

JAPAN INTERNATIONAL COOPERATION AGENCY
MINISTRY OF CONSTRUCTION AND TRANSPORTATION
THE REPUBLIC OF NICARAGUA

THE ROAD IMPROVEMENT
AND
REHABILITATION STUDY
IN
NICARAGUA
FINAL REPORT
ANNEXES III
ENVIRONMENTAL IMPACT ASSESSMENT



JULY 1994

CENTRAL CONSULTANT INC.
NIPPON KOEI CO., LTD.

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THE ROAD IMPROVEMENT AND REHABILITATION STUDY IN NICARAGUA

FINAL REPORT

ANNEXES III ENVIRONMENTAL IMPACT ASSESSMENT

JULY 1994

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**JAPAN INTERNATIONAL COOPERATION AGENCY
MINISTRY OF CONSTRUCTION AND TRANSPORTATION
THE REPUBLIC OF NICARAGUA**

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国際協力事業団

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"Cieba phentaulra"

ABSTRACT

The Environmental Impact Assessment (AIE) was carried out at the stage of Feasibility Study of "The Road Improvement and Rehabilitation Studies in the Republic of Nicaragua" at the project area in order to preserve a natural and living environment.

As a result of the Initial Environmental Examination (IEE) concerning tentatively assigned four road sections at the stage of Master Plan, the necessity of the Environmental Impact Assessment had been recommended to be enforced at the stage of Feasibility Study and the environmental investigations.

The Environmental Impact Assessment was finally carried out four road sections as follows:

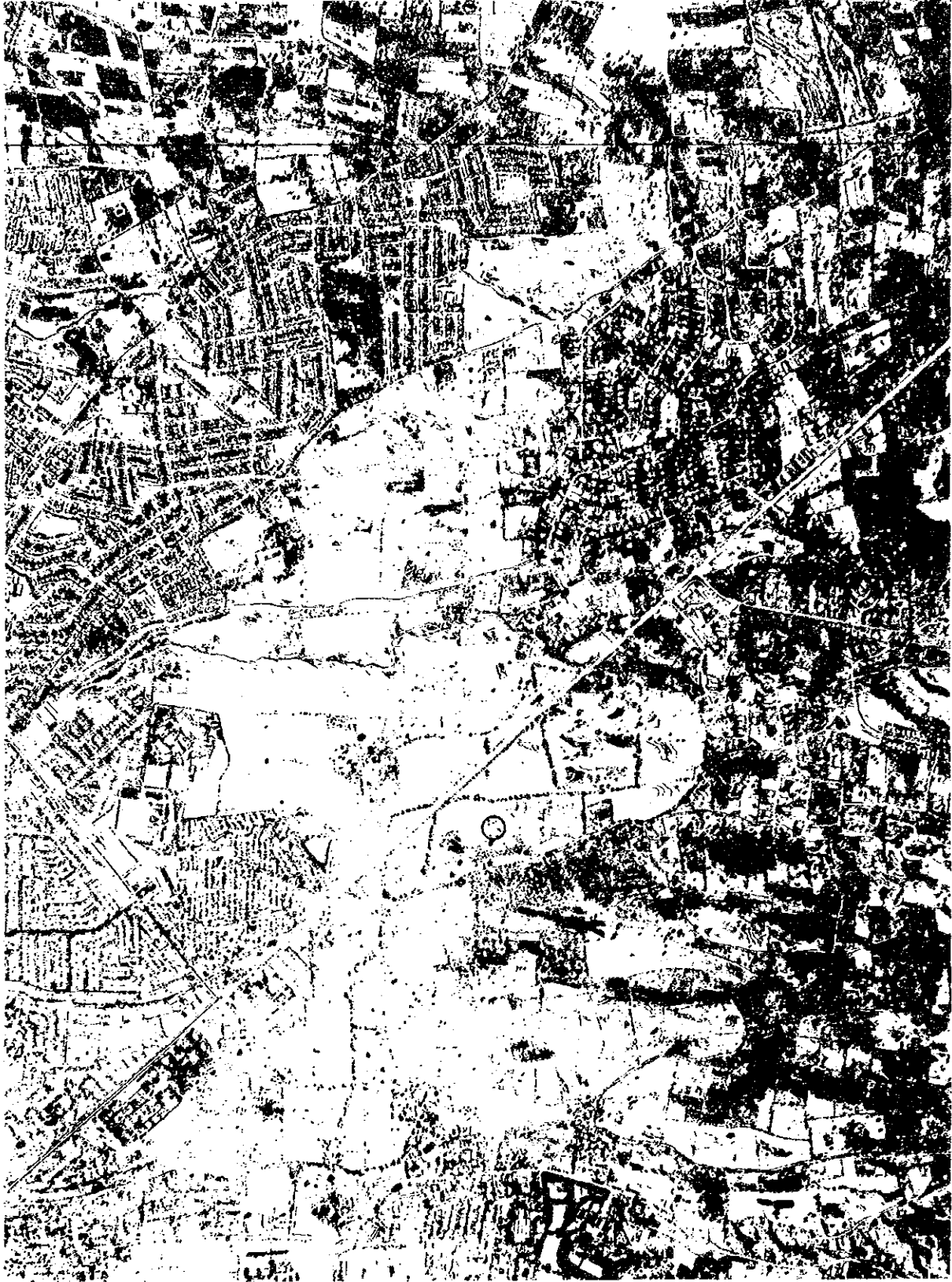
Road Section - 1	: Managua - Masaya	: 27.200 km
- 2	: Managua - Tipitapa	: 4.300 km
- 3	: Nandaime - San Benito	
	a. Nandaime- Masaya	: 27.200 km
	b. Masaya - Tipitapa	: 21.925 km
	c. Tipitapa- San Benito	: 16.000 km
- 4	: Telica - San Isidro	: 95.760 km

The following environmental items for the Environmental Impact Assessment concerning assigned four road sections were selected.

- Living environment (Pollution)
 - 1) Air quality
 - 2) Water quality
 - 3) Noise and Vibration
- Natural environment
 - 4) Land
 - 5) Soil
 - 6) Water
 - 7) Flora
 - 8) Landscape
- Social environment
 - 9) Traffic conditions
 - 10) Social conditions

Concerning each environmental item, environmental investigations of the present condition were carried out and the examinations of prediction and evaluation in 2000 and 2010 were done. As results of the examinations, minor influences of Traffic conditions, Air quality, water quality, Noise and Vibration, Land, Soil, Flora, Landscape and Social conditions were extracted.

The influences of the environmental items except Air quality, Water quality and Noise and Vibration will be very small or minimized by the environmental management plan. However, Air quality, Noise and Vibration will be worse condition than the present in some places, therefore, it will be necessary to set up the monitoring systems for Air quality, Water quality and Noise and Vibration and to control traffic condition depend on the result of the monitoring.



Aero-photograph : Project Road, South of Managua

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1. INTRODUCTION

1.1 General

The Environmental Impact Assessment on the project roads assigned at the stage of Feasibility Study of "The Road Improvement and Rehabilitation Studies in the Republic of Nicaragua" was conducted by the JICA Study Team in cooperation with the Ministry of Construction and Transportation of Nicaragua. The major objectives of study is to preserve the natural and living environment and to consider the necessary environmental management plan.

1.2 Legal Condition

Laws and regulations of the environmental aspects including national parks and protection areas are legislated as shown in Table 1-1. Legislation concerning environmental institution has not been established yet in Nicaragua, However, the discussion of legislating the environmental law began recently in the Diet, it is expected that environmental impact assessment could be institutionalized soon.

Table 1-1 Legislations Related to the Environment

Number, Year	Name
Dec.No.56, 1979	: Creacion del Instituto Nicaraguense de Recursos Naturales y del Ambiente
Dec.No.79, 1979	: Ley Creadora del Parque Nacional Volcan Masaya
Dec.No.112, 1979	: Ley Organica del Instituto Nicaraguense de Recursos Naturales y del Ambiente
Dec.No.13, 1980	: Zona de Refugio para la Vida Silvestre - Proteccion a los Animales Silvestres Cosiguina, Zona de Asilo
Dec.No.1194, 1983	: Creacion del Parque Nacional "Archipiélago Zapatera"
Dec.No.1294, 1983	: Creation de Refugio de Vida Silvestre Rio Escalante-Chacocente
Dec.No.1320, 1983	: Creacion de Reservas Naturales en el Pacifico de Nicaragua
Dec.No.336, 1988	: Ley de Extincion de Irena e Integracion de su Sus Funciones al Midinra
Dec.No.340, 1988	: La Junta de Gobierno de R4 Construccion Nacional de la Republica de Nicaragua
Dec.No.572, 1990	: Creacion de las Areas Naturales Protegidas del Sureste de Nicaragua
Dec.No.42, 1991	: Declaracion de Areas Protegidas en Varios Cerros Macizos Montanosos, Volcanes y Lagunas del Pais
Dec.No.43, 1991	: Declaracion de la Reserva Biologica Marina "Cayos Miskitos y Franja Costera Inmediata"
Dec.No.44, 1991	: Declaracion de la Reserva Nacional de Recursos Naturales "Bosawas"
Dec.No.38, 1992	: Creacion de Reservas Forestales

1.3 Environmental Studies

The process of environmental consideration including the Initial Environmental Examination and Environmental Impact Assessment for the project cycle is shown in Figure 1-1. The Initial Environmental Examination is situated at the stage of Master Plan, examined the project by general point of view, and is continuously followed by the Environmental Impact Assessment at the stage of Feasibility Study, if necessary.

As a result of the Initial Environmental Examination by Environmental Checklist, the necessity of the Environmental Impact Assessment had been recognized at the stage of the Feasibility Study. The flow of the Environmental Impact Assessment is shown in Figure 1-2.

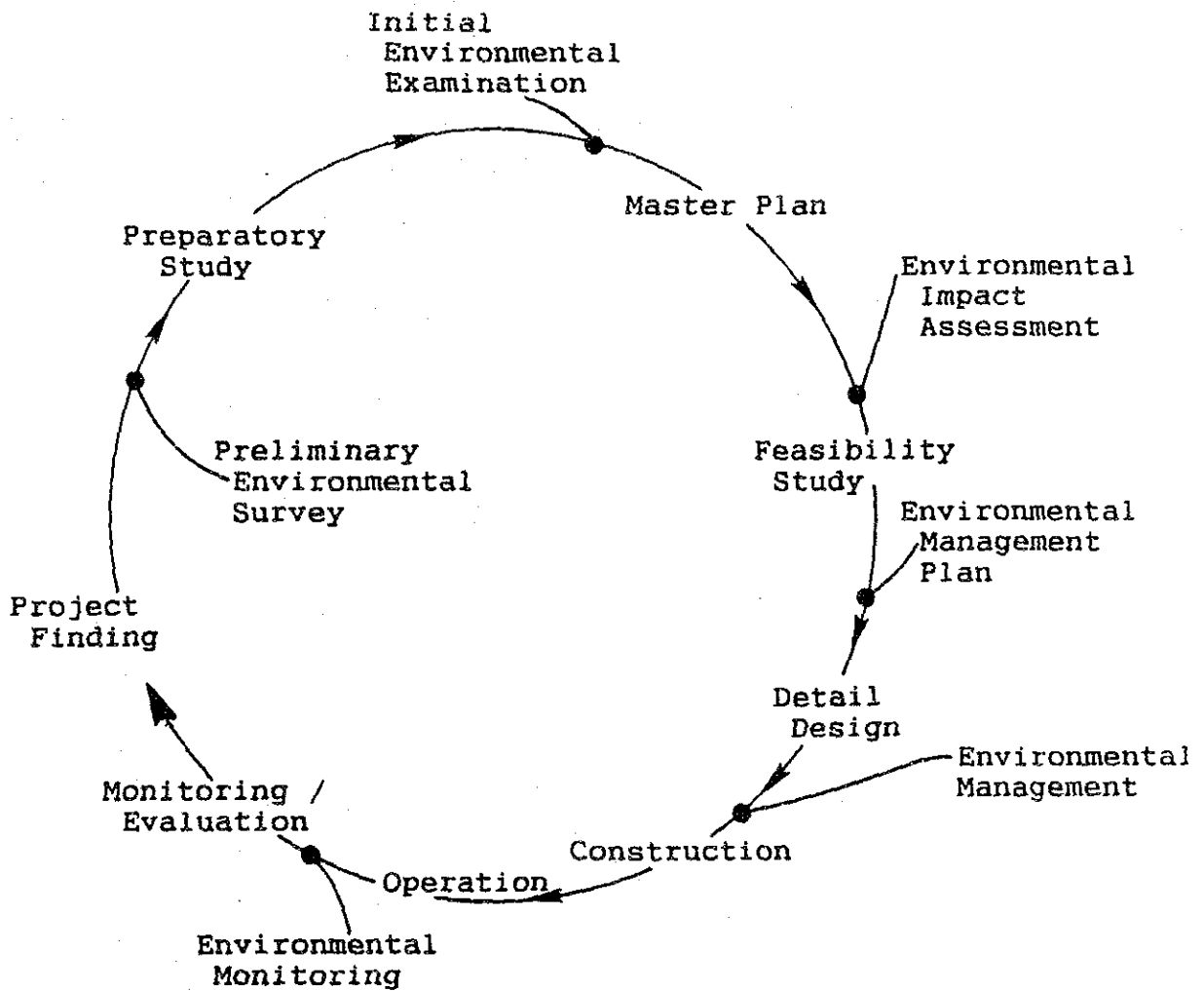


Figure 1-1 Flow of Environmental Consideration of Project Cycle

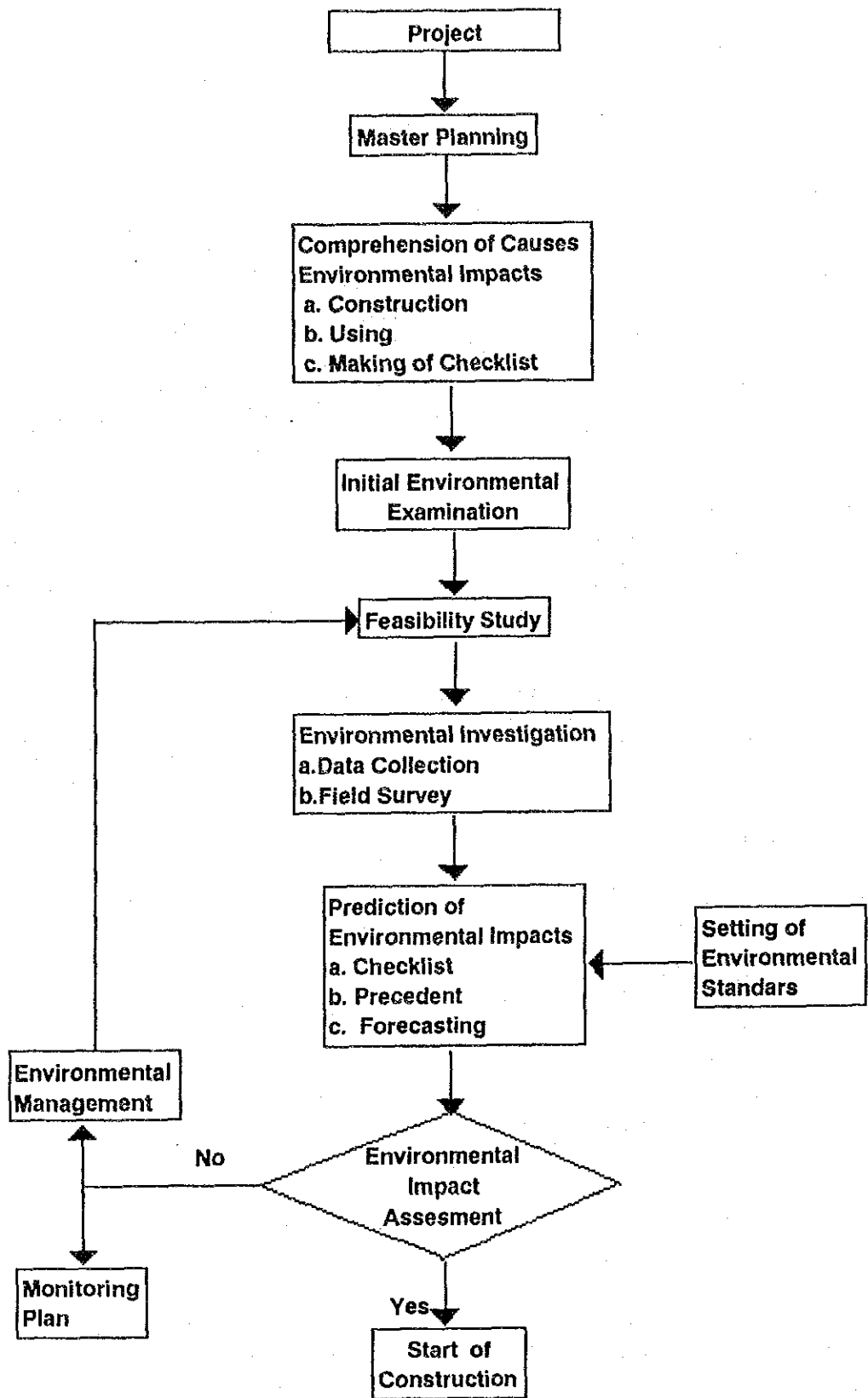


Figure 1-2 Flow of Environmental Impact Assessment

2. Outline of Project

2.1 Objectives of Project

The objectives of the project are to prioritize projects in the Master Plan and to carry out the Feasibility Study, including road improvement and rehabilitation, on the selected projects, approximately 200 km, within the nation's primary and secondary roads (approximately 3,000 km long, as shown in Figure 2-1) in the whole area of the country.

2.2 Target Year

The year of 2,010 is defined as the target year for the Master Plan Study, and the 2,000 is defined as the target year for the medium term plan.

2.3 Project Area and Road Network

The project area is located in the western and southwestern part (So-called Pacific Region) of Nicaragua as shown in Figure 6-2-1. The assigned road sections for the Feasibility Study are shown in Table 2-1.

Table 2-1 Assigned Roads for Feasibility Study

Road Sections	Name of Road	Length (km)	Design traffic volume
1. Managua -- Masaya	: N.R.-4 *1	: 27.200	: 12,000
2. Managua -- Tipitapa	: N.R.-1	: 4.300	: 12,000
3. Nandaime -- San Benito	:		
a. Nandaime -- Masaya	: N.R.-11, 18, 4 & 2	: 27.200	: 8,000
b. Masaya -- Tipitapa	: N.R.-11	: 21.925	: 12,000
c. Tipitapa -- San Benito	: N.R.-1	: 16.000	: 12,000
4. Telica -- San Isidro	: N.R.-26	: 95.760	: 11,000*2 : 7,000*3
Total		:192.385 km	

*1 : Route Number of National Road

*2 : Flat area

*3 : Mountainous area

2.4 Design Standard of Road

The design Standard of road in the stage of Feasibility

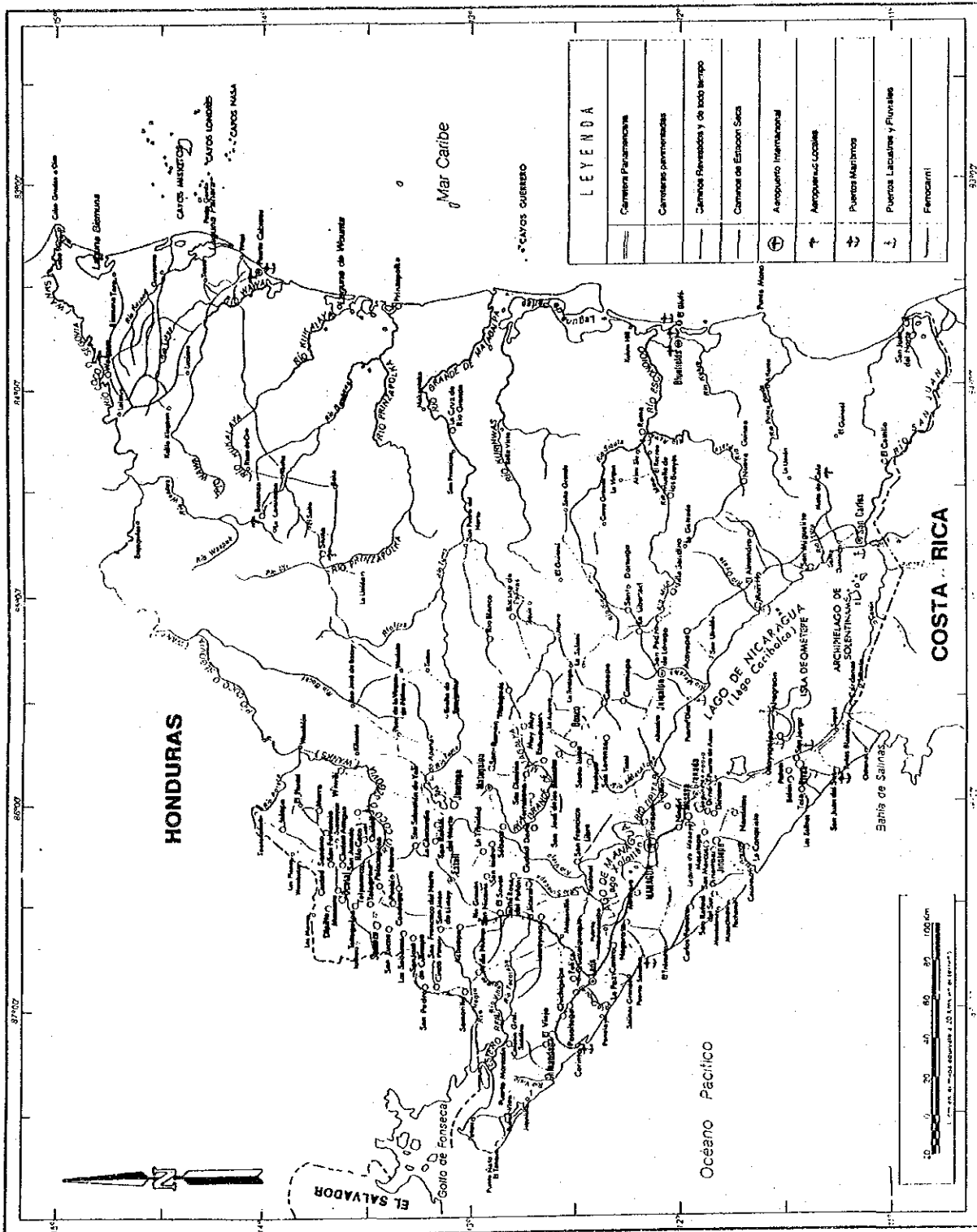


Figure 2-1 Road system of Nicaragua

Study is shown in Table 2-2. Large scale of change concerning design standards of road at the assigned project roads except road section between Managua and Masaya is not planned. But, the road section between Managua and Masaya is planned to improve four lane road. The alignment of road at Cristalito between Telica and San Isidro and the bypass between El Panama and Tipitapa are planned. The typical road sections of two lane and four lane roads are shown in Figure 2-2. And then, the main road facilities are listed up in Table 2-3.

Table 2-2 Design Standard of Road

Road sections	: Road class	: Number of lane	: Width of road (m)	: Design Speed (km/h)
1. Managua -- Masaya	: TP-I(s)	: 4	: 30 & 40	: 100
2. Managua -- Tipitapa	: TP-I	: 2	: 40	: 80
3. Nandaime -- San Benito				
a. Nandaime -- Masaya	: TP-I	: 2	: 40	: 80
b. Masaya -- Tipitapa	: TP-I	: 2	: 40	: 80
c. Tipitapa -- San Benito	: TP-I	: 2	: 40	: 80
4. Telica -- San Isidro	: TS-I	: 2	: 40	: 80

Table 2-3 Main Road Facilities

Road section	: Road facilities (number)
1. Managua -- Masaya	: Intersection (3), Bridge (3), Culvert (8)
2. Managua -- Tipitapa	: Intersection (2), Culvert (3)
3. Nandaime -- San Benito	
a. Nandaime -- Masaya	: Intersection (4), Bridge (4), Culvert (23)
b. Masaya -- Tipitapa	: Intersection (3), Culvert (18)
c. Tipitapa -- San Benito	: Intersection (3), Culvert (13)
4. Telica -- San Isidro	: Intersection (2), Bridge (14), Culvert (124)

