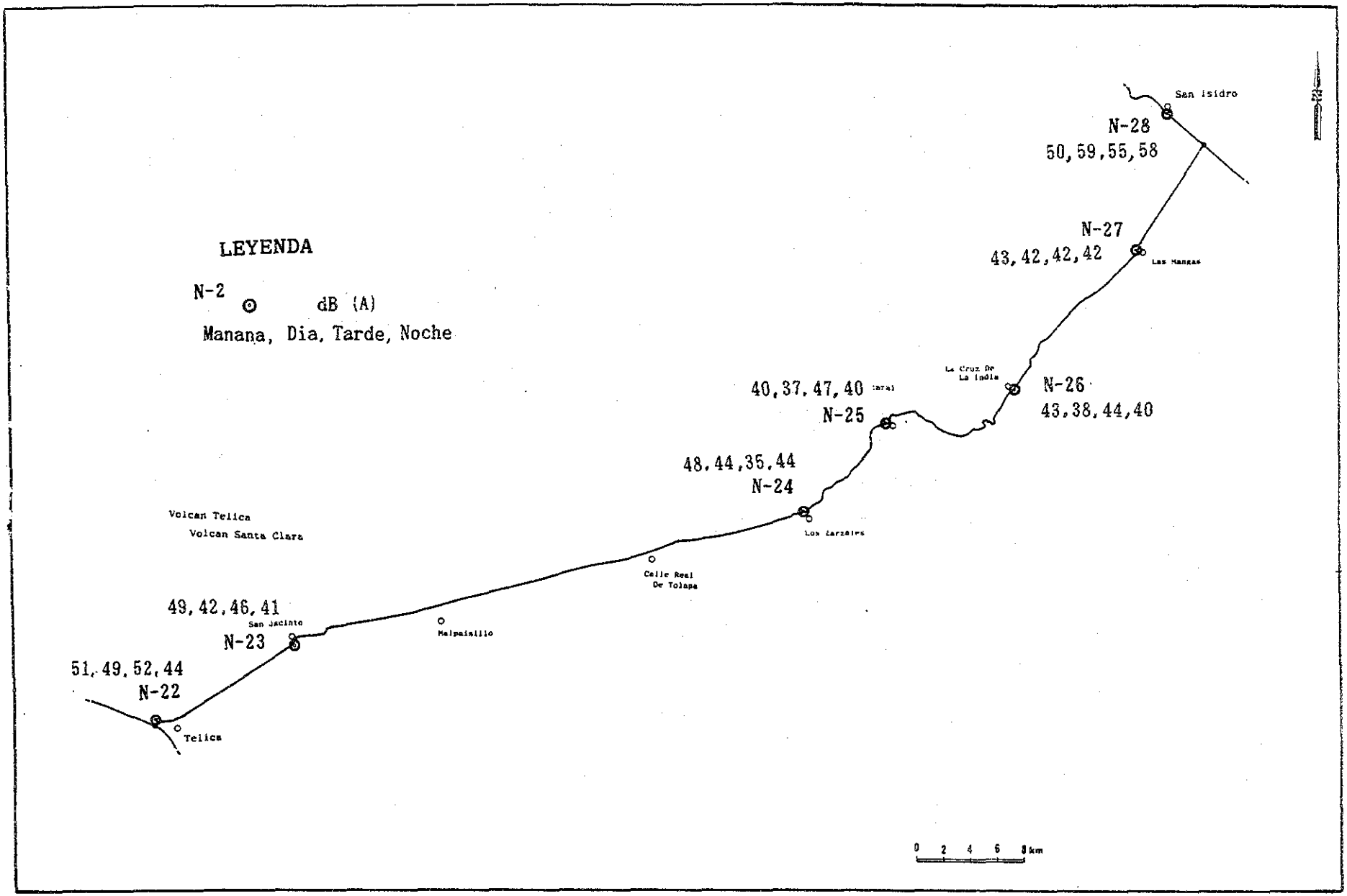


Figure II-6-28 Noise levels of the Project Area (1)



6-99

Figure 6-26(2) Noise Level of the Project Area

The noise between Telica and San Isidro ranges 35 to 59 dB(A). These values are less than noise standard. Because this section is extremely low traffic volume. Therefore, the noise level in the section between Telica and San Isidro is assumed to correspond with the noise level of background.

6.5.2 Prediction of Noise

The prediction areas are major urban area and intersections as shown in Figure 6-27, i.e., Managua, Masaya, Catarina, Nandaime, Tipitapa, San Benito, Telica and San Isidro. The prediction year is the year of 2000 and 2010.

(1) Condition of prediction

The forecasting traffic volume in 2000 and 2010 and by hour are shown in Table 6-11 and Figure 6-13 (refer to Appendix 5).

The source conditions of noise as shown in Figure 6-27 are as follows:

- Height of stack : 0.3 m
- Speed of vehicles : 60 km/hour
- Topodraphy : Flat
- Average power level (Lw) :

  Lw = 86 + 0.2V + 10log(a1+ 8*a2)

  V : Average speed (km)

  a1, a2: Rate of vehicle mixed (%)

  1 : Light vehicle

  2 : Heavy vehicle
- Width of road : 40 m wide in general
  30 m wide in Masaya
- Prediction points : 0, 10, 20, 30, 40, 50, 75, 100 and 150 m from border of road

(2) Method of prediction

The formula for simulating of Noise is as follows:

$$L50 = Lw-8-20*\log l+10*\log(p*l/d*\tanh 2pl/d)+ai$$

Formula 6-3

L50 : Central value of noise (dB(A))
Lw : Average power level per vehicle (dB(A))
l : Distance between noise source and measured point (m)
ai : Reviced factor
p : Circular constant

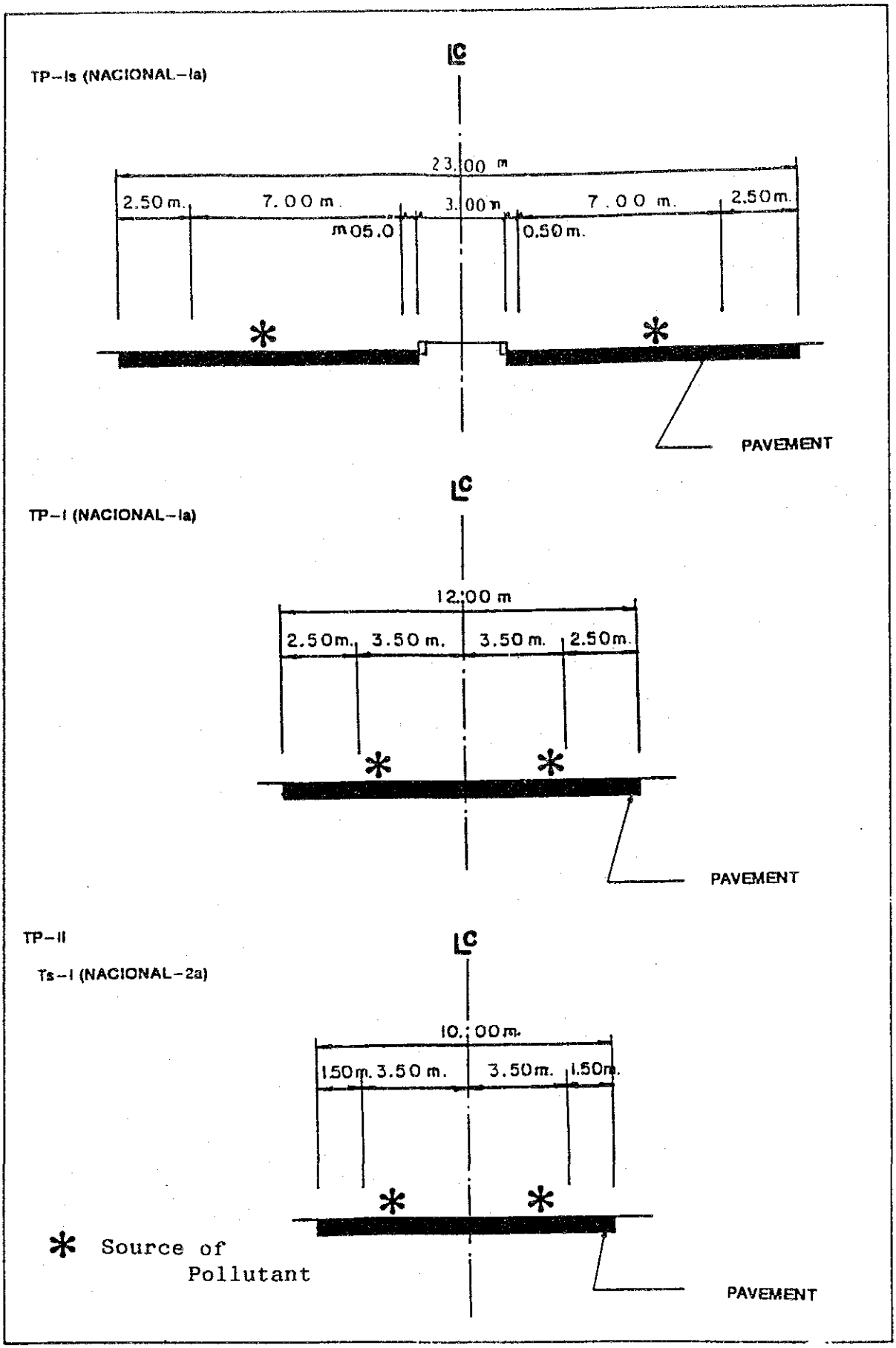


Figure 6-27 Source of Noise and Vibration

(3) **Results of prediction**

The results of simulation in 2000 and 2010 year concerning Noise are shown in Figure 6-28 (refer to Appendix 11).

The predicted noise level between Managua and Masaya in 2000 and 2010 year ranges 51 to 70 dB(A), and these values are beyond the noise standard. The predicted profiles of Noise in 2000 and 2010 at Managua are shown in Figure 6-29. The noise level will be decreased to 40 ~ 45 dB(A) at 100 to 150 m distance from the border of road due to the decay by distance.

The noise level at Tipitapa, San Benito and Nandaime ranges 39 to 59 dB(A), being less than noise standard. But the condition of noise will become slightly worse than the present.

The noise condition between Telica and San Isidro is predicted 19 to 45 dB(A) in 2000 and 2010 year. These values are less than present noise values.

6.5.3 Prediction of Vibration

The prediction areas are major urban area as shown in Figure 6-25, i.e. Managua, Masaya, Nandaime, Tipitapa - San Benito and Telica San Isidro. The prediction year is 2000 and 2010 year.

(1) Condition of prediction

The forecasting traffic volume in 2000 and 2010 year and by hour are shown in Table 6-11 and Figure 6-13 (refer to Appendix 2). The item of prediction concerning vibration is upper value of 80 % range of vibration level (L10).

The source of vibration as shown in Figure 6-27 is as follows:

- Speed of vehicles : 60 km/hour
- Topodraphy : Flat
- Base ofroad : Sand
- Pavement : Asphalt
- Corrugation : 10 mm
- Width of road : 40 m wide in general
  30 m wide in Masaya
- Prediction time : Daytime and night
- Prediction points : 0, 10, 20, 30, 40, 50, 75, 100 and 150 m from border of road

