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JAPAN INTERNATIONAL COOPERATION AGENCY

No. 23

MINISTRY OF CONSTRUCTION AND TRANSPORTATION
THE REPUBLIC OF NICARAGUA

THE ROAD IMPROVEMENT AND REHABILITATION STUDY IN NICARAGUA

FINAL REPORT
VOLUME I
MASTER PLAN

JICA
THE ROAD IMPROVEMENT AND REHABILITATION STUDY IN NICARAGUA
FINAL REPORT
VOLUME I
MASTER PLAN
JULY 1994

JULY 1994

CENTRAL CONSULTANT INC.
NIPPON KOEI CO., LTD.

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PREFACE

In response to a request from the Government of Nicaragua, the Government of Japan decided to conduct The Road Improvement and Rehabilitation Study in Nicaragua, and entrusted the study to the Japan International Cooperation Agency (JICA).

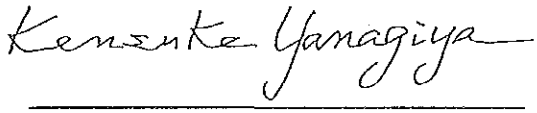
JICA sent to Nicaragua a study team headed by Mr. Takashi Tachikawa of Central Consultant Inc. and composed of members from Central Consultant Inc. and Nippon Koei Co., Ltd., three times between February 1993 and February 1994.

The team held discussions with the officials concerned of the Government of Nicaragua, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of Nicaragua for their close cooperation extended to the Study Team.

July, 1994



Kensuke Yanagiya
President
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

July, 1994

Mr. Kensuke Yanagiya
President
Japan International Cooperation Agency
Tokyo, Japan.

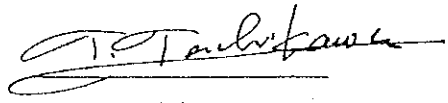
We are pleased to submit to you the final report on the Road Improvement and Rehabilitation Study in Nicaragua.

This study was conducted by the consortium of Central Consultant Inc. and Nippon Koei Co., Ltd., under a contract to JICA, during the period February 1993 to July 1994. In conducting the study, we have examined the various aspects related to the improvement and rehabilitation of the road network in order to formulate the Road Network Master Plan in Nicaragua. Then, we have also examined the feasibility of priority projects, which were selected during the course of the Master Plan Study stage.

We wish to take this opportunity to express our sincere gratitude to the officials concerned of JICA, the Ministry of Foreign Affairs, and Ministry of Construction. We would also like to express our gratitude to the officials concerned of the Ministry of Construction and Transportation and the Embassy of Japan in Nicaragua for their cooperation and assistance throughout our field survey.

Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,



Takashi Tachikawa
Project manager,
Study team on Road Improvement and
Rehabilitation Study in Nicaragua
Central Consultant Inc.

TABLE OF CONTENTS

PREFACE

LETTER OF TRANSMITTAL

CHAPTER 1 INTRODUCTION

1.1 BACKGROUND OF THE STUDY 1- 1
1.2 OBJECTIVES OF THE STUDY 1- 2
1.3 BASIC APPROACH TO THE STUDY 1- 2
1.4 CONTENTS OF THE REPORTS 1- 2
1.5 STUDY ORGANIZATION 1- 4

CHAPTER 2 PRESENT CONDITION OF THE STUDY AREA

2.1 NATIONAL ECONOMIC CONDITIONS 2- 1
2.1.1 Economic Outlook of Nicaragua 2- 1
2.1.2 GDP 2- 1
2.1.3 Central Government Finance 2- 4
2.1.4 Inflation 2- 4
2.1.5 Foreign Public Debt 2- 5
2.1.6 Exports and Imports 2- 6
2.2 NATURAL CONDITIONS 2-11
2.2.1 Topography 2-11
2.2.2 Geology 2-11
2.2.3 Meteorology 2-13
2.3 PRESENT TRANSPORTATION SYSTEM 2-16
2.3.1 Conditions of Transport Subsectors 2-16
2.3.2 Role of the Road Subsector 2-20