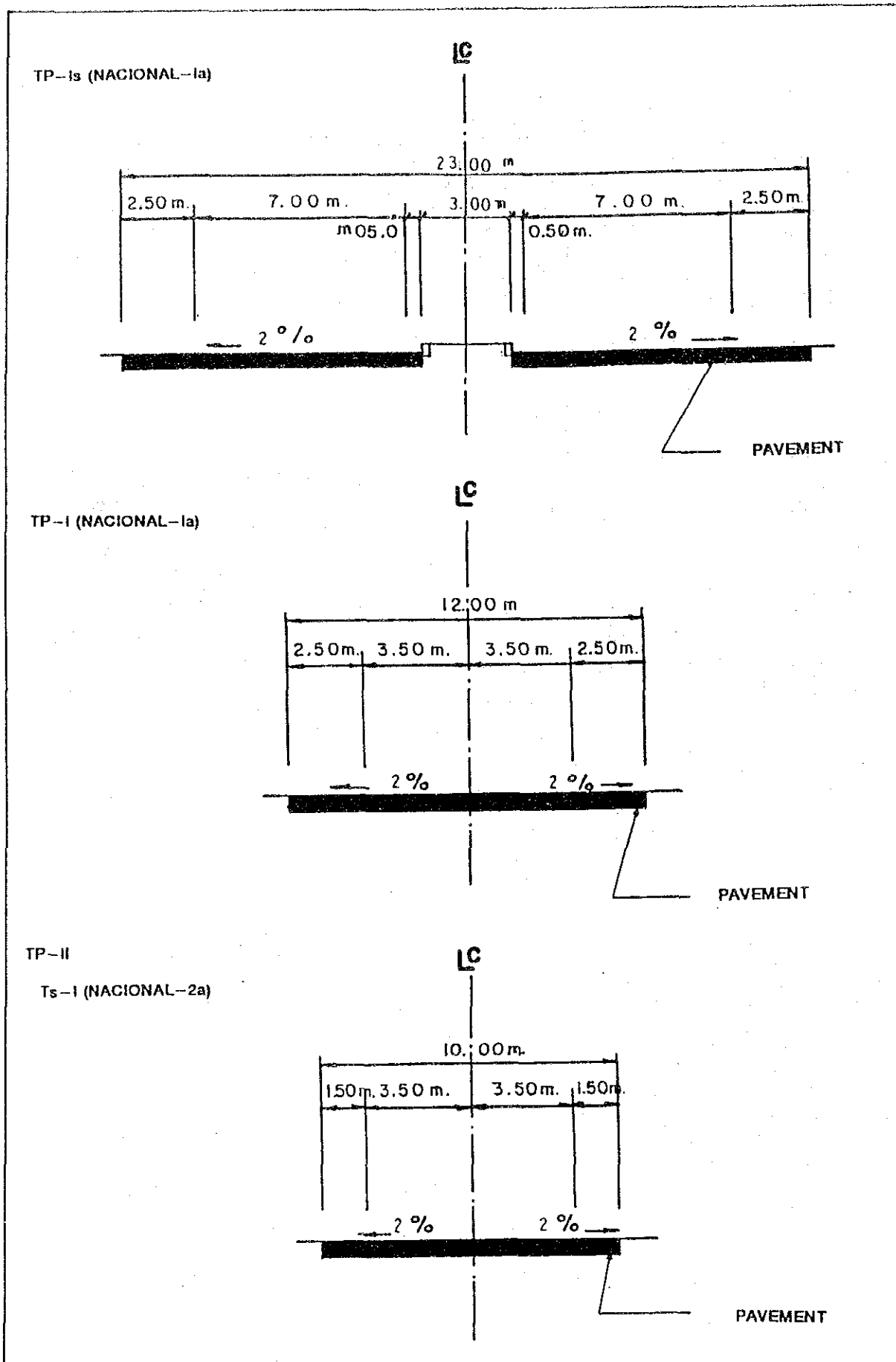


Figure 2-2(1) Typical Road Section

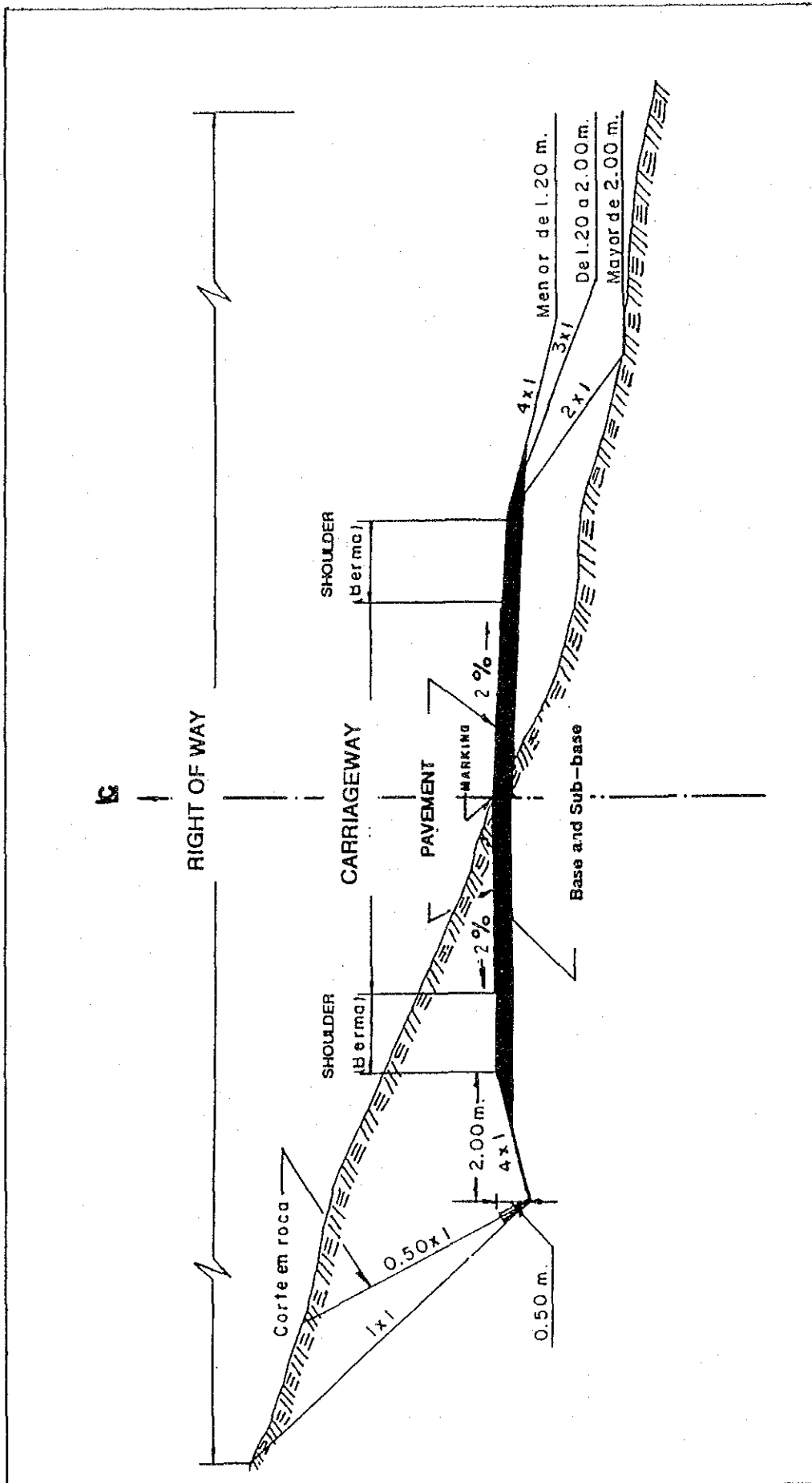
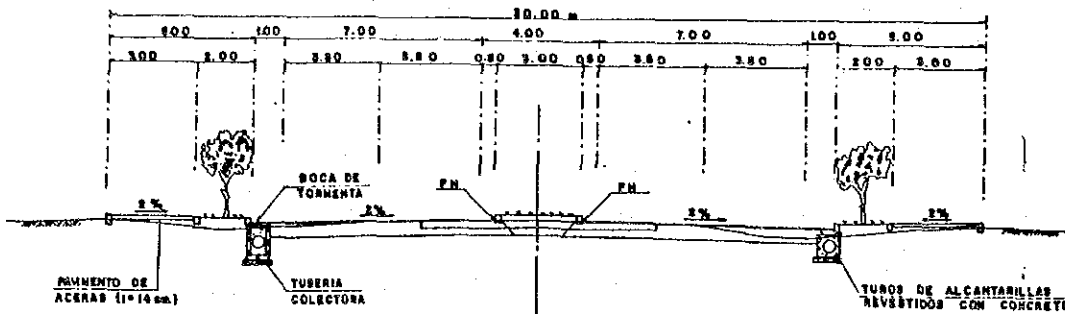
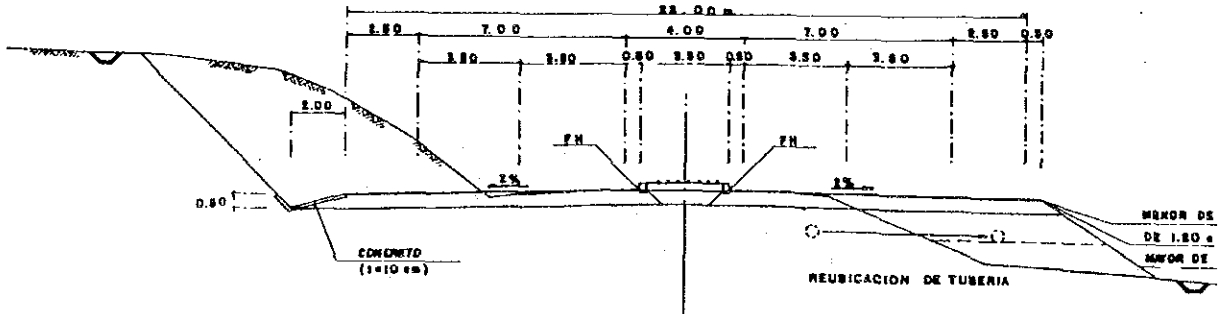


Figure 2-2(2) Typical Road Section



NOTA: INSTALACION DE BOCAS DE TORMENTA A CADA 5CM

SECCION TIPICA CON ACERA
 ESCALA 1:100



SECCION TIPICA SIN ACERA

Figure 2-2(3) Typical Road Section

2.5 Road Construction Facilities

Other facilities for road construction, including sand and rock quarries, asphalt plants, etc. are planned to use existing facilities.

3. SETTING OF THE ENVIRONMENTAL ITEMS

3.1 Environmental Factor

Based on the components of the project, the environmental impacts are thought to be mainly caused by road construction and using of road.

The construction work of road as a environmental factor can be divided into the following works and sub-works.

- Stage of construction

- 1) Cleaning of woods
- 2) Earth work (cutting, embankment, stripping, etc.)
- 3) Using heavy machines and dump tracks for transportation
- 4) Bridge
- 5) Culvert
- 6) Controlling of water
- 7) waste (domestic waste, waste of unused soil, Soil dump area)
- 8) Quarry for aggregate and sand
- 9) Pavement and asphalt plant
- 10) Concrete plant
- 11) Facilities for worker

- Use of road

- 12) Road facilities (road, bridge, culvert, sidewalk, etc.)
- 13) Traffic and Traffic safety

3.2 Setting of the Environmental Items

The environmental items concerning the road construction consist generally of as below.

- Living environment (Pollution)

- 1) Air quality
- 2) Water quality
- 3) Soil contamination
- 4) Noise and Vibration
- 5) Land subsidence
- 6) Odor
- 7) Light

- Natural environment

- 7) Land (topography and geology)
- 8) Soil
- 9) Water (river, lake, etc.)
- 10) Underground water
- 11) Meteorology
- 12) Sea and sea shore

14) Landscape

- Social environment

- 15) Waste
- 16) Histrial and cultural monuments
- 17) Traffic conditions
- 18) Sanitaly
- 19) Hazards
- 20) Cutting district
- 21) Relocation
- 22) Socio-economic conditions
- 23) Safety
- 24) Community
- 25) Receation facilities
- 26) Water right and Right of common

The selection of environmental items should be done by matrix method as shown in Fig. 3-1, which is integrated the relationship between environmental items and environmental factors as well as a condition of influence due to each environmental factor.

The environmental items including odor, land subsidence, soil contamination, light, meteorology, sea and sea shore, fauna, sanitaly, cutting district, socio-economic, community, reeation facilities, water right and right of common could be excluded from the investigating items due to no existing facilities or ignored influence.

Consequently, the following environmental items are selected.

- Living environment (Pollution)

- 1) Air quality
- 2) Water quality
- 3) Noise and vibration

- Natural environment

- 4) Land (topography and geology)
- 5) Soil
- 6) Water (river, lake, underground water)
- 7) Flora
- 8) Landscape

- Social environment

- 9) Traffic conditions
- 10) Social conditions (including waste, relocation, safety, etc.)

Table 3-1 Selection of Environment Items

Environmental factors * 1	Stage of construction											Use of road	Selection of items
	1	2	3	4	5	6	7	8	9	10	11		
I. Living environment													
1) Air quality	-	B	B	-	-	-	-	-	-	-	-	A	Selected
2) Water quality	B	A	-	B	B	B	B	B	B	-	-	-	Selected
3) Soil contamination	-	-	-	-	-	-	-	-	-	-	-	-	-
4) Noise and vibration	-	B	B	-	-	-	-	-	-	-	-	A	Selected
5) Land subsidence	-	-	-	-	-	-	-	-	-	-	-	-	-
6) Odor	-	-	-	-	-	-	-	-	-	-	-	-	-
II. Natural environment													
7) Land	-	A	-	B	-	A	-	-	-	-	-	B	Selected
8) Soil	B	A	-	-	A	-	-	-	-	-	-	-	Selected
9) Water	B	A	-	A	-	B	-	-	-	-	A	-	Selected
10) Underground water	-	-	-	-	-	-	-	-	-	-	-	-	-
11) Meteorology	-	-	-	-	-	-	-	-	-	-	-	-	-
12) Sea and sea shore	-	-	-	-	-	-	-	-	-	-	-	-	-
13) Flora and fauna	A	-	-	-	B	B	-	-	-	-	B	-	Selected
14) Landscape	A	A	-	-	B	B	-	-	-	-	A	-	Selected
III. Social environment													
15) Waste	B	A	-	B	A	-	B	B	B	B	B	-	Selected
16) Histrial and cultural monuments	-	B	-	-	-	-	-	-	-	-	B	-	Selected
17) Traffic	-	B	-	B	-	-	-	-	-	-	-	-	Selected
18) Sanitaly	-	-	-	-	-	-	-	-	-	-	-	-	-
19) Hazards	-	B	-	B	-	-	-	-	-	-	B	-	Selected
20) Relocation	-	-	-	-	-	-	-	-	-	-	A	-	Selected
21) Socio-economic condition	-	-	-	-	-	-	-	-	-	-	-	-	-
22) Cuttin district	-	-	-	-	-	-	-	-	-	-	-	-	-
23) Safety	-	B	-	-	-	-	-	-	-	-	A	-	Selected
24) Community	-	-	-	-	-	-	-	-	-	-	-	-	-
25) Recreation facilities	-	-	-	-	-	-	-	-	-	-	-	-	-
26) Water right and right of common	-	-	-	-	-	-	-	-	-	-	-	-	-

* 1 : Environmental factors

- Stage of construction
 1. Cleaning of woods
 2. Earth works
 3. Using heavy machines
 4. Bridge and culvert
 5. Waste
 6. Quarry for aggregate and sand
 7. Pavement and asphalt plant
 8. Concrete plant
 9. Facilities for worker
- Use of road
 10. Road facilities
 11. Traffic and Traffic safety

* 2 : A : Major influence

- B : Minor influence
- : Non influence

3.3 Checklist

The environmental checklist for the Environmental Impact Assessment based on the environmental factors is shown in Table 3-2. The components of environmental checklist consist of environmental items same as Matrix method and their sub-divisions, checking the present environmental condition, environmental evaluation based on the results of environmental investigations and prediction by the simulation, application of precedent and experiences and extraction of environmental problems.

Table 3-2 Environmental Checklist

Environmental items	: Condition *1 :	: P *2 :	: E *3 :	Problems
I. Living environment				
1) Air quality	:	:	:	
- Heavy machine				
- Transportation				
- Dust				
- Traffic				
2) Water quality	:	:	:	
- Cutting				
- Embankment				
- Discharge of water pumped				
- Quarry				
- Waste				
- Drainage				
3) Soil contamination	:	:	:	
4) Noise and vibration	:	:	:	
- Heavy machine				
- Transportation				
- Traffic				
5) Land subsidence	:	:	:	
6) Odor	:	:	:	
- Asphalt plant				
II. Natural environment				
7) Land	:	:	:	
- Cutting				
- Embanking				
- Quarry				
- Waste dump area				
8) Soil	:	:	:	
- Soil erosion				
- Soil dump area				
- Drainage				
9) Water	:	:	:	
- Cutting				
- Embankment				
- Water course				
- Bridge				
- Drainage				
10) Underground water	:	:	:	
- waste				
11) Meteorology	:	:	:	

(Continued..)

Environmental items	: Condition *1 :	Problems
	: P *2 : E *3 :	
12) Sea and sea shore	:	:
13) Flora and fauna	:	:
- Cutting		
- Embankment		
- Stockyard		
- Greening		
14) Landscape	:	:
- Cleaning		
- Cutting		
- Embankment		
- Greening		
III. Social environment		
15) Waste	:	:
- Waste		
- Worker's facilities		
- Bus stop area		
16) Historical and cultural monuments	:	:
17) Traffic conditions	:	:
18) Sanitary	:	:
19) Hazards	:	:
- Flood		
- Earthquake		
- Landslide		
- Collapse		
20) Relocation	:	:
21) Socio-economic conditions	:	:
22) Cutting district	:	:
23) Safety	:	:
- Sidewalk		
- Domestic animals		
24) Community	:	:
25) Recreation facilities	:	:
26) Water right and right of common	:	:

* 1 : 1 : Major influence
2 : Minor influence
3 : very small or none influence
* 2 : Present environmental condition
* 3 : Environmental evaluation

4. ENVIRONMENTAL QUALITY STANDARD

The environmental quality standards for air quality is used American standards. The standards for water quality in Nicaragua is discussing, so that the water quality standards is tentatively applied from Japanese standards.

The standards for noise and vibration are tentatively applied from Japanese standards. The influences of other environmental items, including land subsidence, odor, waste, land, water, flora and fauna, landscape, hazards, traffic safety and socio-economic problems, in the project area should be minimized.

The environmental standards for air quality, water quality, noise and vibration are shown in Table 4-1, 4-1, 4-3 and 4-4 respectively.

Table 4-1 Environmental Quality Standards for Air Quality

Items	Standard value
CO	: 10 mg/m ³ / 8 hours (9 ppm) 40 mg/m ³ / 1 hour (35 ppm)
SO ₂	: 80 ug/m ³ / day (0.03 ppm) 365 ug/m ³ / 24 hours (0.14 ppm)
NO _x	: 100 ug/m ³ / year (0.05 ppm) variable in 24 hours with NO ₂
HC	: 160 mg/m ³ / 3 hours (0.24 ppm)
Macro-Particular	: 25 mg/m ³ / year or 260 g/m ³ / 24 hours
Suspended Particulate Matter	: 260 mg/m ³ / day 75 mg/m ³ *1
O ₃	: 235 mg/m ³ / hour (0.12 ppm)
Pb-Ps	: 1.5 mg/m ³ / 3 months

*1 : Annual arithmetic mean

Table 4-2 Environmental Quality Standards for Water Quality

Items	Standard value
- pH	: Effluent to coastal sea : 5.0 - 9.0 Others : 5.8 - 8.6
- Biochemical Oxygen Demand	: 160 mg/l (daily average : 120 mg/l)
- Chemical Oxygen Demand	: 160 mg/l (daily average : 120 mg/l)
- Suspended Solid	: 200 mg/l (daily average : 150 mg/l)
- Normal hexane extraction matter:	5 mg/l (mineral oil) 30 mg/l (animal and vegetable oil)
- Copper	: 3 mg/l
- Zinc	: 5 mg/l
- Dissolved iron	: 10 mg/l
- Dissolved manganese	: 10 mg/l
- Chromium	: 2 mg/l
- Fluorine	: 15 mg/l
- Number of Coliform bacteria group	: 3,000 points/cm ³ (daily average)
- Nitrogen	: 120 mg/l (daily average)
- Phosphorus	: 16 mg/l (daily average)

Table 4-3 Environmental Standards for Noise

Item	Area	Environmental standards *1		
		Daytime	Morning/Evening	Night
General :				
	AA*2	< 45	< 40	< 35
	A *3	< 50	< 45	< 40
	B *4	< 60	< 55	< 50
Area facing road :				
	A *5	< 55	< 50	< 45
	A *6	< 60	< 55	< 50
	B *5	< 65	< 60	< 55
	B *6	< 65	< 65	< 60

- *1 : Standard value : dB(A)
- *2 : Need quiet area, medical care facilities.
- *3 : Residential area.
- *4 : Industrial and commercial areas.
- *5 : Two lane road
- *6 : Road beyond two lane

Table 4-4 Environmental Standards for Vibration

Standard value of vibration : 50 dB(B) on the boundary

-- Influences of vibration on the human body --

Vibration level dB(B)	Influences on the human body
< 60	: No perceptible feeling. Does not influence sleep.
60 - 65*	: Can be felt. Complaints of slight vibration is 50 %.
65 - 70*	: Disturbs sleep slightly. Complaints of vibration becomes 30 %.
70 - 75*	: Complaints of vibration becomes 40 %.
75 - 80*	: Light physical damage occurs. Complains of vibration becomes 40 %.
> 80	: Vibration can be felt strongly. Physiological influences occur.

* : <
=

5. ENVIRONMENTAL INVESTIGATION AND METHODOLOGY

5.1 Environmental Investigation

The environmental investigation for the Environmental Impact Assessment consists of the following items which are selected by the matrix method of environment.

- Traffic conditions
- Air quality
- water quality
- Noise and vibration
- Land
- Soil
- Water
- Flora
- Landscape
- Social conditions

5.2 Methodology

The components of environmental investigations and method of prediction of each selected environmental item are shown in Tables 5-1 and 5-2 respectively.

The investigating area is limited in the periphery of each road section of the project.

Table 5-1 Environmental Investigation

I t e m s	: C o m p o n e n t s
1. Traffic conditions	: Examination of present condition, control points, hazard records, etc.
2. Air quality	: SO _x ; Measurement point: intersections in major urban area
3. Water quality	: 20 items ; Ca, Mg, Na, K, HCO ₃ , SO ₄ , Cl, SiO ₂ , Fe, PO ₄ , NO ₃ N, NH ₄ N, Cd, PB, Cr, As, Hg, Mn, pH, EC Sampling point ; main water course and spring/ water well
4. Noise and vibration	: Environmental noise and vibration ; Measurement point : intersections at the major cities
5. Land	: Mophological and geological field survey
6. Soil	: Soil investigation; Soil section, Jar test
7. Water	: Data collection ; water level and volume of outflow at major river, underground water, water spring
8. Flora	: Base-line survey for flora, 200 m long
9. Landscape	: Extraction of major site of landscape
10. Social conditions	: Interview survey at each municipality

Table 5-2 Components and Method of Prediction

I t e m s	: Components ; Method
1. Traffic	: Forecasting Traffic volume in 2000 and 2010 year
2. Air quality	: Concentration of NOx and CO in 2000 and 2010 year; plume diffusion method
3. Water quality	: Suspended Solid (SS); Complete mixing method
4. Noise and vibrayion	: Road traffic noise and vibration; Sound level(dB(A)) and vibration level(dB)
5. Land	: Cutting and embankment; Standard slope gradient
6. Soil	: Soil erosion and generation of SS
7. Water	: Volume of outflow of river, flood, drainage
8. Flora	: Disappearance of flora due to cleaning of woods, planting
9. Landscape	: Extraction of major site of landscape
10. Social condition	: Examination of waste, relocation, monu-ment, traffic safety, hazards

ENVIRONMENTAL IMPACT ASSESSMENT

6. ENVIRONMENTAL IMPACT ASSESSMENT

6.1 Present Condition of the Project Area

The present environmental conditions of the roads and their vicinity of the project area are integrated in Figures 6-1 (Plan), 6-2 (Profile) and 6-3 (Profile). Figures 6-2 and 6-3 are described concerning natural conditions and social conditions respectively.

6.1.1 Social Condition

(1) Administrative division

The administrative division in the project area consists of Region II, III and IV as shown in Figures 6-4. Each Region is sub-divided into Department and Municipality. The administrative division of Municipality related to the project area is composed of 15 Municipales as shown in Table 6-1 and Figures 6-2 and 6-3.

Table 6-1 Administrative Division
in the Project Area

Region	: Department	: Municipality
II Occidental	: Leon	: Telica, Rosa del Penon, El Jicaral, Malpaisillo
III Managua	: Managua	: Managua, Tipitapa, Ticuantepe, Nindiri
IV Sur	: Masaya	: Masaya, Catarina, San Juan de Oriente
	: Granada	: Diria, Diriomo, Nandaime
V Norte	: Matagarpa	: San Isidro

(2) Population

The population of Nicaragua is estimated 3,673,044 in 1990. The rate of population increase, birth and death is 4.3 %, 1.8 % and 0.2 % respectively. The population, population density and increase of the each municipality are shown in Table 6-2.

Urban area except Managua being more than 70,000 in population is only Masaya and Tipitapa. Other local urban areas including Nandaime, Catarina, San Isidro, etc. are less than 40,000 in population. The population increase in recent of Ticuantepe, Masaya, San Juan de Oriente and Nindiri along the road section between Managua and Masaya is remarked and their value is beyond 16 percents par year. The development of the suburbs of Managua is recognized.

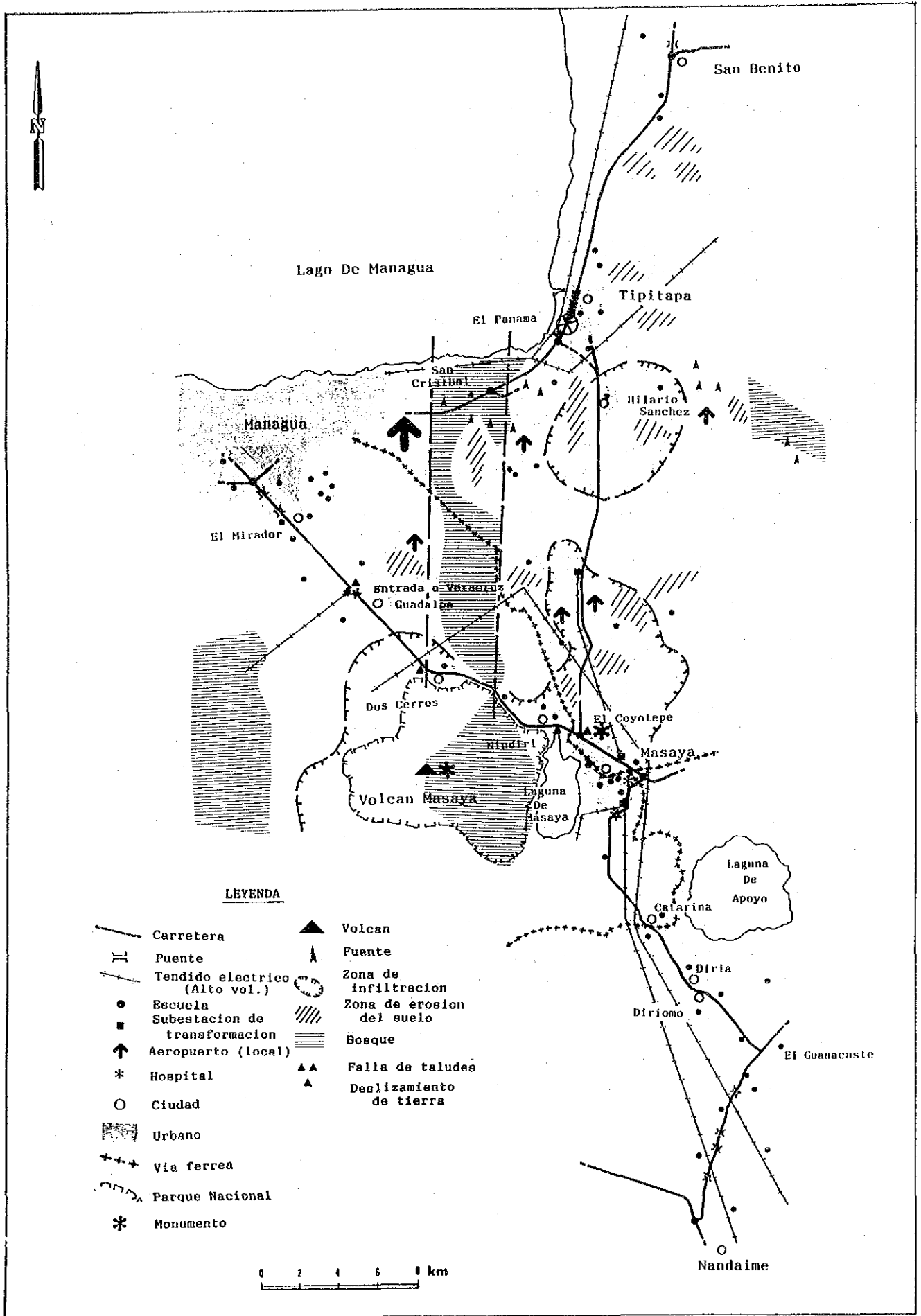
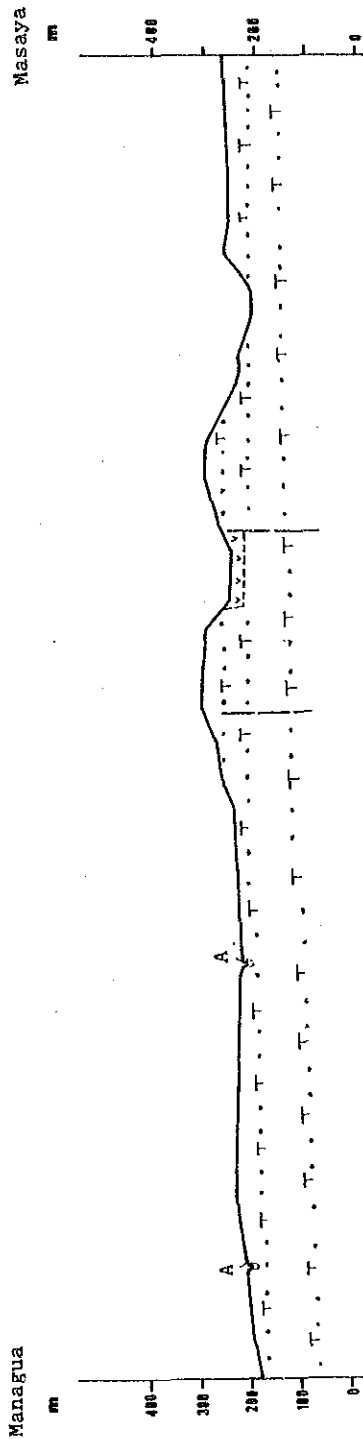


Figure 6-1(1) Environmental Present Conditions,

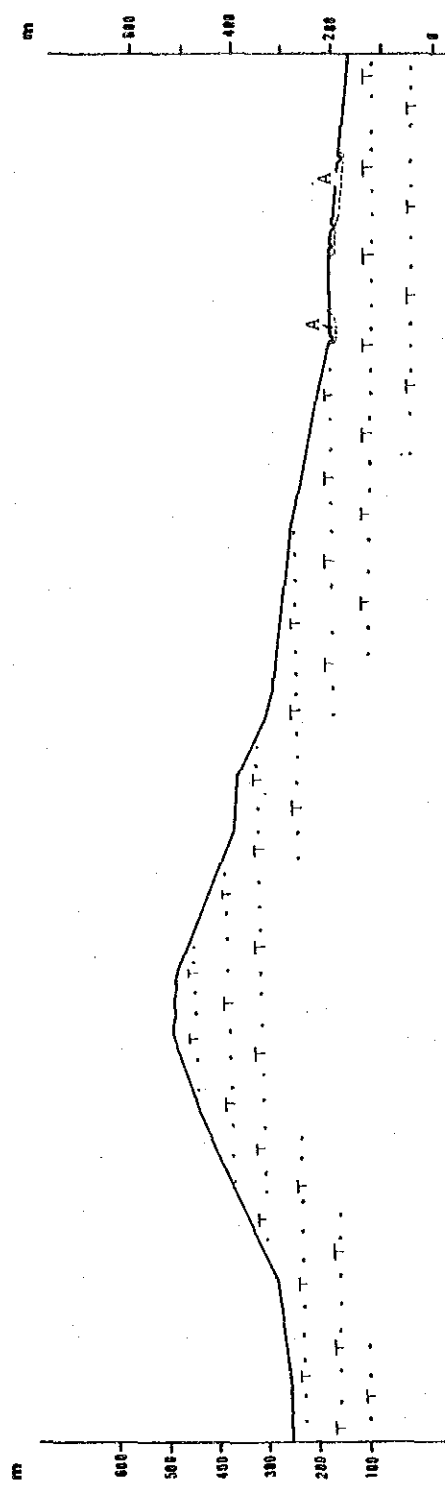
Managua - Masaya



Estacion (km)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
Puente																										
Alcantarilla																										
Ebanque																										
Talud																										
Topografia	Pendiente volcanica											Borde de la caldera de volcan Masaya			Graben		Planicie volcanica									
Geologia	A: Aluvion											Formacion Las Sierras											Basalto			
Suelo	Inceptisol											Inceptisol														
Cuenca hidrografica	San Isidro de la Cruz Verde		El Mirador		Rio Las Enramadas		Rio Santa Elena		Borrio Nuevo																	
Vegetacion	Ecological Region I-1																									
Uso del suelo	Urbano Managua		El Mirador		Granja		Nindiri		Granja		Urbano Masaya															
Otros																										