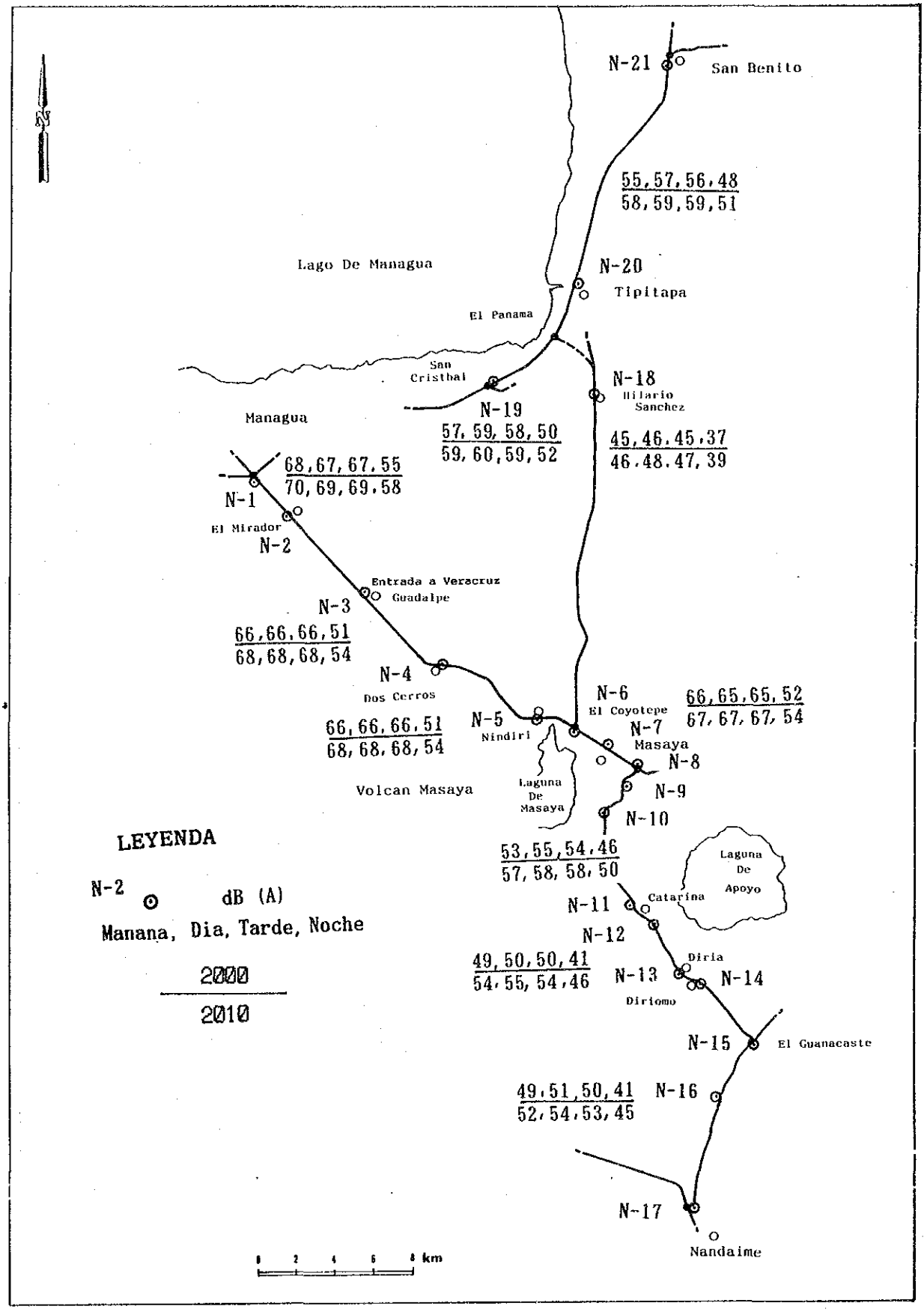


Figure 6-28(1) Predicted Noise Conditions in 2000 and 2010

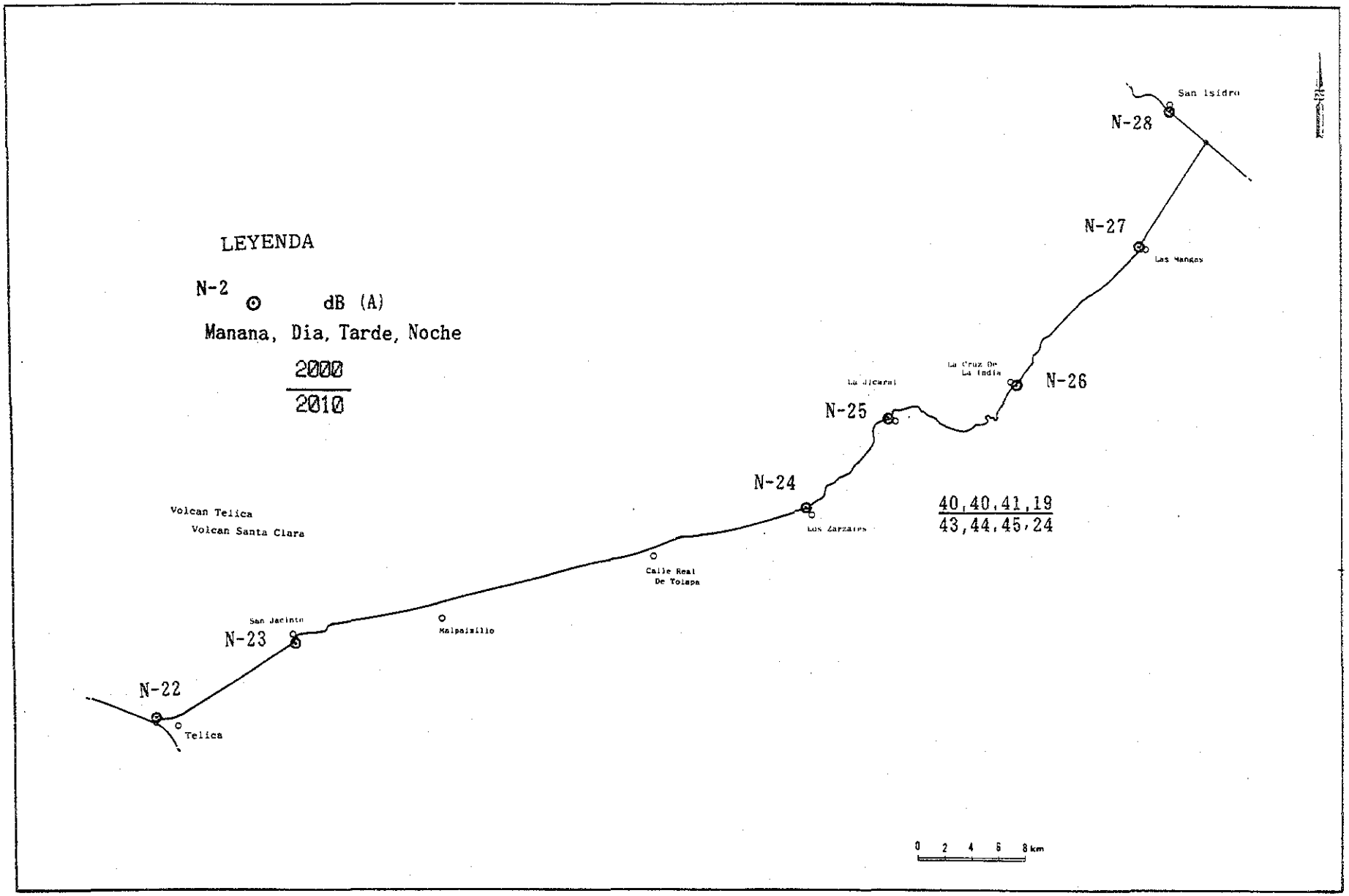


Figure 6-28(2) Predicted Noise Conditions in 2000 and 2010

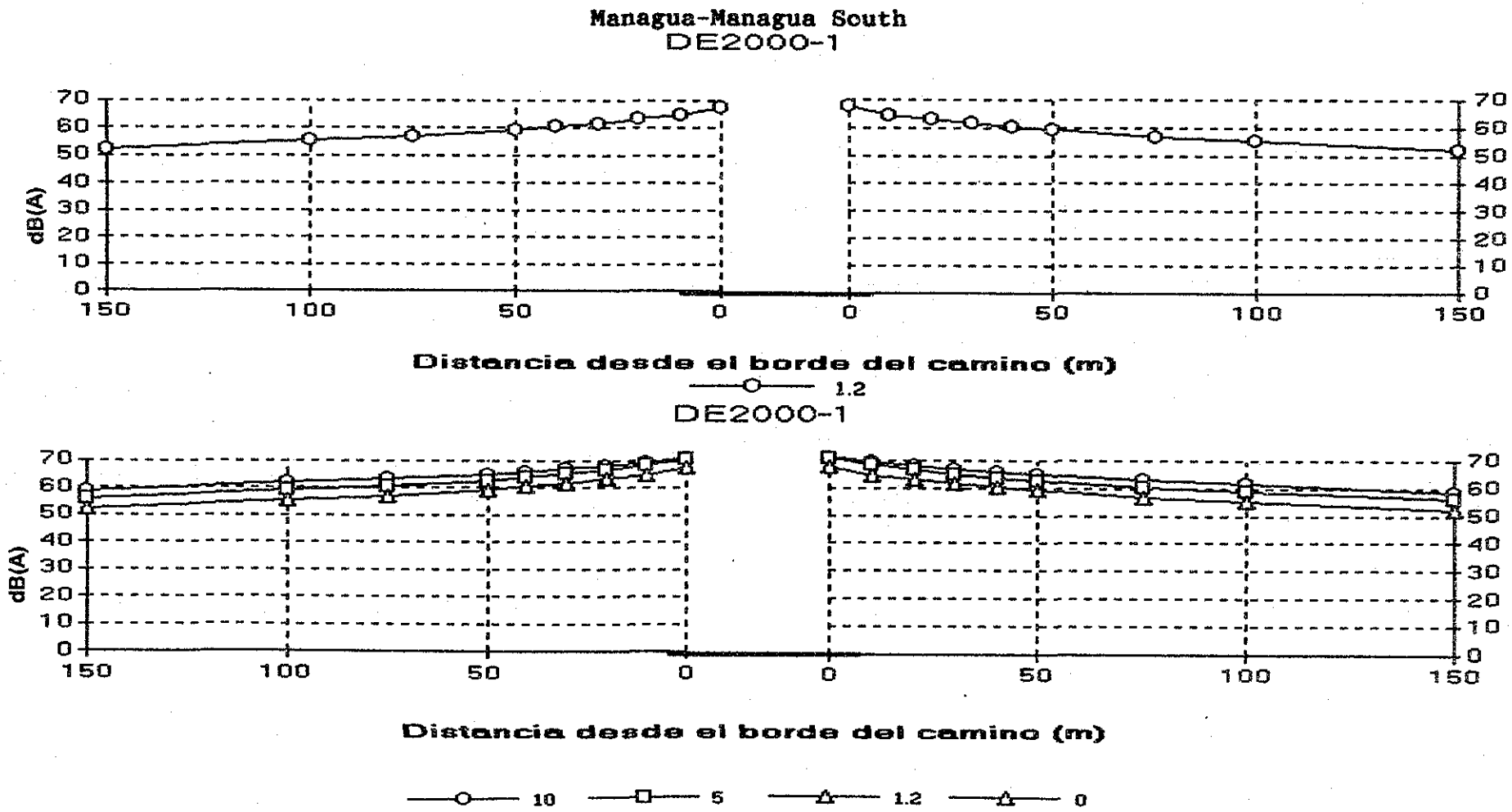


Figure 6-29(1) Predicted Profiles of Noise in 2000 and 2010 at Managua

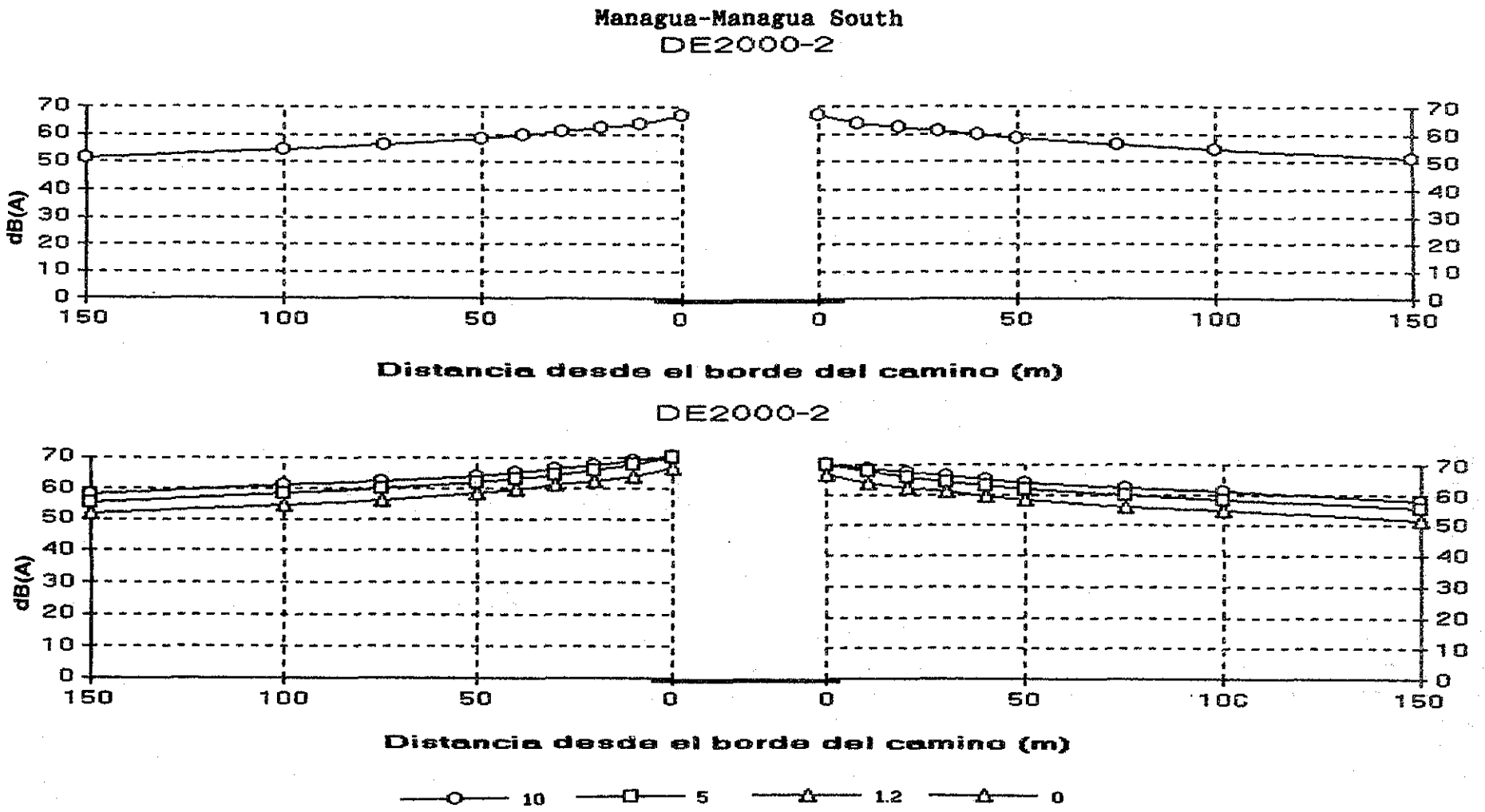


Figure 6-29(2) Predicted Profiles of Noise in 2000 and 2010 at Managua

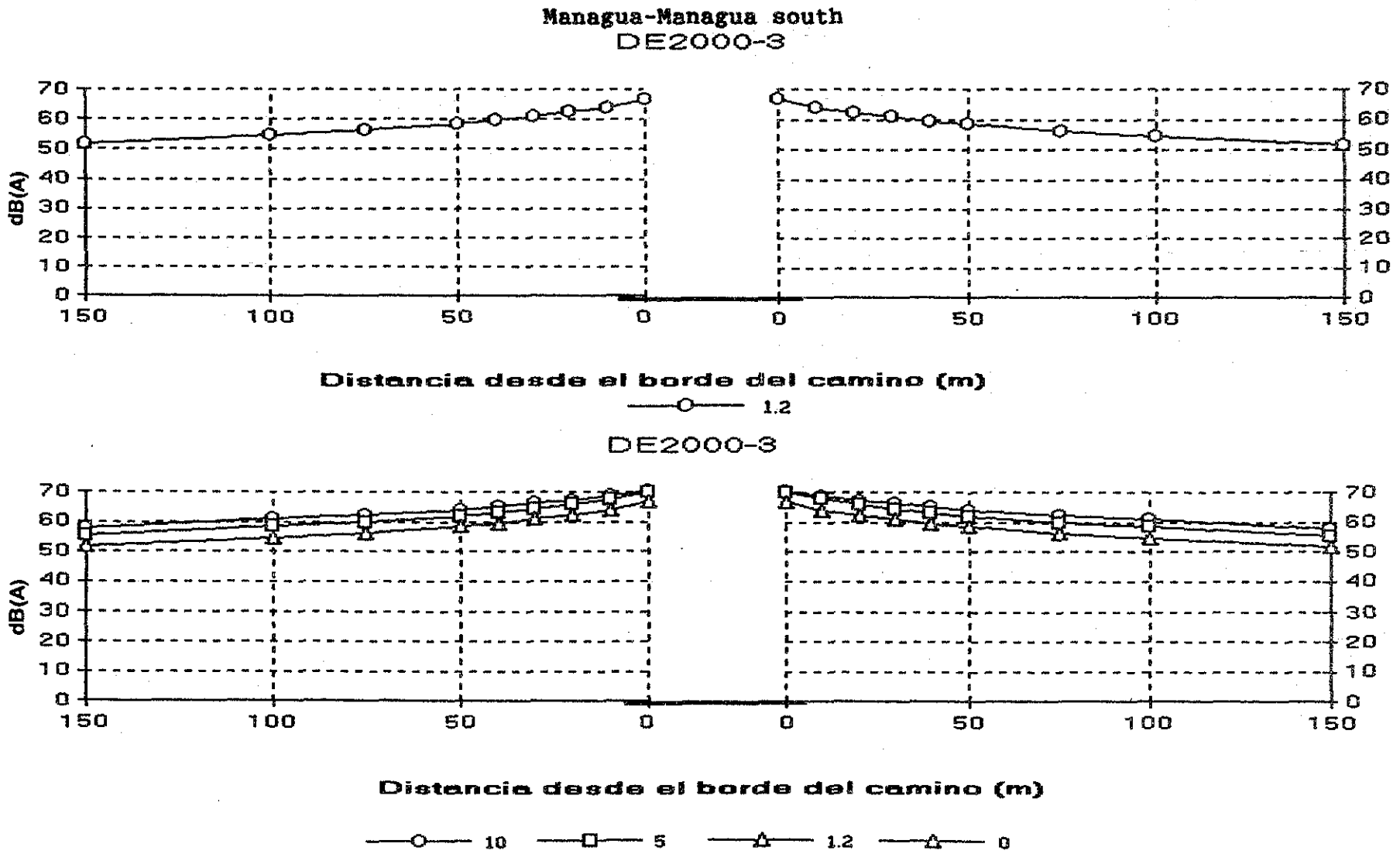


Figure 6-29(3) Predicted Profiles of Noise in 2000 and 2010 at Managua

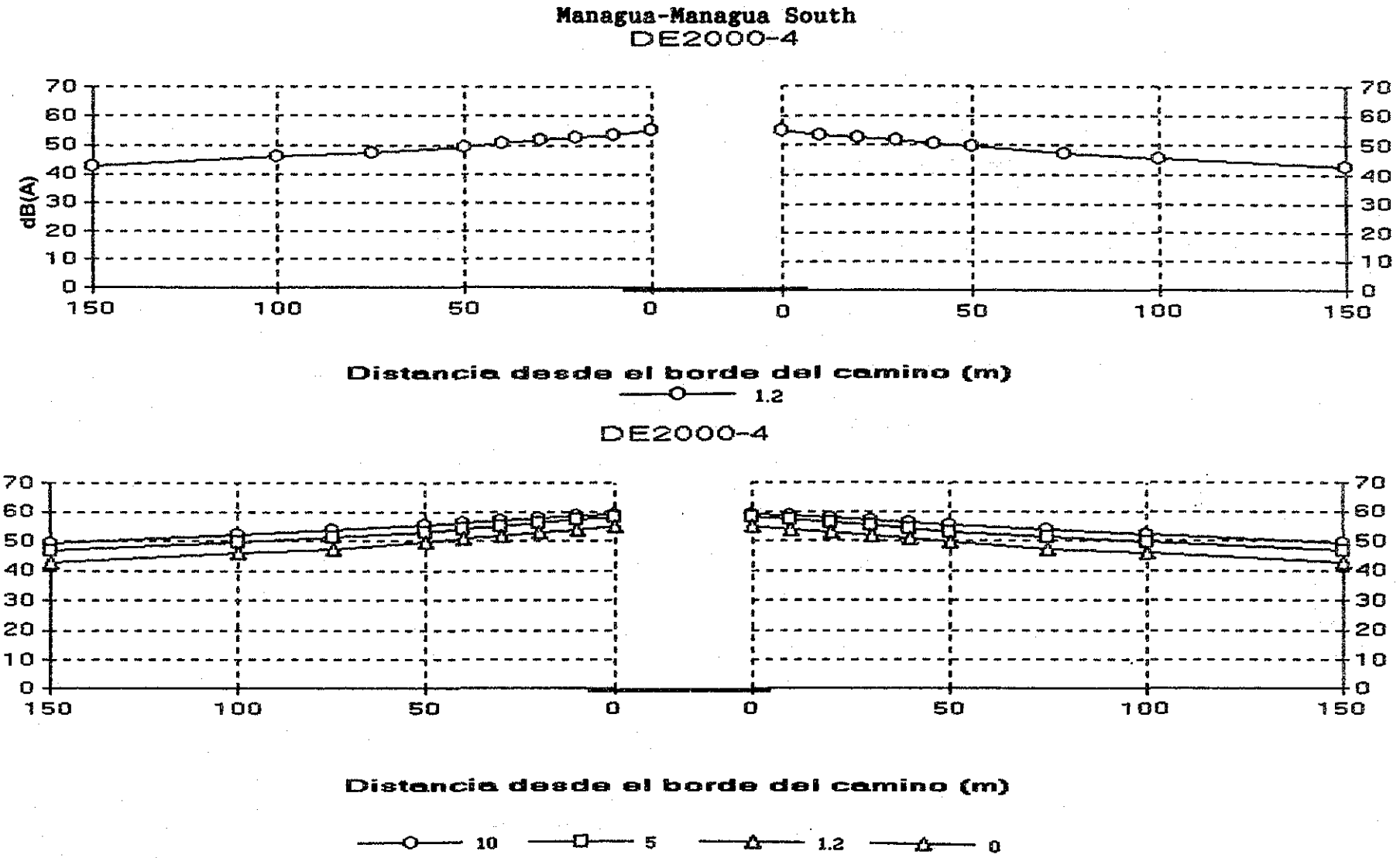


Figure 6-29(4) Predicted Profiles of Noise in 2000 and 2010 at Managua

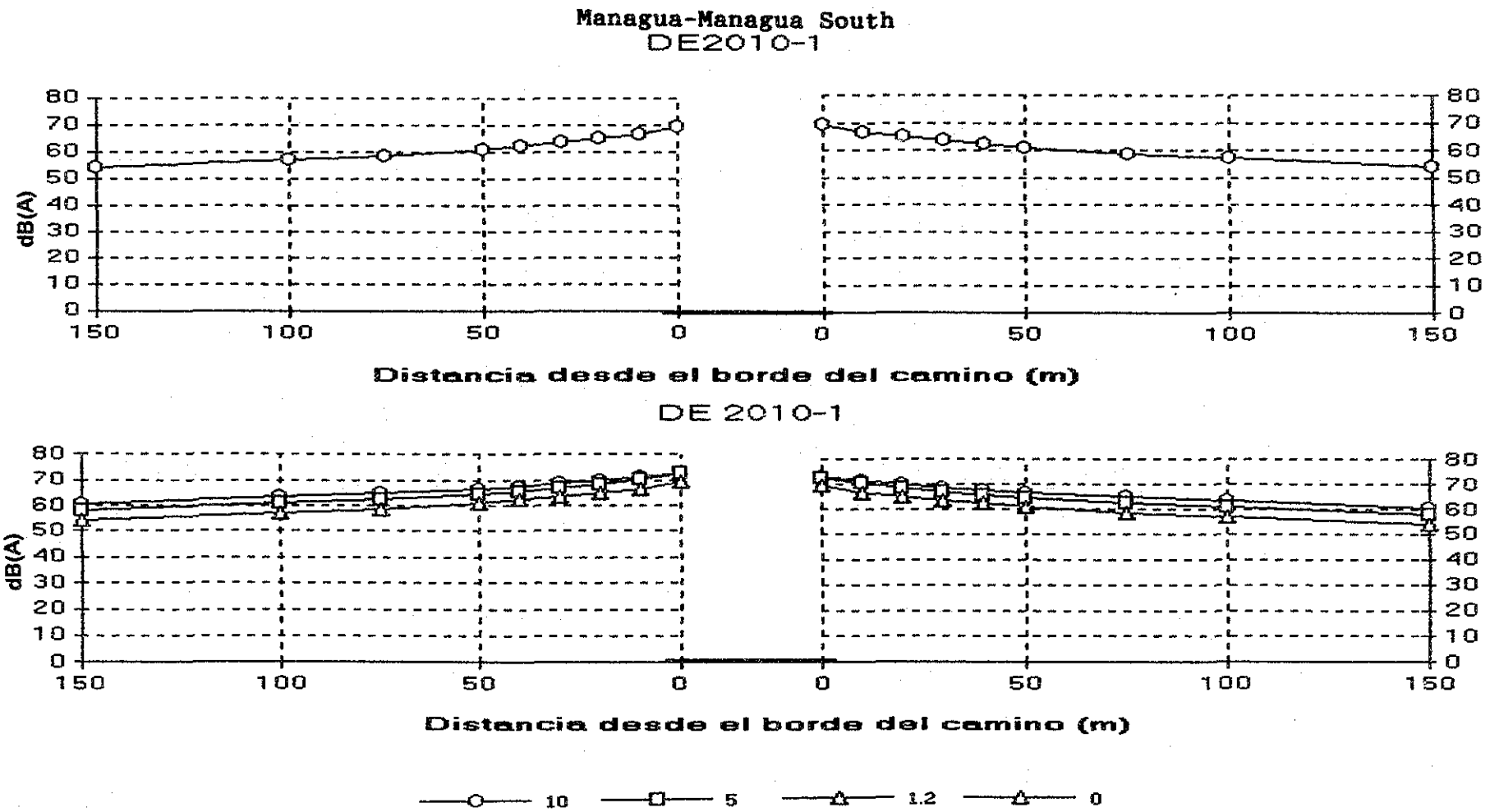


Figure 6-29(5) Predicted Profiles of Noise in 2000 and 2010 at Managua

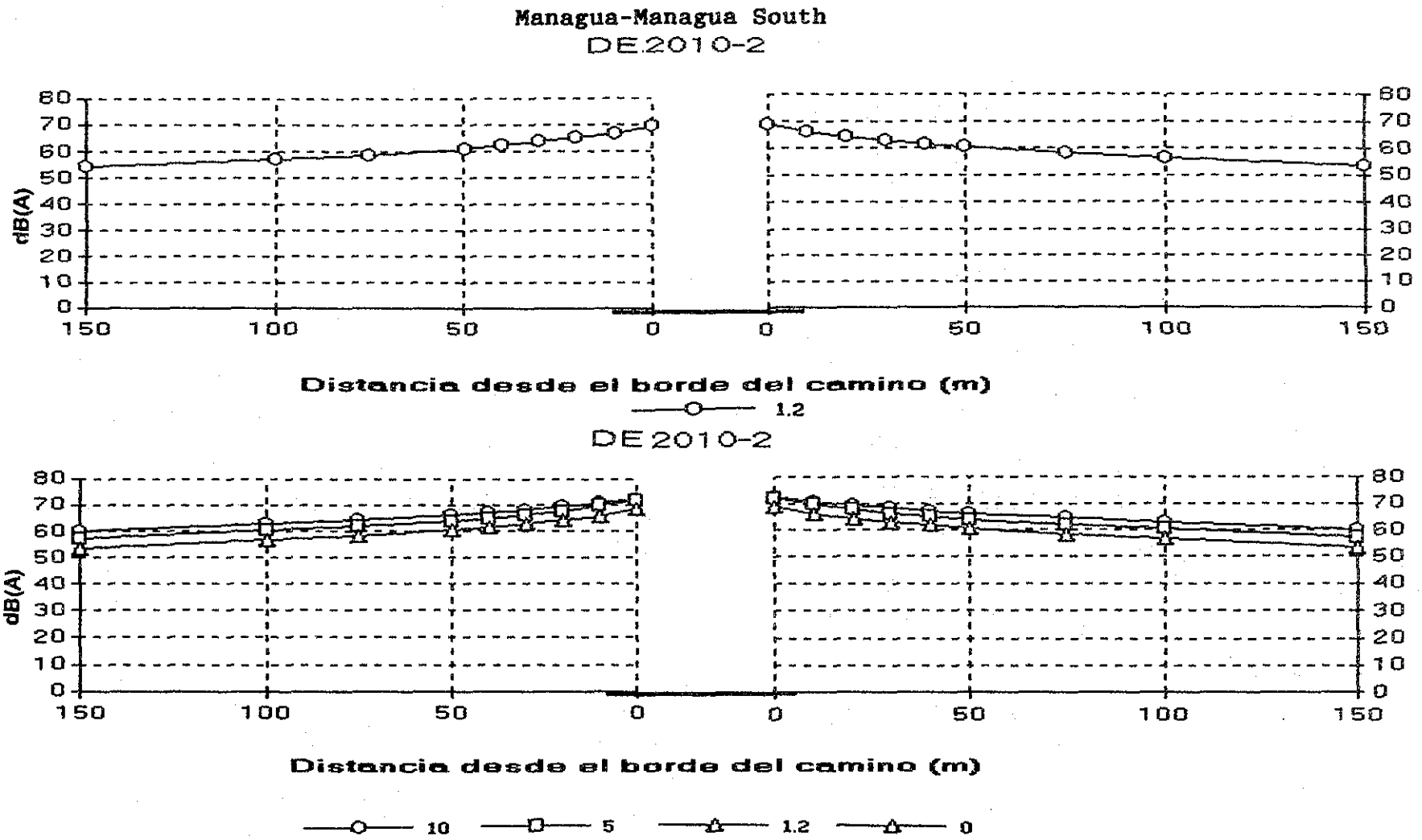


Figure 6-29(6) Predicted Profiles of Noise in 2000 and 2010 at Managua

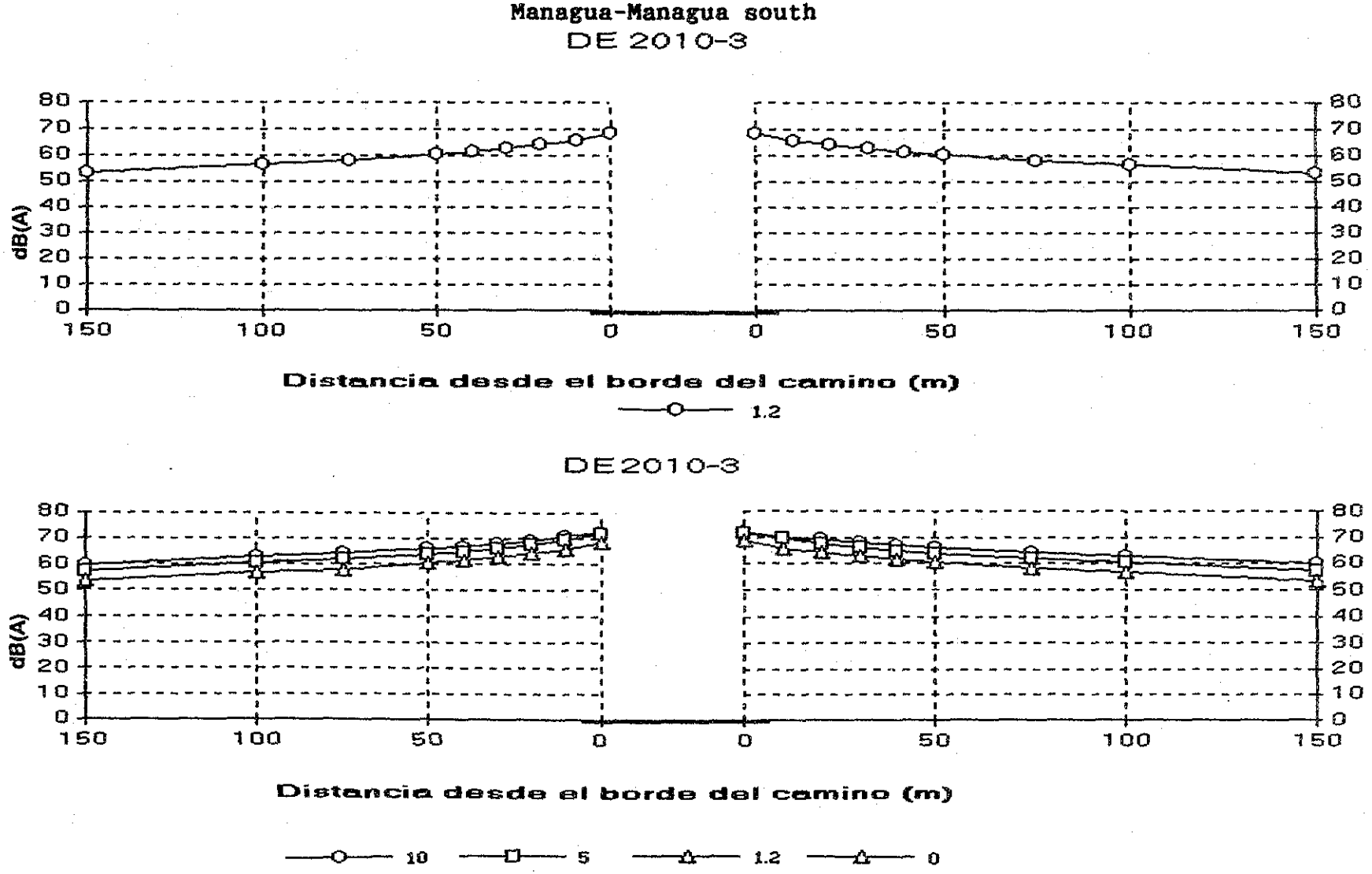


Figure 6-29(7) Predicted Profiles of Noise in 2000 and 2010 at Managua

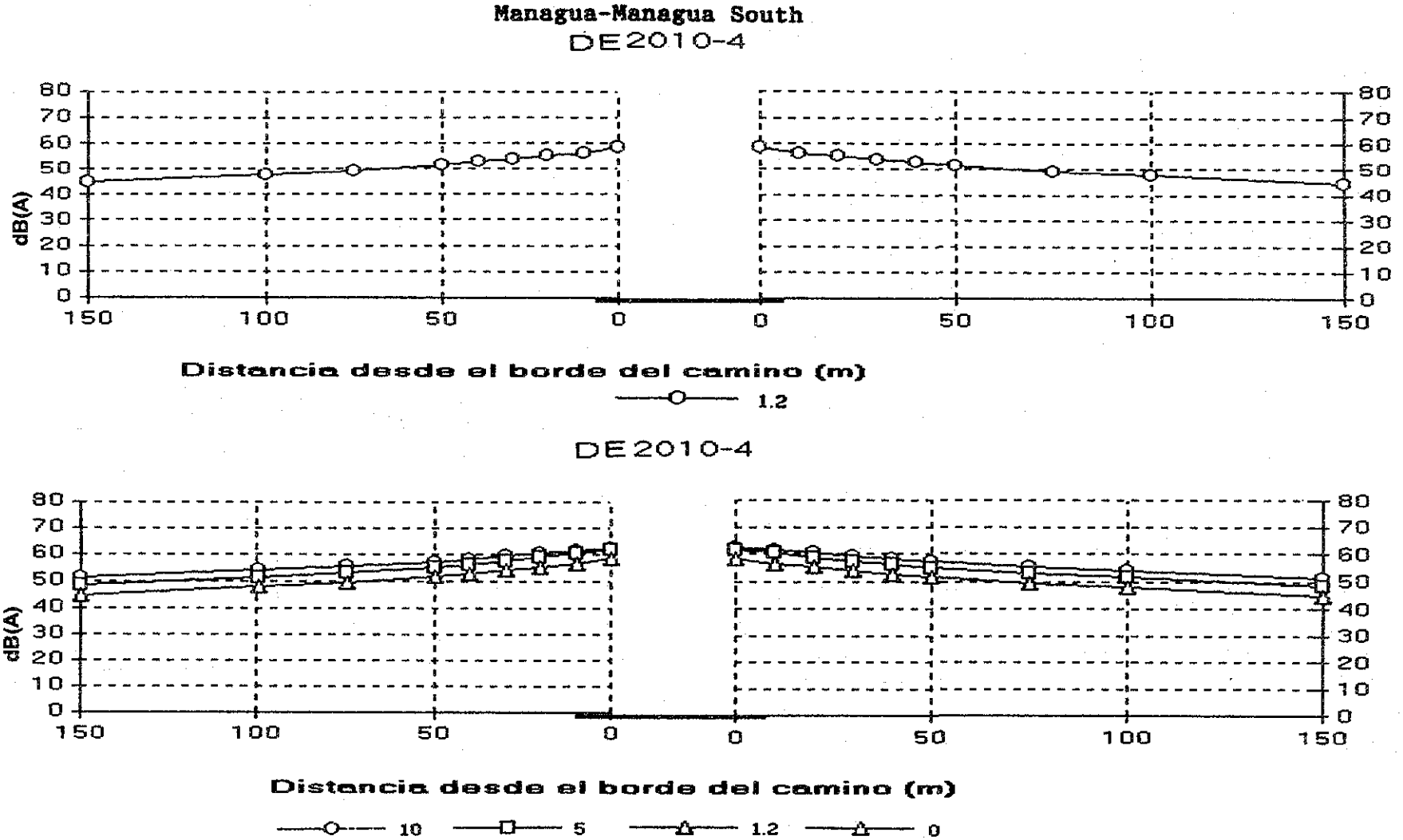


Figure 6-29(8) Predicted Profiles of Noise in 2000 and 2010 at Managua

(2) Method of prediction

The formula for simulating of vibration is as follows:

$$L10 = a*\log(\log Q)+b*\log V +c*\log M +d+Ag+Aj+As+Ap$$

Formula 6-4

L10 : upper value of 80 % range of vibration level (dB)
Q : Traffic volume per 500 seconds for one lane (vehicle/500 sec/lane)

$$Q = \frac{500}{3,600} * \frac{1}{M} * (Q1+12*Q2)$$

Q1 : Traffic volume of light vehicles (vehicle/hour)
Q2 : Traffic volume of heavy vehicles (vehicle/hour)
V : Average vehicle speed (km/hour)
M : Number of lanes
Ag : Revised value by corrugation (dB)
Aj : Revised value by road basement (dB)
As : Revised value by road structure (dB)
Ap : Value of distance decrease (dB)

(3) Results of prediction

The results of simulation in 2000 and 2010 year concerning vibration are shown in Figure 6-30 (refer to Appendix 2).

The predicted vibration level between Managua and Masaya in 2000 and 2010 year ranges 35.9 to 60.2 dB, which is slightly higher than other major urban areas, including Tipitapa, San Benito and Nandaime. The predicted profiles of Vibration in 2000 and 2010 at Managua are shown in Figure 6-31. The vibration level will be extremely decreased at 50 to 100 m distance from the border of road due to the decay by distance.

The vibration condition between Telica and San Isidro is predicted less than 45 dB in 2000 and 2010 year.

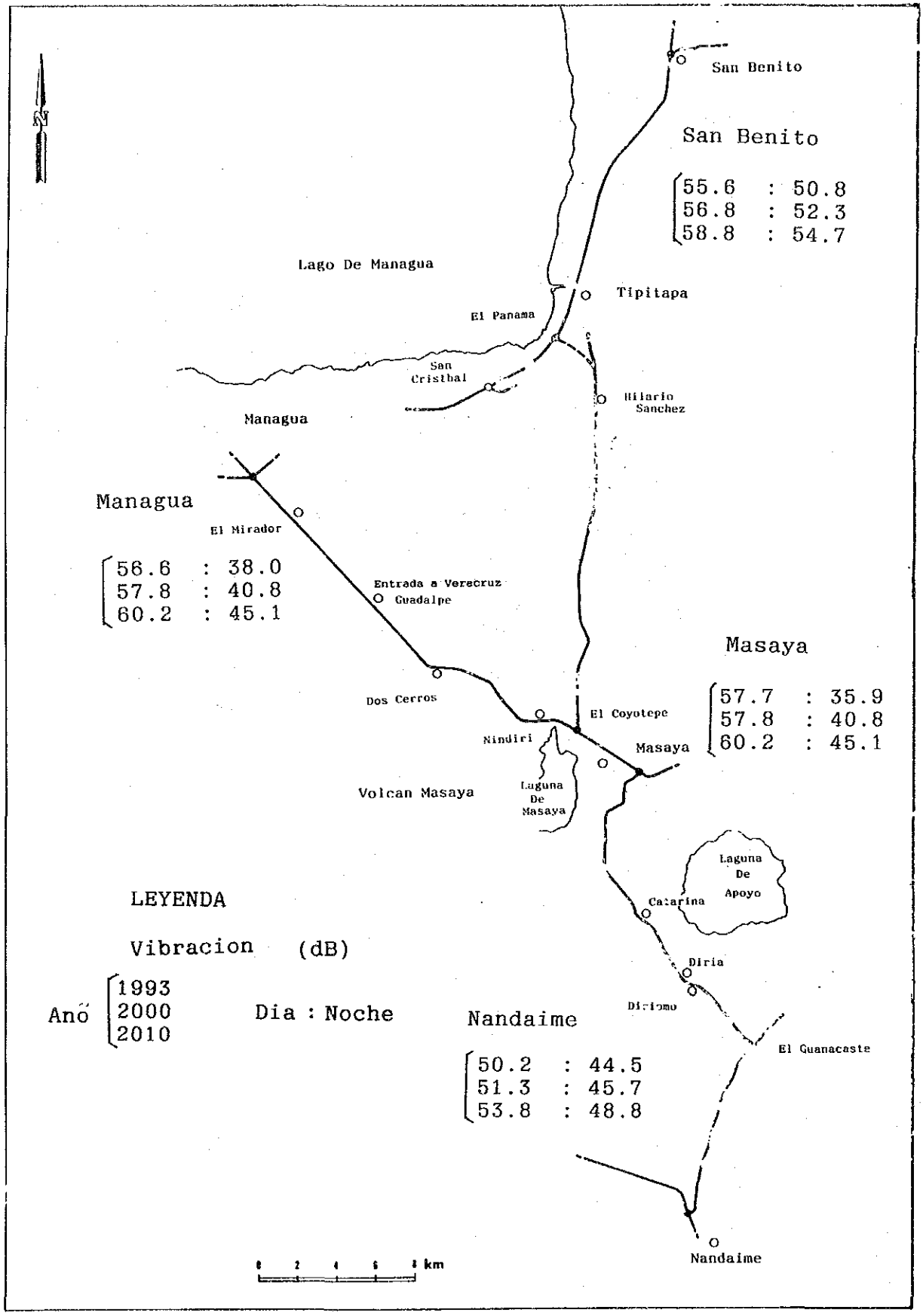


Figure 6-30(1) Predicted Vibration Conditions in 2000 and 2010

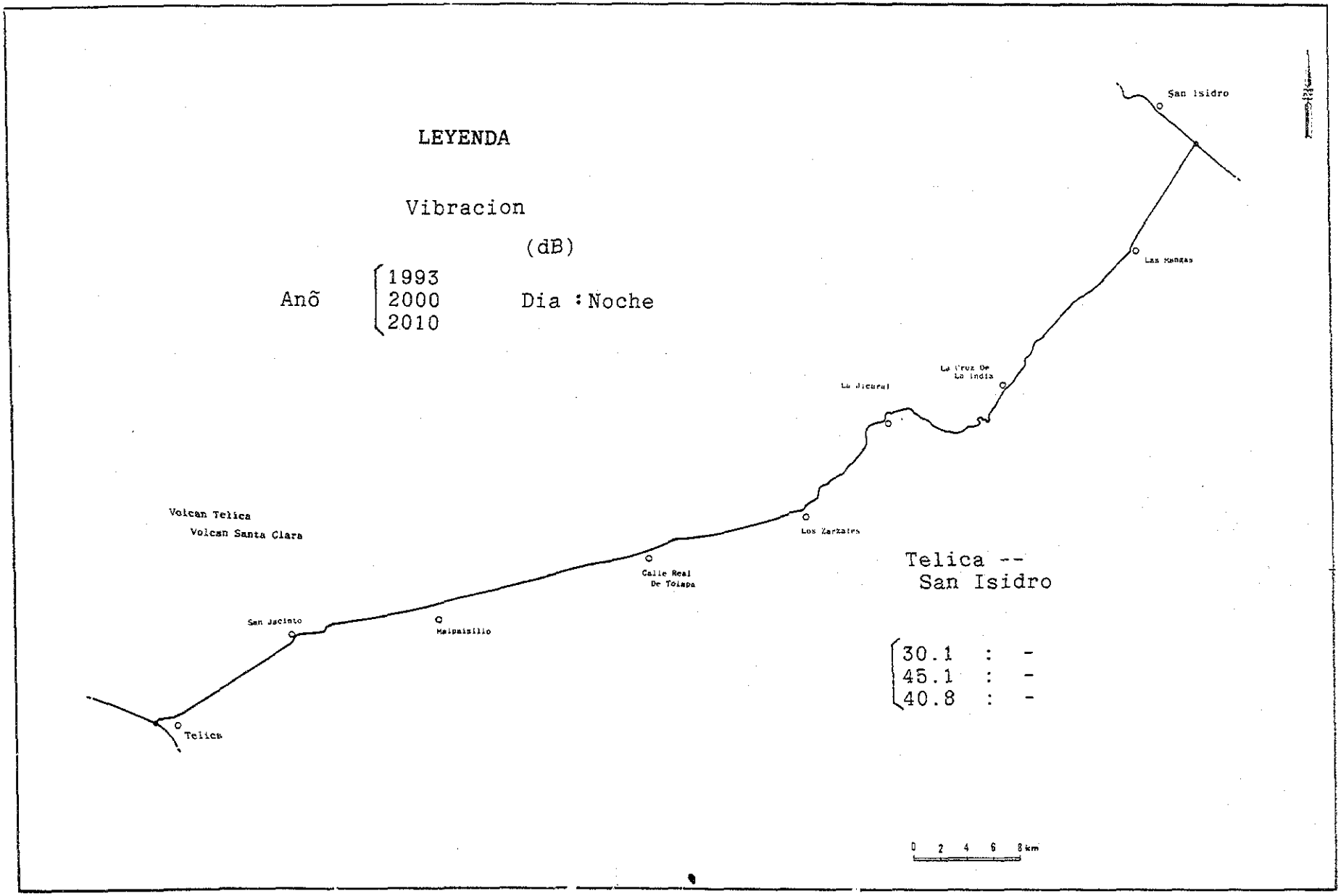


Figure 6-30(2) Predicted Vibration Conditions in 2000 and 2010

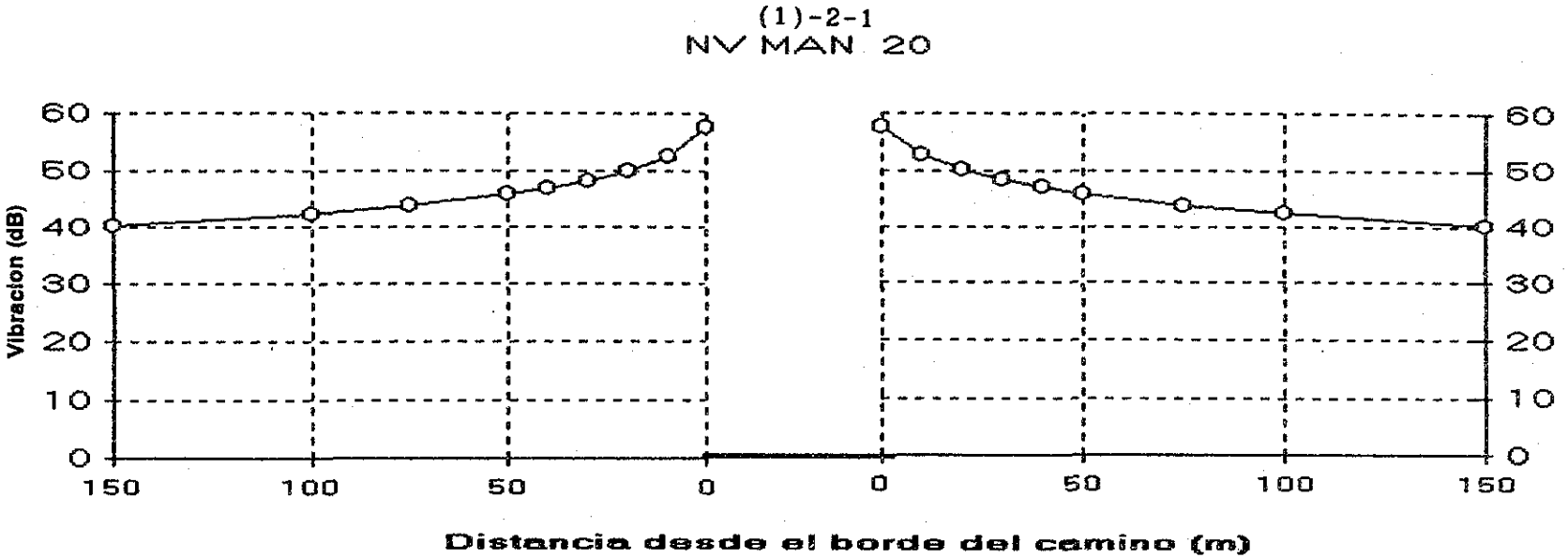


Figure 6-31(1) Predicted Profiles of Vibration in 2000 and 2010 at Managua

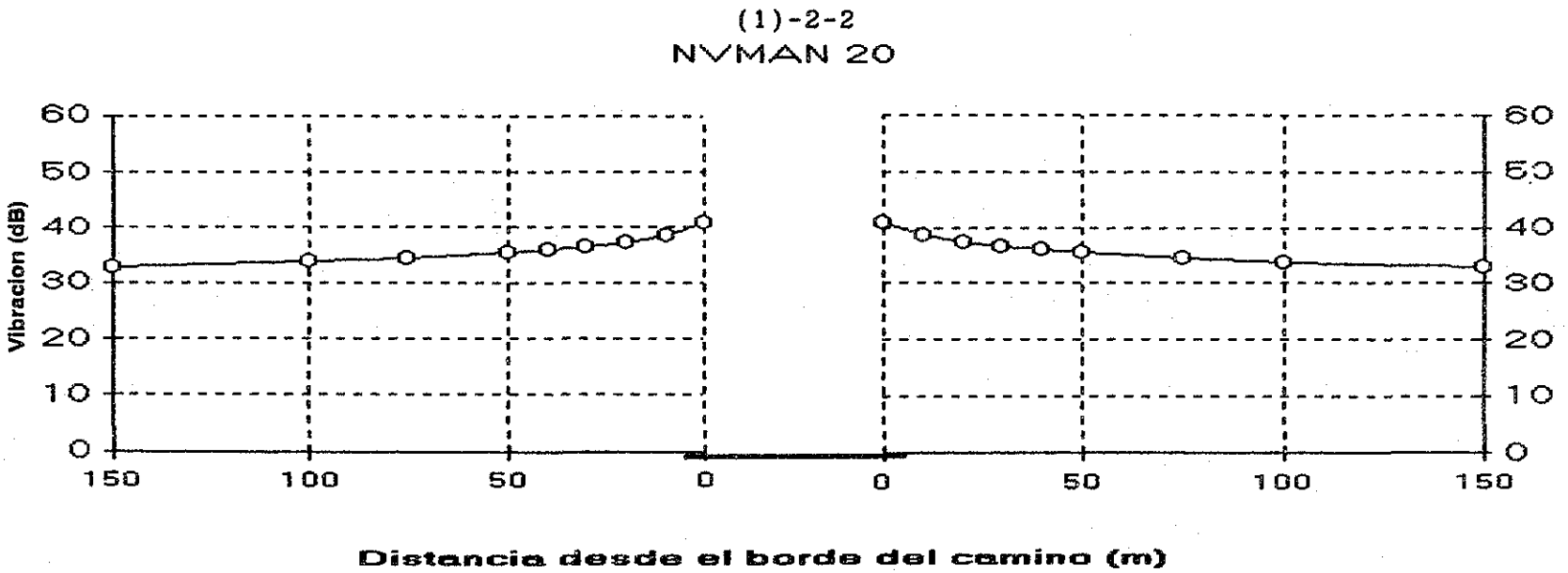


Figure 6-31(2) Predicted Profiles of Vibration in 2000 and 2010 at Managua

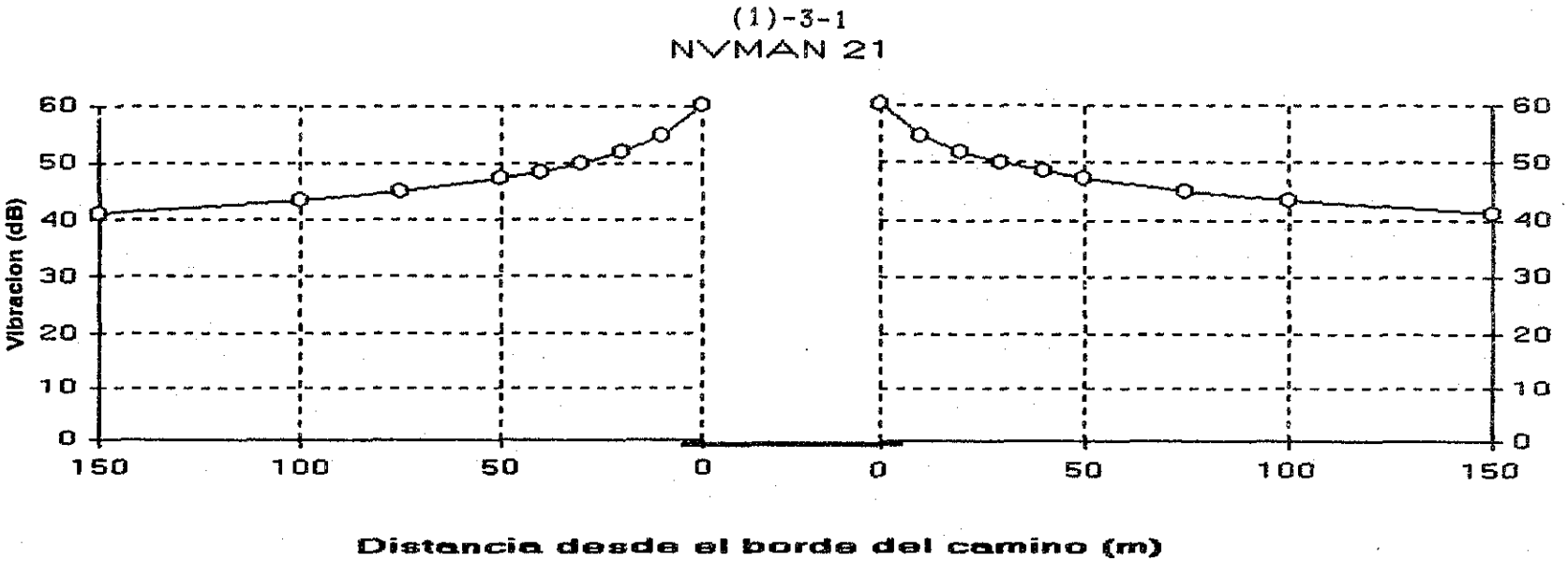


Figure 6-31(3) Predicted Profiles of Vibration in 2000 and 2010 at Managua

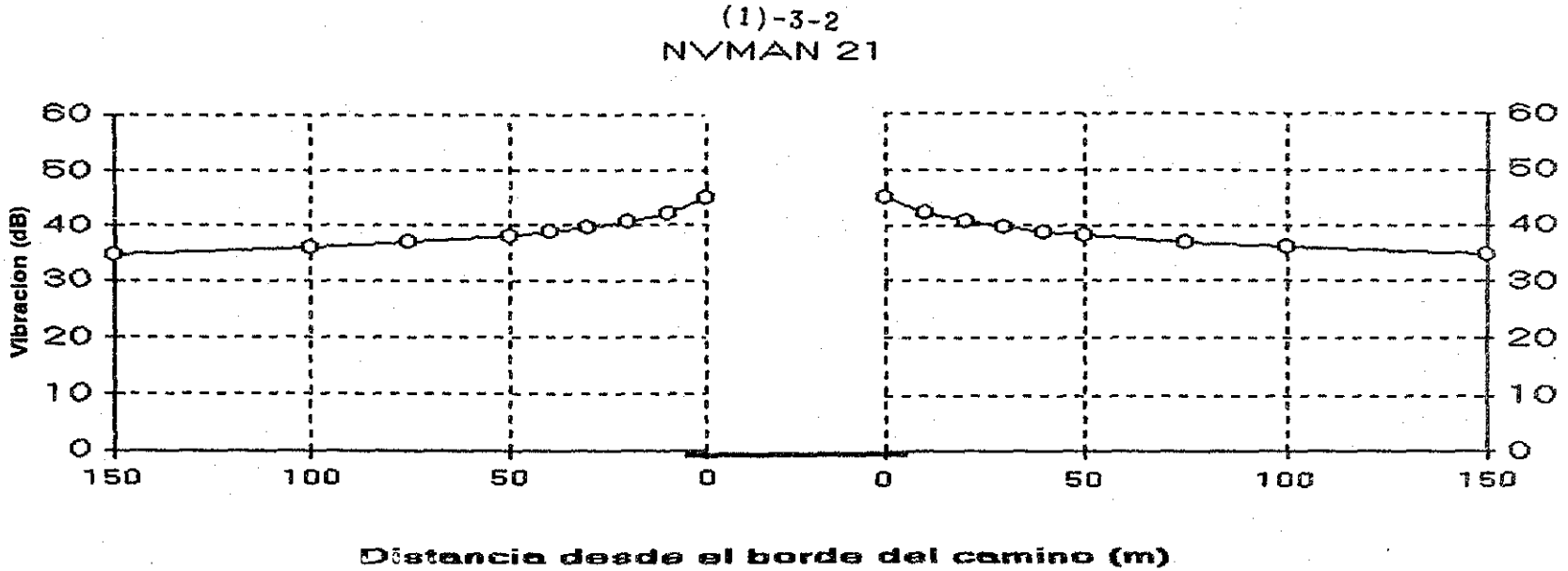


Figure 6-31(4) Predicted Profiles of Vibration in 2000 and 2010 at Managua

6.5.4 Evaluation of Noise and Vibration

(1) Noise

The environmental quality standard for Noise is 60 (daytime), 55 (morning and evening) and 50 (night) dB(A) at the place facing to the road as shown in Table 4-3.