CHAPTER 3 ROAD NETWORK EVALUATION

3.1 PRESENT ROAD NETWORK IN NICARAGUA 3- 1
3.1.1 Development of the Road Network 3- 1
3.1.2 Functional Classification of the Road Network 3- 1
3.2 ESTABLISHMENT OF THE OBJECTIVE ROAD NETWORK 3- 4
3.3 EXISTING ROAD NETWORK CONDITIONS 3- 7
3.3.1 General 3- 7
3.3.2 Objective Road Network to Be Evaluated 3- 7
3.3.3 Evaluation of Existing Road Conditions 3- 7
3.3.4 Bridge Investigation 3-25

CHAPTER 4 PRESENT TRAFFIC SITUATION

4.1 EXISTING TRANSPORTATION INFORMATION AND DATA 4- 1
4.1.1 Transportation Survey and Study 4- 1
4.1.2 Existing Traffic Volume on the Major Roads 4- 9
4.2 TRAFFIC SURVEY 4-11
4.2.1 Roadside O-D Survey 4-11
4.2.2 Traffic Volume Counting Survey 4-15
4.2.3 Travel Speed Survey 4-18

4.2.4 Axle Load Survey 4-20
4.3 RESULTS OF THE TRAFFIC SURVEY 4-21
4.3.1 Setting the Traffic Zone 4-21
4.3.2 Data Processing 4-26
4.3.3 Results of Roadside O-D survey 4-27
4.3.4 Traffic Volume Counting Survey 4-32
4.3.5 Vehicle Speed Survey 4-35
4.3.6 Establishment of the Present O-D Table 4-36

CHAPTER 5 GEOLOGICAL CONSIDERATIONS

5.1 GENERAL GEOLOGY 5- 1
5.2 RECENT VOLCANISM 5- 9
5.3 EARTHQUAKES IN NICARAGUA 5-13
5.4 LANDSLIDES AND CREEPS 5-19
5.5 SOFT GROUND 5-21

CHAPTER 6 METEOROLOGICAL AND HYDROLOGICAL CONSIDERATIONS

6.1 METEOROLOGY 6- 1
6.1.1 Meteorological Information 6- 1
6.1.2 Rainfall 6- 1
6.1.3 Temperature 6- 4
6.1.4 Relative Humidity 6- 4
6.1.5 Evaporation 6- 6
6.1.6 Daylight Hours 6- 6
6.1.7 Wind 6- 7
6.2 HYDROLOGY 6- 8
6.2.1 River Systems 6- 8
6.2.2 Flood Inundation Area 6-10
6.3 FLOOD DISASTERS ON ROAD NETWORK 6-12

CHAPTER 7 INITIAL ENVIRONMENTAL EXAMINATION

7.1 GENERAL 7- 1
7.2 OUTLINE OF INITIAL ENVIRONMENTAL EXAMINATION 7- 2
7.2.1 Flow of Initial Environmental Examination 7- 2
7.2.2 Selection of Environmental Items 7- 4
7.2.3 Present Environmental Conditions 7- 6
7.2.4 Environmental Problems 7-21
7.3 INITIAL ENVIRONMENTAL EXAMINATION 7-22
7.3.1 Setting of Environmental Quality Standards 7-22
7.3.2 Initial Environmental Examination 7-24
7.4 CONCLUSIONS AND RECOMMENDATIONS 7-26
7.4.1 Conclusions 7-26
7.4.2 Recommendations 7-27

CHAPTER 8 SOCIO-ECONOMIC CONSIDERATIONS

8.1 PRESENT SOCIO-ECONOMIC CONDITIONS 8- 1
8.1.1 Area 8- 1
8.1.2 Present Land Use 8- 3
8.1.3 Population 8- 4

8.1.4 Employment 8- 7
8.1.5 Number of Registered Vehicles 8- 9
8.1.6 Agriculture 8-10
8.1.7 Livestock 8-12
8.2 DEVELOPMENT PLAN 8-16
8.2.1 Medium-Term Development Strategy 1992-1996 (1992, Government of Nicaragua) 8-16
8.2.2 Strategic Guidelines for Territorial Arrangement (1992:INETER) 8-18
8.2.3 Agriculture, Forestry and Agroindustrial Strategy in Nicaragua 1992-1996 8-19
8.2.4 Forestry Action Plan Nicaragua (1992, PAF-NIC) 8-21
8.2.5 Summary of the Five-Year Plan for 1991-1995 and Other Years 8-23
8.3 FUTURE SOCIO-ECONOMIC FRAMEWORK 8-26
8.3.1 GDP 8-26
8.3.2 Future Population 8-27
8.3.3 Vehicles Registered 8-29
8.3.4 Increase in Agricultural Production through Redevelopment 8-30