Figure 6-2(1) Environmental Present Natural Conditions

Nandaime - Masaya



Estacion (km)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Fuente																											
Alcarrizilla																											
Embaque																											
Talud																											
Topografia	Planicie volcanica										Pendiente volcanica										Planicie volcanica						
Geologia	Formacion Las Sierras																										
Suelo	Inceptisol																										
Cuenca hidrografica	Rio Agua Agria							*El Portillo							Rio Arroyo							Rio El Pastor					
Vegetacion	Ecological Region I-1							Ecological Region I-3										Ecological Region I-1									
Uso del suelo	Granja			Urbano Catarina			Urbano Diria			Granja Diria			Urbano Diriono			Granja											
Otros																											

Figure 6-2(2) Environmental Present Natural Conditions

Tipitapa-Managua

Rio Panama San Cristobal

Tipitapa - San Benito

Rio Panama San Benito

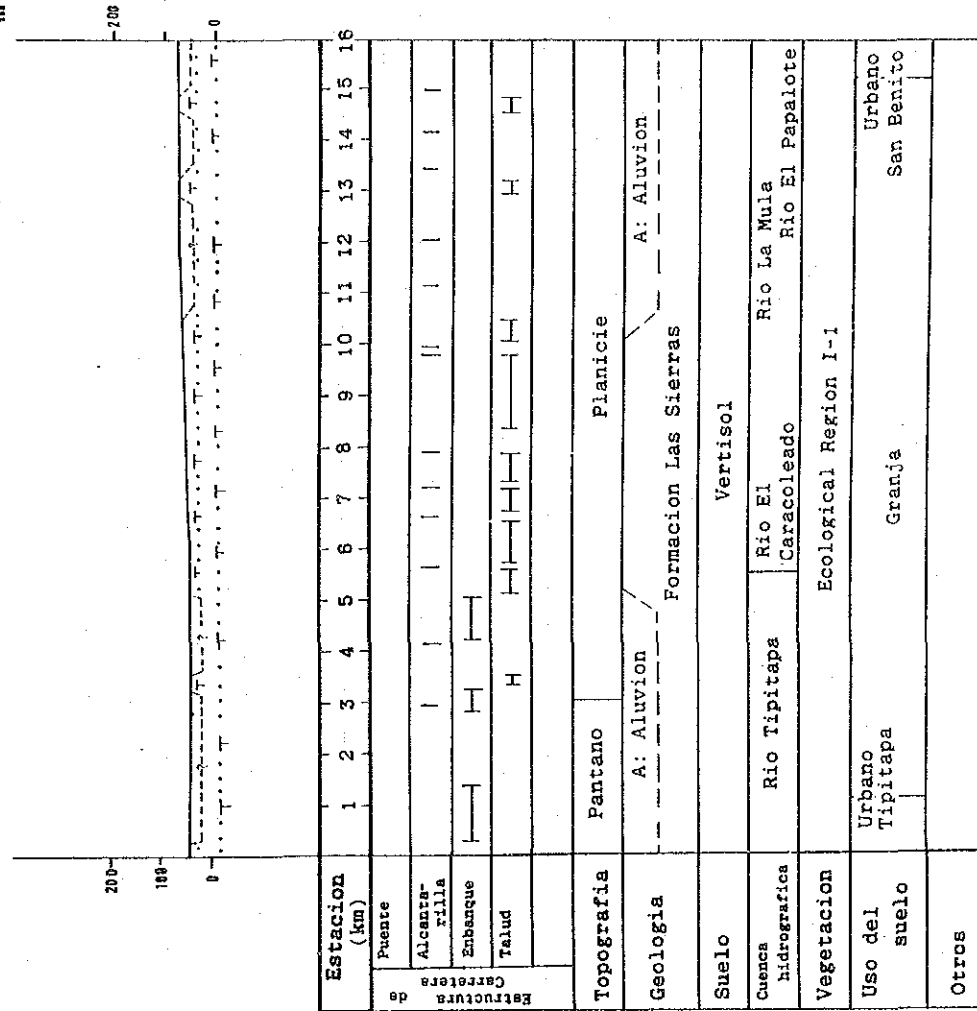
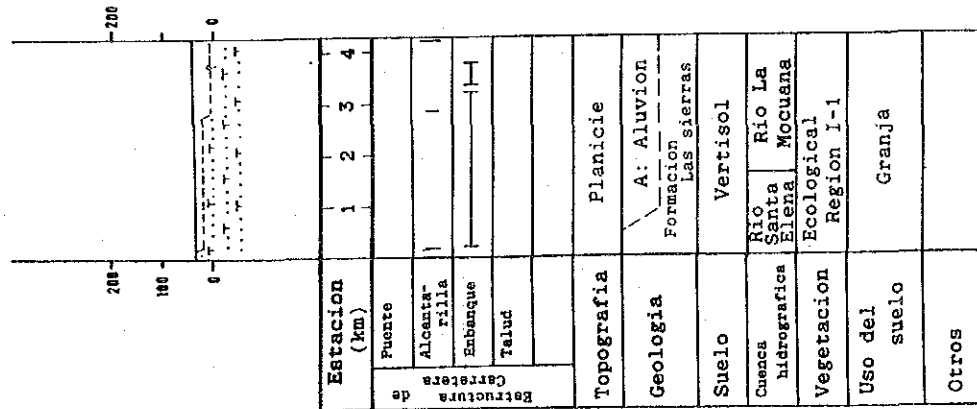
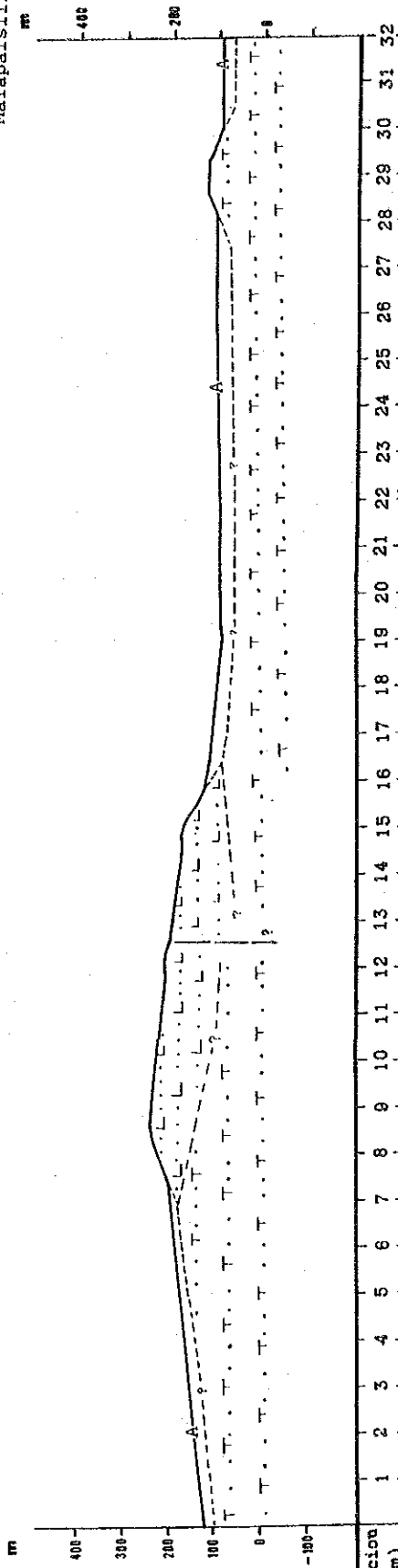


Figure 6-2(4) Environmental Present Natural Conditions

Telica

Telica - San Isidro (1)

Malpaisillo



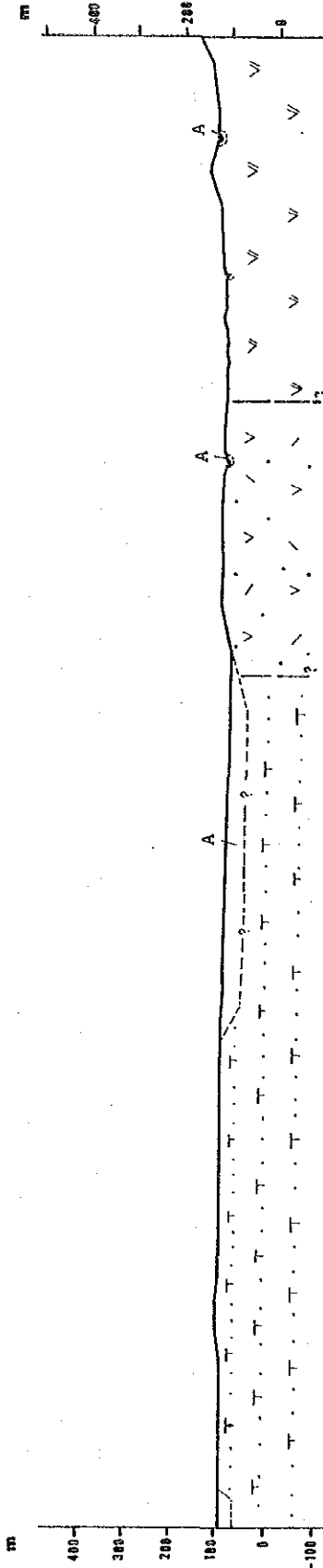
Estacion (km)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32							
Fuente																																							
Alcantarilla																																							
Ebanque																																							
Talud																																							
Topografia	Planicie volcanica			Planicie volcanica			Pendiente volcanica			Planicie volcanica			Planicie volcanica			Planicie volcanica			Planicie volcanica			Planicie volcanica			Planicie volcanica			Planicie volcanica			Planicie volcanica								
Geologia	Formacion Las sierras			Formacion Las sierras			Volcan Santa Clara			Volcan cerro Rota			Volcan cerro Rota			Volcan cerro Rota			Formacion Las sierras			Formacion Las sierras			Formacion Las sierras			Formacion Las sierras			Formacion Las sierras								
Suelo	Mollisol																																						
Cuenca hidrografica	Rio Telica			Rio Telica			San Jacinto			San Jacinto			El Cacaso			El Cacaso			San Ildofonso Sur			San Ildofonso Sur			Malpaisillo			Malpaisillo			Santa Teresa			Rio Meseales					
Vegetacion	Ecological Region 1-2																																						
Uso del suelo	Granja			Granja			Urbano			Urbano			San Jacinto			San Jacinto			Granja			Granja			Granja			Urbano			Urbano			Malpaisillo			Granja		
Otros																																							

Figure 6-2(5-1) Environmental Present Natural Conditions

Malapaisillo

Telica - San Isidro (2)

El Jicaral



Estacion (km)	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	
Puente																																
Alcantarilla																																
Enbanque																																
Talud																																
Estructura de Carreteras																																
Topografia	Cuenca																Cerro															
Geologia	Formacion Las Sierras																Formacion el Fraile															
Suelo	Vertisol																Vertisol															
Cuenca hidrografica	Cuenca																Cuenca															
Vegetacion	Ecological Region I-2																Ecological Region II															
Uso del suelo	Granja																Urbano															
Otros	Los Zarzales																Urbano															
																	Granja															
																	El Jicaral															
																	Granja															
																	Bosque															

Figure 6-2(5-2) Environmental Present Natural Conditions

Managua - Masaya

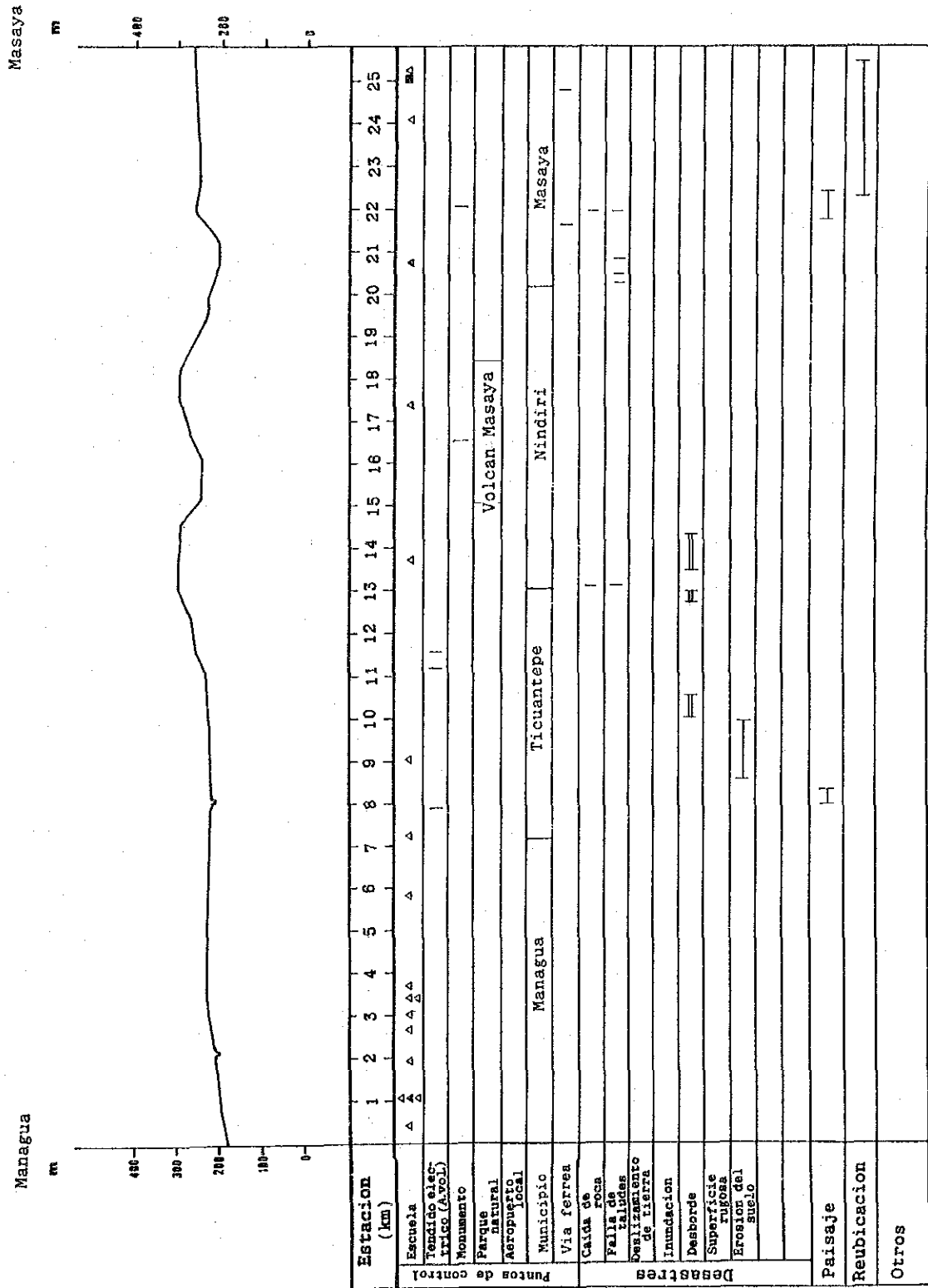
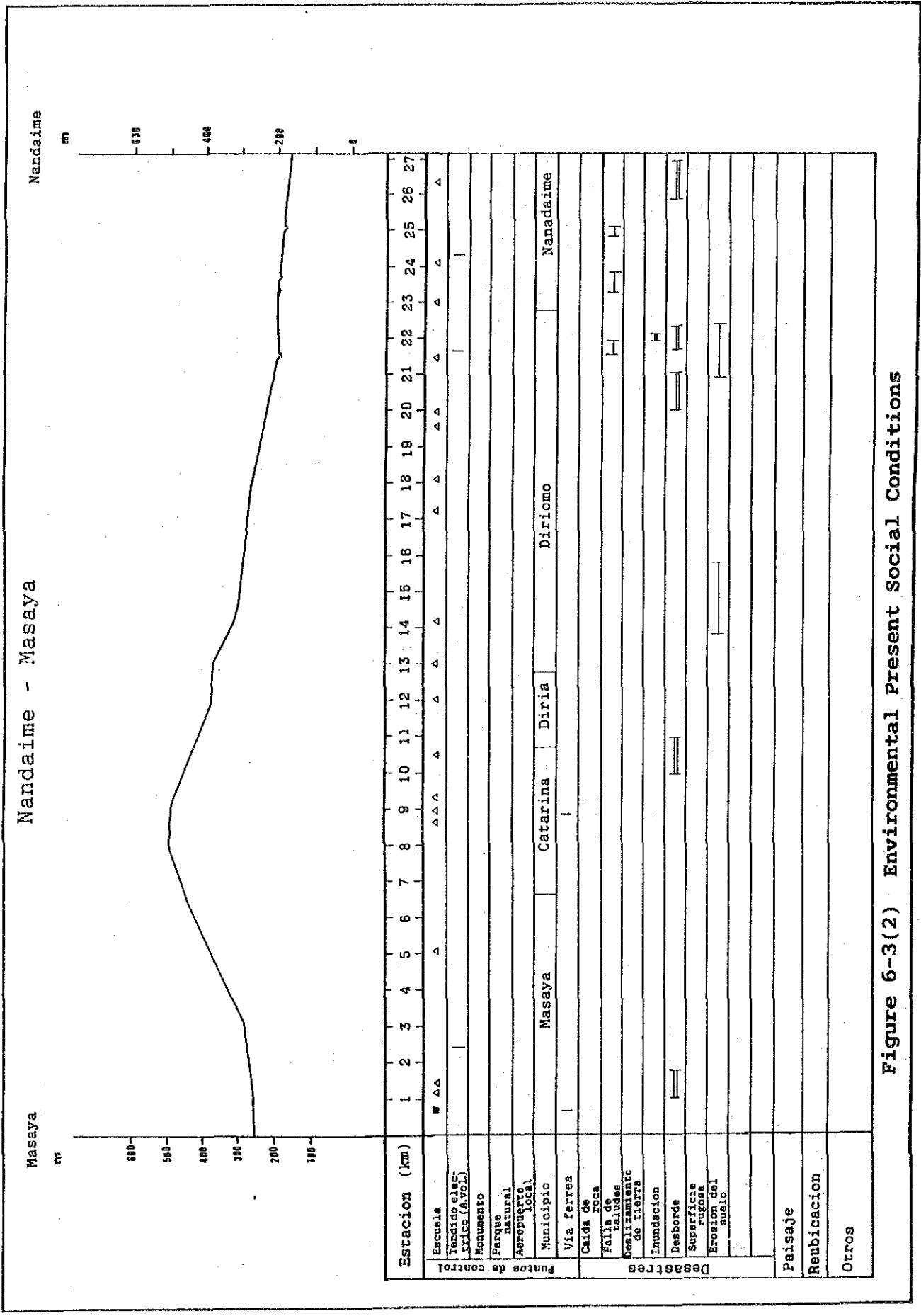


Figure 6-3(1) Environmental Present Social Conditions



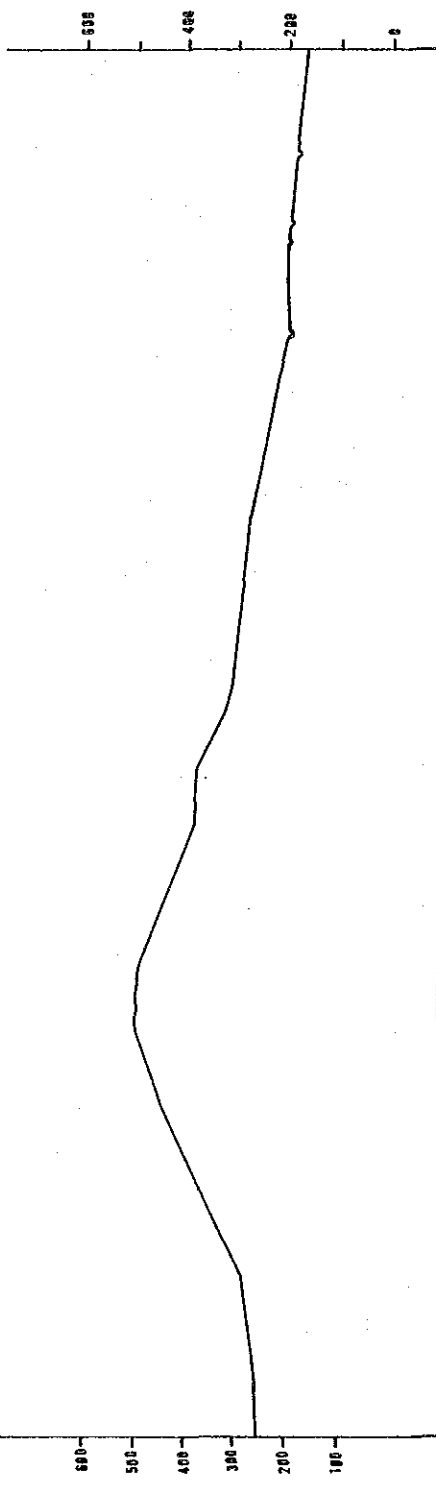
Masaya

Nandaime - Masaya

Nandaime

m

m

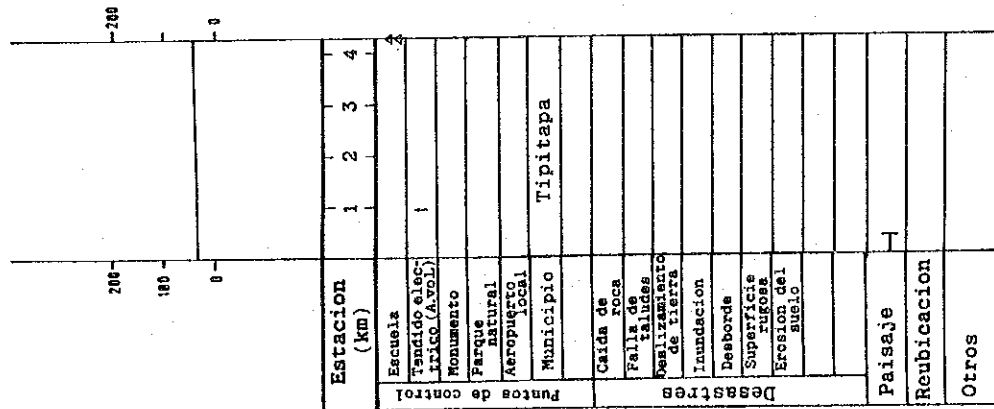


Estacion (km)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Escuela	■	▲	▲																								
Tendido eléctrico (A.V.O.L.)																											
Monumento																											
Parque natural																											
Aeropuerto local																											
Municipio																											
Via ferrea																											
Caida de roca																											
Falla de taludes																											
Deslizamiento de tierra																											
Inundacion																											
Desborda																											
Superficie de erosión del suelo																											
Paisaje																											
Reubicacion																											
Otros																											

Figure 6-3(2) Environmental Present Social Conditions

Tipitapa-Managua

Rio Panama San Cristobal m



Tipitapa - San Benito

Rio Panama San Benito m

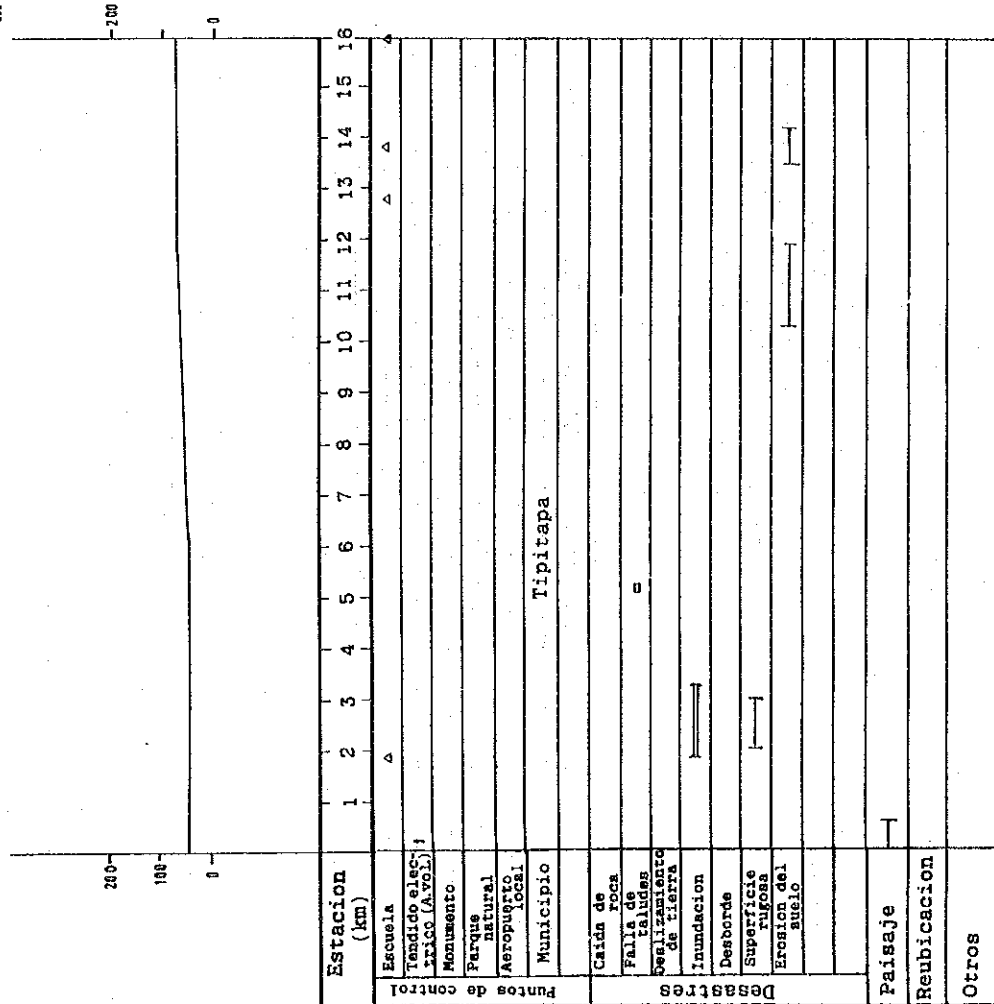


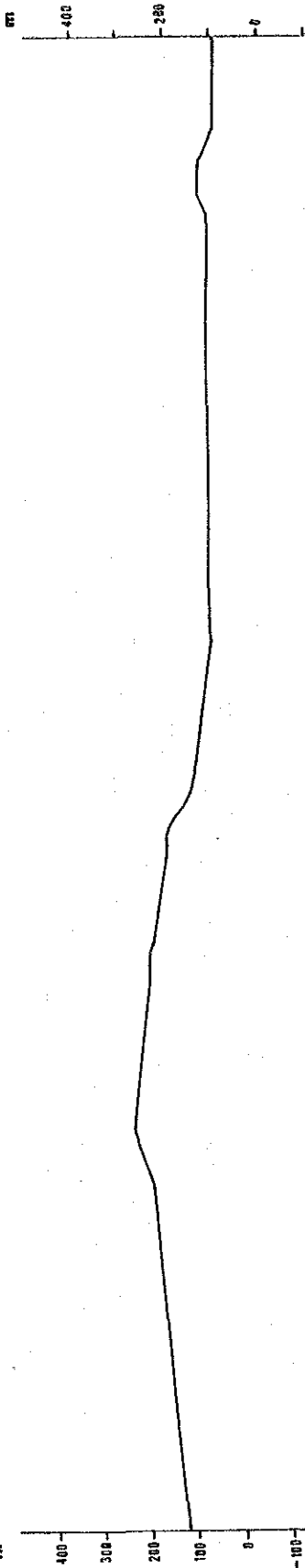
Figure 6-3(4) Environmental Present Social Conditions

Telica - San Isidro (1)

Malpaisillo

Telica

m



Estacion (km)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Puntos de control	Δ			Δ Δ																		Δ Δ										
Escuela																																
tendido electrico (A.V.O.L)																																
Monumento																																
Parque natural																																
Aeropuerto ICAI																																
Municipio																																
Via ferrea																																
Caida de agua																																
Falla de fallas																																
Salud																																
Sembramiento de tierra																																
Inundacion																																
Desborde																																
Superficie rugosa																																
Erosion del suelo																																
Paisaje																																
Reubicacion																																
Otros																																