The predicted noise level between Managua and Masaya in 2000 and 2010 year are beyond the noise standard. The noise condition will become worse than the present condition because of increasing background noise (approximately +2~6 dB(A)).

The noise conditions at Tipitapa, San Benito, Nandaime and between Telica and San Benito in 2000 and 2010 year are mostly less than noise standard. But the noise condition will become slightly worse than the present.

(2) Vibration

The environmental quality standard for Vibration is 50 on the border of road as shown in Table 4-4.

The predicted vibration level at Managua, Masaya,Tipitapa and San Benito in 2000 and 2010 year are slightly beyond the vibration standard during daytime. The vibration condition will become gradually worse than the present condition.

The vibration conditions at Nandaime and between Telica and San Benito in 2000 and 2010 year are mostly less than vibration standard.

6.6 Land

6.6.1 Topography

The section between Managua and Masaya, 27.200 km long, belongs to the Nicaraguan Depression Region (Figures 6-2 and 6-6). The sub-section between Managua and Dos Cerros is completely straight line road and flat, less than 0.3 %. The sub-section between Dos Cerros and Masaya, passing along northern foot and rim of caldera of Volcan Masaya as well as Masaya National Park, ranges from 0.2 to 3.4 % in gradient. The highest point of the section is 310 m in elevation, located on the boundary of outer caldera of northeast of Masaya Volcano.

The section between Managua and Tipitapa,4.300 km long, and Masaya and San Benito (37.925 km long), is almost flat area, belonging the Nicaraguan Depression Region. The sub-section between Masaya and Tipitapa belongs to the northern part of the volcanic gentle slope of Masaya Volcano, approximately 0.5 % in gradient. The sub-section

between Tipitapa and San Benito passes along the Managua Lake, approximately 70 m in elevation.

The section between Masaya and Nandaime,27.200 km long, topographically belongs to the volcanic slope, foot-hill of the outer caldera of Masaya Volcano and Apoyo Volcano, ranging from 240 m to 420 m in elevation, and the area is locally incised deeply.

The section between Telica and San Isidro, 5.760 km long, belongs geographically to the Nicaraguan Depression and Interior Highland. The sub-section between Telica and Las Zarzales belongs the Nicaraguan Depression Region and passes volcanic gentle slope of Telica and Santa Clara Volcanos and low hilly land. The sub-section between Los Zarzales and Monte Grande belongs the Interior Highland Region passes hilly and mountainous areas ranging from 200 to 500 m in elevation along the Sinecapa River. The sub-section between Monte Grande and San aIsidro is basin and forms locally wetland ranging from 440 to 460 m in eleah-tion.

6.6.2 Geology

(1) Geology

The geology of the section between Managua and Masaya, Managua and Tipitapa, Masaya and Tipitapa, Masaya and Nandaime is mainly composed of Las Sierras Formation of the Pliestcene, basalt lavaflow of Volcan Masaya and River Sediments (Alluvium) of Holocene, (Figures 6-7 and 6-2).

The Las Sierras Formation consists mostly of unconsoli-dated, stratified, dark grey lapilli tuff and coarse and fine tuff. The formation is almost flat and shows slightly wavy in some places. The permeability of the formation is quite high.

Basalt lavaflow of Volcan Masaya is located at north of volcan Masaya and recent basalt lava flowed to the north direction along the small-scaled graben. The basalt is composed of various size of blocks (so-called clinker), fragments of lava tunnel broken and vesiculous, black massive lava. Lava is fresh and developed much cooling joint and crack.

River sediments (or lake deposits) of Alluvium are found between Managua and San Benito around Managua Lake. It consists mainly of sand, silt and clay.

The geology of the section between Telica and San Isidro consists of Masachapa Formation of the Oligocene to Middle Miocene, El Fraile Formation of the Miocene, Coyol Group of the Pliocene, Las Sierras formation of the Pliestcene and Basaltic and Andesitic Rocks and River sediments of

the Holocene.

The Masachapa Formation is found around La Cruz De La India. The formation consist mainly of grey, pinkish/whity grey, fracture developed and massive rhyorite. They are altered by argillization and silicification in some places.

The El Fraile Formation is found between Los Zaezales and west of La Cruz De La India and around Las Mangas. The formation consist of brownish/whity grey and massive rhyolite, dark gery, hornblende bearing and massive andesite, brownish grey and dark grey, acidic coarse and lapilli tuff and whity grey, pumicious and andesitic tuff breccia. The rhyolite shows a obvious flow structure and planner and columnar joints in some places.

The Coyol Group is found around Los Zarzales and east of La Cruz De La India. The rocks consist mainly of whity/ pinkish grey rhyolite and dark grey andesite lava. Rhyolite is locally altered by silicification accompanied with thin quartz veins.

The Las Sierras Formation is found between Malpaisillo and Calle Real De Tolapa sists mostly of unconsoli-dated, stratified, dark grey lapilli tuff and coarse and fine tuff. The formation is almost flat and shows slightly wavy in some places.

Basalt lavaflow of Volcan Santa Clara is located at west of San Jacinto. But the outcrop of lava is not clear along the road.

River sediments of Alluvium are found between Managua and San Benito around Telica, Malpaisillo, Calle Real De Tolapa and San Isidro. It consists mainly of gravel, sand, silt and clay.

(2) Lineament

The lineament (-photo) is examined using aerophotographs as shown in Figure 6-32. In the area of Managua, Masaya, Tipitapa and Nandaime, three minor lineaments, i.e. north-south, northwest-southwest and northwest-southeast, are marked. In the section between Telica and San Isidro, one major and two minor lineaments, i.e. northwest-southeast, north-south and east-west, are recognized. These lineaments are thought to be formed by the geological, geological structural and topographical features, i.e. fault, zone of fractures, permeability, erosive material, etc.

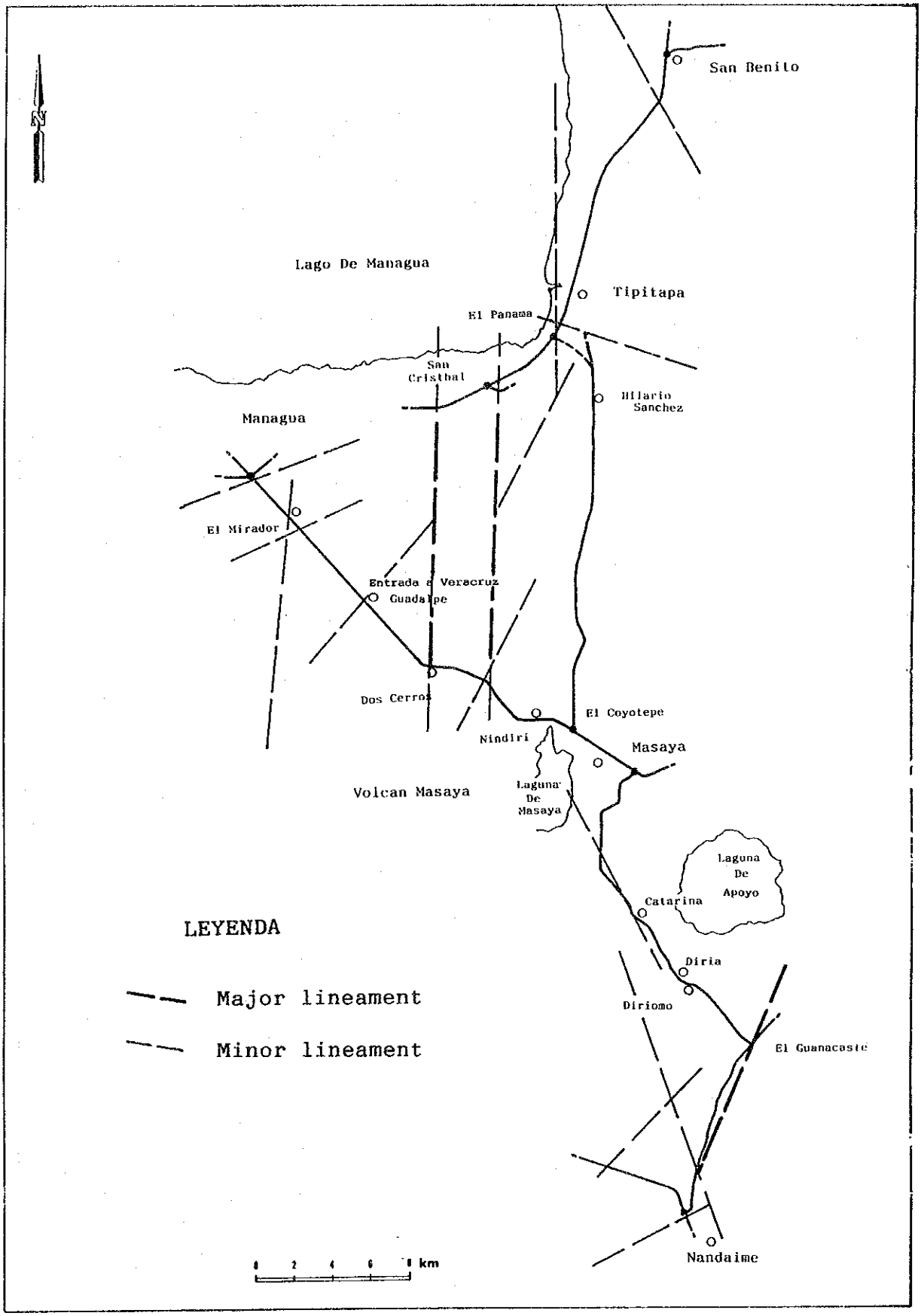


Figure 6-32(1) Lineament (Photo-) in the Project Area

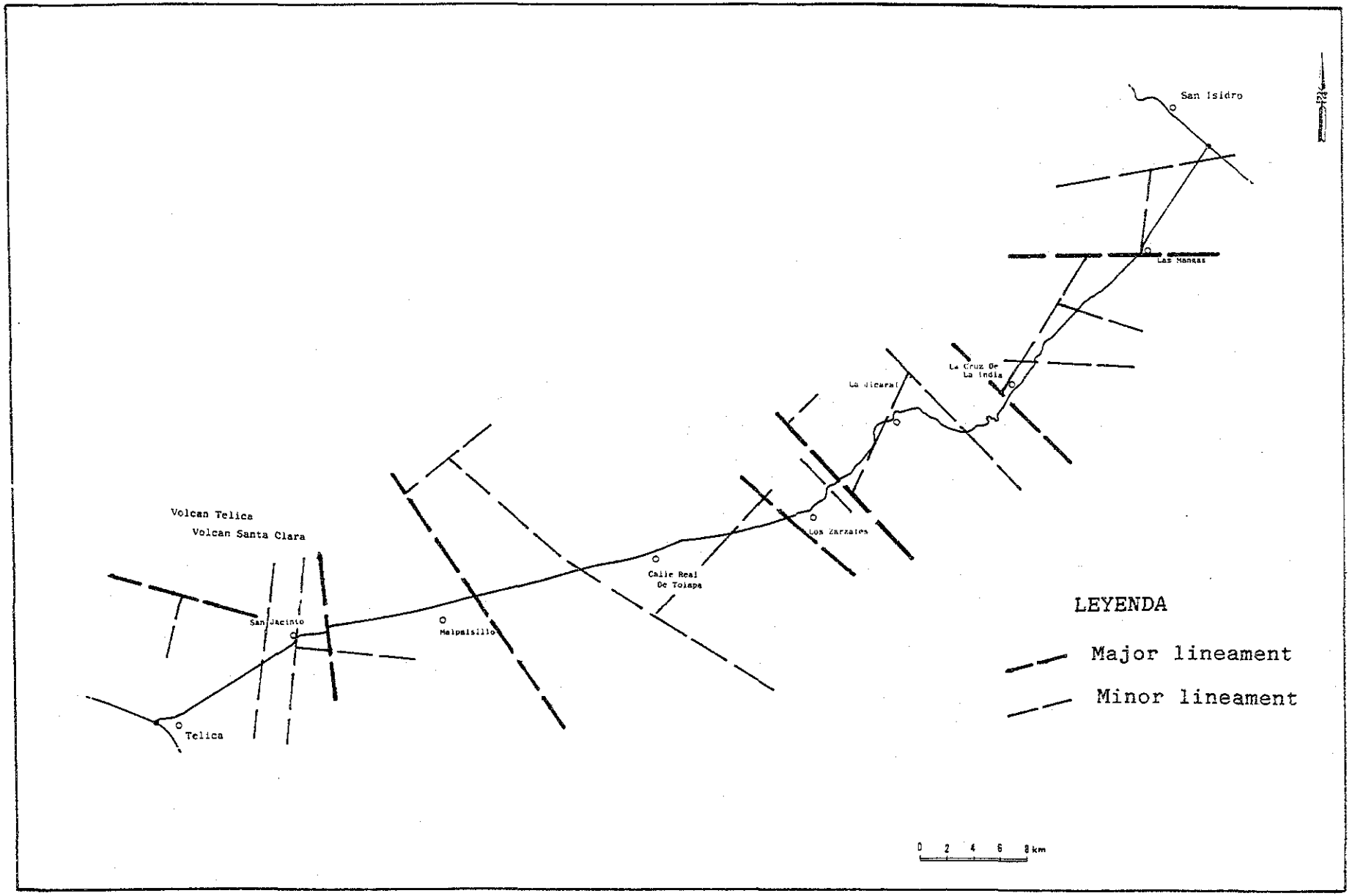


Figure 6-32(2) Lineament (Photo-) in the Project Area

(3) Landslide and slope failure

Large scaled landslides are not existing along the project road. But, minor landslides and slope failures are found in mamy places (Figure 6-1).

In the section between Masaya and Managua, near Tipitapa and Catarina, small slope failures are found around Dos Cerros and El Coyotepe. These slopes are cutting slope and are made up of fine tuff. People are digging sand from these slope and this actions influence the expansion of slope failure in some places.

In the section between Telica and San Isidro, small slope failures are found at San Jasinto, Los Zarzales, east of La Jicaral, Cristalito, north of La Cruz De La India and Las Mangas. These Slope failures are less than 10 m wide and 15 m high. Detritus and falling stones occur in some places.

Minor landslides are found west of Cristalito and south-west of Las Mangas. The landslides at west of Cristalito are located eastern slope of cuesta topography. Those of southwest of Las Mangas are thought to be old landslide.

(4) Rough surface of road

Rough surface of road is recognized at Tipitapa, Calle Real De Tolapa and northeast of Las Mangas as shown in Figures 6-1, 6-2 and 6-3 and Table 6-21. The surface of these roads occurs sunken ground, which is less than 10 cm deep and approximately 10 to 20 m wide and long. These zones existing rough surface correspond with the zone distributed soft ground. The cause of rough surface of road is assumed to be due to circular sliding and/or subsidence within the embankment and upper part of the base (soft ground).

Table 6-17 Rough Surface of Road

Road Section	Location (km)
1. Managua - Masaya	-
2. Managua - Tipitapa	-
3. Nandaime - Masaya	-
4. Masaya - Tipitapa	-
5. Tipitapa - San Benito	(1) 2 + 000 ~ 3 + 000
6. Telica - San Isidro	(1) 30 + 400 ~ 32 + 500
	(2) 45 + 000 ~ 46 + 700
	(3) 89 + 900 ~ 90 + 600
	(4) 91 + 600 ~ 92 + 500
	(5) 93 + 500 ~ 94 + 300

6.6.3 Examination of Slope for Cutting and Embankment

The gradient of cutting slope generally depends on the

geology, condition of weathering, underground water, erosion, strength of rock or earth. The standard slope gradient of the project area is shown in Table 6-22. Massive rhyorite and andesite are sesignated as a hard rock. And jointed rhyorite and andesite, tuff breccia, lapilli and fine tuff are designated as a soft rock. However, in case of weathered and altered rocks, it is necessary to demote to a lower gradient up to 1:1.5 (H:V).

The gradient of embankment slope depends mainly on the filling materials, geology of base and hydrological condition. The standard slope gradient of embankment in the project area is shown in Table 6-18.

6.6.4 Evaluation of Land

The slope of cuts and embankments are thought to be stable due to the planned standard gradient of slopes. The stable slopes will be preserved by drainage systems and slope protection for the slope failures and falling stones.

Table 6-18 Standard Slope Gradient in the Project Area

Type of slope	Condition and classification	Slope gradient (H : V)*1
Cutting		
	Hard rocks	(1 : 4 ~ 1.5)*3
	Soft rocks	(1 : 2 ~ 1.5)*3
	Earth	(1 : 1)
Embankment		
	h <= 1.2 m	(3 : 1)
	1.2 < h <= 2.0 m	(2 : 1)
	h > 2.0 m*2	(1.5 : 1)

*1 H : Horizontal, V : Vertical
*2 h : Height (m)
h > 8 m : setting beams at every 5 m high (1.5 m wide)
*3 : In case of weathered condition

6.7 Soil

6.7.1 Present Condition

(1) Field investigation

a. Components of investigation

The number of soil investigation was carried out 43 places in the project area as shown in Figure 6-33. The pit for soil investigation is located at 10 meters point away from the border of road. The size of pit is 1x1.5x1.3 m (long, wide and deep). And then, the soil samples for Jar Test were collected from surface upto 30 cm deep by channel sampling at the same time.

b. Results of investigation

Results of soil investigation are shown in Figure 6-34 and

Table 6-19. The soil in the project area is classified into three groups, i.e. Inceptisol, Vertisol and Mollisol (according to the U.S. Department of Agriculture Soil Taxonomy).

The Inceptisol is located in the section between Managua, Masaya and Nandaime surrounding Volcan Masaya. The soil is characterized by dark brown to black in color, corresponding with " Andosol". The soil is formed from volcanic materials derived from Volcan Masaya. The soil ranges 45 to +130 cm in thickness and consists of A (20-80 cm th.) and B (10-80 cm th.) layers. The distributing zone of this soil is relatively high peameability and forms infilteration area and good drainage.

The Mollisol is found between Telica and Las Zarzales. The soil is characterized by mollic epipedon horizon consisting of secondary mineralized horizon existing between 18 and 25 cm deep. The soil is dark brown in color and contains humus as an A1 layer and much clay in A layer. Total thickness of this soil is approximately 80 - 110 cm thick. The distributed zone of this soil is mainly hilly terrain where the drainage is relatively good.

The Vertisol is found along Managua Lake, Malpaisillo and between Los Zarzales and San Isidro. The soil is characterized by containing much clay and dark brown to black in color. the thickness of A and B layers ranges 30 to 40 cm. Average total thickness is 65 cm. When dry season, the surface of soil occurs cracks. The drainage is bad because of containing much clay.

Results of Jar test for suspended solid (SS) are shown in Table 6-20. The quantity of SS ranges 0.5 to 4 mg/l. The vertisol and Mollisol are slightly higher quantity of SS than Inceptisol, because of much clay containing.