CHAPTER 9 PROJECTION OF FUTURE TRAFFIC DEMAND

9.1 PROJECTION METHOD 9- 1
9.1.1 Estimation of Past O-D Tables 9- 2
9.1.2 Future Total Trip Production 9- 3
9.1.3 Future Zonal Trip Generation and Attraction 9- 4
9.1.4 Traffic Increment Through Increasing Agricultural Production Resulting from Redevelopment Policy of the Government 9- 6
9.1.5 Future O-D Table Forecast 9- 6
9.2 FUTURE TRAFFIC ASSIGNMENT 9-12

CHAPTER 10 ROAD NETWORK IMPROVEMENT PLAN

10.1 GENERAL 10- 1
10.2 ROAD NETWORK STRATEGIES 10- 2
10.2.1 Purpose and Planning Issues 10- 2
10.2.2 Process of the Master Plan Formulation 10- 2
10.2.3 Elements of Road Functions 10- 4
10.2.4 Strategies for Formulation of Master Plan 10- 9
10.2.5 Determination of Road Improvement Level 10-16
10.3 ROAD NETWORK EVALUATION 10-21
10.4 COST ESTIMATION 10-23
10.5 ECONOMIC EVALUATION OF THE IMPROVEMENT PLAN 10-24
10.5.1 Evaluation Method 10-24
10.5.2 Project Costs 10-24
10.5.3 Economic Benefit 10-25
10.5.4 Economic Evaluation Results 10-28
10.6 PRIORITY EVALUATION OF THE FUTURE ROAD NETWORK 10-29
10.6.1 Priority Analysis Weighting 10-29
10.6.2 Priority Analysis Weighting 10-30
10.7 FORMULATION OF THE MASTER PLAN 10-38
10.8 SELECTION OF PROJECTS FOR THE FEASIBILITY STUDY 10-39
10.9 EXISTING BRIDGES ON THE ROADS 10-42

LIST OF TABLES

Table 1-1 Contents of the Reports 1- 2

Table 2-1 GDP 2- 2
Table 2-2 Real GDP Growth Rates 2- 2
Table 2-3 GDP (Production) 2- 3
Table 2-4 GDP (Expenditure) 2- 4
Table 2-5 Composition of Central Government Finance 2- 4
Table 2-6 Inflation Rates 2- 5
Table 2-7 Central America Disbursed Foreign Public Debt Balances 2- 6
Table 2-8 Import and Export Countries 2- 7
Table 2-9 Main Import Goods (1988-1993) 2- 8
Table 2-10 Main Export Products (1977-1983) 2- 9
Table 2-11 Existing Roads by Surface Type in Each Region (1992) 2-16
Table 2-12 Railway Network in 1993 2-17
Table 2-13 Past Trend of Railway Transport 2-17
Table 2-14 Existing Airports in Nicaragua 2-18
Table 2-15 Transition of Air Transport 2-18
Table 2-16 Transition of Loading/Unloading at Seaports 2-19

Table 3-1 Development of the Road Network 3- 1
Table 3-2 Road Density by Region (1992) 3- 2
Table 3-3 Present Road Length by Region and Functional Classification (1988) 3- 3
Table 3-4 Objective Road Network 3- 5
Table 3.5 Evaluation Ranks and Definitions 3-13
Table 3-6 Ranks for Evaluating Pavement Structure Conditions 3-14
Table 3-7 Drainage Condition Evaluation Ranks 3-14
Table 3-8 Cross-Sectional Evaluation Ranks 3-15
Table 3-9 Existing Road Network Conditions 3-17
Table 3-10 Summary of Existing Bridges 3-26