Figure 6-3(5-1) Environmental Present Social Conditions

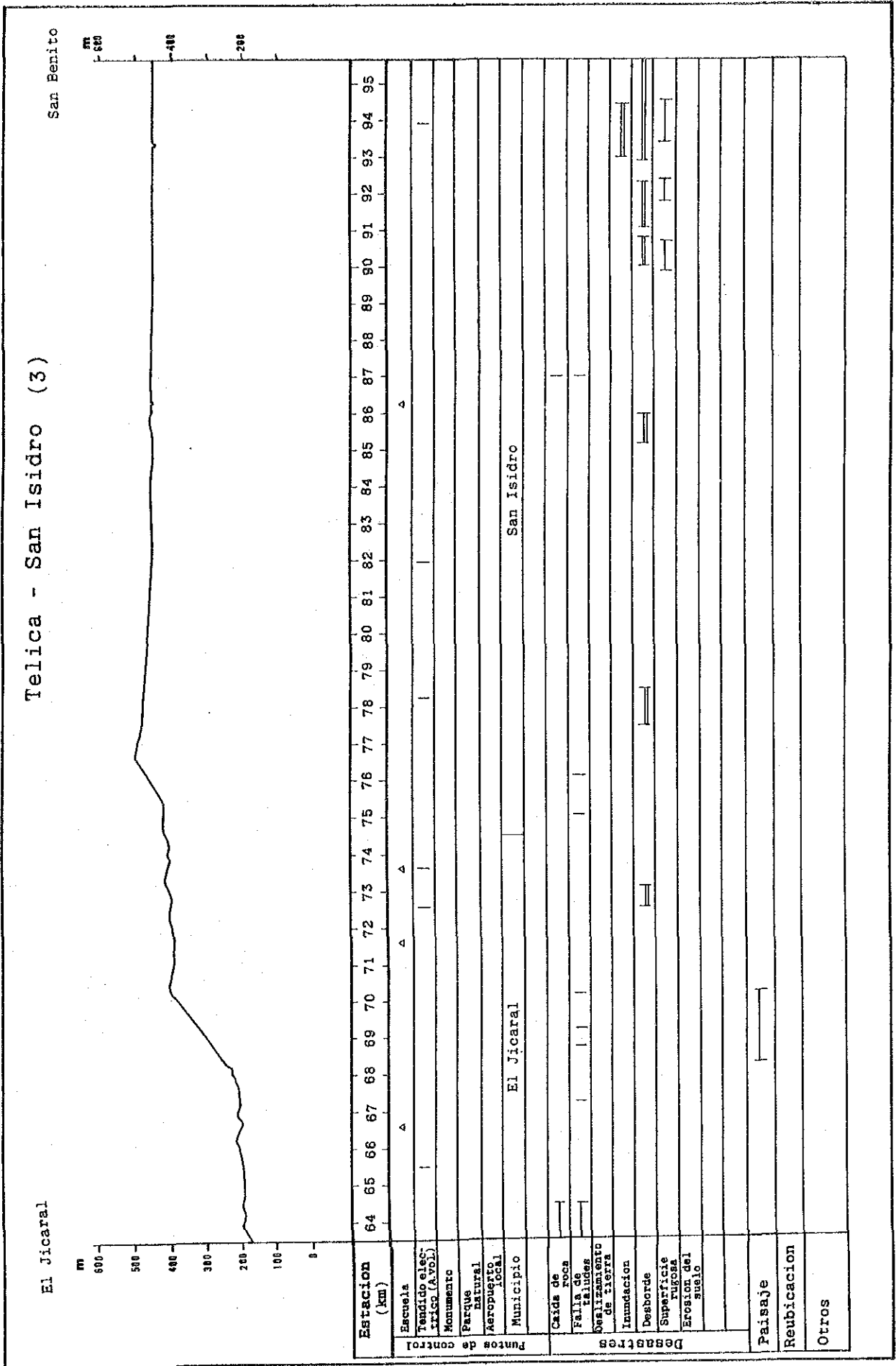


Figure 6-3(5-3) Environmental Present Social Conditions

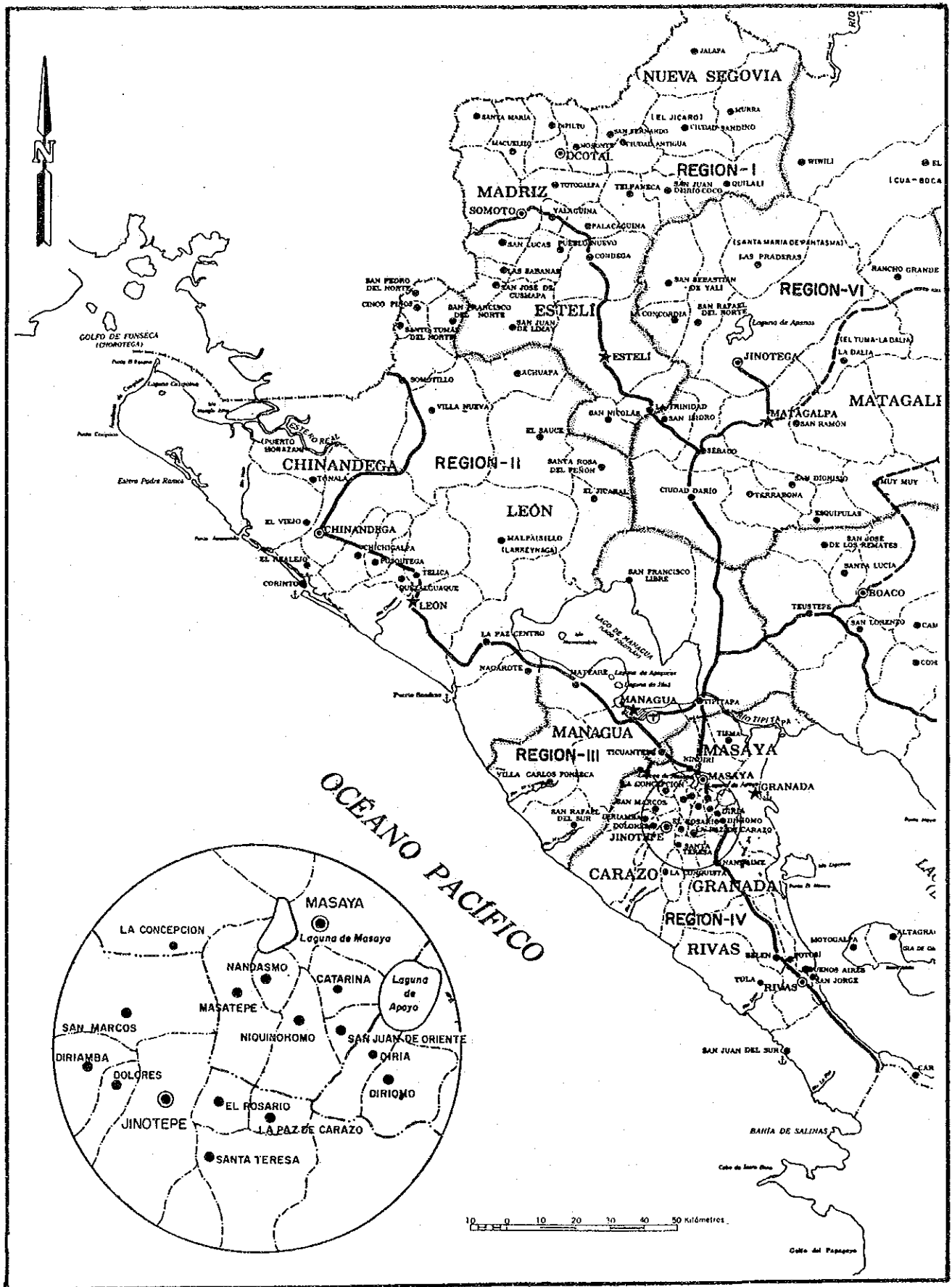


Figure 6-4 Administrative Division in the Project Area

Table 6-2 Population by Municipality

Department Municipality	Area (km2)	Population 1981	Population 1993	Inc. (%)*3	Density *4
Managua					
Managua	683	693,884	1,141,476	13.7	1,671
Tipitapa	973	49,793	75,024	12.6	77
Ticuantepé	68	8,643	22,600	21.8	332
Masaya					
Masaya	141	51,200	101,596	16.5	720
Catarina	13	3,889	6,336	13.6	487
San Juan de Oriente	13	1,549	2,898*	17.0	223
Nindirí	132	** 8,217	28,181*	16.3	213
Granada					
Diriá	16	3,653	8,740*	21.8	546
Diriomo	42	12,181	21,482*	16.0	511
Nandaime	340	21,795	35,852*	15.0	105
Leon					
Telica	400	14,623	22,276	12.7	56
Santa Rosa del Penon	238	5,543	7,934*	13.0	28
El Jicaral	434	4,278	8,485*	18.0	20
Malpaisillo	888	23,428	35,505	12.6	40
Matagalpa					
San Isidro	150	13,261	17,580	11.0	117
Total	4,531	915,937	1,535,965	14.0	339

* : Population in 1992

** : Population in 1971

*3 : Population density (people / km2) in 1993 or 1992

*4 : Population increase par year = (P.1981/P.1993)/12

(3) Land use

a. Natural conservation area

There are laws and decrees regarding the protection of wild life and land reservation for nature, wild life and genetics.

No area reserved and protected as a natural conservation area in the survey area is existing, but, Volcan Masaya National Park is adjoined the project area and several areas reserved and protected in the vicinity of the project area are existing as shown in Figure 6-5 and Table 6-3.

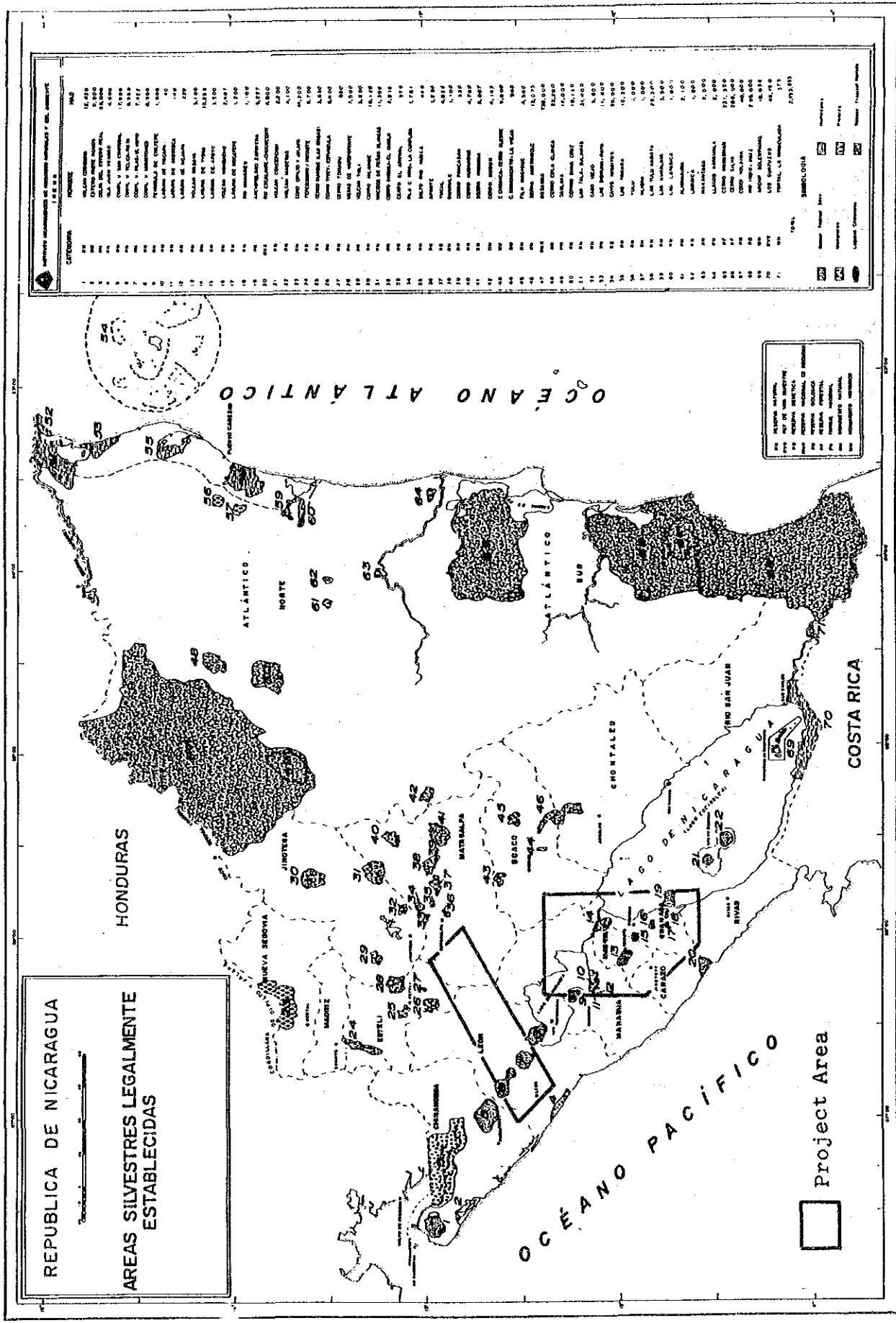


Figure 6-5(1) National Conservation Area in the Project Area

INSTITUTO NICARAGUENSE DE RECURSOS NATURALES Y DEL AMBIENTE
(IRENA)

	CATEGORIA	NOMBRE	HAS
1	RN	VOLCAN COSIGUINA	12,420
2	RN	ESTERO PADRE RAMOS	8,800
3	RN	DELTA DEL ESTERO REAL	55,000
4	RN	ISLA JUAN VENADO	4,600
5	RN	COMPL. V. SAN CRISTOBAL	17,950
6	RN	COMPL. V. TELICA-ROTA	9,088
7	RN	COMPL. V. PILAS-EL HOYO	7,422
8	RN	COMPL. V. MOMOTOMBO	8,500
9	RN	PENINSULA DE CHILTEPE	1,800
10	RN	LAGUNA DE TISCAPA	40
11	RN	LAGUNA DE ASOSOSCA	140
12	RN	LAGUNA DE NEJAPA	220
13	RN	VOLCAN MASAYA	5,100
14	RN	LAGUNA DE TISMA	10,295
15	RN	LAGUNA DE APOYO	3,500
16	RN	VOLCAN MOMBACHO	2,487
17	RN	LAGUNA DE MACATEPE	1,200
18	RN	RIO MANARES	1,100
19	PN	ARCHIPIELAGO ZAPATERA	5,227
20	RVS	RIO ESCALANTE-CHOCOCENT	4,800
21	RN	VOLCAN CONCEPCION	2,200
22	RN	VOLCAN MADERAS	4,100
23	RN	CORD. DIPILTO Y JALAPA	41,200
24	RN	TEPESMOTO/PATASTE	8,700
25	RN	CERRO QUIABUC (LAS BRISAS)	3,630
26	RN	CERRO TISEY - ESTANZULA	6,400
27	RN	CERRO TOMABU	850
28	RN	MESAS DE MOROPOTENTE	7,500
29	RN	VOLCAN YALI	3,500
30	RN	CERRO KILAMBE	10,128
31	RN	MACIZOS DE PENAS BLANCAS	11,308
32	RN	CERRO DATANLI-EL DIABLO	2,216
33	RN	CERRO EL ARENAL	575
34	RN	FILA C. FRIO-LA CUMPLIDA	1,781
35	RN	SALTO RIO YASICA	445
36	RN	APANTE	1,230
37	RG	YUCUL	4,826
38	RN	GUABULE	1,100
39	RN	CERRO PANCASAN	330
40	RN	CERRO KUSKAWAS	4,760
41	RN	SIERRA KIRAGUA	8,087
42	RN	CERRO MUSUN	4,142
43	RN	C. CUMAICA - CERRO ALEGRE	5,000
44	RN	C. MOMBACHITO-LA VIEJA	940
45	RN	FILA MASIGUE	4,580
46	RN	SIERRA AMERRISQUE	12,073
47	RNR	BOSAWAS	730,000
48	RN	CERRO COLA BLANCA	22,200
49	RN	SASLAYA	15,000
50	RN	CERROS BANA CRUZ	10,130
51	RN	LAG. TALA-SULAMAS	31,400
52	RN	CABO VIEJO	5,800
53	RN	LAG. BISMUNA-RAYA	11,800
54	RB	CAYOS MISKITOS	50,000
55	RN	LAG. PAHARA	10,200
56	RN	YULU	1,000
57	RN	KLIGNA	1,000
58	RN	LAG. YULU KARATA	25,300
59	RN	LAG. KUKALAYA	3,500
60	RN	LAG. LAYASICA	1,800
61	RN	ALAMIKAMBA	2,100
62	RN	LIMBAICA	1,800
63	RN	MAKANTAKA	2,000
64	RN	LLANOS KARAWALA	2,000
65	RF	CERRO WAWASHAN	231,500
66	RF	CERRO SILVA	286,000
67	RN	CORDI. YOLAINA	40,000
68	RB	RIO INDIO-MAIZ	295,000
69	MN	ARCHIP. SOLENTINAME	18,930
70	RVS	LOS GUATUZOS	43,750
71	MH	FORTAL. LA INMACULADA	975
		TOTAL	2,153,855

Figure 6-5(2) National Conservation Area in the Project Area

**Table 6-3 Natural Conservation Area
in the Project Area**

I t e m (Abbreviation):	Area number*1 :	Area (ha)
- Natural reservation area	(RN):7, 8,14,15,16, 17,18,21 & 22	40,804
- National park	(PN):13 & 19	10,327
Total	: 11 areas	: 51,131

*1 : Number of area is same as Figure 6-5.

b. Land use

The present condition of land use in the project area is shown in Figures 6-2 and 6-3 (refer to Appendix II.1). The land use along the Road Section between Managua and Masaya consists of urban areas, agricultural area of cotton, banana, cone and vegetables, erosive area with bush and rocky wasteland. Most of area except around the Volcan Masaya National Park is cultivated and residential zones.

The land use along the section between Masaya and San Benito consists of urban areas, pasture, agricultural area of cotton, cone, vegetables, etc. and shrub. The area is characterized by pasture and cultivated zone. Primary forest is not found in the area, but secondary forest is locally distributed.

The land use along the section between Masaya and Nandaime mainly consists of coffee, pasture, agricultural area and urban area. The secondary forest is locally remained in the area.

The land use along the section between Telica and San Isidro consists of urban areas, agricultural fields of cotton, coffee, rice, cone, etc., pasture, pasture with tropical sabannah Shurb, thick and thin broad-leaved forests and erosive area with bush.

(4) Water use

The drinking water in the project area is mostly used underground water by water well. Major urban areas including Managua, Masaya, Tipitapa, Telica, etc. are mostly settled water supply. In Managua, the drinking water is supplied from 83 drilled water wells (70 % in rate of water supply) and Asososca (volcanic crater) Lake (30 %). Local towns are used small water-supply system and digged (artesian) wells.

Agricultural water in the project area is mainly irrigated by underground water, because most of rivers become dry up during not only dry season but also wet season, and the region is widely overlain recent and sub-recent thick volcanic sediments which are relatively permeable layer.

(5) Natural and historical monuments

The local historical monument, Fortaleza El Coyotepe, is located in the north of Masaya City along the Road Section between Managua and Masaya.

(6) Public facilities

a. Schooling

The educational system consists of elementary, secondary and higher education. The compulsory education is presently six years during elementary school.

The educational conditions of each municipality in 1993 are shown in Table 6-4 (refer to Appendix 2) and Figures 6-1, 6-2 and 6-3. The schools situated along and near the roads are also listed up in Appendix 2.

b. Public health

The medical condition by municipality is shown in Table 6-5 and Figure 6-1 (refer to Appendix 3). In addition, a old-age home facility exists along the Section between Managua and Masaya.

c. Other facilities

Other public and major facilities including Municipal office, police station, fire department, post office, library, public center, airport, radio station, bank, etc. are listed on Table 6-6.

(7) Economy and industry

Gross National Product (GNP) is 2,670,000,000 U.S.Dollars in 1986 and the GNP per person is 970 U.S.Dollars. The constituent rate of GDP in 1991 under the new administration shows in Table 6-7.

The condition of heavy-chemical and light industries is shown in Appendix 6. The industry of each municipality except Managua and Masaya is rare.

Table 6-4 Educational Condition in 1993

(1) Primary and secondary education

Municipality	Number of Student		Total	Number of teacher
	F	M		
Managua	126,342	123,051	249,357	6,505
Ticuantepe	1,980	1,951	3,931	84
Catarina	781	699	1,480	53
San Juan de Oriente	357	380	737	25
Masaya	16,503	16,469	32,972	840
Diria	806	844	1,650	57
Diriomo	2,771	2,820	5,591	116
Nandaime	3,919	4,116	8,035	241
Santa Rosa del Penon	787	805	1,592	53
Tipitapa	11,238	10,951	22,189	636
El Jicaral	1,645	1,512	3,157	117
Telica	2,922	2,809	5,731	162
Malpaisillo	4,202	4,085	8,287	254
San Isidro	2,289	2,505	4,794	158
Total	179,757	175,928	355,685	9,479

(refer to Appendix II.3)

(2) Higher education

Name of University	Location	Number of student	
		1987	1991
- Universidad Centro Americana	: Managua	: 3,284	: 5,041
- Universidad Nac. Autonomo de Nic. Managua	: Managua	: 8,336	: 10,289
- Universidad Nacional de Ingenieria	: Managua	: -	: 6,049
- Universidad Nacional de Agricultera	: Managua	: 1,419	: 2,316
- Inst. Politecnico de Salid	: Managua	: -	: 474

Source : MED, 1992 and Municipal office, 1993

Table 6-5 Medical Condition by Municipality

Name of Municipality:	Number of hospital :	Number of beds :	Number of clinic :	Number of Health center :	Health center beds :
Managua	: 15	: 2,108 :	25	: 23	: -
Masaya	: 2	: 176 :	2	: 3	: -
Ticuantepe	: 1	: - :	4	: 2	: -
Catarina	: -	: - :	-	: 4	: -
San Juan de Oriente	: -	: - :	-	: 2	: -
Diria	: -	: - :	-	: 4	: -
Nandaime	: 1	: - :	7	: 5	: 30
Santa Rosa del Penon	: -	: - :	-	: 7	: -
El Jicaral	: -	: - :	-	: 7	: -
Diriomo	: -	: - :	-	: 1	: -
Tipitapa	: -	: - :	3	: 7	: -
Telica	: -	: - :	-	: 5	: -
Malpaisillo	: 1	: 17 :	1	: 1	: 10
San Isidro	: -	: - :	-	: 1	: -

(refer to Appendix 3)

Table 6-6 Main Facilities in the Project Area

(1) Public Facilities

Name of Municipi.	Public Facilities								
	:Office: *1	:Police: stat	:Fire dep: Station	:Post Office	:Lib.	:Public: hall	:Air- port	:Met Stat	
Ticuantepo	:Alcal.: 1	:	:	: 1	: 1	:	:	: 1	
Catarina	:Alcal.: -	:	:	: 1	: 1	: 1	:	: -	
Sn. Juan de Oriente	:Alcal.: -	:	:	: 1	:	:	:	: -	
Diria	:Alcal.: -	:	:	: 1	:	:	:	: -	
Nandaima	:Alcal.: 1	:	:	: 1	:	:	: 2	: -	: 1
Sta. Rosa del Penon	:Juzg.: 1	:	:	: 1	: 1	:	:	: -	: -
	:Alcal.: -	:	:	: -	:	:	:	: -	: -
	:C. Com.: -	:	:	: -	:	:	:	: -	: -
San Isidro	:Alcal.: -	:	:	: 1	: 1	: 1	:	: -	: 1
Tipitapa	:INAA: 1	:	:	: 1	: 3	:	:	: -	: 1
	:INE: -	:	:	: 3**	:	:	:	: -	: -
	:TELCOR: -	:	:	: -	:	:	:	: -	: -
	:Alcal.: -	:	:	: -	:	:	:	: -	: -
Masaya	:Alcal.: 1	:	: 1	: 1	: 8	: 2	:	: -	: 1
	:MINSA: -	:	:	: 12*	:	:	:	: -	: -
	:MED: -	:	:	: -	:	:	:	: -	: -
	:MC: -	:	:	: -	:	:	:	: -	: -
	:MT: -	:	:	: -	:	:	:	: -	: -
Jicaral	:Alcal.: 1	:	:	: 1	:	:	:	: -	: -
Malpaisillo	:Alcal.: 1	:	:	: 1	: 1	: 2	:	: -	: 1
	:INAA: -	:	:	: -	:	:	:	: -	: -
	:INE: -	:	:	: -	:	:	:	: -	: -
	:MED: -	:	:	: -	:	:	:	: -	: -
Telica	:TELCOR: 1	:	:	: 1	: 1	: 1	:	: *	: 1
Managua	:Palac.: 6	:	: 7	: 16	: 9	: 3	:	: 1	: 26
	:Nac. C. de Gob.: -	:	:	: -	:	:	:	: -	: -
	:Reg. Pub.: -	:	:	: -	:	:	:	: -	: -
Nindiri	:Alcal.: 1	:	:	: 1	: 1	: 1	:	: -	: 1
	:Juzg.: -	:	:	: -	:	:	:	: -	: -
	:MED: -	:	:	: -	:	:	:	: -	: -
Diriomo	:INAA: 1	:	:	: 1	: 1	:	:	: -	: -
	:TELCOR: -	:	:	: -	:	:	:	: -	: -
	:Juzg.: -	:	:	: -	:	:	:	: -	: -
	:MED: -	:	:	: -	:	:	:	: -	: -
	:Alcal.: -	:	:	: -	:	:	:	: -	: -

(refer to Appendix 4)

- *1 : Alcal. : Municipal office
- Juzg. : Court
- TELCOR : Telecommunication institute
- MED : Ministry of education
- INAA : Water supply institute
- Reg. Pub. : Public register
- C. de Gob : Government office
- MC : Ministry of culture
- MT : Ministry of labor
- Palac. Nac. : National palace
- C. Com. : Community office
- Lib. : Library

(2) Other Facilities

Name of Municipality	Bank Number	Bank Name	Cinema	Radio Station	TV Station	News Paper
Ticustepe	-	-	-	-	-	-
Catarina	-	-	-	-	-	-
Sn Juan de Oriente	-	-	-	-	-	-
Diria	-	-	-	-	-	-
Nandaime	1	BANADES	-	-	-	-
Sta. Rosa del Penon	-	-	-	-	-	-
San Isidro	-	-	-	-	-	-
Tipitapa	1	BANADES	1	Atenas	-	-
Masaya	1	BANIC	1	2	-	-
	1	BP	-	-	-	-
	1	BANADES	-	-	-	-
El Jicaral	-	-	-	-	-	-
Telica	-	-	Telica	-	-	-
Managua	*	BANCENTRO	Margot	Reloj	Canal 2	La Tribuna
	*	B.C.N	Cabrera	B.B Streo	Canal 4	La Prensa
	*	BA	Jardin	Bautista	Canal 6	Barri-cada
	*	BAC	America	Catolica	Canal 8	El Nvo Diario
	*	BCP	Bello H	Comunicac	-	El Semana
	*	BANEXPO	Trebol	Corpora-cion	-	-
	*	BANPRES	Maria	Pensa-miento	-	-
	*	BANADES	Aguerri	Stereo	-	-
	*	BANPRO	Tetel	Gueguense	-	-
	-	-	Cinema-taca Nac.	Istmo	-	-
	-	-	-	La Prime-risima	-	-
	-	-	-	Maranatha	-	-
	-	-	-	Minuto	-	-
	-	-	-	Mundial	-	-
	-	-	-	Nicaragua	-	-
	-	-	-	Noticias	-	-
	-	-	-	Periodica	-	-
	-	-	-	Ultima hora	-	-
	-	-	-	Pirata	-	-
	-	-	-	Sandino	-	-
	-	-	-	Sistema	-	-
	-	-	-	Movil	-	-
	-	-	-	Tiempo	-	-
	-	-	-	Ya	-	-
	-	-	-	Ondas Sonoras	-	-
	-	-	-	Ondas de Luz	-	-
	-	-	-	America	-	-
	-	-	-	Univer-sidad	-	-
Nindiri	-	-	-	Volcan	-	-
	-	-	-	Stereo	-	-
	-	-	-	Universeal	-	-
Diriomo	-	-	-	-	-	-
alpaisillo	-	BANADES	-	-	-	-

(refer to Appendix 5)

Met.Stat:	Meteorological Station	Munici:	Municipality
Dep:	Departament	Lib:	Library
*	Branch	**	No estan funcionando
Alcal.:	Alcaldia	Juzg:	Juzgado
C.Com:	Casa comunal	BP:	Banco Popular
MC:	Ministerio de Cultura	MT:	Ministerio del Trabajo
BANCENTRO:	Banco Centroamericano	BCN:	Banco Central de Nicaragua
EA:	Banco de America	BAC:	Banco de America Central
BCP:	Banco de Credito Pop.	BANEXPO:	Banco de Exportacion
BANPRES:	Banco de Prestamos	BANADES:	Banco Nacional de Des.
BANPRO:	Banco de la Produccion	BANIC:	Banco Nicaraguense

Table 6-7 Constituent Rate of GDP in Nicaragua

Industry	:	1980 (%)	:	1989 (%)
Agriculture	:	28.6	:	29.2
Mining	:	0.7	:	0.7
Industry	:	19.8	:	16.2
Construction	:	2.6	:	3.0
Electricity, gass, water	:	0.8	:	1.2
Transportation, telecommunication	:	4.7	:	5.2
Commerce	:	30.2	:	30.4
Financial, service:	:	5.4	:	5.9
Government	:	2.5	:	3.8
Others	:	4.7	:	4.4
Total	:	100.0	:	100.0

(refer from IADB,1992)

(8) Transportation system

Existing transportation systems in the project area consist of roads, railways and air. The railways passing project area are shown in Table 3-8. Recently, passenger and cargo transports by railways have been rapidly decreased, because the railways is in much lower role as a transport mode in Nicaragua.

Table 6-8 Existing Railways in the Project Area

Section	:	Length(km)	:	Condition
Granada-Managua-Leon	:	132.5	:	Operating
Masaya-Diriamba	:	56.0	:	No operating
Leon-Rio Grande	:	86.0	:	Operating

Concerning airport, there is not operating airport in the project area. But August C. Sandino International Airport is adjoined in the section between Managua and Tipitapa. And there are many seasonable or non-operating local airport scattered in the section between Masaya and Tipitapa, Terica and Loa Zarzales.

The total length of the roads in 1992 was 15,011.2 km. The role of roads as a transport is rapidly increased in recent.