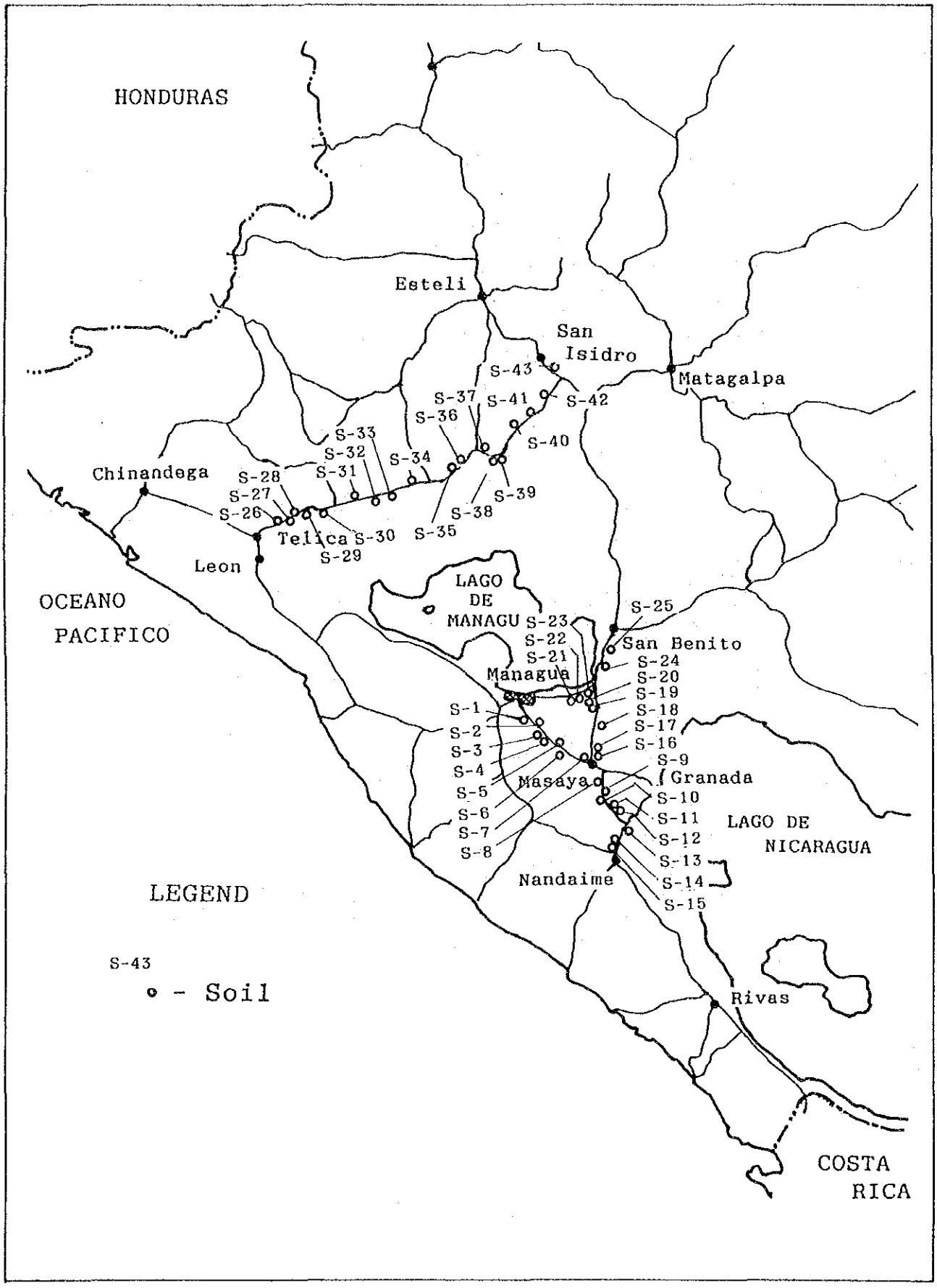


Figure 6-33 Sampling Points of Soil in the Project Area

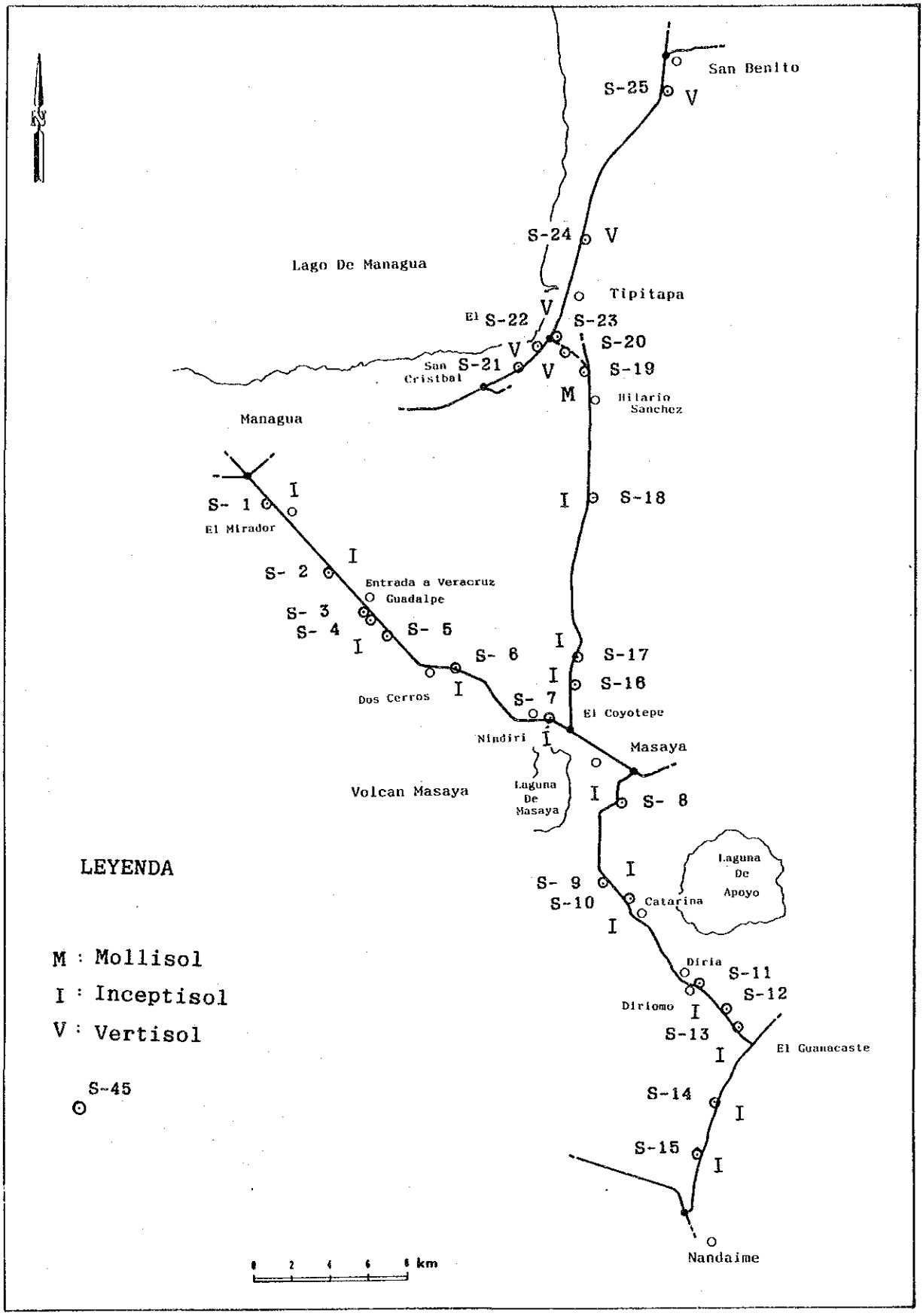


Figure 6-34(1) Results of Soil Investigation

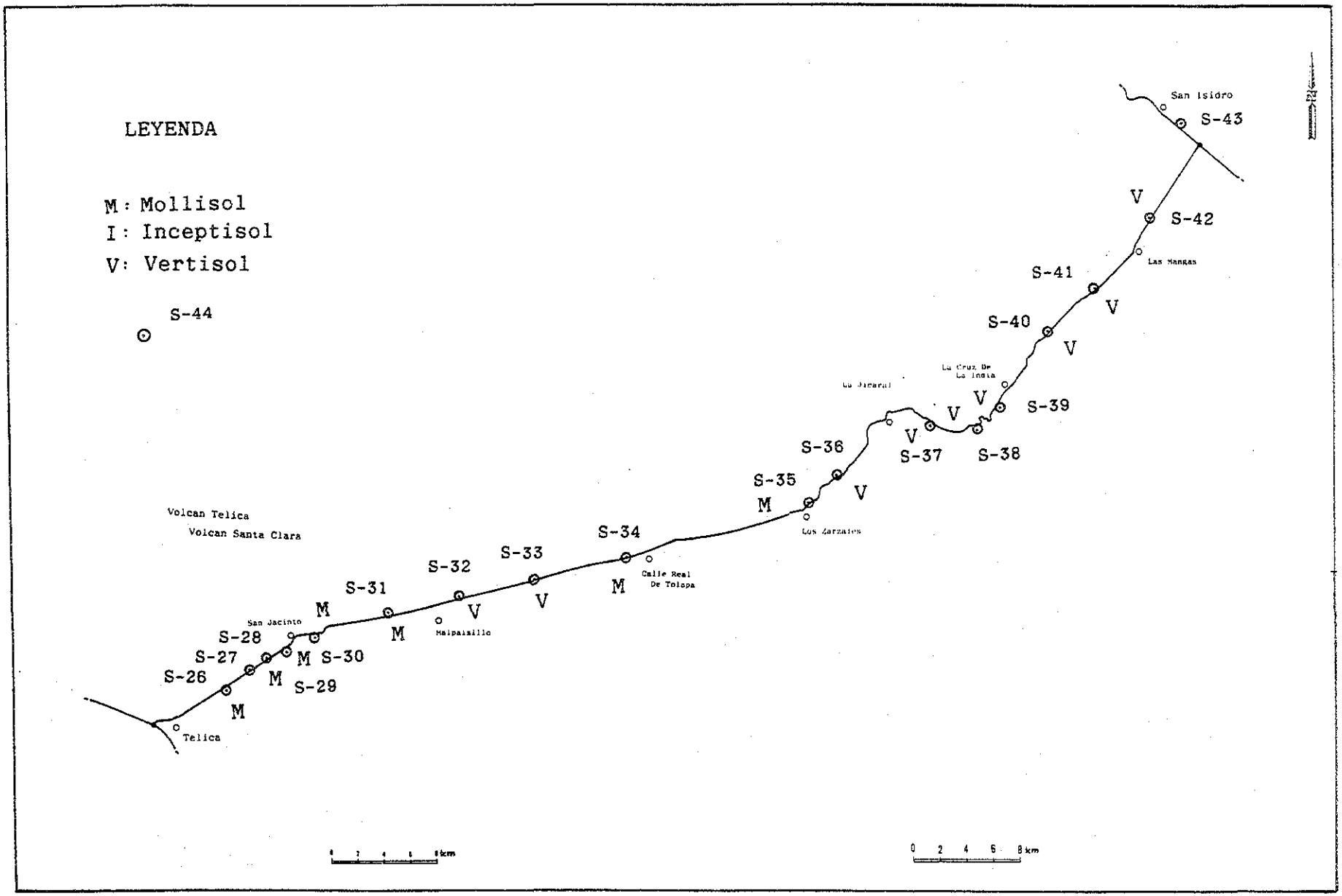


Figure 6-34(2) Results of Soil Investigation

Table 6-19(1) Result of Soil Investigation in the Project Area

No.	Soil classification	Soil layer A (cm)	Soil layer B (cm)	Total Th. (cm)	Color	In. *1	Geology
S- 1	Inceptisol	A1 A2 (25)(10)	B (30)	60	7.5Yr 2/1	3	Tuff
S- 2	Inceptisol	A (70)	B (50)	120	7.5Yr 2/1	0	Tuff
S- 3	Inceptisol	A (40)	B (40)	80	7.5Yr 2/2	0.5	Tuff
S- 4	Inceptisol	A (20)	B (50)	70	5 Yr 3/1	90	Tuff
S- 5	Inceptisol	A (20)	B (50)	70	7.5Yr 3/1	9	Tuff
S- 6	Inceptisol	A (45)	B (35)	80	7.5Yr 1/1	0	Tuff
S- 7	Inceptisol	A (35)	B1 B2 (60)(+35)	+130	2.5Yr 2/1	2	Tuff
S- 8	Inceptisol	A (30)	B (80)	110	7.5Yr 3/2	0	Tuff
S- 9	Inceptisol	A (40)	B (30)	70	10Yr 2/2	70	Tuff
S-10	Inceptisol	A (30)	B (60)	90	7.5Yr 3/2	2	Tuff
S-11	Inceptisol	A1 A2 (20)(60)	B (+50)	+130	7.5Yr 2/3	90	Tuff
S-12	Inceptisol	A (35)	B (10)	45	7.5Yr 2/2	0	Tuff
S-13	Inceptisol	A (90)	B (+40)	+130	7.5Yr 2/2	0	Tuff
S-14	Inceptisol	A (60)	B (70)	+130	2.5Yr 3/3	60	Tuff
S-15	Inceptisol	A (10)	-	10	10Yr 2/3	10	Tuff
S-16	Inceptisol	A (50)	B (15)	65	7.5Yr 3/2	0	Tuff
S-17	Inceptisol	A (80)	B (+50)	+130	10Yr 2/3	0	Tuff
S-18	Inceptisol	A (80)	B (+50)	+130	10Yr 2/3	0	Tuff
S-19	Inceptisol	A1 A2 (5) (20)	B (45)	70	7.5Yr 2/3	1	Tuff
S-20	Vertisol	A (40)	B (55)	55	10Yr 1.7/1	0	Tuff
S-21	Vertisol	A (30)	B (+20)	+50	2.5Yr 2/1	0	Alluvium

*1 : Inclination (degree)
S-6 : No existing soil, Basalt lavaflow

Table 6-19(2) Result of Soil Investigation in the Project Area

No.	Soil Classification	Soil Layer A (cm)	Soil Layer B (cm)	Total Th. (cm)	Color	In.	Geology
S-22	Vertisol	A1 A2 (20)(10)	B (+30)	60	2.5Yr 6/1	0	Alluvium
S-23	Vertisol	A (40)	B (40)	80	7.5Yr 1.7/1	0	Alluvium
S-24	Vertisol	A (40)	B (50)	90	7.5Yr 3/3	2	Alluvium
S-25	Vertisol	A (30)	B (30)	60	5Yr 3/6	0	Alluvium
S-26	Mollisol	A (85)	-	85	7.5Yr 3/3	30	Andesite
S-27	Mollisol	A (90)	-	90	7.5Yr 3/3	0	Tuff
S-28	Mollisol	A (20)	B1 B2 (30)(+50)	+130	7.5Yr 3/3	1	Alluvium
S-29	Mollisol	A (20)	B1 B2 (30)(+50)	+100	5Yr 3/1	2	Tuff
S-30	Mollisol	A (20)	B1 B2 (30)(30)	80	5Yr 3/3	0	Tuff
S-31	Mollisol	A (20)	B1 B2 (30)(+50)	+100	5 Yr 3/1	2	Tuff
S-32	Vertisol	A1 A2 (5) (25)	B1 B2 (30)(25)	85	2 Yr 1.7/1	2	Tuff
S-33	Vertisol	A (130)		130	N 3/10	1	Alluvium
S-34	Mollisol	A1 A2 (10)(30)	B (40)	80	5 Yr 3/3	3	Tuff
S-35	Mollisol	A (15)	B (25)	85	5 Yr 3/1	60	Tuff
S-36	Vertisol	A (15)	B (45)	60	10Yr 4/1	90	Tuff
S-37	Vertisol	A (25)	B (30)	55	2.5Yr 5/2	50	Tuff
S-38	Vertisol	A (25)	B (20)	45	2.5Yr 4/2	60	Tuff
S-39	Vertisol	A (70)		70	2.5Yr 6/5	10	Tuff
S-40	Vertisol	A (30)	B (35)	65	7.5Yr 7/1	40	Tuff
S-41	Vertisol	A (40)	B (30)	70	10 Yr 2/3	5	Tuff
S-42	Vertisol	A (50)	B (+50)	+100	7.5Yr 2/2	3	Alluvium
S-43	Vertisol	A (15)		15	7.5Yr 3/2	10	Tuff

6.7.2 Examination of Soil

The examination was done in Section 6.4 (Water Quality).

6.7.3 Evaluation of Soil

The suspended solid (SS) will occur from bare ground during rain-fall at the stage of road construction. The predicted SS value ranges 101 to 184 ppm which is less than environmental quality standard for water quality. But, it is necessary to prevent SS from bare ground.

Table 6-20 Result of Jar Test of Soil in the Project Area

Sample number	Volume of SS (g/l)	SC *1	Sample Number	Volume of SS (g/l)	SC *1
S - 1	1	I	S -23	2.5	V
S - 2	0.5	I	S -24	2	V
S - 3	1	I	S -25	1	V
S - 4	2	I	S -26	0.5	M
S - 5	1	I	S -27	2	M
S - 6	1	I	S -28	1.5	M
S - 7	2	I	S -29	0.5	M
S - 8	1	I	S -30	1	M
S - 9	1	I	S -31	1.5	M
S -10	2.5	I	S -32	0.5	V
S -11	2	I	S -33	2	V
S -12	2	I	S -34	2	M
S -13	1	I	S -35	1.5	M
S -14	4	I	S -36	1.5	V
S -15	2	I	S -37	2.5	V
S -16	2	I	S -38	2.5	V
S -17	3	I	S -39	1.5	V
S -18	2	I	S -40	2	V
S -19	1	I	S -41	0.5	V
S -20	1	V	S -42	2.5	V
S -21	2	V	S -43	2	V
S -22	2.5	V			

*1 : Soil Classification

6.8 Water

6.8.1 Present Condition

(1) River system

Refer to Section 6.4 (Water Quality).

(2) Field investigation

a. Components of investigation

The field investigation concerning Water is measurement of outflow of rivers which have a current, and water well. The cross section of rivers are done by surveying and the current speed was measured by "Float method". The investigation of digged water wells consists of depth of water level and measurement of temperature and pH of water.

b. Results of investigation

There are five rivers with current in the project area during rain season (September to November). Results of outflow are shown in Table 6-21. And the results of digged water wells in the project area are shown in Table 6-22 and Figure 6-35.

In addition, the drainage condition of road facilities, including bridge, culvert, side ditch and drainage system, was investigated during heavy rain. These results are described in Figure 6-3.

The outflow of rivers are extremely variable, because the current depends on the intensity of rain-fall and quite high infilteration in the project area. Therefore, estimation of the maximum outflow is thought to be better to use the mark of maximum current level in the river, if posible.

The underground water level in the project area ranges 2 to 49 m deep (41 to 467 m in elevation). Partiqularly, infilteration area such as north of Masaya, Nandaime and between Telica and Malpaisillo, is very deep. The temperature is constantly 26 to 29 °C. The pH of underground water ranges 6.8 to 7.9.

Table 6-21 Outflow of Rivers in the Project Area

No.	Name of river	Area of current (m2)	Current velosity (m/s)	Outflow (m3/s)	Remarks
1. W- 2	Rio Mocuana	2.31	16.23	37.5	
2. W-14	Rio El Caimito	3.82	0.03	0.1	
3. W-17	(El Tague)*1	5.60	6.67	5.6	
4. W-18	Rio Cinecapa	0.15	0.03	0.15	
5. W-19	Rio Las Pilas	0.14	0.02	0.14	
6. W-22	Rio El Carriso	2.79	6.72	20	

*1 : No name on the map.

Table 6-22 Digged Water Well in the Project Area

No.	Section	Station (km)	Depth (m)	Elevation of W.L.	pH	Temperature (degree C.)
P- 1	Masaya - Nandaime	24+200	-42	148 m	7.25	26.3
P- 2	Masaya - Tipitapa	14+200	-37	103 m	7.54	28.2
P- 3	Tipitapa - San Benito	2+000	-2.4	41 m	7.95	31.0
P- 4	Telica - San Isidro	2+500	-45	95 m	6.35	26.0
P- 5	Telica - San Isidro	4+500	-49	114 m	6.51	28.1
P- 6	Telica - San Isidro	11+300	?	? m (Hot spring : 50~60°)	6.54	26.6
P- 7	Telica - San Isidro	14+000	-45	53 m	6.97	28.1
P- 8	Telica - San Isidro	17+500	-45	48 m	7.02	28.1
P- 9	Telica - San Isidro	26+000	-38	62 m	7.05	29.3
P-10	Telica - San Isidro	32+900	-17	53 m	7.21	29.1
P-11	Telica - San Isidro	39+000	-17	66 m	6.85	29.4
P-12	Telica - San Isidro	56+400	- 6	94 m	7.15	28.9
P-13	Telica - San Isidro	61+500	- 2	118 m	6.80	29.2
P-14	Telica - San Isidro	79+900	- 8	467 m	7.81	28.1

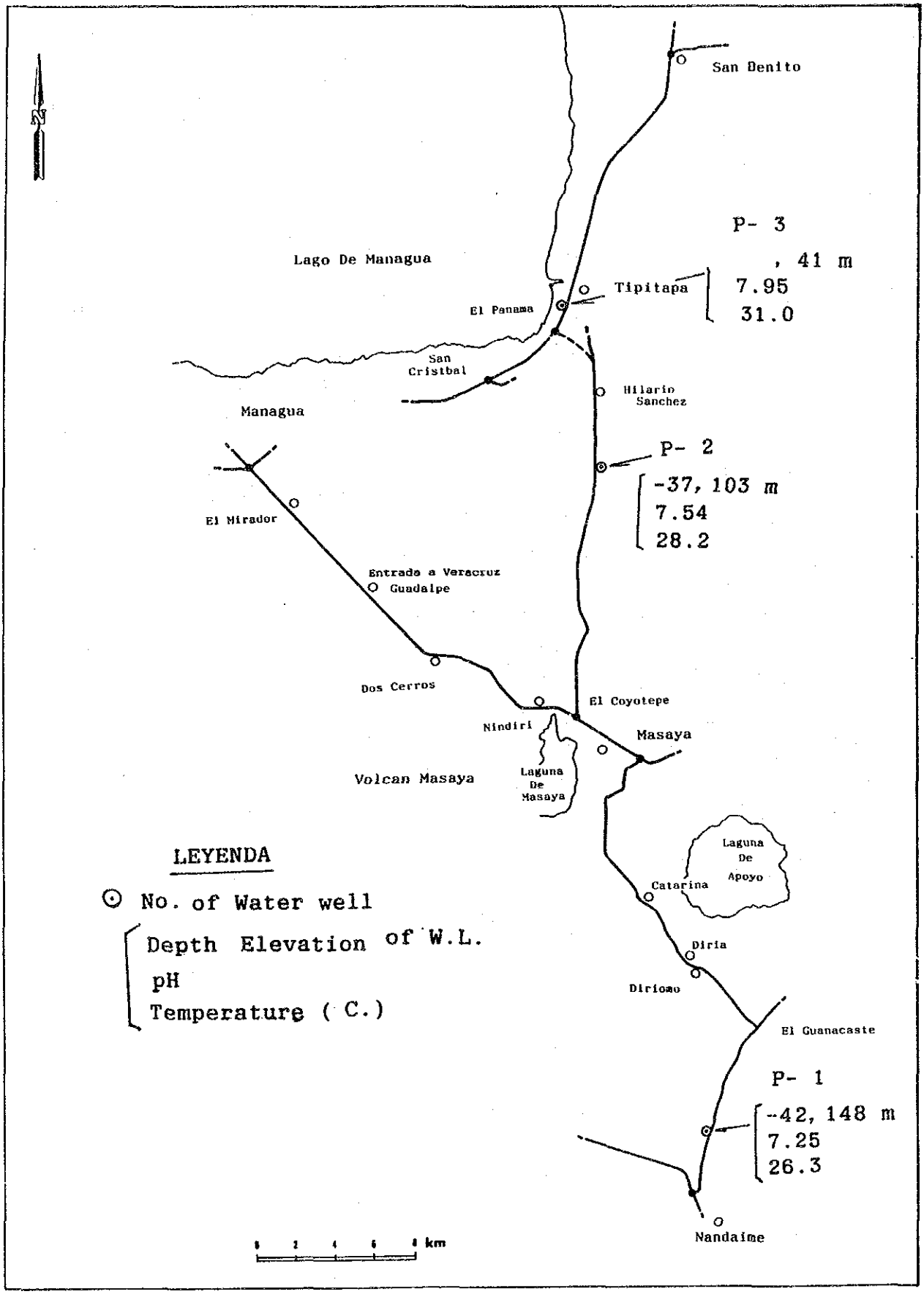


Figure 6-35(1) Present Condition of Water Well in the Project Area

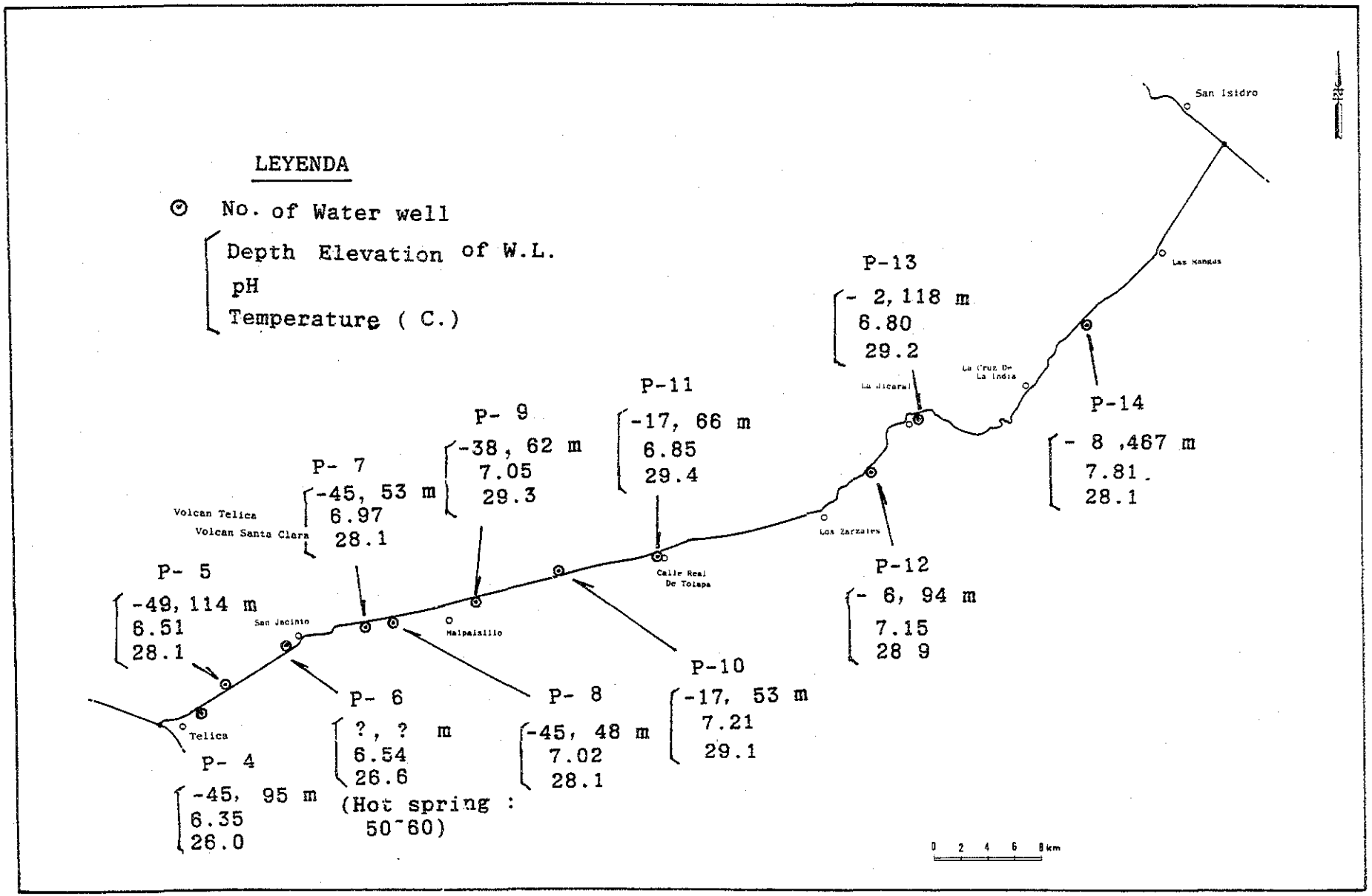


Figure 6-35(2) Present Condition of Water Well in the Project Area

6.8.2 Examination of Water

Influence on Water by road is the change of volume of outflow. The examination area is whole of project area.