Table 4-1 Traffic Volume Projection By MCT 4- 4
Table 4-2 Passenger Forecasts (1990 - 2000) 4- 6
Table 4-3 Goods Forecasts (1990 - 2000) 4- 6
Table 4-4 Traffic Volume in 1982 and 1989 ..... 4- 9
Table 4-5 List of O-D Survey Stations 4-12
Table 4-6 List of Travel Speed Survey Routes 4-18
Table 4-7 Location of Weighing Stations 4-20
Table 4-8 Zone Code 4-22
Table 4-9 Summary of O-D Survey 4-28
Table 4-10 Direction by Vehicle Type 4-28
Table 4-11 Direction by Purpose 4-29
Table 4-12 Vehicle Type by Purpose 4-29
Table 4-13 Survey Time by Vehicle Type 4-31
Table 4-14 Survey Time by Purpose 4-32
Table 4-15 Comparison of Traffic Volume 4-33
Table 4-16 Vehicle Speed Survey Results 4-35
Table 4-17 Sample Rates and Day/Night Ratios 4-38
Table 4-18 Composition of Vehicular Trips 4-40

Table 4-19 Trip Generation and Attraction by Zone 4-42
Table 4-20 Present O-D Table 4-43

Table 5-1 Summary of Main Eruptions of Active Volcanoes in Nicaragua 5-12

Table 6-1 Monthly and Annual Rainfall 6- 1
Table 6-2 Mean Monthly and Annual Temperature 6- 4
Table 6-3 Mean Monthly and Annual Relative Humidity 6- 6
Table 6-4 Monthly and Annual Evaporation 6- 6
Table 6-5 Monthly and Annual Daylight Hours 6- 7
Table 6-6 Mean Monthly and Annual Wind Velocity 6- 7
Table 6-7 River Systems 6- 8
Table 6-8 Damage by Hurricane "Joan" in October 1988 6-12

Table 7-1 Selection of Environmental Items 7- 5
Table 7-2 Fauna and Flora Registered as Endangered Species 7-10
Table 7-3 Educational System from 1987 to 1991 7-13
Table 7-4 Hospitals and the Number of Beds 7-14
Table 7-5 Hospitals and Beds by Region in 1991 7-14
Table 7-6 Monthly Density of Pollutants 7-15
Table 7-7 Air Quality Standards 7-17
Table 7-8 Present Condition of Managua Lake (1988-89) 7-18
Table 7-9 Records of Major Earthquakes and Volcanic Eruptions in Nicaragua (1520 - 1973) 7-19
Table 7-10 Environmental Problems 7-21
Table 7-11 Air Quality Standards 7-22
Table 7-12 Water Quality Standards 7-23
Table 7-13 Noise Standards 7-23
Table 7-14 Vibration Standards 7-23
Table 7-15 Soil Contamination Standards 7-24
Table 7-16 Tentatively Selected Roads for the Feasibility Study 7-24
Table 7-17 Environmental Evaluation 7-25
Table 7-18 Environmental Investigation 7-27

Table 8-1 Area by Region and Department 8- 1
Table 8-2 Area by Zone 8- 3
Table 8-3 Present Land Use by Classification 8- 3
Table 8-4 Population by Year 8- 4
Table 8-5 Population by Region (1993) 8- 5
Table 8-6 Population by Department 8- 6
Table 8-7 Population by Zone 8- 7
Table 8-8 Population by Age Group 8- 8
Table 8-9 Number of Insurance-Paying Individuals 8- 9
Table 8-10 Number of Vehicles Registered 8- 9
Table 8-11 Value of Agricultural Production 8-11
Table 8-12 Cultivated Area, Productivity, and Production Volume of Main Crops 8-11
Table 8-13 Beef Consumption 8-12
Table 8-14 Development Strategy by Development Zone 8-18
Table 8-15 Crop Production Projections 8-21
Table 8-16 Future Livestock Production 8-21
Table 8-17 Objectives of the Five-Year Plan by MCT 8-24
Table 8-18 Paved Roads Plans 8-24

Table 8-19 Investment Program for 1992 8-24
Table 8-20 Road Projects in Nicaragua (1993) 8-25
Table 8-21 GDP Growth Rate in Central American Countries 8-26
Table 8-22 Population Estimation 1995-2025 by Zone 8-28
Table 8-23 Model and Parameters for Vehicles Registered 8-30
Table 8-24 The Number of Vehicles Registered in 2000 and 2010 8-30
Table 8-25 Projections for Agricultural Products 8-31
Table 8-26 Agricultural Production by Zone 8-31
Table 8-27 Trip Expansion Rate Resulting from Redevelopment and Natural Growth of Agricultural Production 8-33