The recent condition of traffic accidents has been slightly increased. The number of traffic accidents by Region II, III, IV and V is shown in Table 6-8. In addition, the dangerous places for pedestrian are recognized at near the urban area and villages because of no side-walk installed in the road.

Table 6-9 Traffic Accidents by Region

Year	: Region II	III	IV	V
1987				
Accidents	: 542	3,838	463	192
Deaths	: 111	165	85	74
Wounded	: 388	1,402	439	255
1991				
Accidents	: 297	4,037	406	237
Deaths	: 97	146	70	36
Wounded	: 231	784	362	154

6.1.2 Natural Conditions

(1) Land

a. Topography

The country is generally divisible into four geographic Region, namely Interior Highlnds Region and Atlantic Region, as shown Figure 6-6.

The project area belongs mainly the Nicalaguan Depression Region and subordinate Interior Highland in the section between Los Zarzales and San Isidro.

b. Geology

The project area is mainly composed of El Fralle Formation of the Oligocene to Mid Miocene, Coyoi Group of the Pliocene, Las Sierras Formation of the Pleistocene and Holocene volcanic rocks and alluvium in ascending order as shown in Figure 6-7.

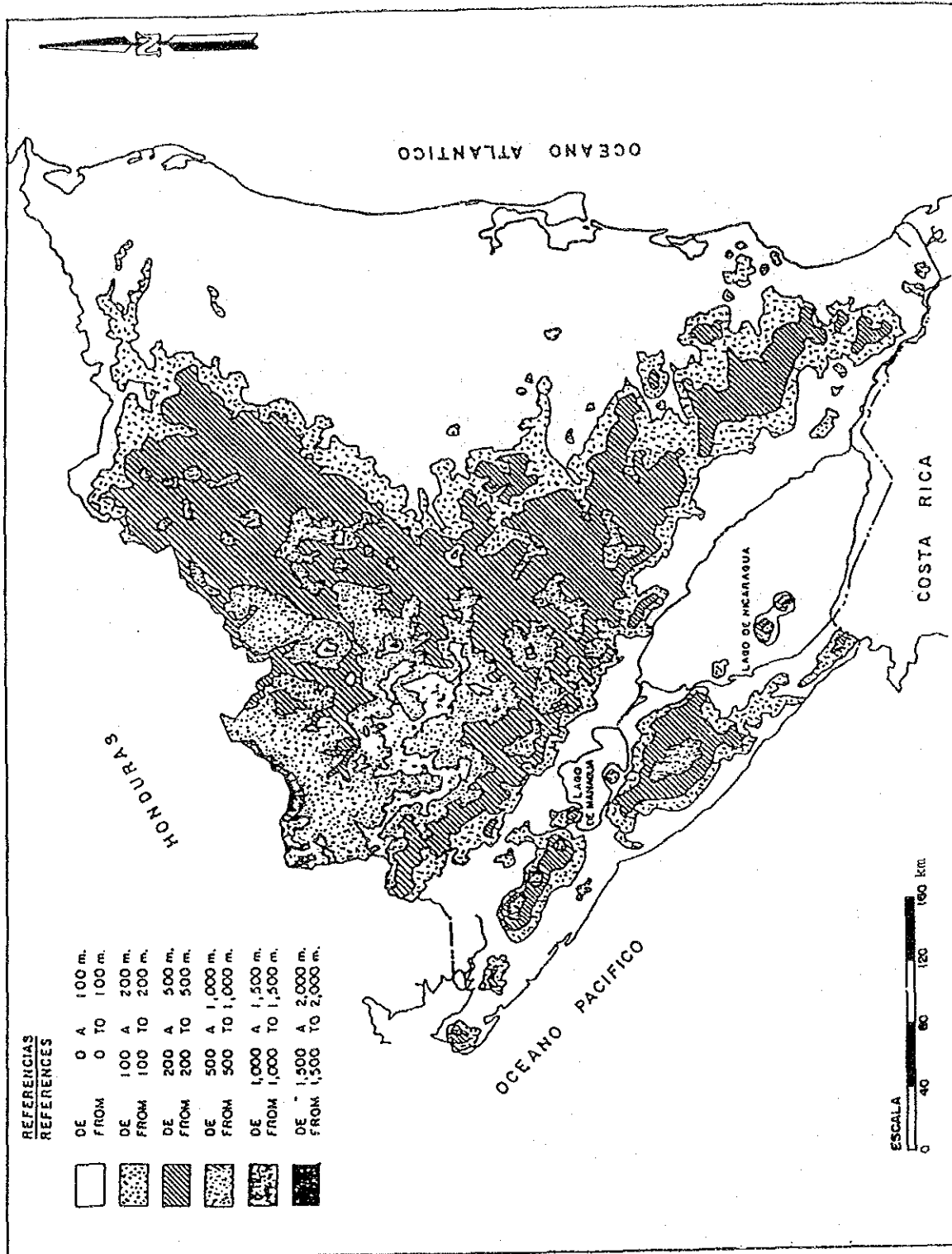
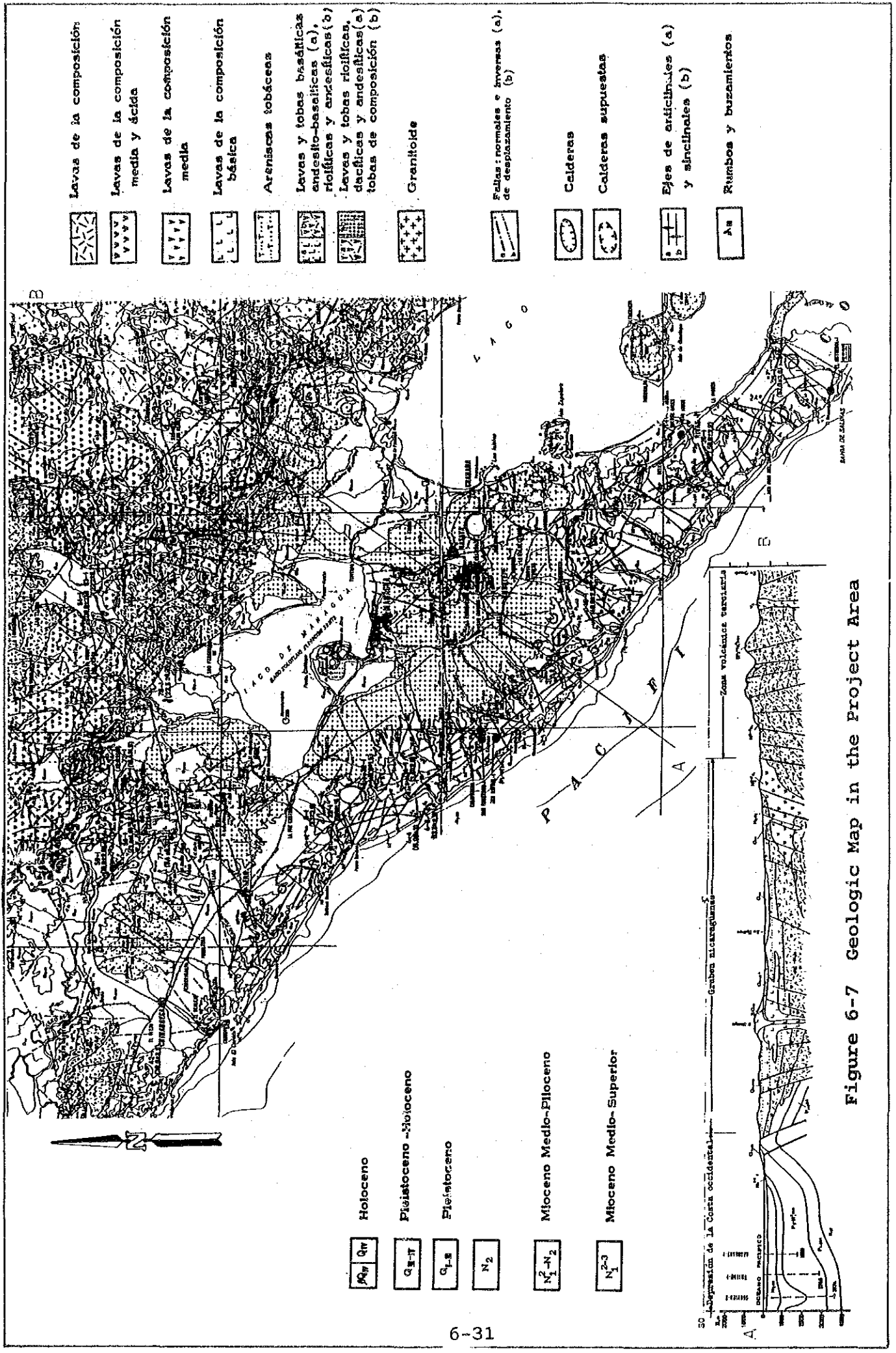


Figure 6-6 Hypsographic Map in Nicaragua



- Lavas de la composición
- Lavas de la composición media y ácida
- Lavas de la composición media
- Lavas de la composición básica
- Areniscas tobáceas
- Lavas y tobas basálticas andesito-basálticas (a), riolíticas y andesíticas (b)
- Lavas y tobas riolíticas, dacíticas y andesíticas (a) tobas de composición (b)
- Granitoide
- Fallas: normales e inversas (a), de desplazamiento (b)
- Calderas
- Calderas supuestas
- Ejes de anticlinales (a) y sinclinales (b)
- Rumbos y buzamientos

- Holoceno
- Pleistoceno - Mioceno
- Pleistoceno
- Mioceno Medio-Plioceno
- Mioceno Medio-Superior

Figure 6-7 Geologic Map in the Project Area

(2) Meteorology

The climate in Nicaragua is mainly classified into four types, including Tropical savannah (Aw), Tropical savannah in highland (AwH), Tropical monsoon (Am) and Tropical forest (Afl), in accordance with the W. Koppen method as shown in Figure 6-8. The project area belongs to the Tropical savannah (Aw) climate. The Tropical savannah (AwH) is locally distributed, but objective road is not directly passed in the zone.

Tropical savannah (Aw) : It occupies in the Pacific and western foot-hills of the central mountains. It is characterized by mid-temperature of 21 to 30 degrees centigrades and typical dry season of 5 to 6 months between November and April as shown in Figure 6-9 and Table 6-9. The volume of precipitation of this zone is 700 to 2,000 mm in a year. The probable intensity of rain-fall at the major locations in the project area is shown in Appendix 8.

(3) Water

The project area belongs to the Lake and Pacific Watersheds as shown in Figure 6-10. Most of the rivers in the project area flows into the two large lakes, Lago de Managua and Lago de Nicaragua, except Telica area, which belongs to the Pacific Watershed.

(4) Flora and fauna

The project area belongs ecologically to the Ecological Region I (Pacific Region) and II (Central Mountainous Region) as shown in Figure 6-11. The Region I is subdivided into eight subzones, including Subzone - 1, 2, 3, 4, 7, 22, 24 and 25 as shown in Figure 6-12. The Region II is subdivided into nine subzones, including Subzone - 1, 2, 3, 4, 5, 6, 7, 8 and 9.

The regulations of reservation, preservation and protection of forest, wild life and marine fauna in the survey area are legislated as shown in Figure 6-5. The conservation areas in the survey area are No. 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18 and 19, which correspond with volcanos except No. 14, which is Laguna De Tisma Lake along Tipitapa River.

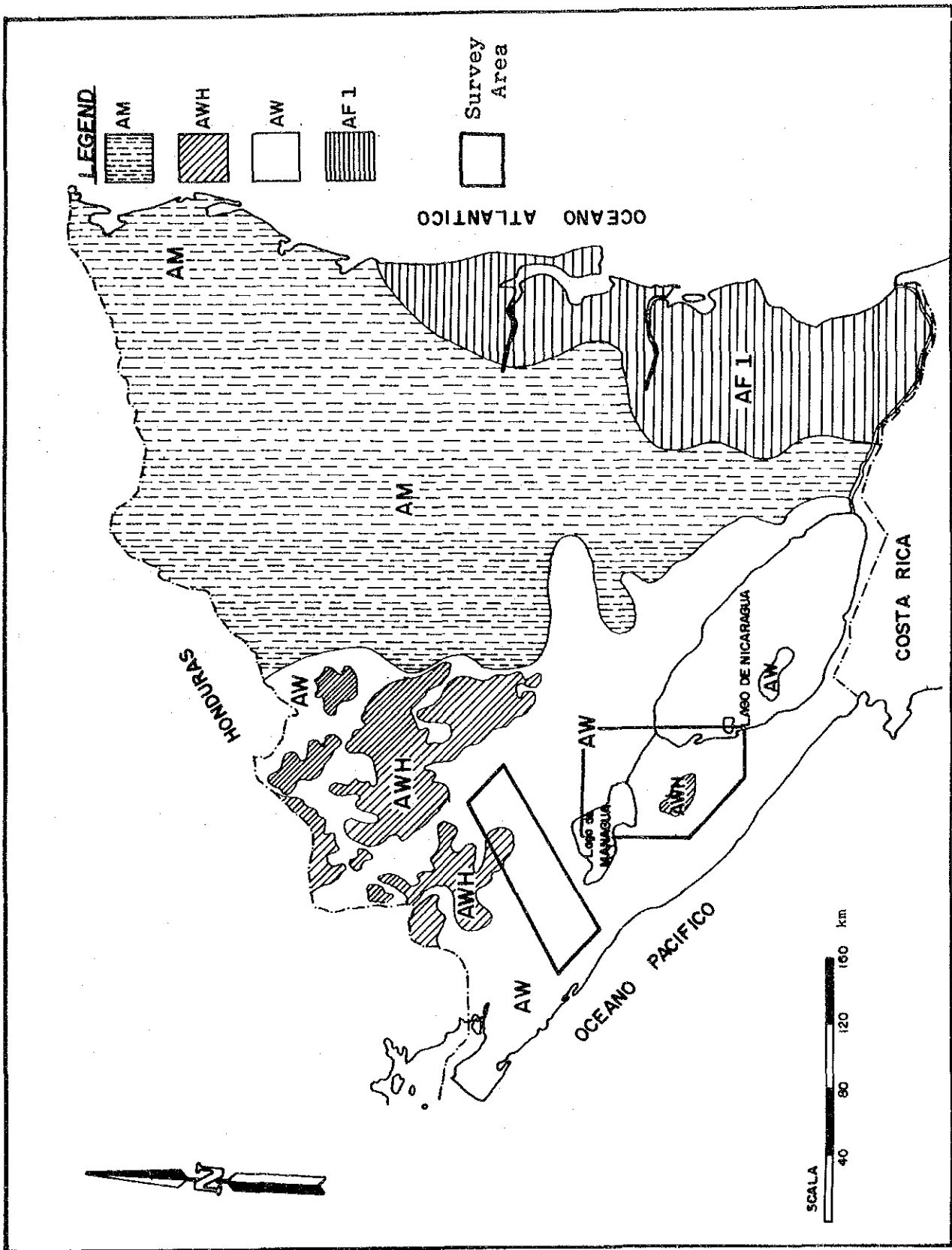


Figure 6-8 Meteorological classification in Nicaragua

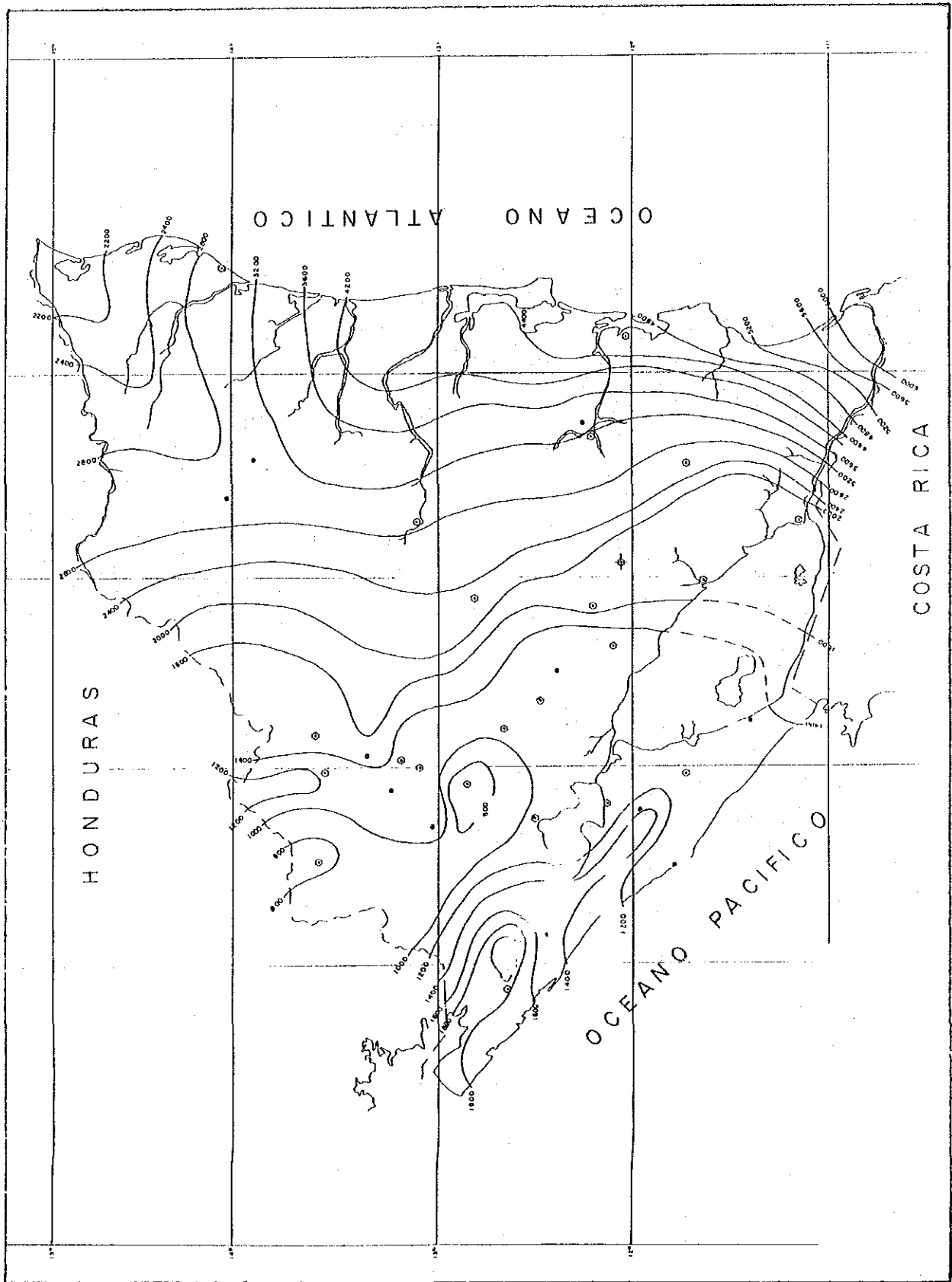


Figure 6-9 Precipitation in Nicaragua

Table 6-10 Meteorological Data in the Project Area

LISTADO DE ESTACIONES METEOROLOGICAS
 CON INFORMACION EN EL ANUARIO METEOROLOGICO 1990

Sección de Informática

CODIGO	NOMBRE	CUENCA	TIPO	LATITUD		LONGITUD		ELEVAC METER	DATOS		INSTIT	MAP ESC 1:50,000	NOMBRE DEL CUADRANTE
				NORTE	OESTE	DESDE	HASTA						
45017	OCCOTAL	COCO	HNP	133730	862836	612	MAY-58	DIC-91	INETER	C2956-IV	OCCOTAL		
55027	MUY MUY	GDE.MATG	HNP	124548	853736	320	JUN-70	DIC-91	INETER	C3054-II	MUY MUY		
64018	CHIHANDEGA	E. REAL	HNP	123800	870800	60	ENE-66	FEB-92	INETER	C2753-I	CHIHANDEGA		
64043	LEON (AEROPUERTO GODOY)	E. REAL	HNP	123536	865448	60	JUL-74	ABR-92	INETER	C2853-III	LEON		
69027	LAS MERCEDES (AERP. A.C.S)	SAN JUAN	HNP	120836	860949	56	ENE-58	DIC-91	INETER	C2952-II	MANAGUA		
69034	JUIGALPA	SAN JUAN	HNP	120600	852200	90	OCT-60	FEB-92	INETER	C3152-III	JUIGALPA		
69070	RIVAS	SAN JUAN	HNP	112606	855000	70	ENE-68	JUL-92	INETER	C3050-III	RIVAS		
45050	CONDEGA	COCO	AG	132022	862307	560	OCT-83	FEB-92	INETER	C2853-IV	POSOLTEGA		
64028	POSOLTEGA (C.E.A.)	E. REAL	AG	123300	863900	80	ABR-75	ENE-92	INETER	C2951-II	MANDAIRE		
68031	INGENIO JULIO BUITRAGO TAM. Y BRIT. AG	TAM. Y BRIT. AG	AG	114600	863000	10	ENE-87	FEB-92	INETER	C2951-II	MANDAIRE		
69033	NAUDAINE (ING. X. GUERRA)	SAN JUAN	AG	114318	860248	95	MAY-58	ENE-92	INETER	C2951-II	MANDAIRE		
69129	CAMPOS AZULES (MASATEPE)	SAN JUAN	AG	115359	860859	470	JUL-83	OCT-91	INETER	C2951-II	MANDAIRE		
69130	TIMAL	SAN JUAN	AG	121900	860400	65	JUN-87	DIC-91	INETER	C2951-II	MANDAIRE		
69131	NAGAROTE	SAN JUAN	AG	121518	863342	80	SEP-83	MAR-91	INETER	C2951-II	MANDAIRE		
69132	RAUL GONZALEZ	SAN JUAN	AG	125448	861130	480	DIC-83	DIC-91	INETER	C2951-II	MANDAIRE		
69115	MASAYA (L. OXIDACION)	SAN JUAN	HNO	115848	860618	210	SEP-77	FEB-91	INETER	C2951-I	MASAYA		
45008	MACUELIZO	COCO	PV	133836	863600	700	ABR-63	MAR-92	INETER	C2856-I	MACUELIZO		
45016	SN FERNANDO	COCO	PV	134030	861854	725	NOV-69	MAR-92	INETER	C2757-III	SAN FERNANDO		
45047	DIPILTO	COCO	PV	134302	863005	880	FEB-84	MAR-92	INETER	C2857-II	DIPILTO		
60006	ACHUAPA	EST. REAL	PV	130309	863515	330	ABR-63	DIC-91	INETER	C2855-II	ACHUAPA		
60020	LAS MARIAS	EST. REAL	PV	123942	865142	5	ABR-75	DIC-90	INETER	C2853-IV	LAS MARIAS		
64035	JICUILLO	E. REAL	PV	124400	872612	5	JUN-69	JUL-91	INETER	C2754-III	PLA. P. DE RAMO		
69067	SAN JOSE DE LOS REMATES	SAN JUAN	PV	123548	854342	520	OCT-69	MAR-91	INETER	C3053-IV	S. J. REMATE		
69077	MERIDA	SAN JUAN	PV	112624	853327	40	ABR-70	AGO-91	INETER	C3050-II	ALTAGRACIA		
69095	ABISINIA	SAN JUAN	PV	114629	843950	160	MAY-73	FEB-92	INETER	C3251-III	ALTAGRACIA		
69113	LA MONTANA	SAN JUAN	PV	125330	862524	680	NOV-72	FEB-91	INETER	C2954-IV	SAN NICOLAS		