(1) Method of examination

The outflow of river is culculated by Formula 6-4.

$$Q = \frac{1}{360} * f * r * A + Qo \qquad \text{(Formula 6-4)}$$

Q : Volume of outflow (m3/sec)
f : Coefficient of outflow
r : Pecipitation (mm/hour)
A : Catchment area (ha)
Qo : Base outflow (m3/sec)

(2) Results of examination

The volume of discherge of each bridge and major culvert is shown in Table 6-23. The capacity of discherge of each bridge and culvert is designed to be beyond the out-flow of rivers.

In addition, the water quality of rivers which have not parmanent current, will contain much dissolved components such as Na+, K+, Ca2+, HCO3-, SO42-, etc.

6.8.3 Evaluation of Water

In addition, the design of bridge and culvert concerning outflow of water are sufficiently estimated. And, gutter, ditch, etc. for drainage also needs enough design for drainage upto the existing drainage system or river.

Table 6-23 Estimated Oischarge of Rivers in the Project Area

(1) Road Section between Managua - Masaya

Location of Station (km)	Catch. area (km2)	Leng. of R. (km)	Dif. of Ele. (m)	Coe. of R.	Time: Con. (h)	Int. Prec. mm/hr	Max. Disc. m3/s
Puente "La Morita" (0 + 490)	23	15.0	300	0.5	2.18	42.87	136.9
Puente (2 + 250)	10	10.5	400	0.5	1.04	93.97	130.5
Puente "El Arroyo" (8 + 170)	104	22.0	690	0.5	2.44	38.60	557.6
(9 + 350)	10	8.5	110	0.5	1.60	61.50	85.4
(10 + 630)	8	7.0	85	0.5	1.37	69.70	77.4

(2) Road Section between Masaya and Nandaime

Location of Station (km)	Catch. area (km2)	Leng. of R. (km)	Dif. of Ele. (m)	Coe. of R.	Time Con. (h)	Int. Prec. mm/hr	Max. Disc. m3/s
Puente "Marayi" (23 + 390)	35	11.5	280	0.5	1.48	60.01	291.7
Puente El arroyo 2: (23 + 790)	20	12.5	190	0.5	2.14	32.00	88.9
Puente El Arroyo 1: (25 + 200)	98	23.0	470	0.5	3.30	28.91	393.5

(3) Road Section between Masaya and Tipitapa

Location of Station (km)	Catch. area (km2)	Leng. of R. (km)	Dif. of Ele. (m)	Coe. of R.	Time Con. (h)	Int. Prec. mm/hr	Max. Disc. m3/s
(12 + 370)	6	5	70	0.5	0.90	125.0	104.2

(4) Road Section between Tipitapa and San Benito

Location of Station (km)	Catch. area (km2)	Leng. of R. (km)	Dif. of Ele. (m)	Coe. of R.	Time Con. (h)	Int. Prec. mm/hr	Max. Disc. m3/s
(7 + 000)	16	7.5	28	0.5	2.98	29.76	66.1

(5) Road Section between Tipitapa and Managua

Location of Station (km)	Catch. area (km2)	Leng. of R. (km)	Dif. of Ele. (m)	Coe. of R.	Time Con. (h)	Int. Prec. mm/hr	Max. Disc. m3/s
(0 + 550)	27	9	60	0.5	3.56	22.42	84.1

(6) Road Section between Telica and San Isidro

Location of Station (km)	Catch. area (km2)	Leng. of R. (km)	Dif. of Ele. (m)	Coe. of R.	Time Con. (h)	Int. Prec. mm/hr	Max. Disc. m3/s
Puente (2 + 970)	14	9.5	580	0.5	0.71	99.88	194.2
Puente (11 + 750)	8.5	5.0	291	0.5	0.53	140.8	166.2
Puente (20 + 520)	6	7.0	592.5	0.5	0.42	172.8	144.0
(23 + 200)	40	10.0	173.5	0.5	1.58	45.90	255.0
(24 + 830)	13	12.0	420	0.5	1.24	61.23	110.6
(33 + 860)	7	5.5	125	0.5	0.83	85.56	83.2
Puente Nagarote (43 + 050)	230	26.0	300	0.5	5.25	11.55	369.0
Puente (45 + 970)	49	10.0	205	0.5	1.43	51.83	352.7
Puente (54 + 480)	15	8.0	570	0.5	0.54	142.9	295.7
Puente El Arenal (61 + 430)	427	43.0	1120	0.5	5.33	11.44	678.3
Puente Los Cabros (68 + 180)	7	10.0	500	0.5	0.84	91.06	88.5
Puente (86 + 810)	66	18.0	780	0.5	164	47.49	435.3
Puente (94 + 205)	76	22.0	820	0.5	2.20	32.63	344.6

6.9 Flora

6.9.1 Present Condition

(1) Field investigation

a. Components of investigation

The investigation of Flora consists of vegetation base-line survey including species composition, plant community and dominant species, which is 200 m long from border of road to the direction of right angles. Number of Flora investigated lines is 26 places as shown in Figure 6-36.

b. Results of investigation

The lists of species composition of Flora in each place are shown in Table 6-24 (refer to Appendix 12). At present, 300 species of Flora are existing in the project area. These species can be classified into three layers, i.e. tree layer, bush layer and undergrowth layer.

These flora can be tentatively sub-divided into five groups, consisiting of dominant species of tree, i.e. Palo prieto, Jicaro + Brasil, Aceituna + Genizaro, Zapote + Cedros and Frijoles groups as shown in Table 6-25. These groups associate with bush and undergrowth, probably forming plant community as shown in Table 6-26. Particularly, undergrowth of each plant community shows relatively clear difference among them.

The Group -1 (Palo prieto) ditributes between Las Zarzales and San Isidro corresponding with the Ecological Region II (refer to Figure 6-12), Central Highland Region. The Group -2 (Jicaro + Brasil) is found between Telica and Malpaisillo, corresponding with the Ecological Sub-region I-2 (Pacific Region). The Group -3 (Aceituna + Genizaro) is found around Lago Managua and Nandaime, corresponding with lowland, the Ecological Sub-region I-2 (Nicaraguan Depression Region). The Group -4 (Zapote + Cedros) is found at Catarina and Diriomo, corresponding with Ecological Sub-region I-3 (highland). The Group -5 (Frijoles) is found in urban and residential areas between Managua and Masaya, consisting mostly of fruite plantation trees, but bush and undergrowth is assumed to form plant community of Zacate + Frijol sub-group.

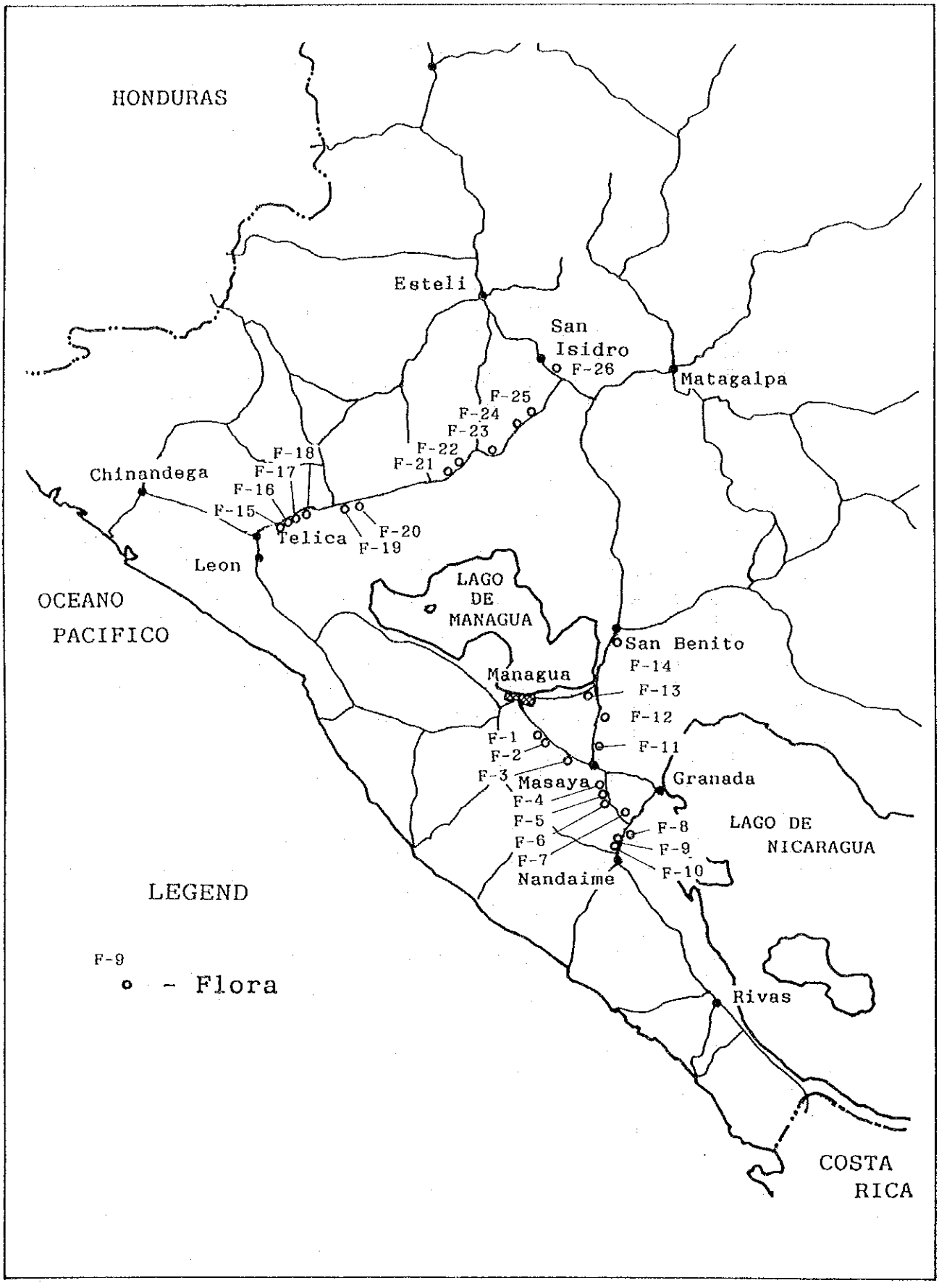


Figure 6-36 Location Map of Flora Investigation in the Project Area

Table 6-24 List of Flora in the Project Area

	Name of Flora	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	F17	F18	F19	F20	F21	F22	F23	F24	F25	F26
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	Horticula	-	+	-	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
	Chegufte	-	+	-	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
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- : 0
+ : 1~3
++ : 4~7
+++ : 8~11
++++ : >11
● : Dominant

Table 6-25 Existing Dominant Species in the Project Area

Dominant Species Group	: Investigation Number (F-)	: location
1. Palo prieto	: 21,22,23,24, 25 & 26	: Las Zarzales, La Jicaral, Las Mangas, San Isidro
2. Jicaro + Brasil	: 15,16,17,18, 19 & 20	: Terica, El Jacinto, Malpaisillo
3. Aceituna + Genizaro	: 8, 9,10,11,12, 13 & 14	: Nandaime, Tipitapa, San Benito
4. Zapote + Cedros	: 4, 5, 6 & 7	: Catarina -- Diriomo
5. Frijoles	: 1, 2 & 3	: Managua -- Masaya

Table 6-26 Plant Community

Dominant Species Group (Plant Community) tree	: Constituent dominant species : Bush	: Undergrowth	: location
1. Palo prieto	: Conouabo, Ron ron, Chaparro	: Zacate, Escob	: highland
2. Jicaro + Brasil	: Arono, Espinos	: Rastrena, Enredadera	:lowland
3. Aceituna + Genizaro	: Tiguite	: Hierba	:lowland
4. Zapote + Cedros	: Platanos, Cacao	: Hoja ancha, Platanillo	:highland
5. Frijoles	: Limonarios, : Hornamentales	: Zacate hoja ancha	:urban area

6.9.2 Examination of Flora

(1) Classification of natural condition

The present condition of vegetation can be classified into

ten Natural grades as shown in Table 6-27. The Natural grade (N.G.) means the condition of nature remained in the area, that is, residential and industrial area is N. G. -1 and natural grassland (pampas) or natural forest are N. G. -9 and -10 respectively.

Table 6-27 Classification of Natural Grade

Natural Grade	Components	Remarks
- 1	Residential, reclaimed reconstructed land	Rare vegetation
- 2	Agricultural land (Farm and rice field)	Including residential area (retio of G.C.*1: +60 %)
- 3	Agricultural land (Orchards)	Fruits plantation, etc.
- 4	Secondary grassland (Low grass)	Turf, etc.
- 5	Secondary grassland (High grass)	Pampas grass, etc.
- 6	Replantation land (Green belt)	Evergreen tree, etc.
- 7	Secondary forest	
- 8	Secondary forest (near natural forest)	
- 9	Natural grassland (plain, swamp)	
- 10	Natural forest	

*1 : Ratio of green coverage

In the project area, Natural grade (N.G.) -9 and 10 are not existing, because cultivation by burning and burning for making pasture were widely done.

In the section between managua and Masaya, Masaya and Tipitapa, Managua and San Benito, most of the area is occupied by residential and agricultural lands, N.G. -2, -3, -4 and -5, the secondary forest (N.G. -7)

In the section between Telica and San Isidro, the area between Telica and Las Zarzales is mainly occupied by N.G. -2, 4 and subordinate N.G. -7 in some places. The area between Las Zarzales and southwest of Las Mangas is covered by thick secondary forests of N.G. -7 and 8. The area between south of Las Mangas and San Isidro is occupied by N.G. -2, 4 and 7. The section between Telica and San Isidro is preserved natural condition of Flora more than the area of Managua, Masaya, Tipitapa, Nandaime and San Benito.

(2) Extinction of species of Flora

Influences on Flora by construction and servicing of road are thought to be deforestration and extinction of valuable species and plant community by deforestation.

There are three places except cutting places, where cleaning of plant is necessary for road improvement, in the project area, namely El Panama, Masaya urban area, south of Tipitapa and Cristalito, east of La Jicaral. Each cutting places are small scale and cutting area is minimized, so that the extinction of flora is thought to be minimized and the sites are covered by secondary bush and grass.

The species and plant community at the above three sites are existing as follows:

1. El Panama
   - Area : 73,850 m2
   - Plant community : -
   - Existing Species: Tiguilote, Furutillo, Malinche, Jobos, Paraiso, Espino Bl, Espino de Playa, Aguijote, Yuca, Tiguilote, Cedro, Madero Negro, Sardinillo, Nancite, Aromo, Pica de Pato, Hierba de hoja ancha, Dolmilona falsa

2. Masaya urban area
   - Area : 6,750 m2 (including paved area:2,250 m2)
   - Length : 6.200 km
   - Plant community : -
   - Existing Species: Street trees (planted) Chilamate, Malinche, Acacia, Jocote, Tiguilote, Casia Amarilla, Roble Sabanero, Chilamate, Laurel de la India, Casuarina, Genizaro

3. Cristalito
   - Area : 84,000 m2
   - Length : 1.400 km
   - Plant community : Palo prieto Group
   - Species : Brasil, Cornizuelo, Palo prieto, Quebracho, Guayaba, Aromo, Chapparo, Mosote, Escoba

There is not including valuable species of flora, listed up in the "List of endangered extinction fauna and flora" in Nicaragua(Appendix II.13).

6.9.3 Evaluation of Flora

The area for cleaning of plant in the project area is minimamized and valuable species are not present. Therefore, the influence to the Flora is considered to be very small.

In addition, it is necessary to be planned replantation at bare ground of quarry sites, stockpile of materials, heavy machines and maintenance office site, etc. and street trees for landscape, safety and erosion.

6.10 Landscape

6.10.1 Present Condition

Landscape in the project area and vicinity is classified into three regions, namly urban, rural (hilly) and mountainous landscape.

The landscape of urban areas are designated at Managua and Masaya. The elements of these landscape consist mainly of residential and commercial zones including El Coyotepe.

Rural landscape contains most of the road sections of the project area, i.e. Nandaime, San Benito, Tipitapa, between Telica and Los Zarzales and between Las Mangas and San Isidro. The elements of the landscape consist of farm and pasture scenery accompanied with hills, forests, rivers, lakes and volcano including Volcan Masaya National Park. In addition, Electric line (high voltage), small villages, etc. as artificial elements are listed up.

Mountainous landscape is designated between Los Zarzales and Las Mangas. The elements of landscape consist of mountainous scenery, rivers, forests, swamp, electric line (high voltage), scattered small villages, etc.

6.10.2 Examination of Landscape

The locations changing topography by improvement of the project are four places, namely southeast of El Mirador

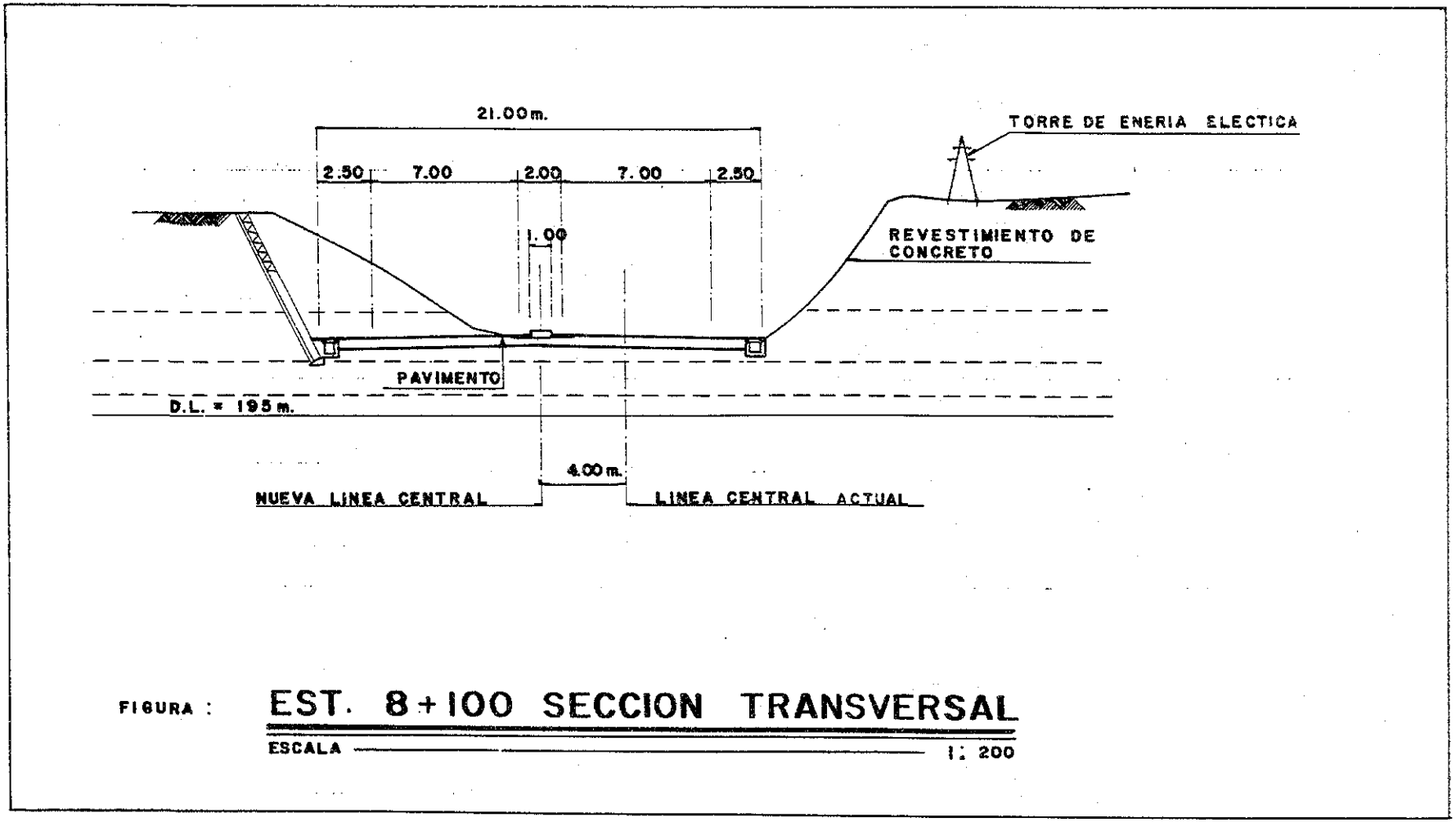


Figure 6-37 Cutting Site (8+100 km) in the South of El Mirador

(Station 8+100 km), El Coyotepe intersection (Station 21+000 km), south of Tipitapa and Cristalito as shown in Figure 6-1.

Southeast of El Mirador will be cut left slope for widening as shown in Figure 6-37 and Photograph 6-1. The redicted condition of cutted left slope is shown in Photograph 6-2 and 6-3.