Table 9-1 Past Traffic Volume Trends 9- 2
Table 9-2 Past Trip Production 9- 3
Table 9-3 Parameter Values for the Trip Production Model 9- 3
Table 9-4 Future Trip Production by Vehicle Type 9- 4
Table 9-5 Values of Parameters of Generation and Attraction Models 9- 5
Table 9-6 Future Trip Generation and Attraction by Zone 9- 5
Table 9-7 Vehicle Volume Increase Resulting from Agricultural Redevelopment 9- 7
Table 9-8 Future O-D Table in 2000 ..... 9- 9
Table 9-9 Future O-D Table in 2010 9-10
Table 9-10 Average Speed and Congestion Rate by Subnetwork 9-14
Table 9-11 Total Vehicle Hours by Case 9-14
Table 9-12 Saving Vehicle Hours by Case 9-15

Table 10-1 Principal Municipalities in Nicaragua 10- 5
Table 10-2 Desired Road Classification 10-11
Table 10-3 Standard Design Traffic Volume 10-11
Table 10-4 Elements of Road Functions 10-12
Table 10-5 Ranking of Service Conditions 10-16
Table 10-6 List of Sub-networks 10-21
Table 10-7 Cost Estimation of Projects by Sub-Network 10-23
Table 10-8 Summary of Project Cost by Sub-network 10-25
Table 10-9 Average Vehicle Running Speed 10-25
Table 10-10 Saving of Vehicle Operation Costs 10-26
Table 10-11 Saving of Travel Time 10-27
Table 10-12 Average Number of Passengers per Vehicle and Trips Related to Economic Activities 10-27
Table 10-13 Saving of Travel Time Cost 10-27
Table 10-14 Summary of IRR, NPV and B/C 10-28
Table 10-15 Weights of the Sub-networks 10-29
Table 10-16 Weights for Road Classification 10-30
Table 10-17 Classification of Priority Levels 10-31
Table 10-18 Priority Value of the Road Network 10-32
Table 10-19 Priority Level 10-35
Table 10-20 Total Cost of the Road Improvement Master Plan 10-38
Table 10-21 Projects Selected for the Feasibility Study 10-39
Table 10-22 Process of Selecting Road Sections for the Feasibility Study 10-40
Table 10-23 Road Sections Selected for the Feasibility Study 10-40
Table 10-24 Bridges Requiring Urgent Repair or Reconstruction 10-42

LIST OF FIGURES

Figure 1-1 Work Flowchart of the Study 1- 3
Figure 1-2 Organization Chart for the Study 1- 4

Figure 2-1 Real GDP Growth Rate 2- 2
Figure 2-2 Annual Inflation Rate 2- 5
Figure 2-3 Foreign Public Debt 2- 6
Figure 2-4 Composition of Import and Export Countries 2- 7
Figure 2-5 Composition of Import Goods 2- 8
Figure 2-6 Main Export Products (1992 and 1993) 2-10
Figure 2-7 Hypsographic Map of Nicaragua 2-12
Figure 2-8 Weather Classification in Nicaragua 2-15

Figure 3-1 Objective Road Network 3- 6
Figure 3-2 Process of Evaluating Existing Road Conditions 3- 8
Figure 3-3 Existing Road Network Charts 3- 9

Figure 4-1 Traffic Volume on Major Roads 4-10
Figure 4-2 Location of Survey Stations 4-13
Figure 4-3 O-D Survey Sheet 4-14
Figure 4-4 Type of Vehicle 4-16
Figure 4-5 Survey Sheet for the Traffic Volume Counting Survey 4-17
Figure 4-6 Travel Speed Survey Route 4-19
Figure 4-7 Zone Map 4-25
Figure 4-8 Survey Time and Direction 4-30
Figure 4-9 Traffic Volume Counting Survey Results 4-34
Figure 4-10 Procedures Used to Create the Present O-D Table 4-36
Figure 4-11 Traffic Volume on the Screen Line 4-39
Figure 4-12 Desired Line 1993 4-41