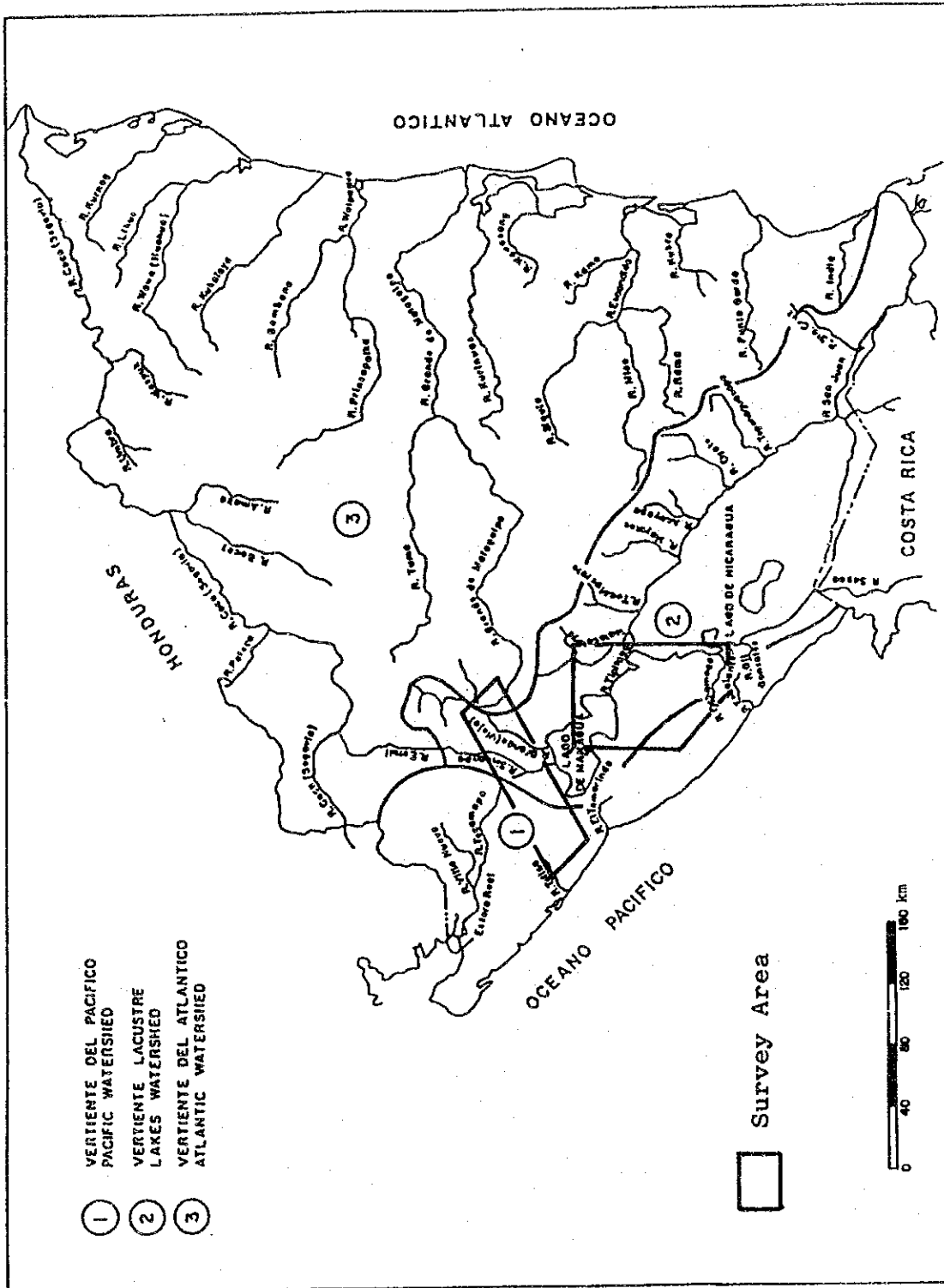


Figure 6-10 Watershed Map in Nicaragua

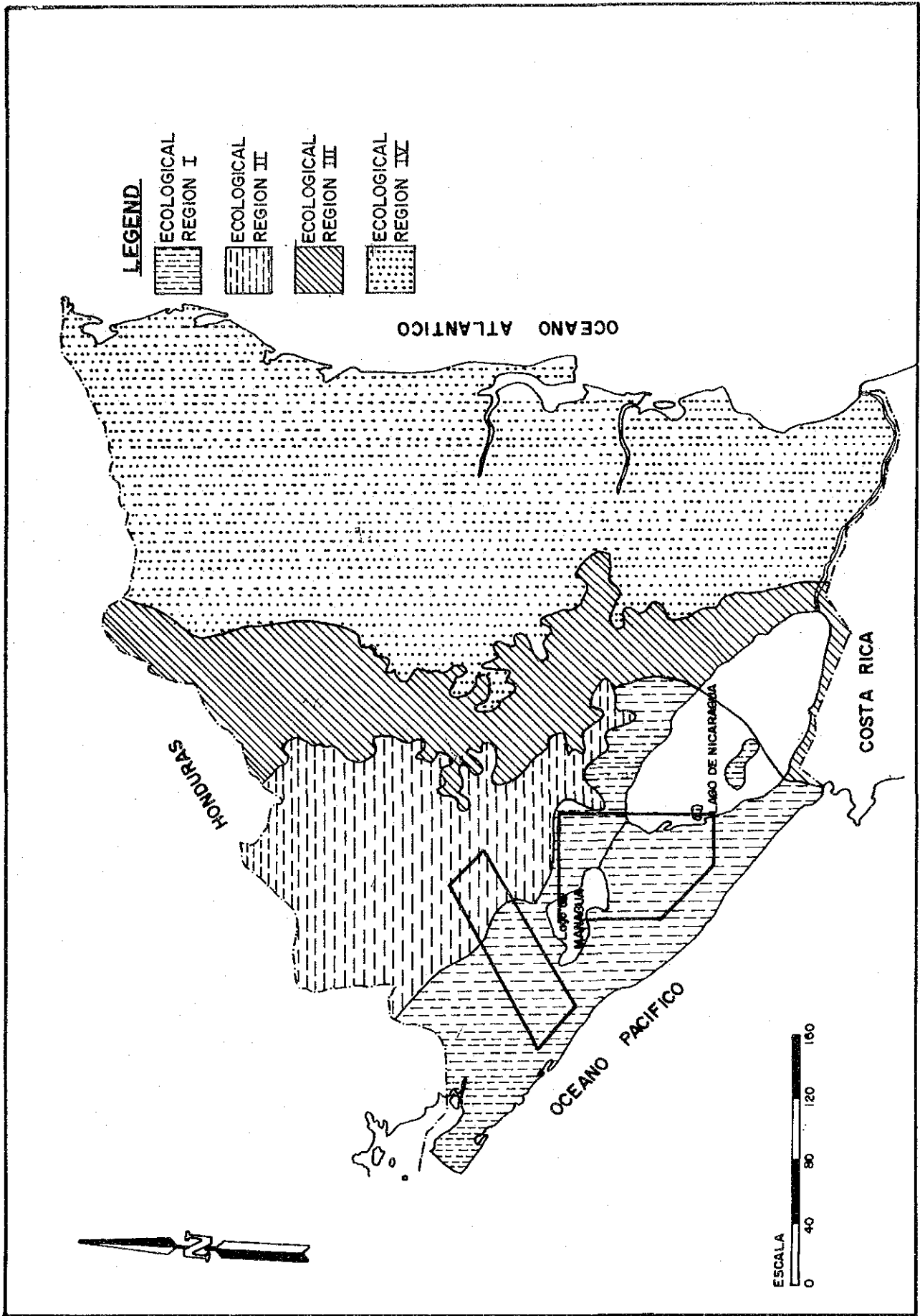


Figure 6-11 Ecological Map in Nicaragua

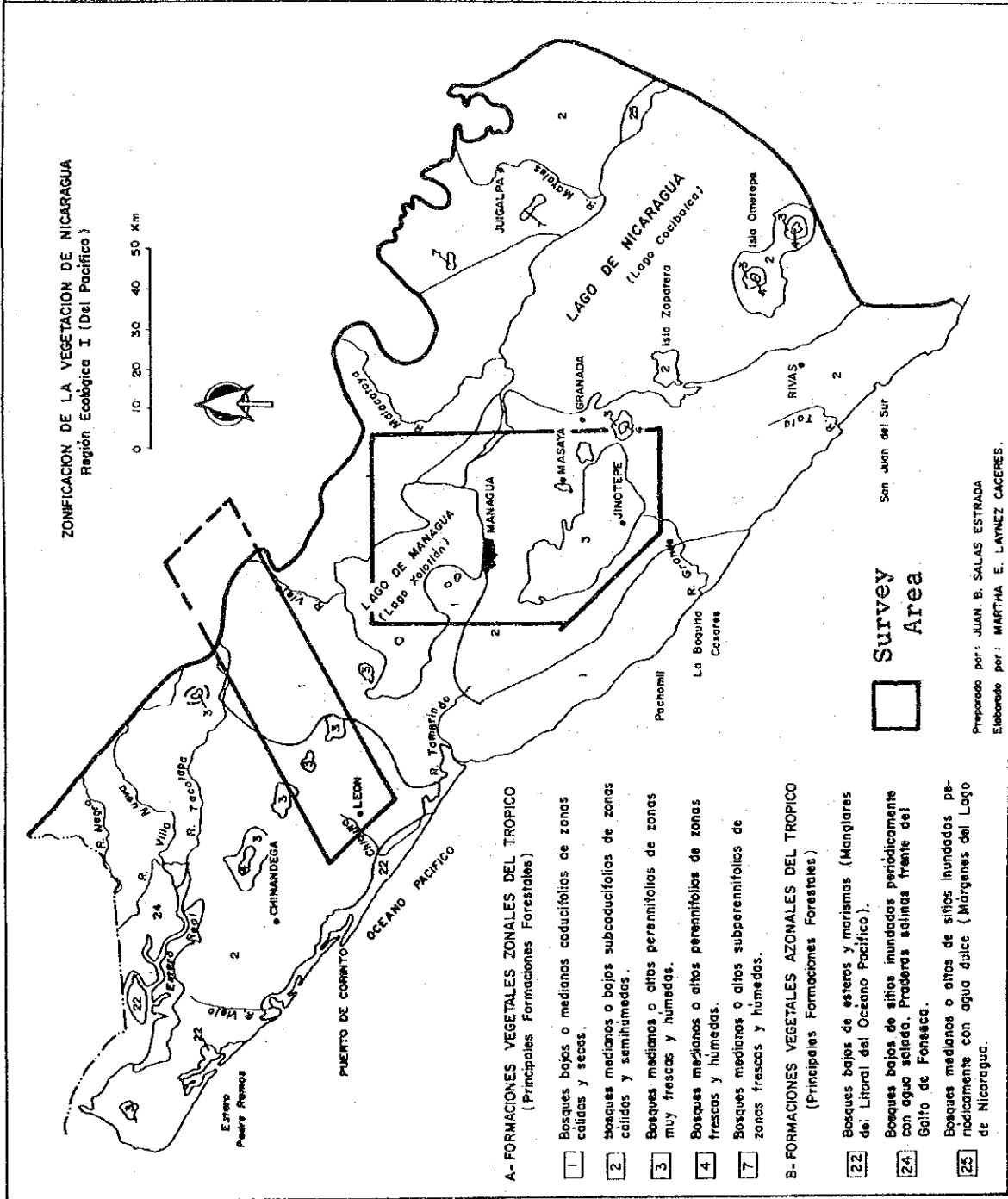


Figure 6-12(1) Vegetation Map in Nicaragua

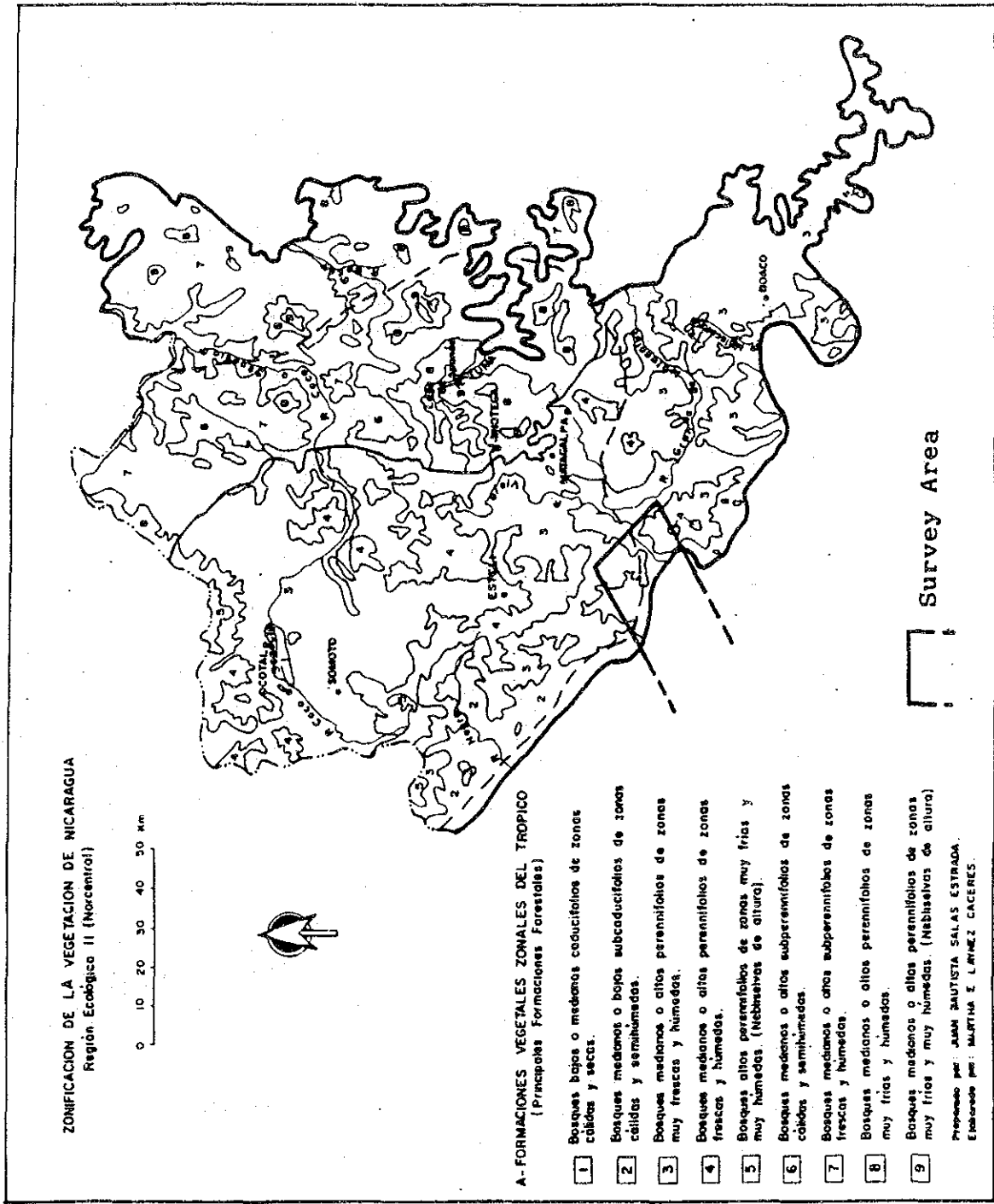


Figure 6-12(2) Vegetation Map in Nicaragua

(5) Landscape

There is one national park, Masaya Volcano National Park, in the project area (Figures 6-1 and 6-2). Generally, the project area is characterized by the beautiful volcanic landscape. Other place of scenic beauty is listed El Jicaral (geothermal activity).

6.2 Traffic Condition

6.2.1 Present Condition

The traffic volume in March of 1993 is shown in Table 6-11 and Figure 6-13 (refer to Appendix 7). The section between Managua and Masaya is more than 10,000 vehicles in a day. But, the sections between Masaya and Tipitapa, Masaya and Nandaime, Tipitapa and San Benito, Telica and San Benito are less than 2,000 vehicles in a day.

Table 6-11 Present Traffic Volume and Traffic Demand Forecasting (vehicle)

Point No. *1	Traffic volume 1993.3 (24H)	Traffic demand forecasting 2000 *2 (24H)	Traffic demand forecasting 2010 *3 (24H)	R.H.V. *4 (%)
1	3,448	4,482	6,551	15.7
2	5,729	7,447	10,885	18.5
3	947	1,231	1,799	31.8
4	5,283	6,867	10,037	27.1
5	675	877	1,282	49.9
6-1	261	339	495	52.2
6-2	426	553	809	49.2
7	2,482	3,226	4,715	34.6
8	1,737	2,254	3,300	38.0
9	5,581	7,255	10,603	22.8
10	9,501	12,351	18,051	9.3
11	20,882	27,146	39,675	10.2
12	10,895	14,163	20,700	23.0
13	2,254	2,930	4,282	47.2
14	892	1,159	1,694	42.8
15	3,689	4,795	7,009	17.7
16	1,560	2,028	2,964	35.2
17	2,638	3,429	5,012	31.6
18	2,036	2,646	3,568	24.5
19	1,413	1,836	2,684	29.8
20	1,654	2,150	3,142	27.2
21	1,740	2,262	3,306	29.2
22	1,130	1,469	2,147	34.2
23	812	1,055	1,542	31.4

- *1 : Point numbers are shown in Figure 6-3.
- *2 : Rate of increasing is 130 % of traffic volume in 1993.
- *3 : Rate of increasing is 190 % of traffic volume in 1993.
- *4 : Rate of heavy vehicle.

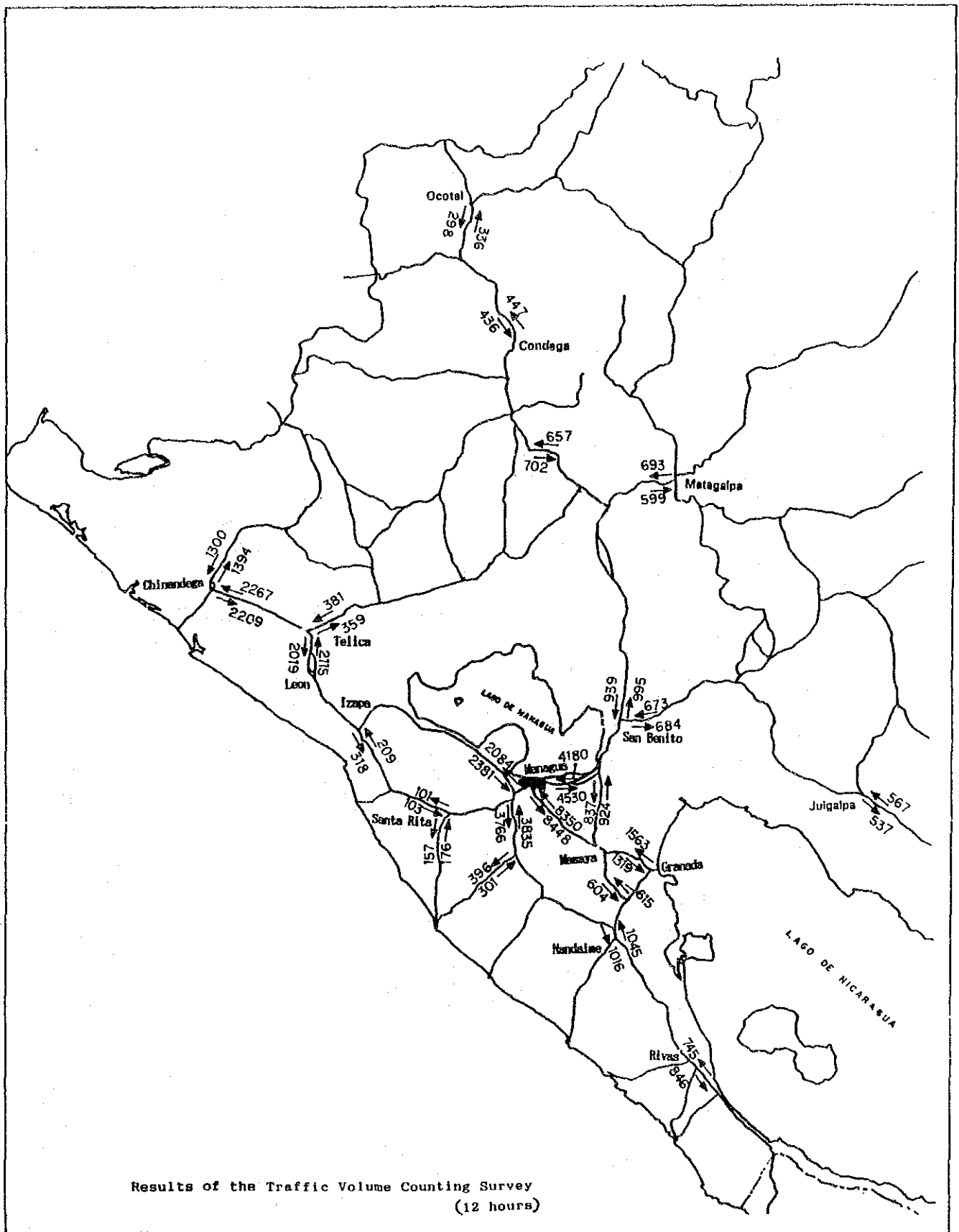


Figure 6-13 Present Traffic Volume around the Project Area

6.2.2 Prediction of Traffic Volume

The traffic demand forecasting in the year of 2000 and 2010 are shown in Table 6-10. Traffic volume in 2000 and 2010 year is estimated to increase 130 % and 190 % in rate to the present traffic volume as shown in Table 6-11 (refer to Appendix 7).

6.3 Air Quality

6.3.1 Present Condition

(1) Source of air pollutants

The source of air pollution is generally classified into fixed source such as factory, office, house, etc. and moved source such as automobile, train, ship, etc. In general, nitrate oxides (NO_x) is mainly generated by automobiles and factories, sulfate oxides (SO_x) is mainly generated by factories and diesel engine such as heavy vehicles, and then carbon oxide (CO) is mostly generated by automobiles.

The basic data of air quality including NO_x, SO_x, CO, SPM, etc. in Nicaragua is not existed at present.

In the project area except Managua and Masaya, there is not fixed origin in large scale, therefore, it is considered that the source of air pollution is mostly generated by automobiles. And then, in the urban area of Managua and Masaya, the source is assumed to be composed of automobiles, factories and houses.

(2) Meteorological condition

The meteorological data were collected in order to examine the diffusion of air pollutants by means of simulation. The meteorological data of six meteorological stations, i.e. Managua (Las Mercedes), Masaya, Nandaime, Leon and San Isidro, consist of wind speed, wind direction, etc. as shown in Appendix 8 and Figure 6-14.

Dominant wind direction at Managua, Masaya, Nandaime and Tipitapa is East to northeast. That around Telica and San Isidro is northwest and north to east respectively. Particularly, Leon is characterized by extremely weak wind.

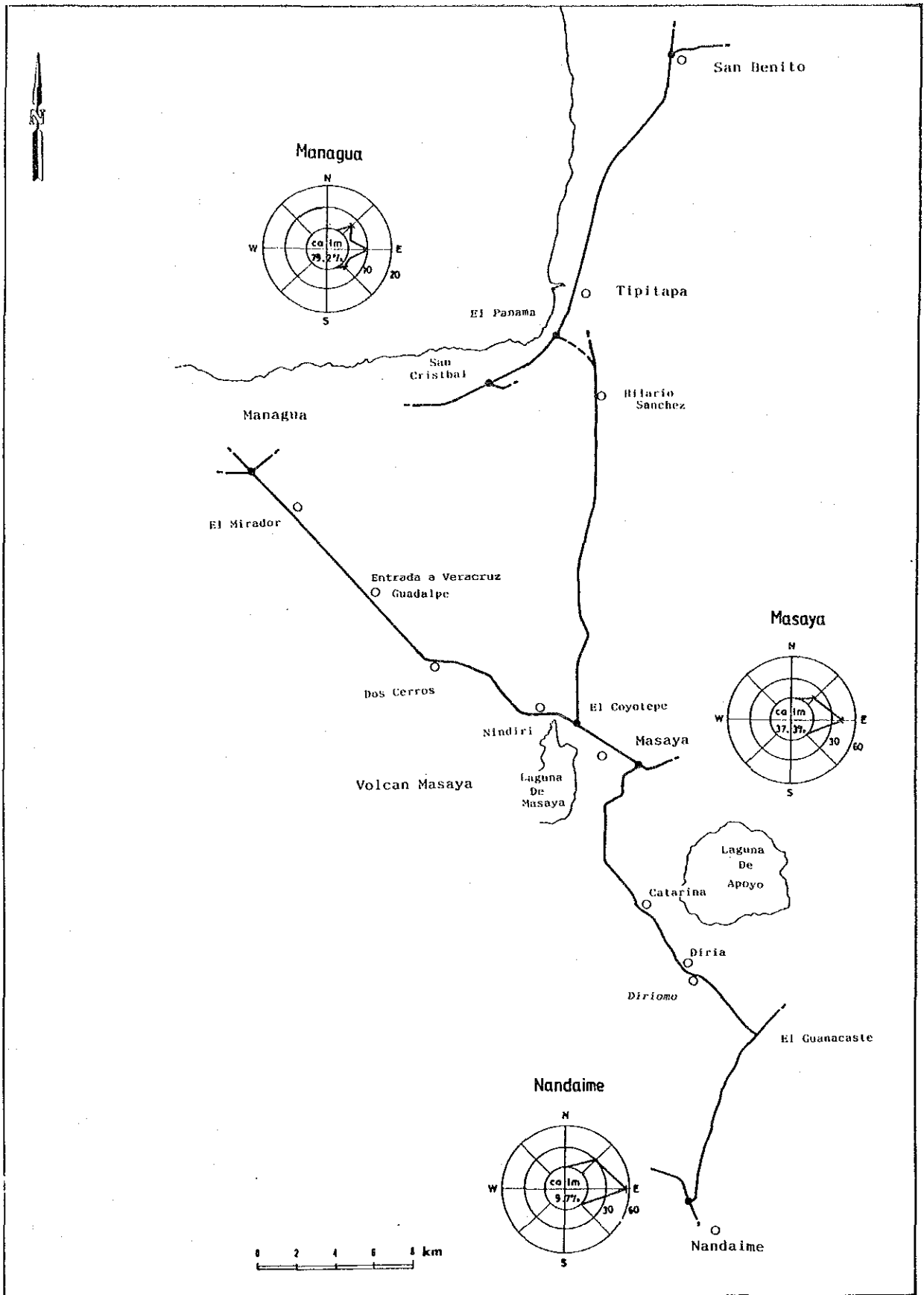


Figure 6-14(1) Wind Direction in the Project Area

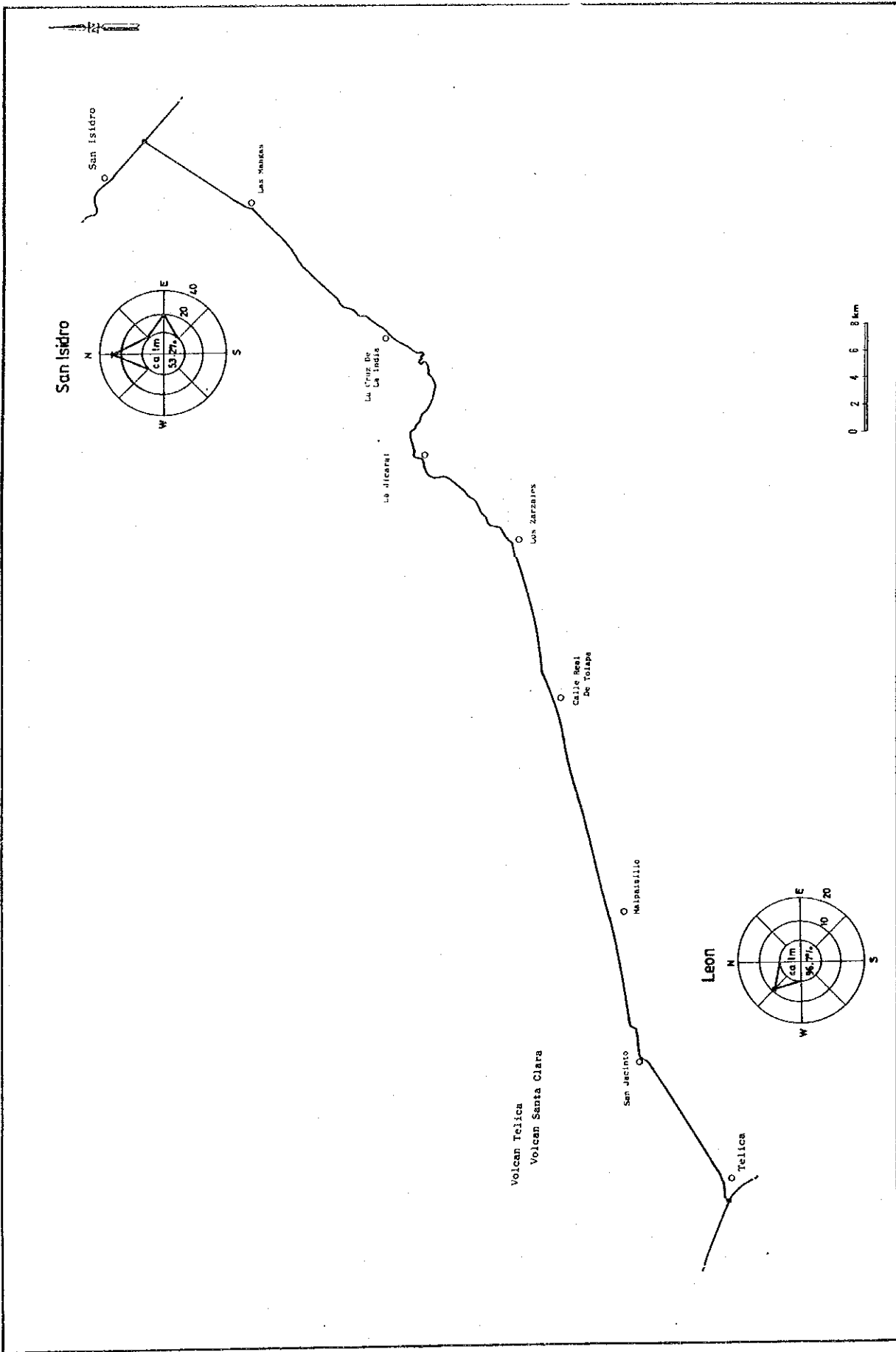


Figure 6-14(2) Wind Direction in the Project Area

(3) Field investigation

a. Components of measurement

Chemical analysis of air is only SO₂. The meteorological measurement, including temperature, wind, wind direction and atmosphere pressure, had been carried out at the same time. The number of measurement is two times of 10:00 a.m. and 3:00 p.m.

1) Location

The number of field investigation of the air quality is 21 places (6 sections) as shown in Figure 6-6-15. Investigating places are limited at the urban areas and major inter-sections.

2) Method of chemical analysis

Method of chemical analysis of air is "Solution electro-conductivity method" using ATM-1 (Atmosfera I, USSR). The period and height of analysis is one hour and 1.5 m above from surface of the earth respectively.

b. Result of measurement

Results of chemical analysis and meteorological measurement are shown in Table 6-12 (1)~(4) and Figure 6-16. The concentration of SO₂ ranges 0.02 to 0.0875 mg/m³. These value is quite lower than the environmental quality standards for air quality as shown in Table 4-1 (SO₂ : 80 ug/m³ or 0.03 ppm). These results are assumed that activity of industry as a fixed source of air pollution is very low and influence of the heavy vehicles is relatively small.

6.3.2 Prediction of Air Quality

Influences on air quality by exhausted gas and dust from heavy machines at the stage of construction and automobiles after completion of construction. However, the generation of pollutants during construction will be controlled by the dispersion of heavy machines and sprinkling water on the bared surface. Therefore, the prediction of air quality is examined concerning exhausted gas from automobiles. The items of prediction are NO_x and CO.

The prediction areas are situated at major urban areas, including Managua, Masaya, Catarina, Nandaime, Tipitapa, San Benito, Telica and San Isidro.