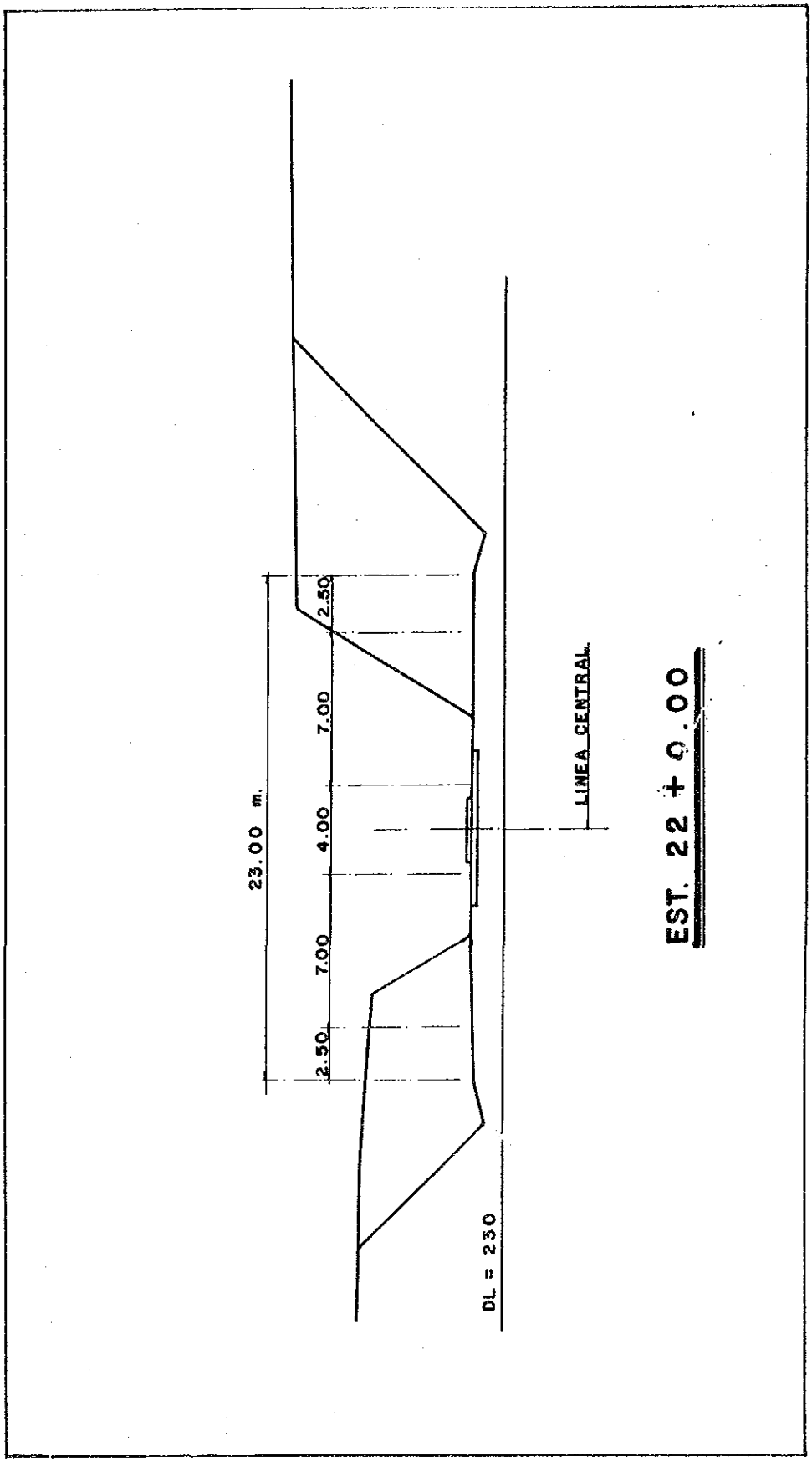
El Coyotepe intersection will be cut both slopes for widening as shown in Figure 6-38 and Photograph 6-3. The predicted condition of cutted both slopes is shown in Photograph 6-4.

South of Tipitapa is planning to make bypass road from south of Tipitapa (Station No. 19+600 km) to Rio Panama (Station No. 21+925 km) as shown in Figure 6-39 and Photograph 6-5 (south of Tipitapa), 6-6 (El Panama) and 6-7 (Rio Panama). The predicted condition of cutted both slopes is shown in Photograph 6-8, 6-9 and 6-10. Photograph 6-5 is aero-photograph and planning route.

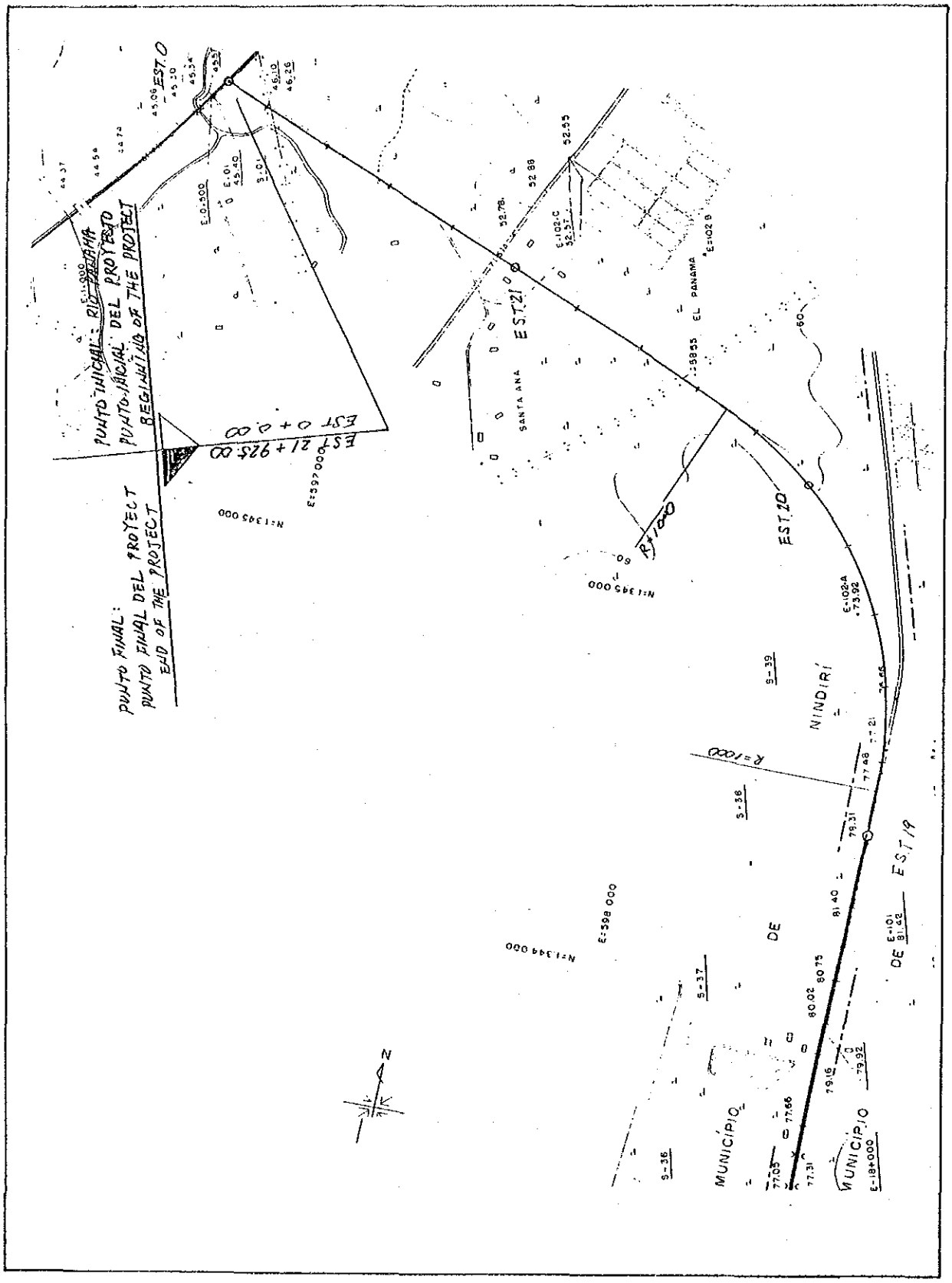
Cristalito is planning to improve an alignment of road as shown in Figure 6-40 and Photograph 6-11, 12, 13 and 6-14. Photograph 6-15 is aero-photograph and planning route is marked.

6.10.3 Evaluation of Landscape

The changing parts for road improvement in the project area are planning to be minimized. Therefore, the influence to the Landscape is considered to be very small.



Fugure 6-38 Cutting Site (22+000 km) at El Coyotepe



Fugure 6-39(1) Bypass (19+000 km - 21+925 km) at Rio Panama

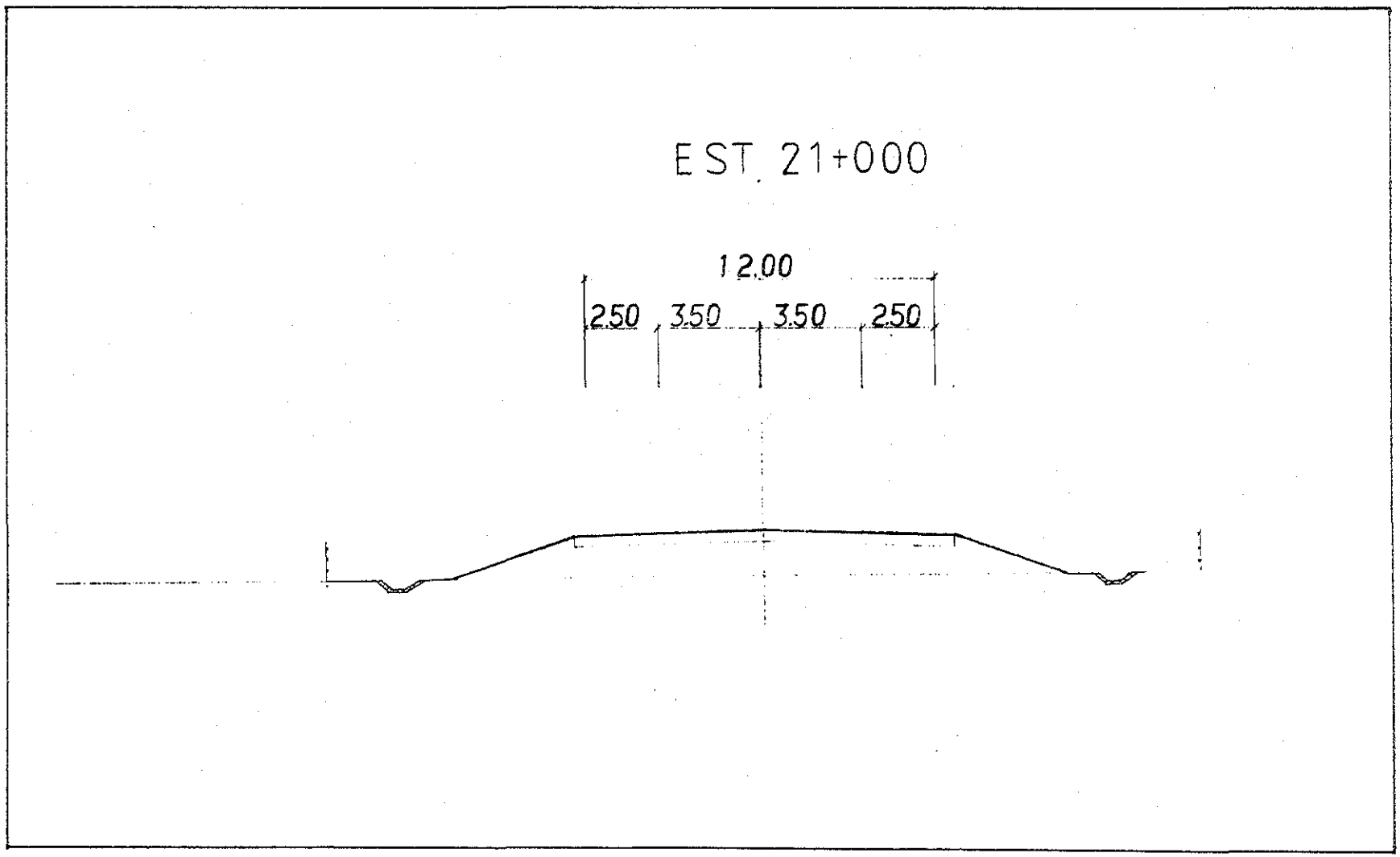


Figure 6-39(2) Bypass (19+000 km - 21+925 km) at Rio Panama

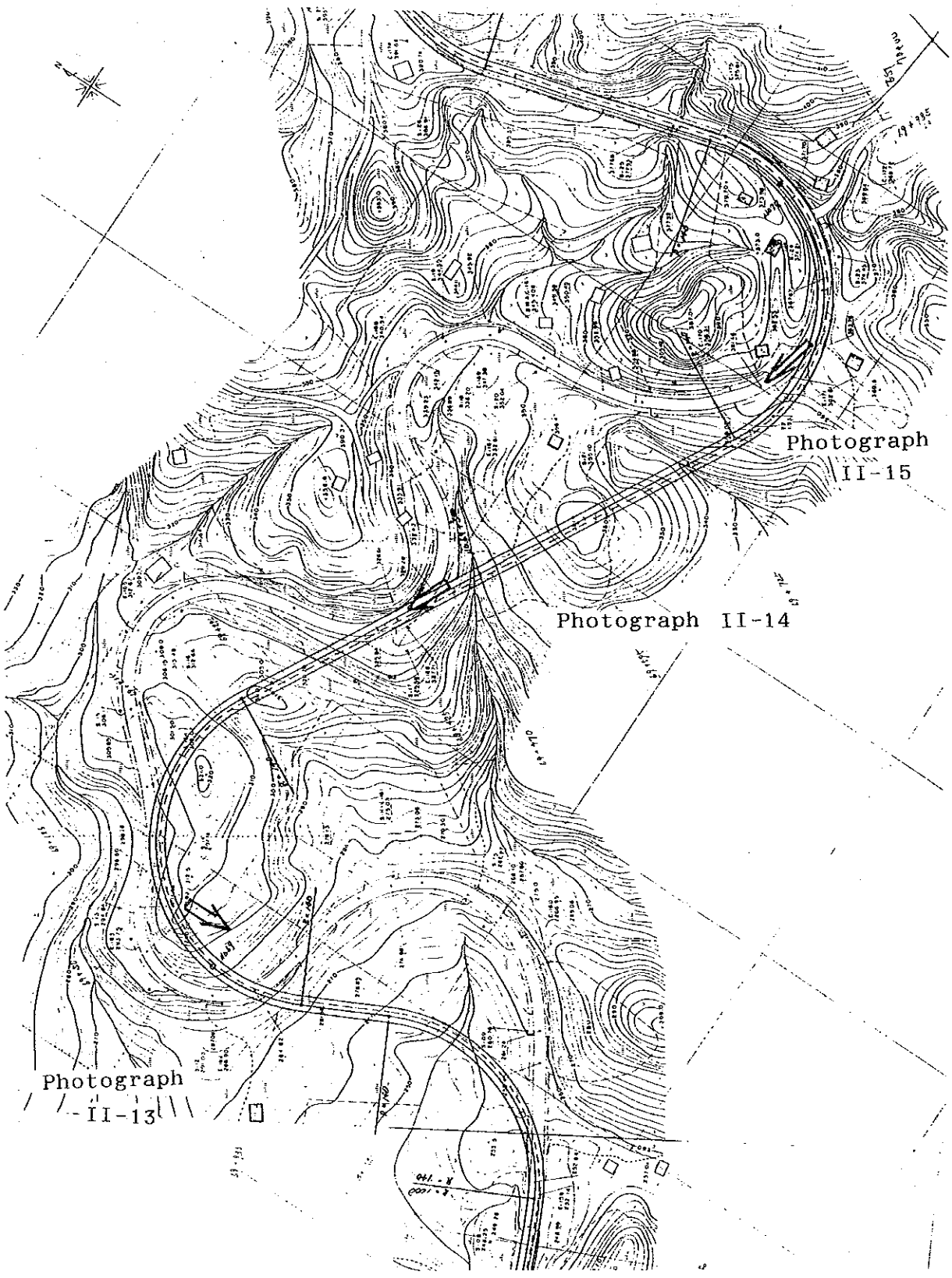
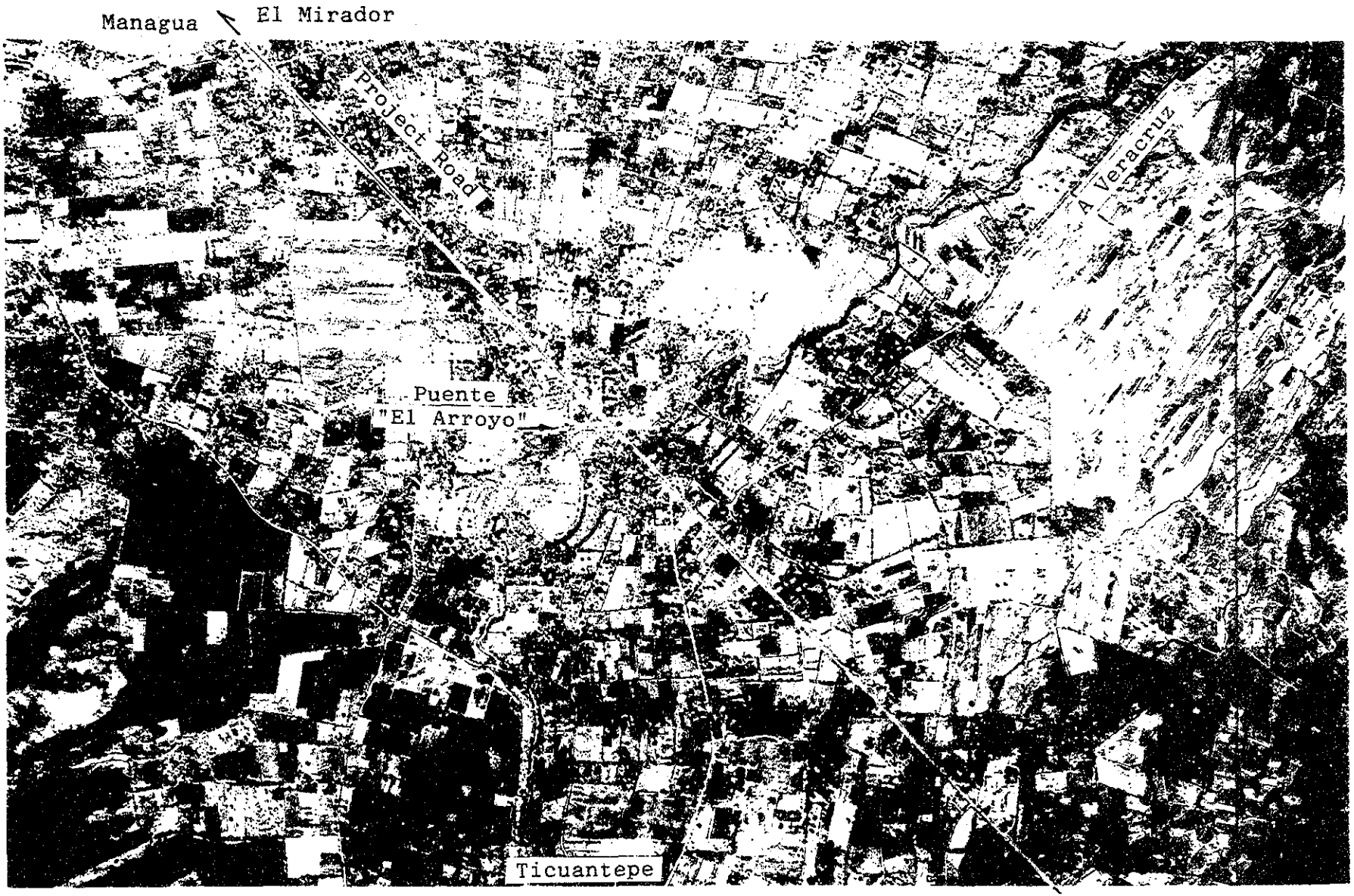


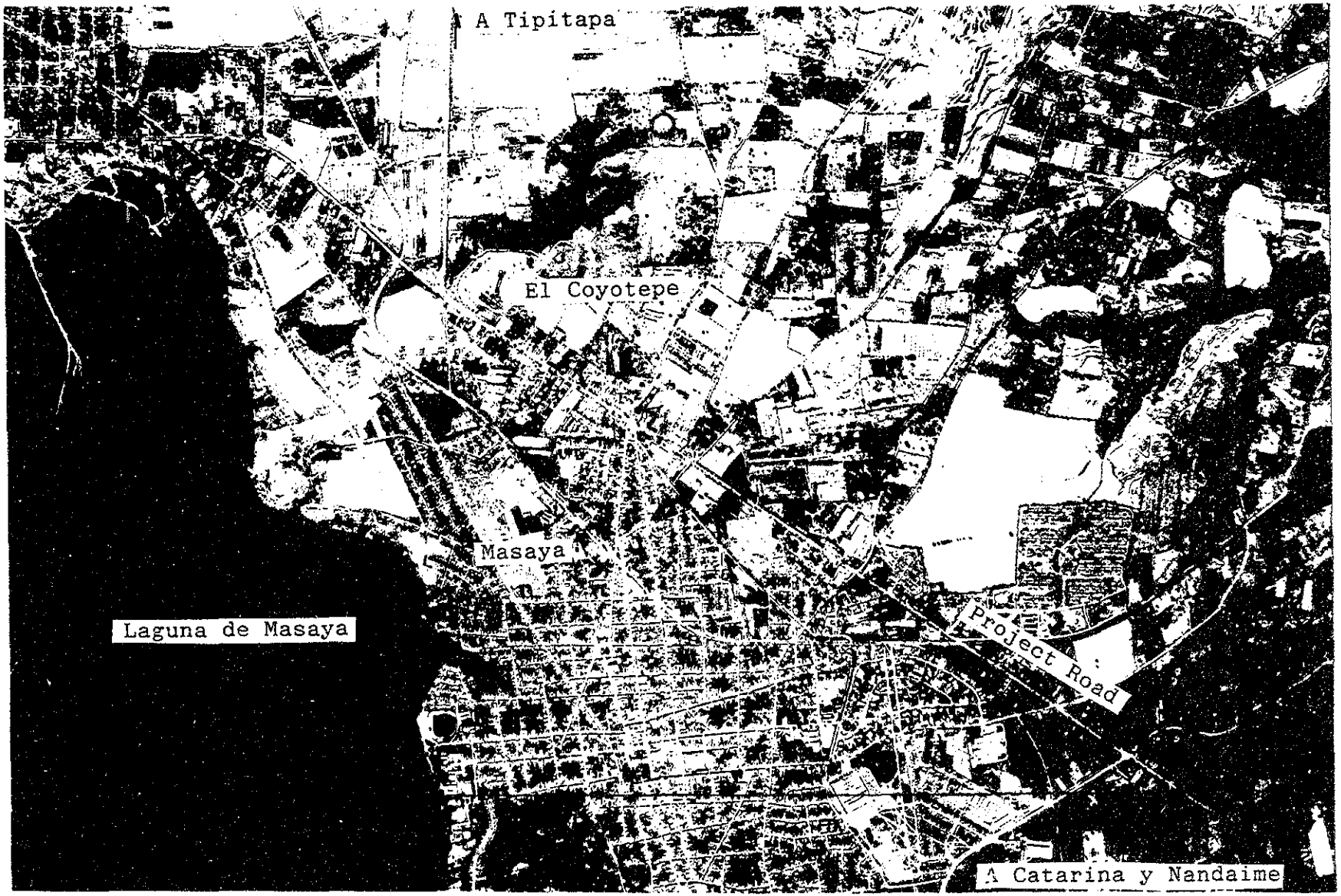
Figure 6-40 Alinement Improvement at Cristalito