Figure 5-1 Nicaraguan Structures, Soil and Landforms 5- 2
Figure 5-2 General Tectonic Structure Map of Nicaragua 5- 3
Figure 5-3 Preliminary Stratigraphic Correlaton within the Traverse 5- 4
Figure 5-4 Simplified Geological Map of Nicaragua 5- 7
Figure 5-5 Geological Section Across Nicaragua 5- 8
Figure 5-6 Volcanic Segments of Central America 5-10
Figure 5-7 Summary Map of the Plates of the Lithosphere in Central America 5-11
Figure 5-8 Generalized Geological Map of the Managua Area Showing Faults Related to the 1931 and 1972 Earthquake 5-14
Figure 5-9 Nicaraguan Epicenter, 1570 - 1973 5-16
Figure 5-10 Records of the Maximum Height of the 1992 Tsunami in Nicaragua 5-17
Figure 5-11 Distribution of Epicenters Offshore Nicaragua 5-18
Figure 5-12 Distribution Map of Landslides in Nicaragua 5-20

Figure 6-1 Locations of Meteorological Stations 6- 2
Figure 6-2 Annual Rainfall 6- 3
Figure 6-3 Annual Mean Temperature 6- 5
Figure 6-4 River Systems 6- 9
Figure 6-5 Historical Flood Inundation Areas 6-11

Figure 7-1 Flow of Environmental Considerations of the Project 7- 2
Figure 7-2 Flow of Initial Environmental Examination 7- 3
Figure 7-3 Vegetation Map of Nicaragua 7- 7
Figure 7-4 Deforestation from 1940 to 1992 ..... 7- 8
Figure 7-5 Natural Conservation Areas in Nicaragua 7-11
Figure 7-6 Map of National Parks and National Monuments in Nicaragua 7-12
Figure 7-7 Survey Points of Air Quality 7-16
Figure 7-8 Distribution of Landslides 7-20

Figure 8-1 Municipality Boundaries 8- 2
Figure 8-2 Population by Sex and by Age 8- 5
Figure 8-3 Number of Registered Vehicles 8-10
Figure 8-4 Production of Main Crops 8-12
Figure 8-5 Production of Main Crops by Region 8-13
Figure 8-6 Beef Consumption 8-14
Figure 8-7 Export and Domestic Consumption of Beef by Region 8-15
Figure 8-8 Population Estimates by Region 8-29

Figure 9-1 Future Traffic Demand Projection Procedures 9- 1
Figure 9-2 Desired Line in 2010 9-11
Figure 9-3 Q-V Formula 9-12
Figure 9-4 Future Traffic Volume on the Road Network 9-13

Figure 10-1 Formulation Process of the Road Network Master Plan 10- 3
Figure 10-2 Hierarchical Road Structure 10- 6
Figure 10-3 Movement of Main Export Goods 10- 7
Figure 10-4 Movement of Main Import Goods 10- 8
Figure 10-5 Principal Road Network Based on Road Function 10-10
Figure 10-6 Proposed Typical Cross Section 10-13
Figure 10-7 Future Road Network Charts - Improvement Levels 10-17
Figure 10-8 Sub-network Map 10-22
Figure 10-9 Road Sections by Priority Level 10-37
Figure 10-10 Road Sections Selected for the Feasibility Study 10-41