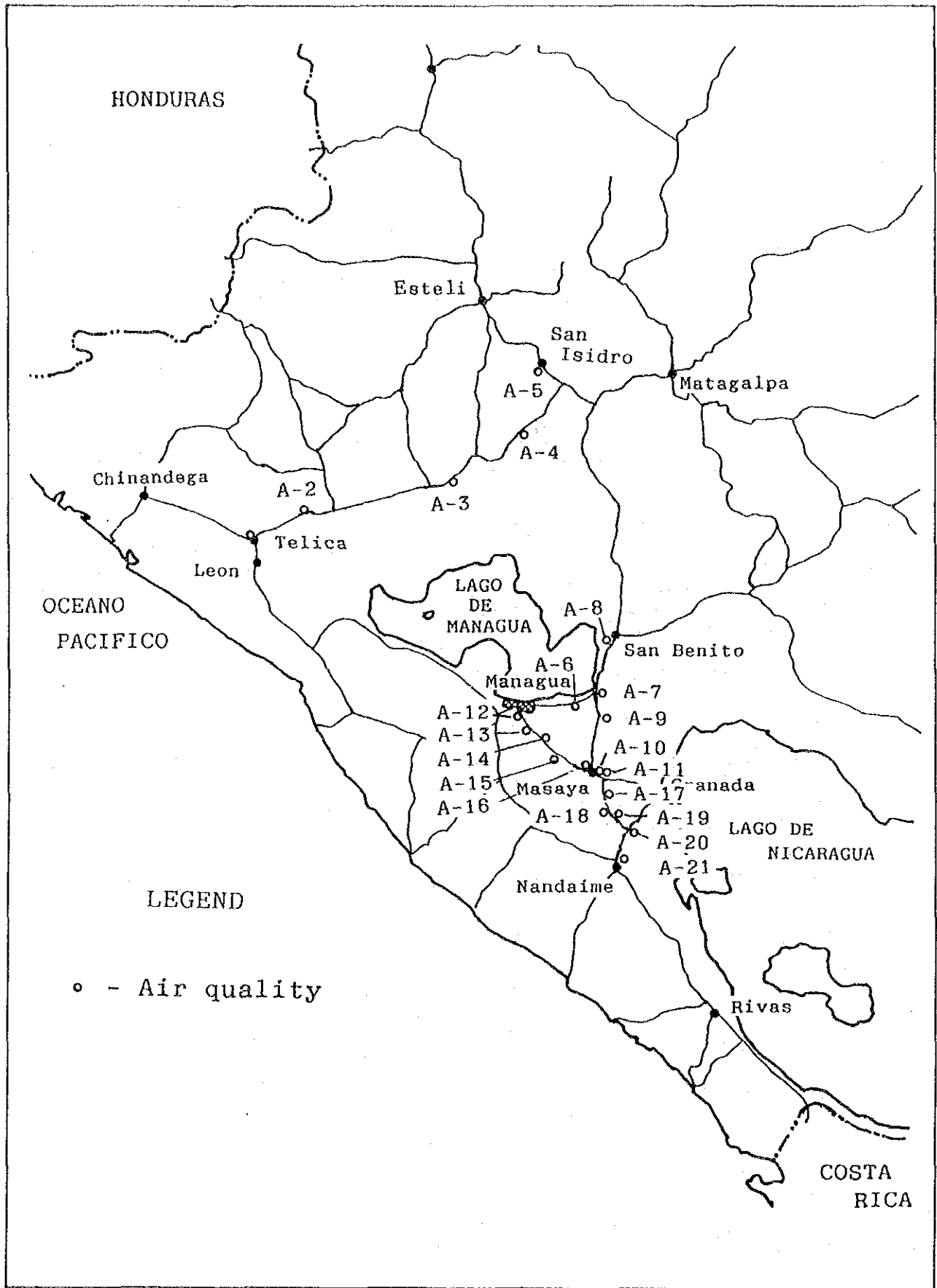


Figure 6-15 Location Map of the Air Quality Investigation

**Table 6-12(1) Present Condition of Air Quality
in the Project Area**

No.	: Nombre	: Fecha	: Hora	: Concentracion: mg/m3
1	: Telica	: 4/10/93	: 9:50-10:00	: 0.0730
2	: Sn. Jacinto	: 4/10/93	: 10:15-10:25	: 0.0650
3	: Zarzales	: 5/10/93	: 9:30- 9:40	: 0.0540
4	: La Mina	: 5/10/93	: 10:05-10:15	: 0.0370
5	: Sn. Isidro	: 5/10/93	: 10:40-10:50	: 0.0760
6	: Cofradia	: 7/10/93	: 9:38- 9:48	: 0.0525
7	: Tipitapa	: 7/10/93	: 9:56-10:06	: 0.0560
8	: Sn. Benito	: 7/10/93	: 10:22-10:32	: 0.0590
9	: Zambrano	: 6/10/93	: 9:35- 9:45	: 0.0345
10	: Coyotepe	: 6/10/93	: 10:05-10:15	: 0.0470
11	: H. Masaya	: 6/10/93	: 10:25-10:35	: 0.0500
12	: C. America	: 8/10/93	: 9:30- 9:40	: 0.0765
13	: Las Colinas	: 8/10/93	: 9:50-10:00	: 0.0780
14	: Ticuantepe	: 8/10/93	: 10:10-10:20	: 0.0695
15	: C. Masaya	: 11/10/93	: 9:50-10:00	: 0.0640
16	: Nindiri	: 11/10/93	: 10:15-10:25	: 0.0590
17	: Monimbo	: 12/10/93	: 9:35- 9:45	: 0.0500
18	: Catarina	: 12/10/93	: 9:55-10:05	: 0.0460
19	: Diriomo	: 12/10/93	: 10:15-10:25	: 0.0300
20	: Guanacaste	: 13/10/93	: 9:50-10:00	: 0.0435
21	: Nandaime	: 13/10/93	: 10:20-10:30	: 0.0260

**Table 6-12(2) Present Condition of Air Quality
in the Project Area**

MANANA

No.:	Nombre	Fecha	DATOS METEOROLOGICOS			
			T Ambiente	dd	VIENTO v v	Presion Atmosferica
1	:Telica	: 4/10/93	: 28.0	:	: calma	: 1007.7
2	:Sn.Jacinto	: 4/10/93	: 27.4	: E	: 2	: 998.4
3	:Zarzales	: 5/10/93	: 28.0	: E	: 1	: 1013.1
4	:La Mina	: 5/10/93	: 28.0	:	: calma	: 979.1
5	:Sn.Isidro	: 5/10/93	: 28.2	:	: calma	: 969.8
6	:Cofradia	: 7/10/93	: 28.4	: E	: 2	: 1015.7
7	:Tipitapa	: 7/10/93	: 28.2	: E	: 2	: 1015.7
8	:Sn.Benito	: 7/10/93	: 28.8	: E	: 2	: 1013.1
9	:Zambrano	: 6/10/93	: 28.4	:	: calma	: 1013.7
10	:Coyotepe	: 6/10/93	: 28.4	: NE	: 1	: 996.4
11	:H.Masaya	: 6/10/93	: 29.0	: NE	: 1	: 995.8
12	:C.America	: 8/10/93	: 28.4	: E	: 1	: 1002.4
13	:Las Colinas	: 8/10/93	: 28.4	: E	: 1	: 997.1
14	:Ticuantepe	: 8/10/93	: 28.8	: E	: 2	: 995.8
15	:C.Masaya	: 11/10/93	: 27.8	:	: calma	: 987.8
16	:Nindiri	: 11/10/93	: 27.8	:	: calma	: 998.4
17	:Monimbo	: 12/10/93	: 28.6	:	: calma	: 986.4
18	:Catarina	: 12/10/93	: 27.2	:	: calma	: 961.1
19	:Diriomo	: 12/10/93	: 26.8	: E	: 2	: 981.1
20	:Guanacaste	: 13/10/93	: 26.6	: E	: 3	: 993.1
21	:Nandaime	: 13/10/93	: 27.8	: E	: 2	: 1003.7

T. Ambiente: (° C)
dd: Direccion

v v: Velocidad del viento(mts/seg)
Presion Atmosferica:(hPa)

**Table 6-12(3) Present Condition of Air Quality
in the Project Area**

TARDE

No.	: Nombre	: Fecha	: Hora	: Concentracion: mg/m ³
1	: Telica	: 4/10/93	: 14:45-14:55	: 0.0520
2	: Sn.Jacinto	: 4/10/93	: 15:15-15:25	: 0.0565
3	: Zarzales	: 5/10/93	: 14:05-14:15	: 0.0550
4	: La Mina	: 5/10/93	: 14:50-15:00	: 0.0165
5	: Sn.Isidro	: 5/10/93	: 15:20-15:30	: 0.0400
6	: Cofradia	: 7/10/93	: 14:32-14:42	: 0.0650
7	: Tipitapa	: 7/10/93	: 14:56-15:06	: 0.0800
8	: Sn.Benito	: 7/10/93	: 15:14-15:24	: 0.0792
9	: Zambrano	: 6/10/93	: 14:45-14:55	: 0.0400
10	: Coyotepe	: 6/10/93	: 15:05-15:15	: 0.0540
11	: H.Masaya	: 6/10/93	: 15:25-15:35	: 0.0510
12	: C.America	: 8/10/93	: 14:30-14:40	: 0.0875
13	: Las Colinas	: 8/10/93	: 14:50-15:00	: 0.0735
14	: Ticuantepe	: 8/10/93	: 15:08-15:18	: 0.0830
15	: C.Masaya	: 11/10/93	: 14:30-14:40	: 0.0605
16	: Nindiri	: 11/10/93	: 15:00-15:10	: 0.0300
17	: Monimbo	: 12/10/93	: 14:45-14:55	: 0.0530
18	: Catarina	: 12/10/93	: 15:05-15:15	: 0.0440
19	: Diriomo	: 12/10/93	: 14:05-14:15	: 0.0300
20	: Guanacaste	: 13/10/93	: 14:45-14:55	: 0.0300
21	: Nandaime	: 13/10/93	: 15:05-15:15	: 0.0200

**Table 6-12(4) Present Condition of Air Quality
in the Project Area**

TARDE

No.:	Nombre	Fecha	DATOS METEOROLOGICOS			
			T Ambiente	dd	v v	Presion Atmosferica
1	:Telica	: 4/10/93	: 32.0	:	: calma	: 1002.4
2	:Sn.Jacinto	: 4/10/93	: 31.8	:	: calma	: 997.1
3	:Zarzales	: 5/10/93	: 28.4	:	: calma	: 1013.1
4	:La Mina	: 5/10/93	: 28.4	:	: calma	: 976.4
5	:Sn.Isidro	: 5/10/93	: 29.8	:	: calma	: 967.1
6	:Cofradia	: 7/10/93	: 30.8	: E	: 2	: 1013.7
7	:Tipitapa	: 7/10/93	: 30.8	: E	: 3	: 1011.7
8	:Sn.Benito	: 7/10/93	: 29.8	: NE	: 3	: 1019.1
9	:Zambrano	: 6/10/93	: 31.0	: NE	: 1	: 1011.7
10	:Coyotepe	: 6/10/93	: 30.8	: NE	: 1	: 991.8
11	:H.Masaya	: 6/10/93	: 30.8	: E	: 1	: 991.8
12	:C.America	: 8/10/93	: 30.0	: E	: 2	: 999.8
13	:Las Colinas	: 8/10/93	: 29.6	: E	: 2	: 990.4
14	:Ticuantepe	: 8/10/93	: 29.6	: E	: 2	: 993.1
15	:C.Masaya	: 11/10/93	: 29.6	: E	: 2	: 982.4
16	:Nindiri	: 11/10/93	: 29.6	: E	: 2	: 995.8
17	:Monimbo	: 12/10/93	: 29.6	:	: calma	: 986.4
18	:Catarina	: 12/10/93	: 27.6	: E	: 1	: 961.1
19	:Diriomo	: 12/10/93	: 27.2	: E	: 4	: 981.1
20	:Guanacaste	: 13/10/93	: 29.6	:	: calma	: 989.1
21	:Nandaime	: 13/10/93	: 29.2	:	: calma	: 1001.1

T.Ambiente:(^o C)
dd:Direccion de viento

v v: Velocidad del viento(mts/seg)
Presion Atmosferica: (hPa)

Fuente : INETER

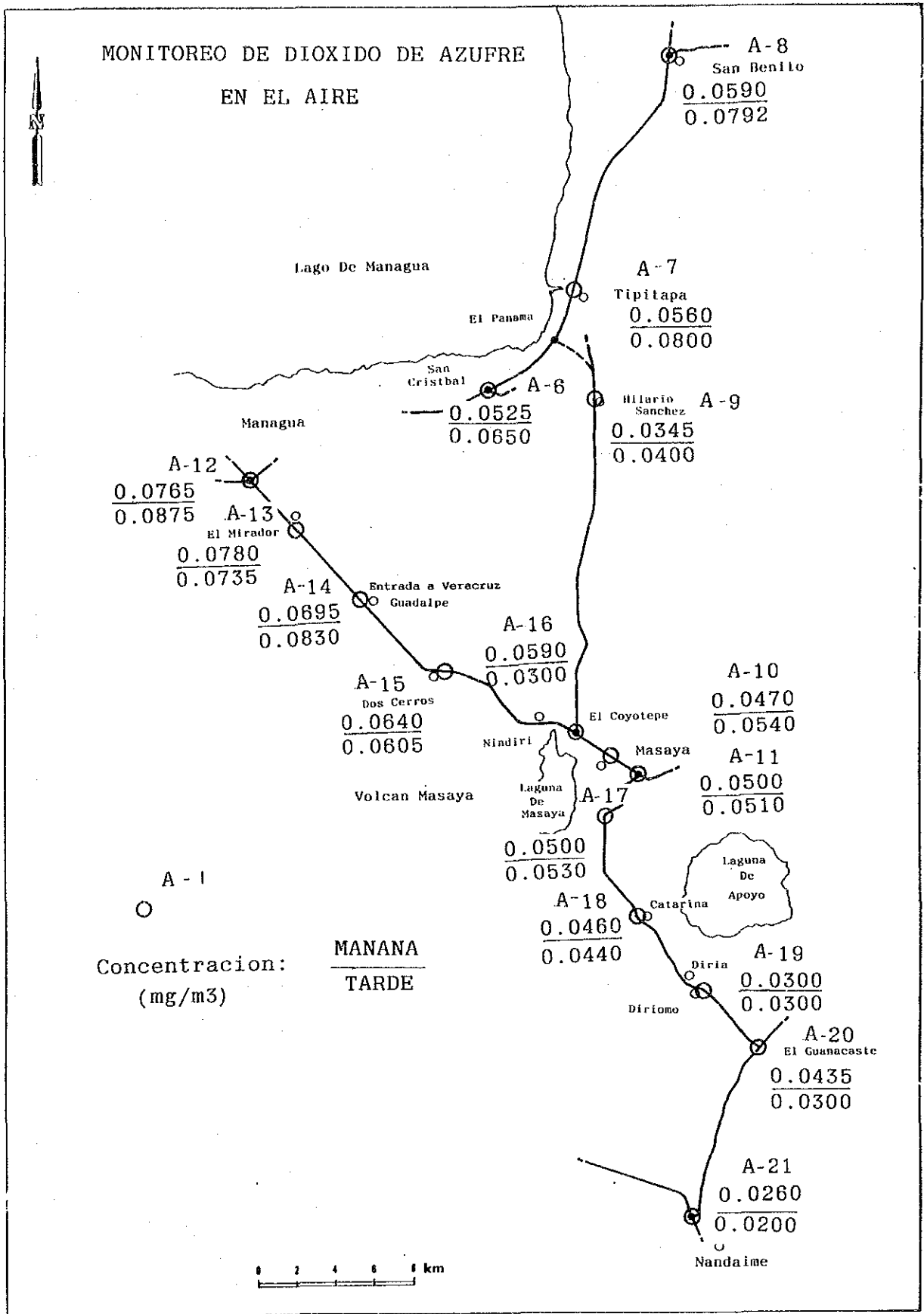


Figure 6-16(1) Present Condition of SO₂ in the Project Area

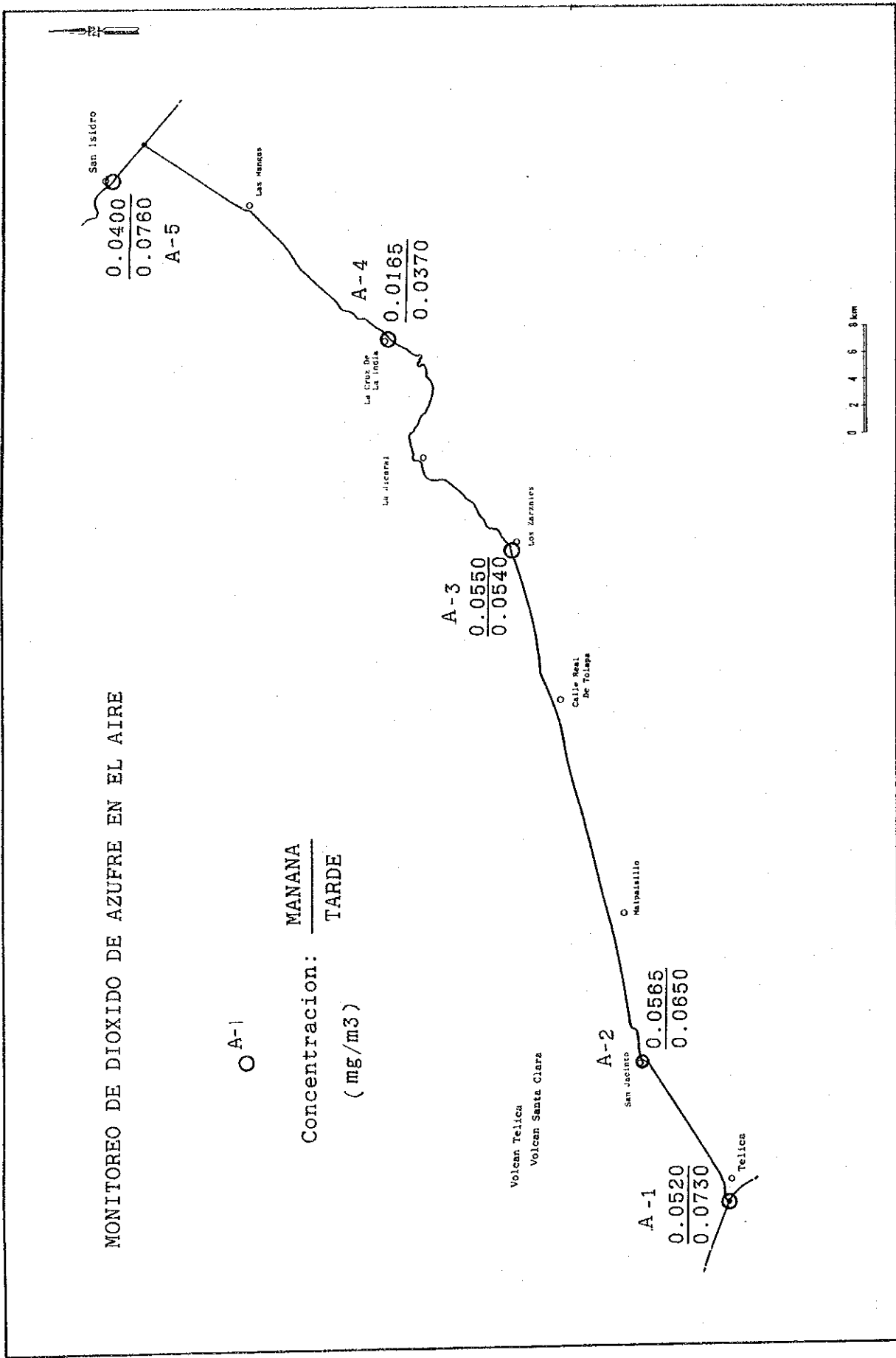


Figure 6-16(2) Present Condition of SOP2 in the Project Area

(1) Condition of prediction

The weather conditions concerning wind and wind direction for the prediction are shown in Figure 6-14 and refer to Appendix 8.

The source conditions of air pollutants as shown in Figure 6-17 are as follows:

- Height of stack : 1.0 m
- Speed of vehicles : 60 km/hour
- Topography : Flat
- Volume factor of pollutant :
 - NOx : 523 ml/g
 - CO : 859 ml/g
- Co-efficient of emission : unit : g/km * vehicle
 - NOx : Light vehi. : 0.222
 - Heavy vehi. : 1.85
 - CO : Light vehi. : 0.769
 - Heavy vehi. : 1.62
- Arrangement of source : 20 m long interval 2 m
180 m long interval 10 m
- 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 plume method (Formula 6-1) is used to predict the concentration of pollutants.

$$C(x, y, z) = \frac{q}{2p \cdot S_y \cdot S_z \cdot u} * F(y) * F(z) \quad \text{Formula 6-1}$$

$$F(y) = \exp \left\{ - \frac{y^2}{2S_y^2} \right\}$$

$$F(z) = \exp \left\{ - \frac{(H-z)^2}{2S_z^2} \right\} + \exp \left\{ - \frac{(H+z)^2}{2S_z^2} \right\}$$

$$S_z = 1.5 + 0.31 * L^{0.83}$$

$$S_y = \frac{W}{2} + 0.46 * L^{0.81}$$

C : Concentration (ppm)
q : Volume of exhausted gas (m³/s)
L : Distance from border of road to prediction point (m)
W : Width of road (m)
u : Wind speed (m/s)
H : Height of emission source
S_y, S_z : Width of diffusion in vertical and horizontal direction

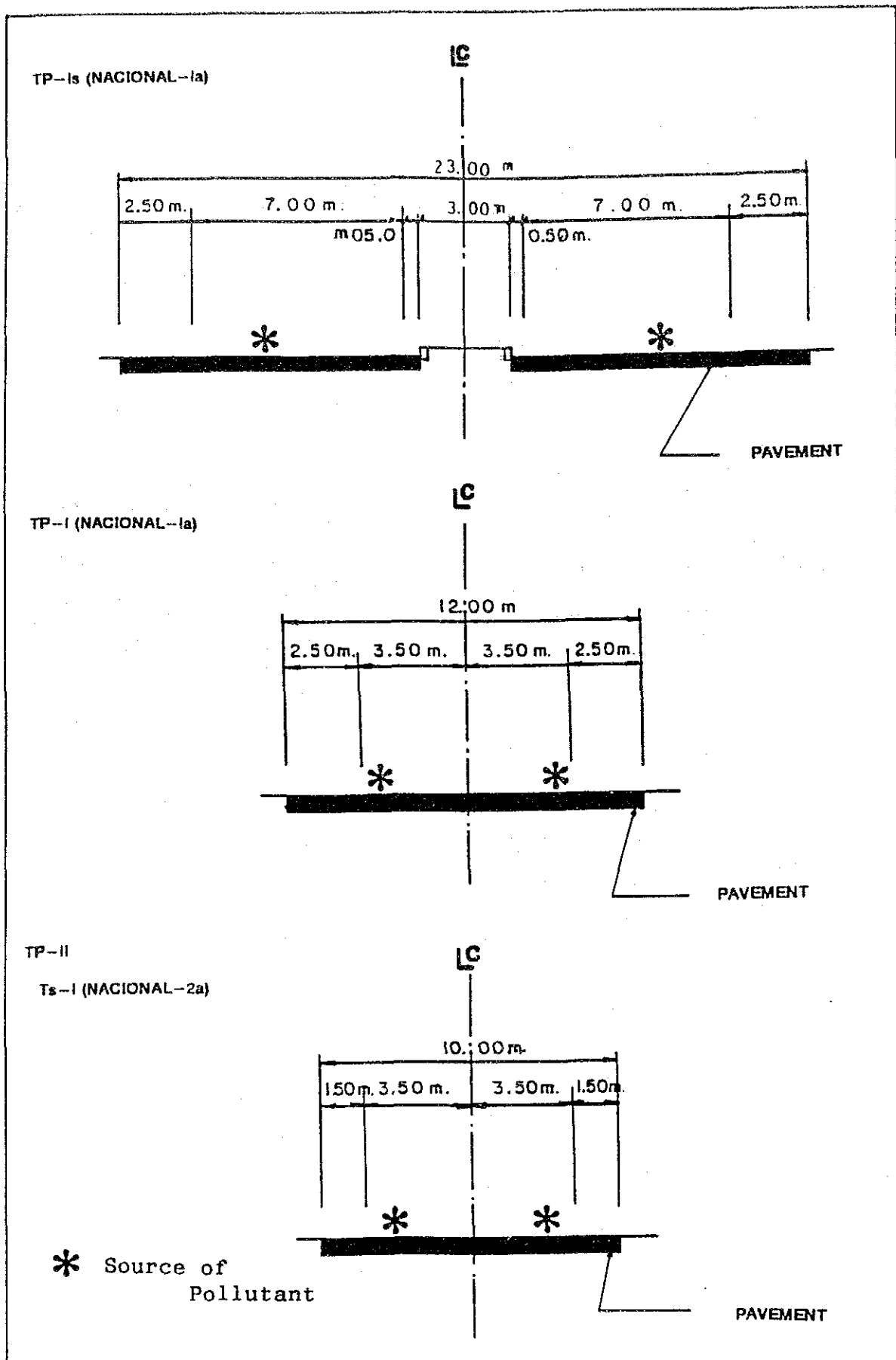


Figure 6-17 Source of Air Pollutant

(3) Results of prediction

The results of simulation concerning NO_x and CO are shown in Figure 6-18 and Table 6-13 (refer to Appendix II.9). The prediction data in 1993 is also presented in order to compare with the year of 2000 and 2010.

The concentrations of NO_x in 1993, 2000 and 2010 range 0.0002 to 0.0127 ppm, 0.003 to 0.0164 ppm and 0.0004 to 0.0255 ppm respectively. The value in Managua shows always maximum, because traffic volume is also maximum. The profiles of predicted concentration of Air quality at Managua in 2000 and 2010 show as a typical example in Figure 6-19. The concentrations of air quality, NO_x and CO will be extremely decreased within 100 m long from the road by diffusion.

The concentrations of CO in 2000 and 2010 year range 0.0003 to 0.0353 ppm. These values are very low.

Table 6-13 River Systems in the Project Area

River system	River	Length (km)	Catchment area (km ²)
Rio Las Enramadas			(87)
	*San Isidro de la Curuz Verde	3.5	42
	*El Mirador	8.5	6
	Rio Las Enramadas	18.5	16
	*Borrio Nuero	6.5	13
Rio Mocuana			(97)
	*Las Ranchitos	3.5	10
	Rio Santa Elena	2	46
	Rio La Mocuana	17	41
Rio Tipitapa	Rio Tipitapa	-	-
Rio La Mula			(38)
	Rio El Caracoleado	1.2	4
	*Monte Alegre	0.5	2
	*San Ildefonso	7	16
	Rio La Mula	3	9
	Rio El Papalote	3.5	7
Rio Agua Agria			(154)
	Rio Agua Agria	10.5	32
	*El Portillo	11	24
	Rio Arroyo	17.5	57
	Rio El Pastor	21	41
Rio Telica			(33)
	**1	1.3	1
	**2	1.8	4
	**3	4.5	12
	**4	1.5	10
	**5	1.2	3
	**6	0.5	3
*Malpaisillo			(84)
	*Malpaisillo	10.5	27
	*San Ildofonso Sur	9	40
	Rio El Jeonoste	10	49
	*El Cacao	4	8
	*San Jacinto	2.5	9
Rio Sinecapa			(891)
	*Santa Teresa	5.5	17
	Rio Meseales	26	230
	*San Juan de Dios	5.5	8
	*El Tague	3	9
	*Primer Leon	4	85
	Rio Las Pilas 1	0.8	4
	2	1.8	4
	3	4	7
	Rio Sinecapa	37.5	478
Rio Tomalapa			(168)
	Rio La Cana	18	45
	Quebrada Honda	7	10
	Rio Santa Rosa	7.5	22
	Rio El Carrizo	15	53
	Rio El Cerro	8.5	14
	Rio Mancaron	3	24

6.3.3 Evaluation of Air Quality

The environmental quality standards for NO_x and CO are 0.05 ppm and 9 ppm respectively as shown in Table 4-1.

Although the predicted concentrations of NO_x in 2000 and 2010 year are not beyond the standard, these values are occurred from automobiles. If background of NO_x will be increased in future by the development of industry, the integrated concentration of NO_x in Managua and will be probably beyond the environmental standard value.

The concentrations of CO will not be so high value. However, it is necessary to monitor the condition of CO together with NO_x in future.