Photograph 6-1 South of Managua, Station 8+100 km between Managua and Entrada de Veracruz

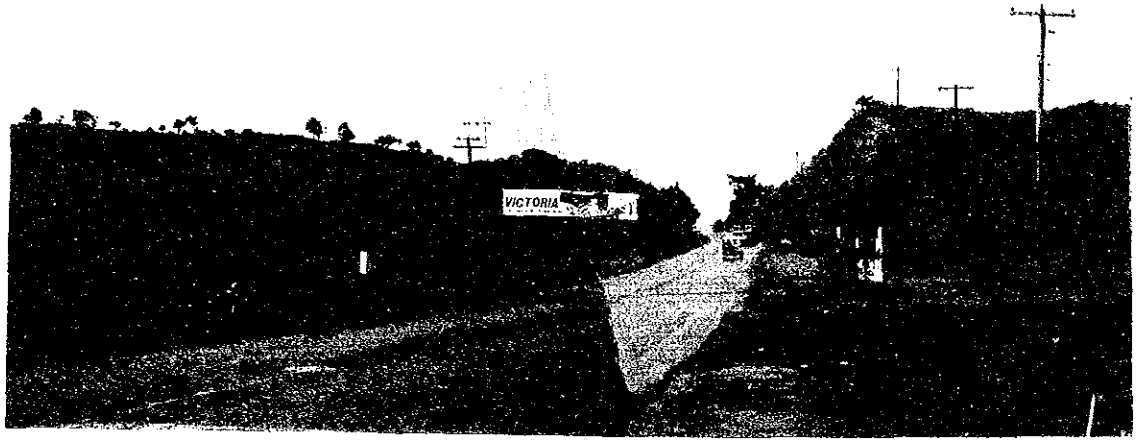
Photograph 6-2 Station 8+100 km (South of Mirador)

Photograph 6-3 Cutted Line at Station 8+100 km

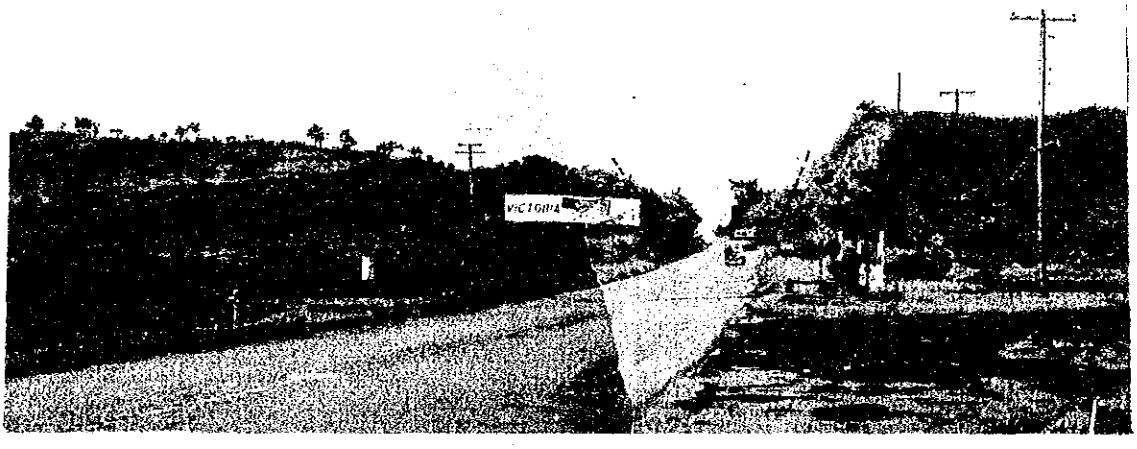


Photograph 6-4 Station 22+000 km (El Coyotepe) between Managua and Masaya

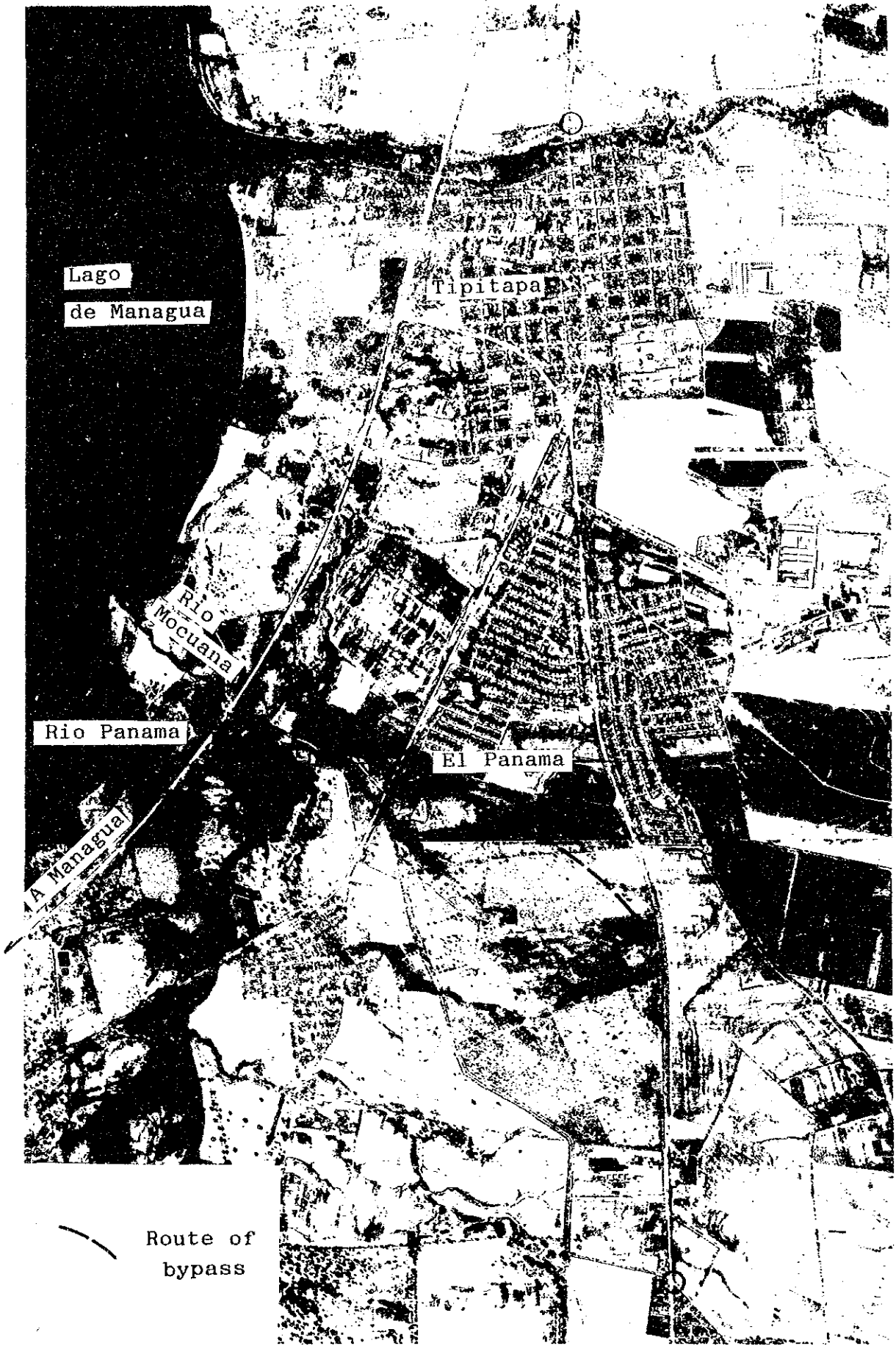
Interection de El Coyotepe



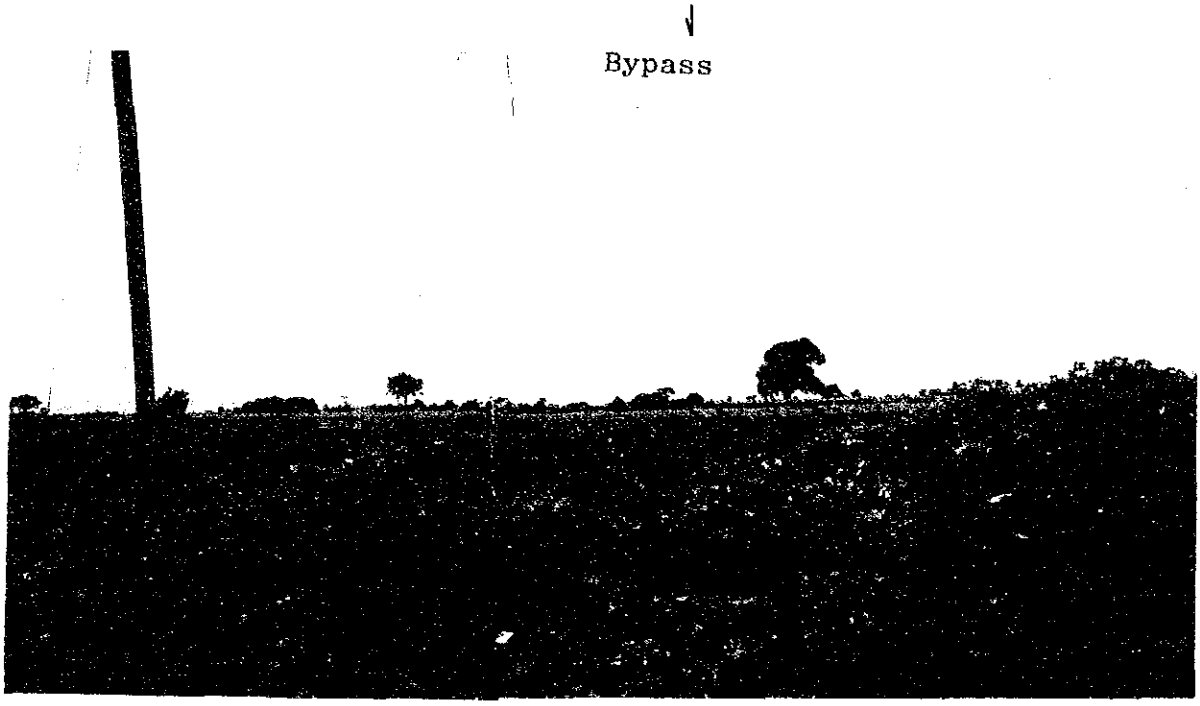
Photograph 6-5 Station 22+000 km (El Coyotepe)



Photograph 6-6 Cutted Line at Station 22+000 km



Photograph 6-7 South of Tipitapa, Bypass



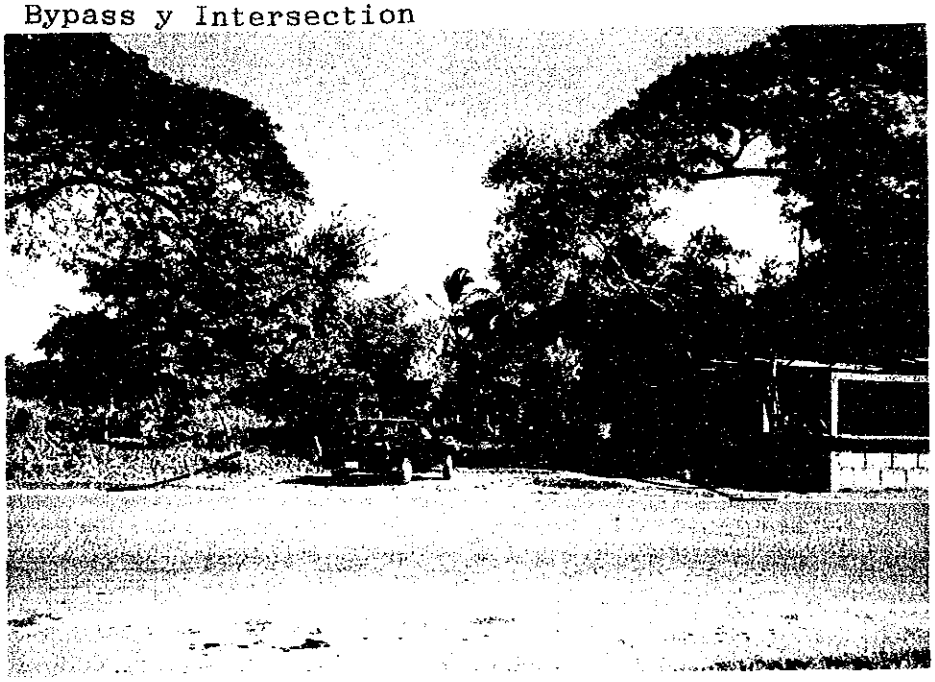
Photograph 6-8 South of Tipitapa, Station 19+000 km between Masaya and Tipitapa

Photograph 6-9 El panama, Station 21+200 km between Masaya and Tipitapa

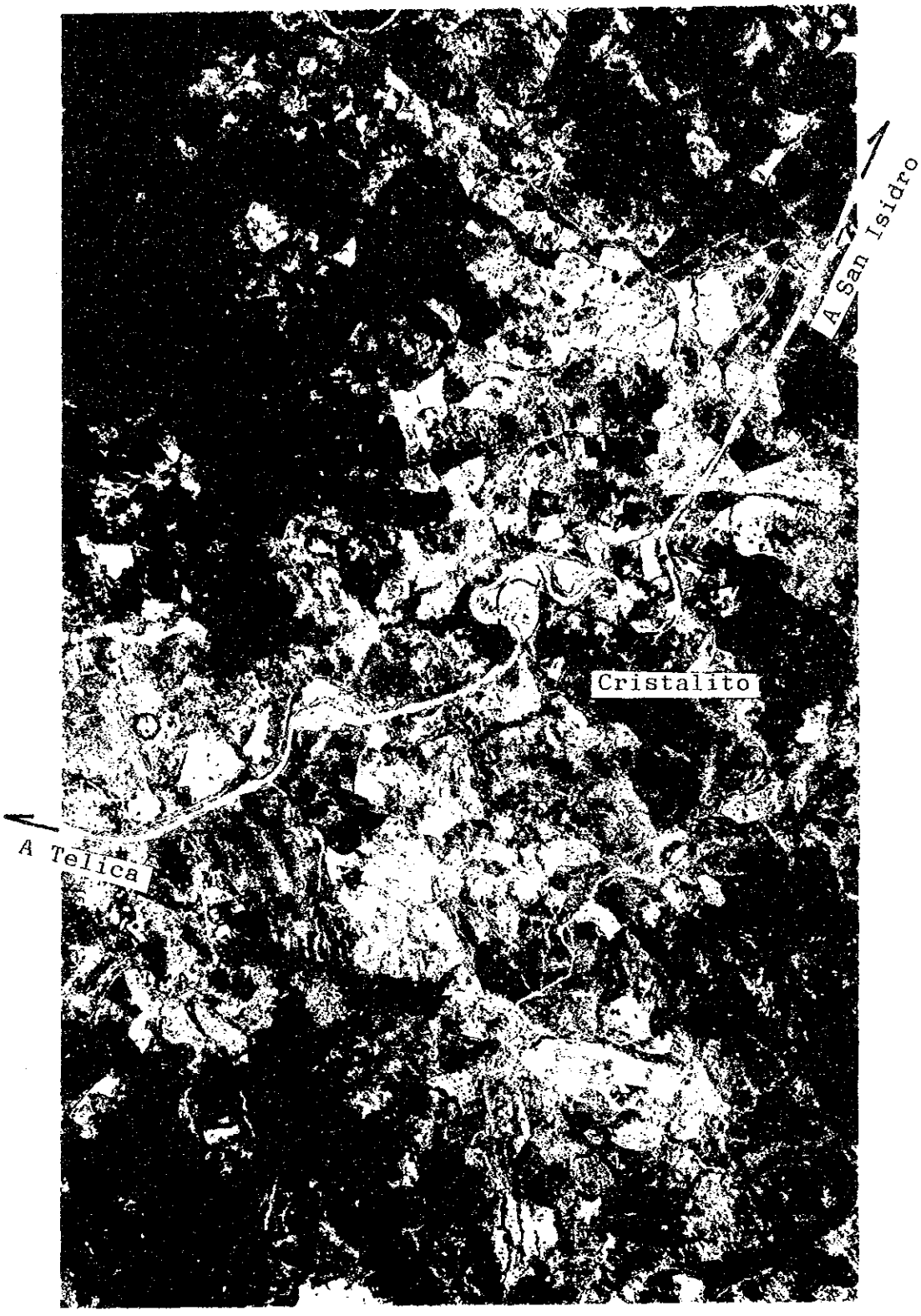
Bypass

Photograph 6-10 El Panama, Station 21+300 km between Masaya and Tipitapa

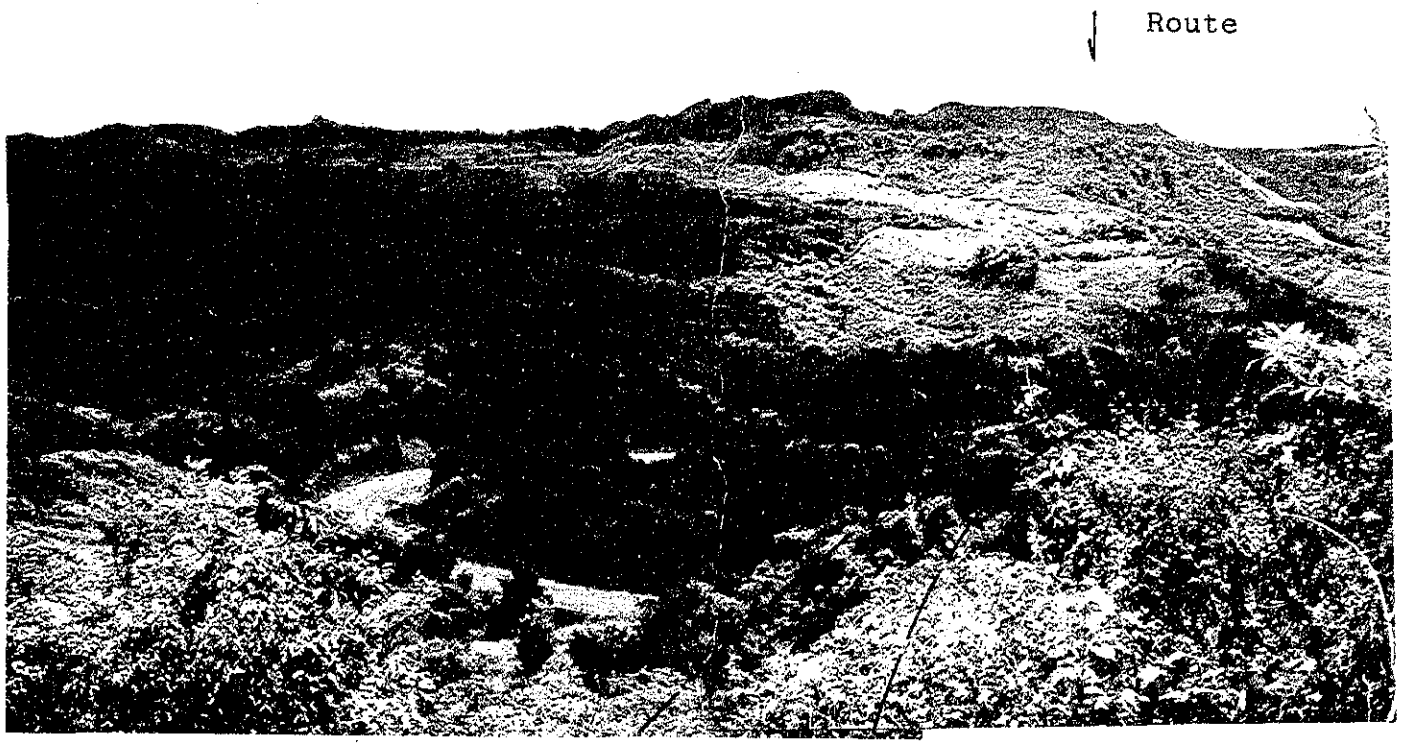
Bypass y Intersection



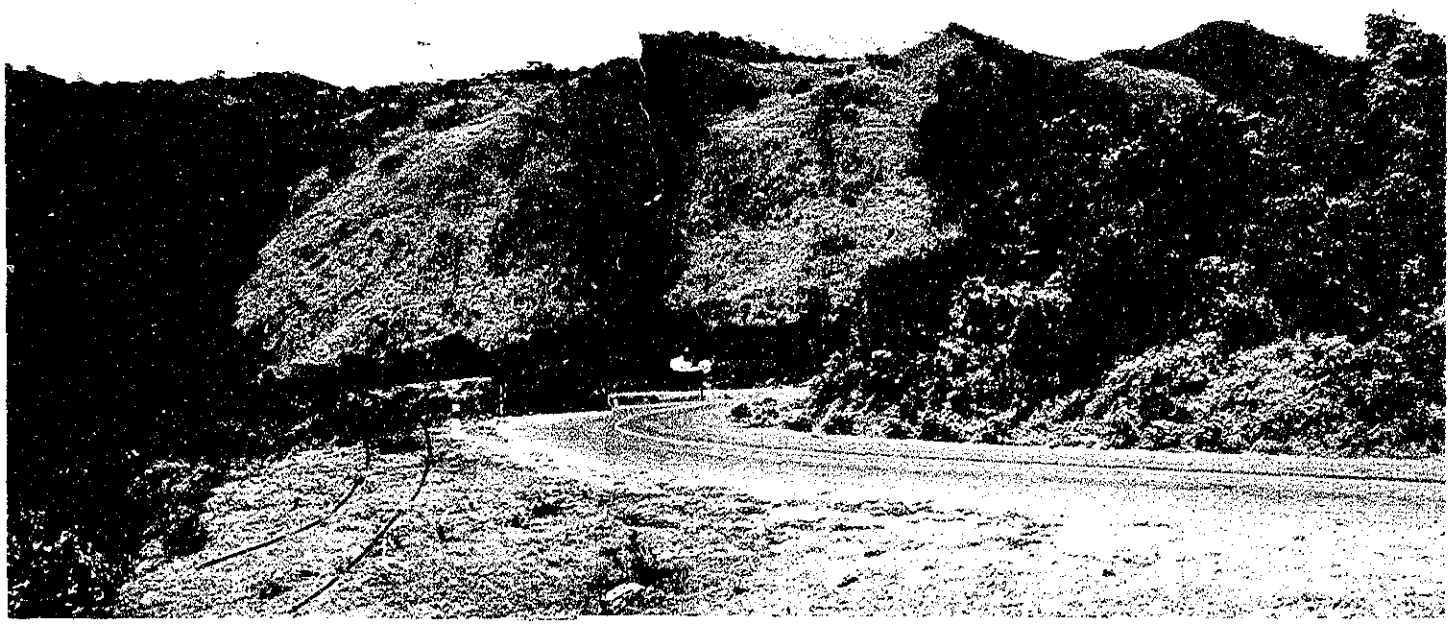
Photograph 6-11 Rio Panama, Station 21+925 km between Masaya and Tipitapa



Photograph 6-12 Road Alinement at Cristalito between Terica and San Isidro



Photograph 6-13 Station 70+000 km (Central of Cristalito) between Terica and San Ishidro



Photograph 6-14 Station 70+400 km (Cristalito) between Terica and San Ishidro

Route

Photograph 6-15 Station 70+800 km (Cristalito) between Terica and San Ishidro