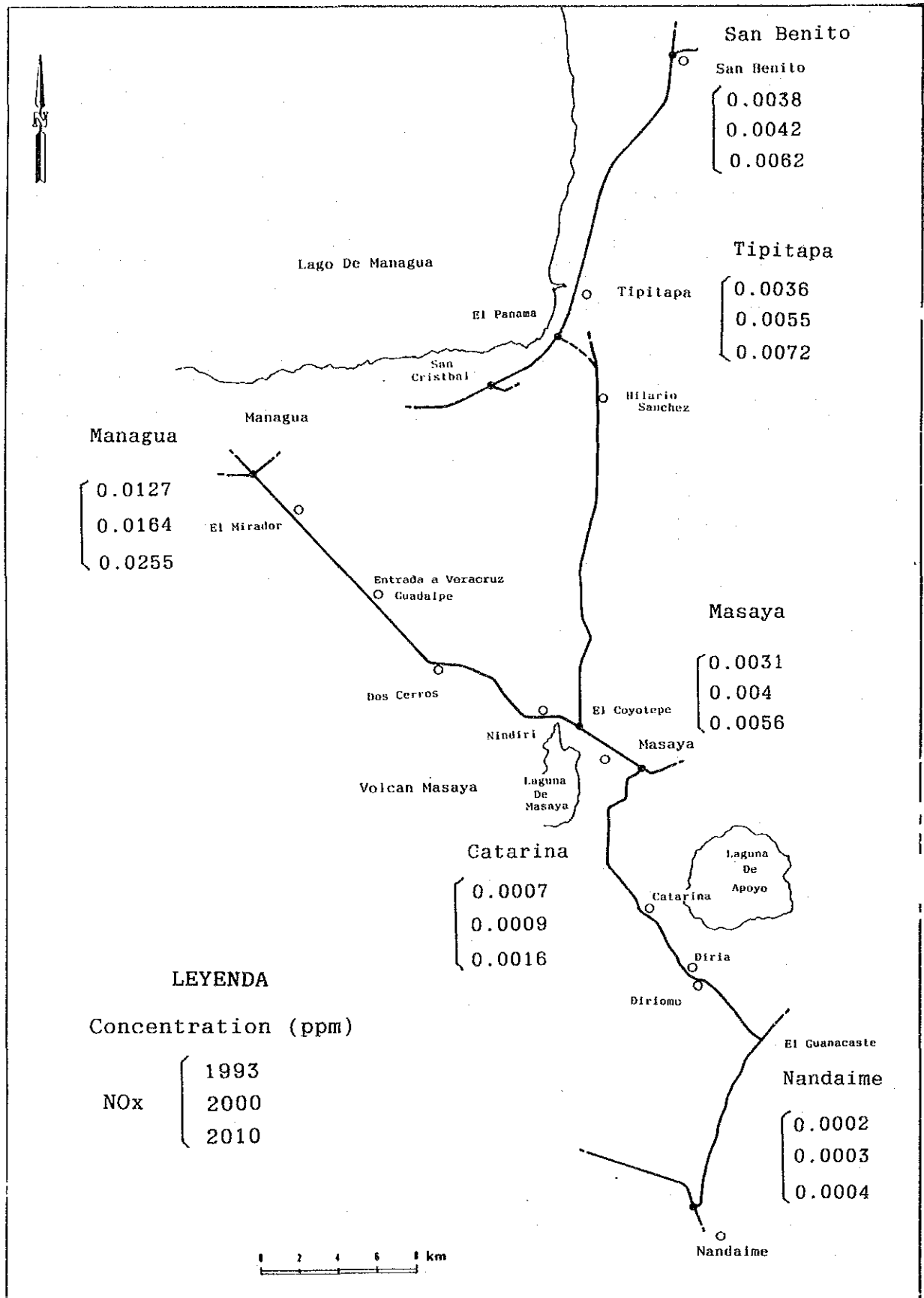


Figure 6-18(1) Predicted Conditions of Air Quality in 2000 and 2010

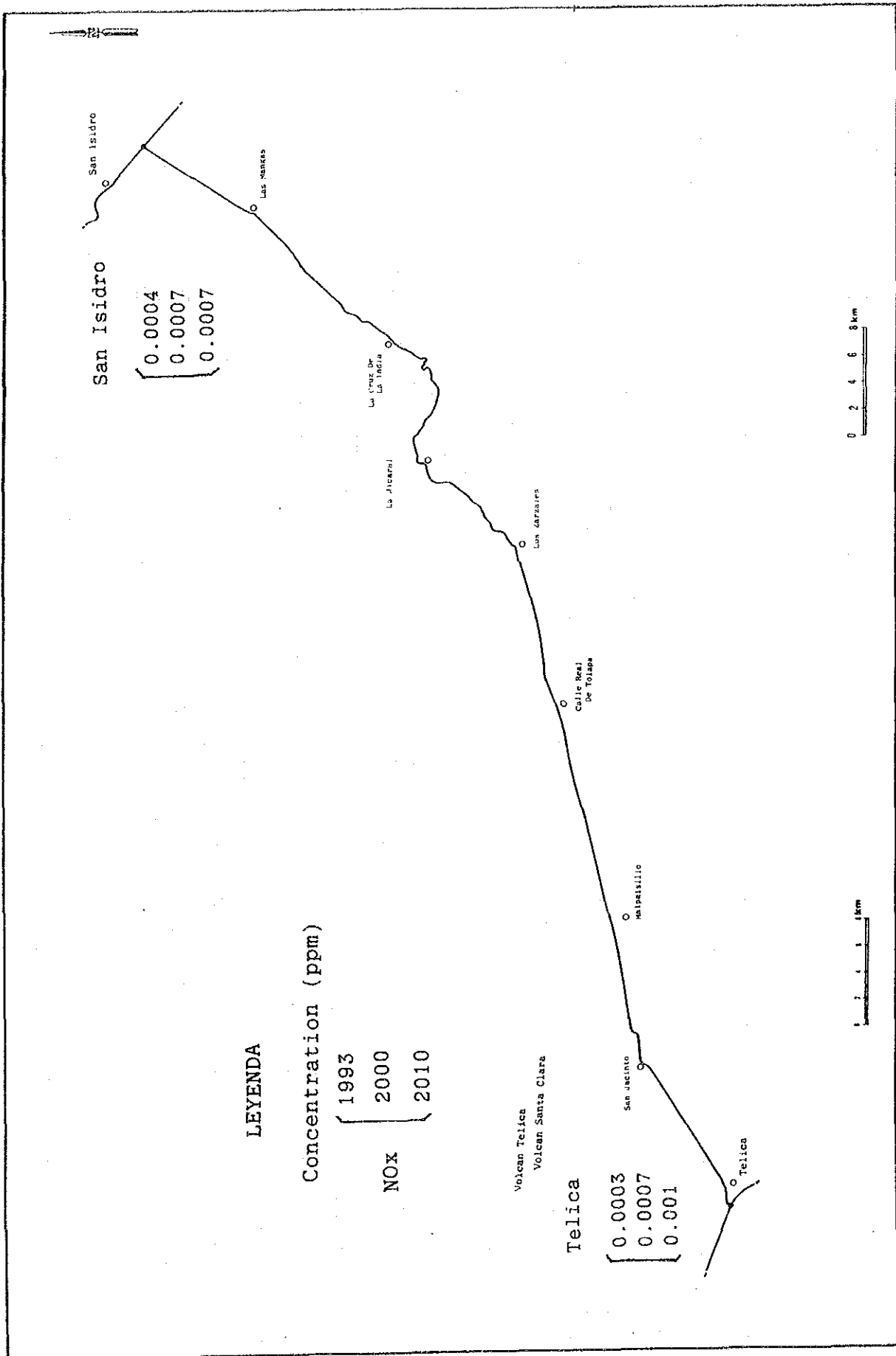


Figure 6-18(2) Predicted Conditions of Air Quality in 2000 and 2010

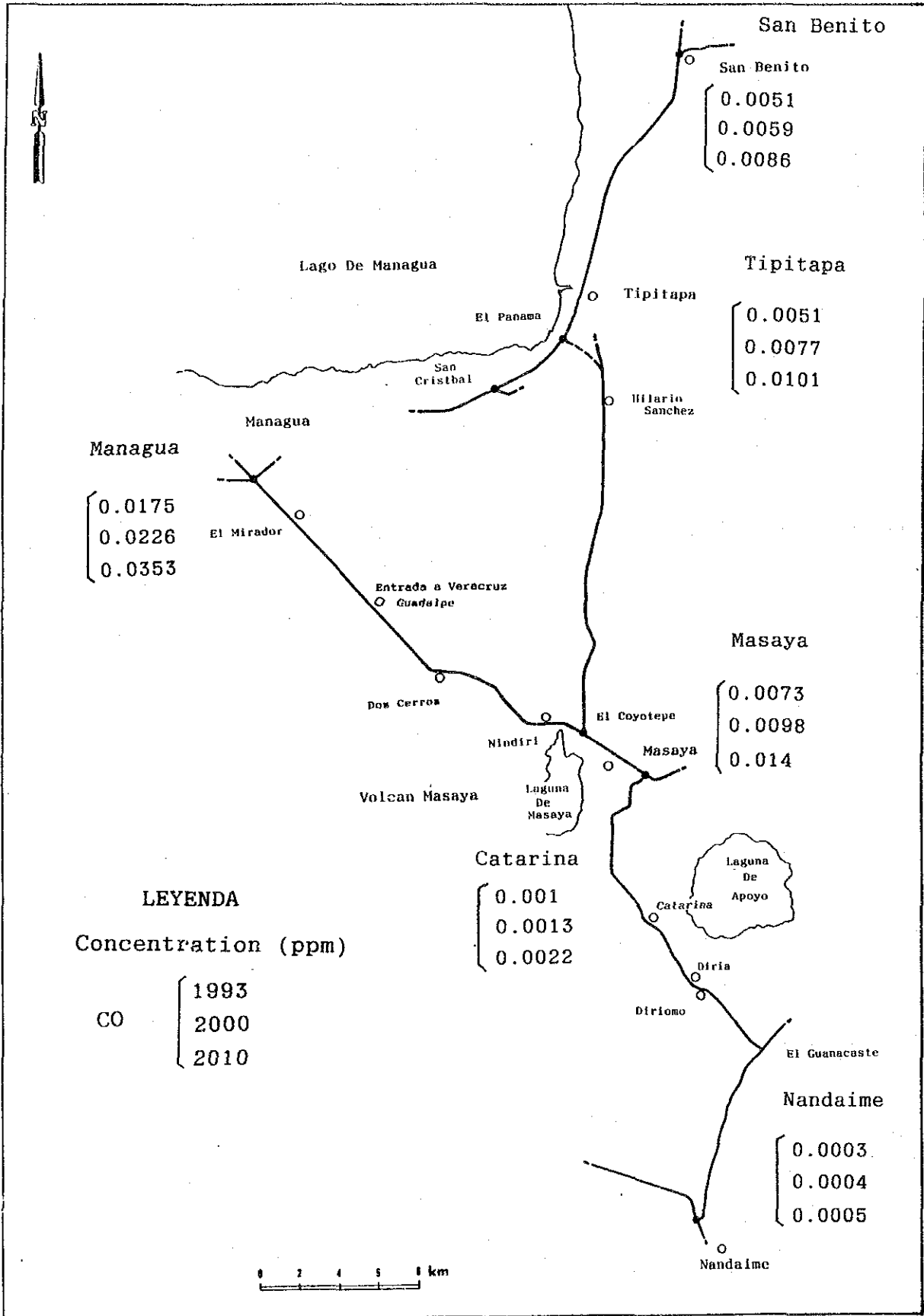


Figure 6-18(3) Predicted Conditions of Air Quality in 2000 and 2010

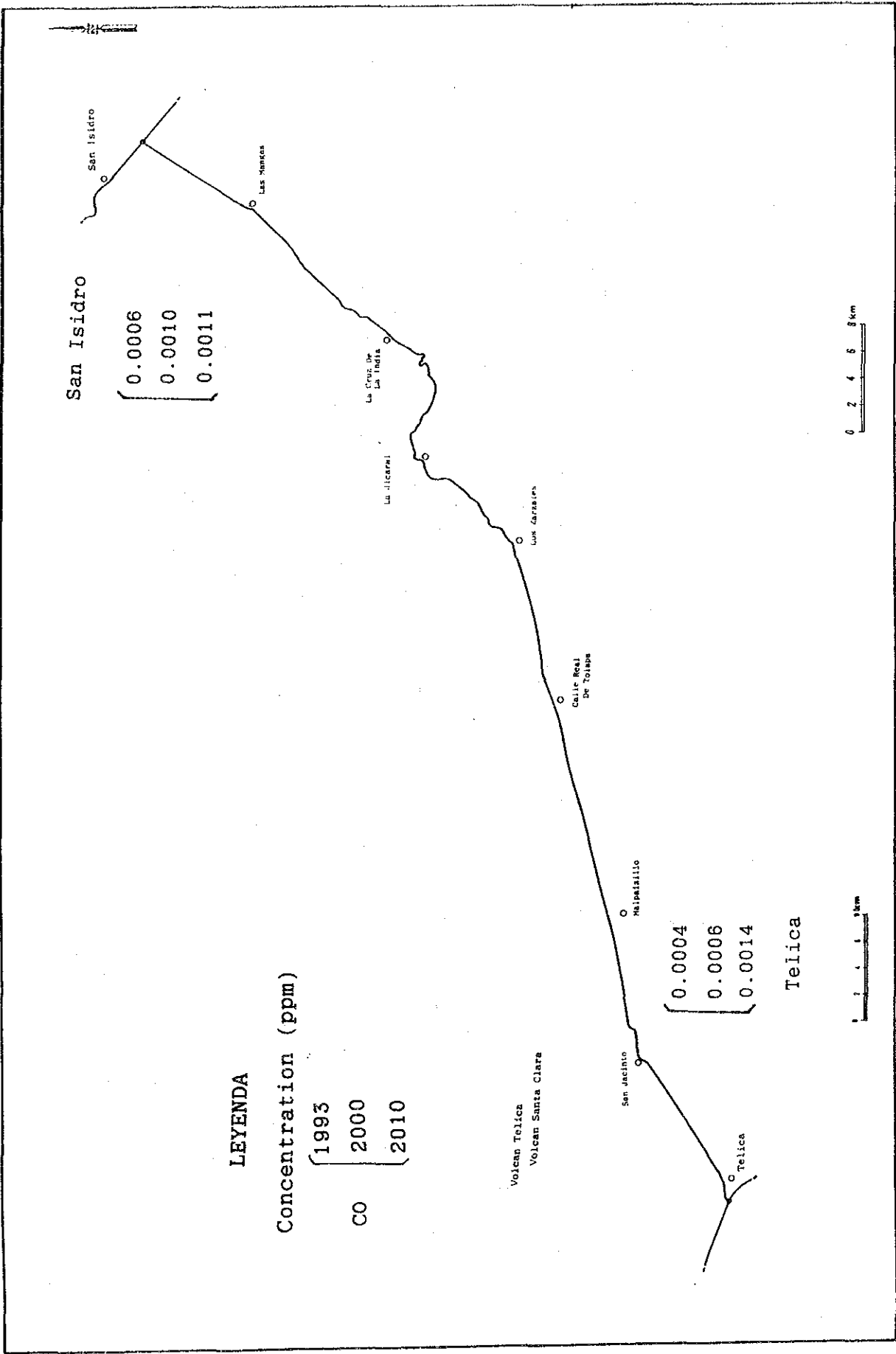


Figure 6-18(4) Predicted Conditions of Air Quality in 2000 and 2010

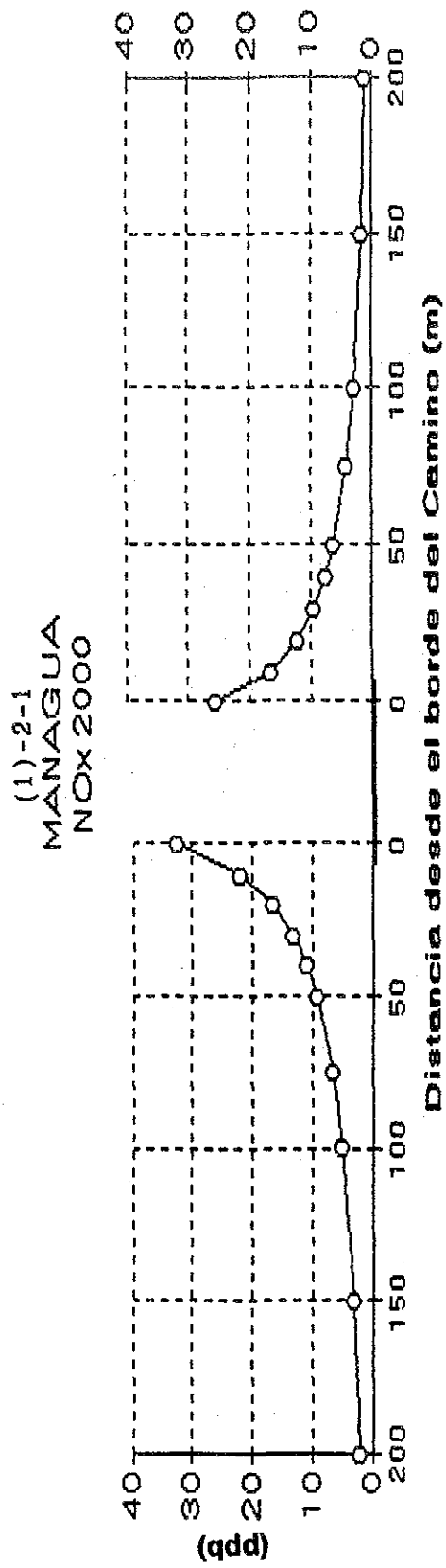


Figure 6-19 (1) Predicted Profiles of Air Quality in 2000 and 2010 at Managua

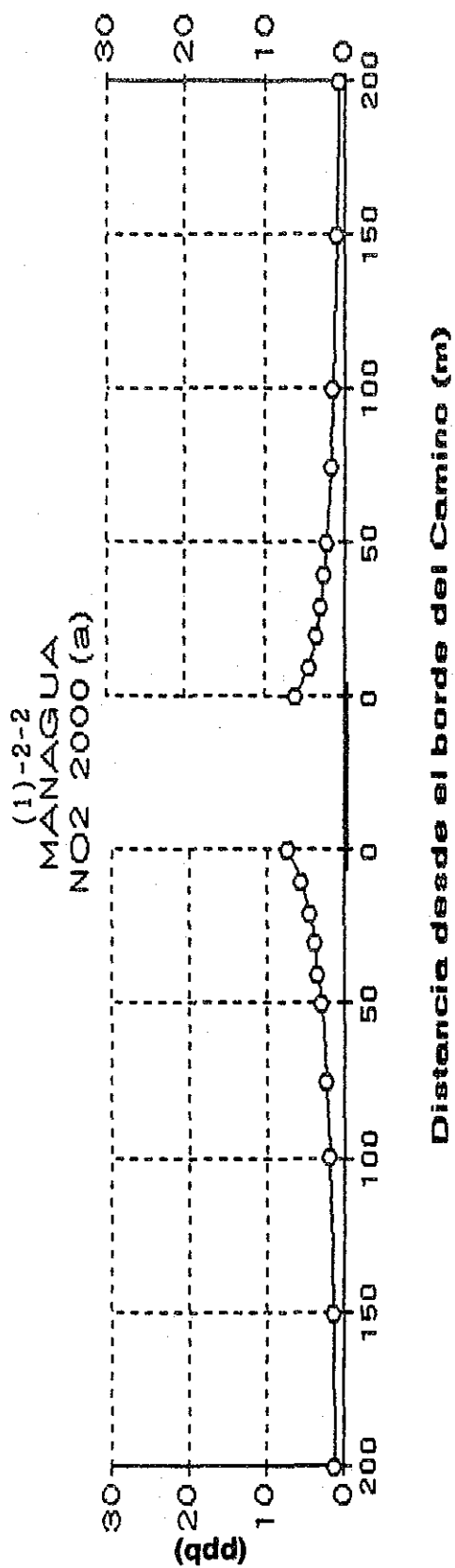


Figure 6-19 (2) Predicted Profiles of Air Quality in 2000 and 2010 at Managua

(1)-2-3
 MANAGUA
 NO2 2000 (b)

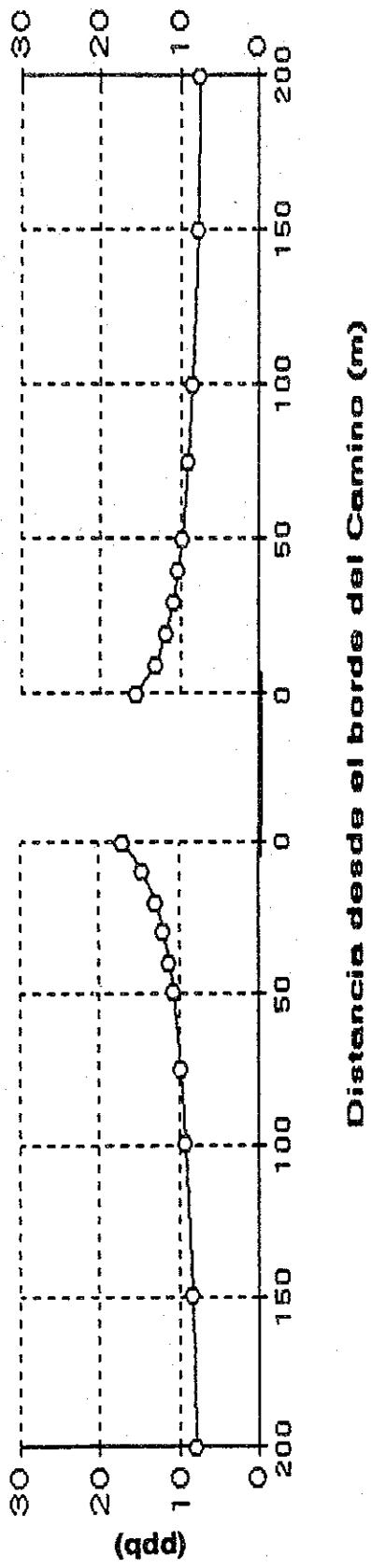


Figure 6-19 (3) Predicted Profiles of Air Quality in 2000 and 2010 at Managua

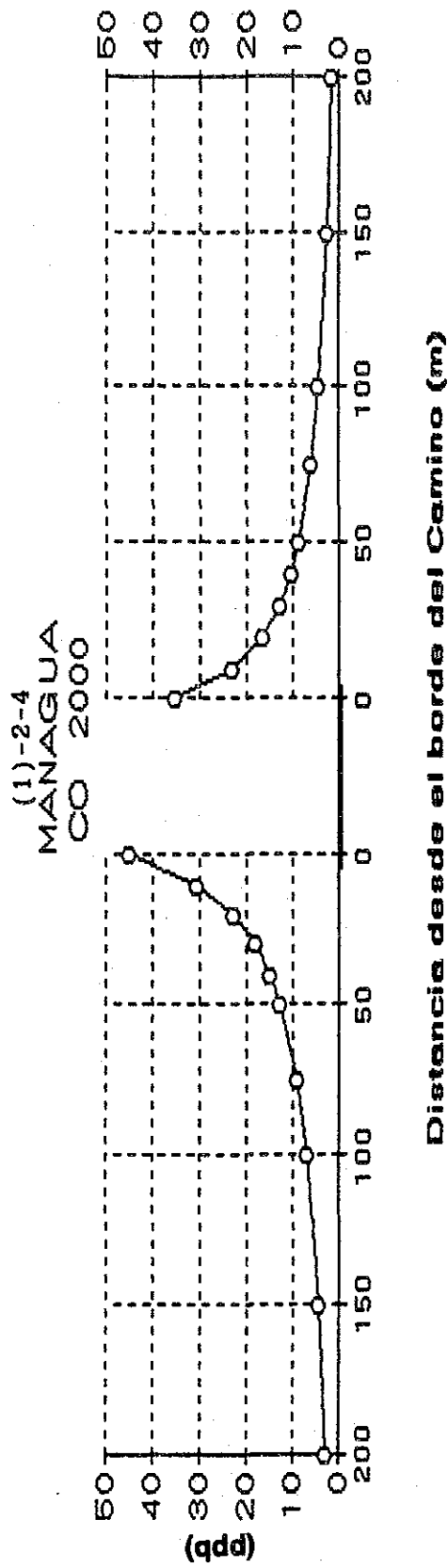


Figure 6-19 (4) Predicted Profiles of Air Quality in 2000 and 2010 at Managua

(1)-3-1
MANAGUA
NOX 2010

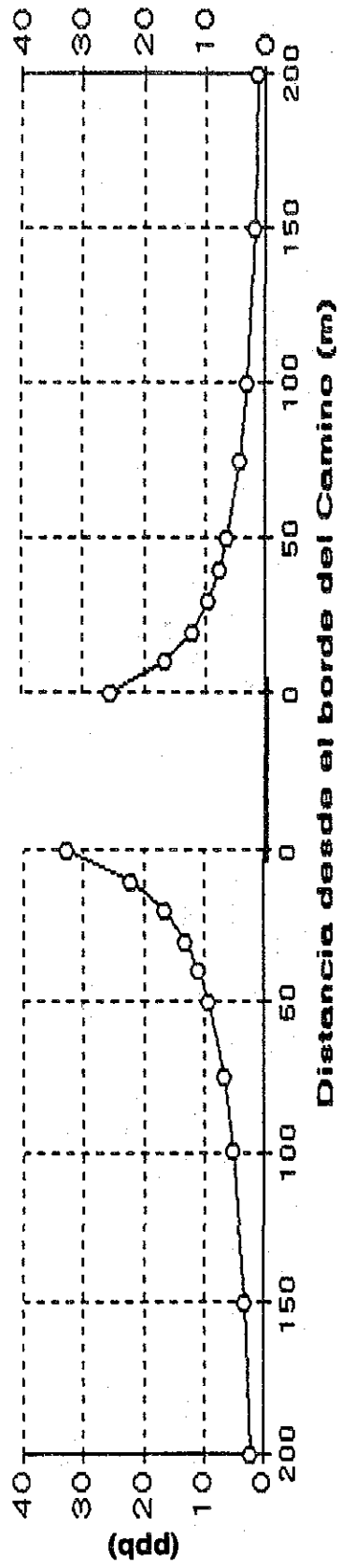


Figure 6-19 (5) Predicted Profiles of Air Quality in 2000 and 2010 at Managua

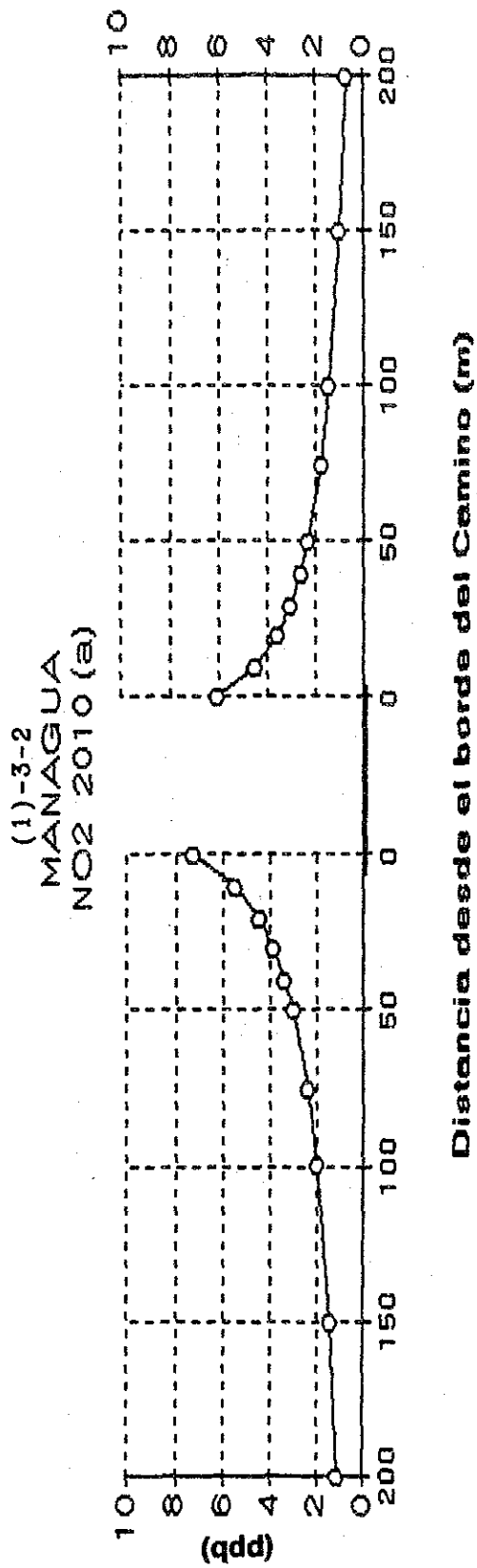
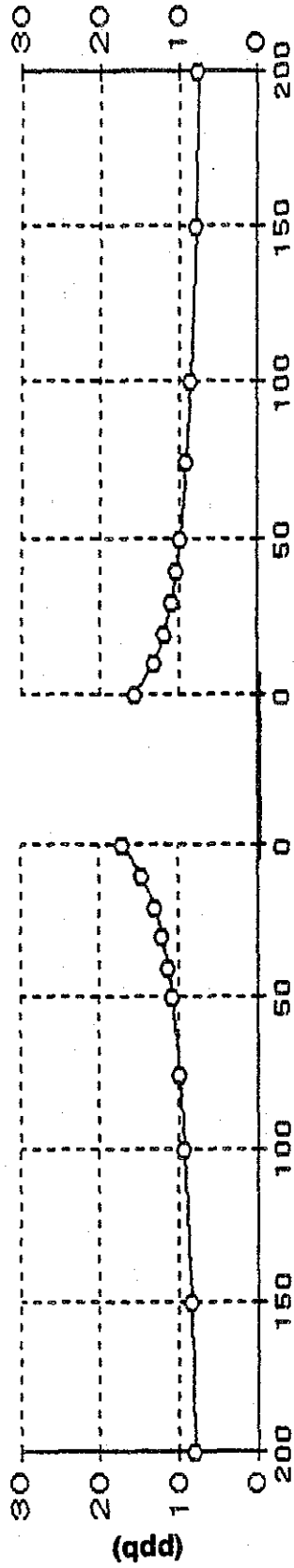


Figure 6-19 (6) Predicted Profiles of Air Quality in 2000 and 2010 at Managua

(1)-3-3
MANAGUA
NO2 2010(b)



Distancia desde el borde del Camino (m)

Figure 6-19 (7) Predicted Profiles of Air Quality in 2000 and 2010 at Managua

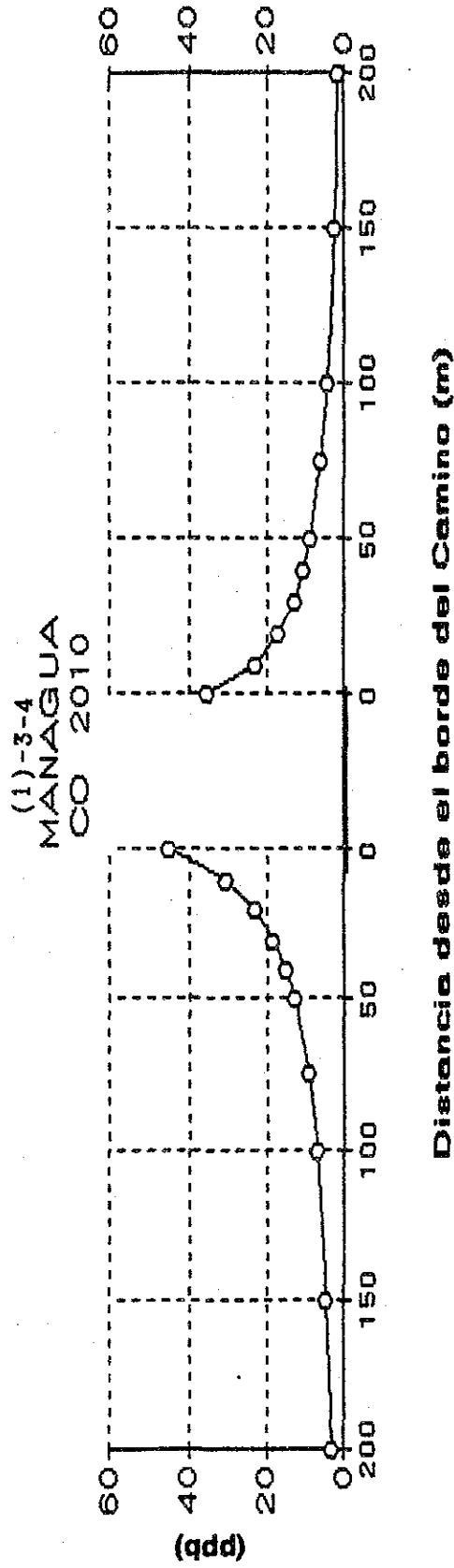


Figure 6-19 (8) Predicted Profiles of Air Quality in 2000 and 2010 at Managua