LIST OF ABBREVIATIONS

AASHTO	: The American Association of State Highway Officials
ADT	: Average Daily Traffic
Afi	: Tropical Forest
Am	: Tropical Monsoon
AMSL	: Above Mean Sea Level
Aw	: Tropical Savannah
AwH	: Tropical Savannah in highland
B/C	: Benefit Cost Ratio
C12	: Chroline
CA	: Central American Highway
CABEI	: Central American Bank for Economic Integration
CBR	: California Bearing Ratio
COMECON	:Council for Mutual Economic Assistance
C.P.	: Collect Road
C.V.	: Community Road
DANIDA	: Danish International Development Agency
dB	:Decibel(s)
DF/R	: Draft Final Report
EIA	: Environmental Impact Assessment
ESDENIC 78	: The Demographic Survey of Nicaragua in 1978
F/S	: Feasibility Study
GDP	: Gross Domestic Products
HS	: HS loadings
IDB	: Inter-American Development Bank
IEE	: Initial Environmental Examination
IMF	: International Monetary Fund
INETEL	: Institute of Territorial Study of Nicaragua
Ing.	: Engineer
INMINE	: Mine Corporation of Nicaragua
INSSBI	: Nicaraguan Institute for Social Security and Welfare
IRENA	: Institute of Natural Resources
IRR	: Internal Rate of Return
IT/R	: Interim Report
JICA	: Japan Internatinal Cooperation Agency
Lic.	: Bachelor of Arts
MAG	: Ministry of Agricalture and Livestock
MCT	: Ministry of Construcyion and Transport
MED	: Ministry of Economy and Development
MINSA	: Ministry of Health
MZ	: Manzanas
M/P	: Master Plan
ND	: Rural Road
NIC	: National Road
NPV	: Net Present Value
N.R.	: National Road
O-D	: Origin and Destination
PAF-NIC	: Forest Action Plan of Nicaragua
PCU	: Passenger Car Unit

PR/R	: Progress Report
QQ	: *Quintales (about 50kg)*
QV	: Quantity-Velocity
RAAN	: North Atlantic Autonomous Region
RAAS	: South Atlantic Autonomous Region
SO2	: Sulfur Dioxide
SS	: Suspended Solid
T.P.	: Primary Trunk Road
T.S.	: Secondary Trunk Road
U.S.A.	: United States of America
VOC	: Vehicle Operating Cost

CHAPTER 1

INTRODUCTION

CHAPTER 1 INTRODUCTION

1.1 BACKGROUND OF THE STUDY

The economy in Nicaragua has been deteriorating since the late 1970's due to a series of natural disasters, national crises, and wars, such as the Managua earthquake and oil crisis of 1972, the revolutionary war conducted by the Sandinistas starting in 1978, the civil war which started in 1981, the economic sanctions leveled by the government of the United States in 1985, and the major hurricane, which struck the area in 1988.

The existing Chamorro government, established by a general election in 1990, has pledged to dedicate itself to reconstructing the Nicaraguan economy. As part of its efforts, the government has emphasized the improvement of the nation's road network for the purpose of stimulating economic development. The government considers the following three policies on road network improvement to be regarded as essential.

- To promote the improvement of the primary road network in line with the development of the Central American Highway network as outlined in the Central America Economic Integration Program.

- To improve the secondary road network to provide accessibility to agricultural and industrial areas.

- To improve and/or construct access roads between the east and west coasts.

Given the existing situation, the Government of the Republic of Nicaragua has requested technical assistance from the Government of Japan to realize an improvement of the nation's road network. In response to this request, the Government of Japan decided to organize a study team (hereinafter referred to as "the JICA Study Team") to conduct this Road Improvement and Rehabilitation Study in Nicaragua (hereinafter referred to as "the Study").

1.2 OBJECTIVES OF THE STUDY

Given the above, the Study shall be carried out by focusing the following objectives;

- To formulate a Master Plan to improve the primary and secondary road network throughout Nicaragua (approx. 3,000 km).
- To prioritize projects in the Master Plan and carry out a Feasibility Study on the selected projects (approx. 200 km).
- To transfer technology to the Nicaragua counterpart personnel in the course of the Study.

1.3 BASIC APPROACH TO THE STUDY

The Study included the Master Plan in the first phase and a Feasibility Study in the second phase. In order to realize the above objectives, the Study was carried out according to the work flowchart illustrated in Figure 1-1.

1.4 CONTENTS OF THE REPORTS

The reports, which are the main result of the Study, were composed as shown in Table 1-1.

Table 1-1 Contents of the Reports

Phase	Reports	Output	Date of Submission
First Phase	Inception Report	Study Contents and Schedule	Beginning of March, 1993
	Progress Report I	Part of the Results of the Master Plan	End of May, 1993
	Interim Report	Results of the Master Plan	End of August, 1993
Second Phase	Progress Report II	Part of the Results of the Feasibility Study	End of November, 1993
	Draft Final Report	Results of the Whole Study	End of February, 1994
	Final Report	Revision of the Draft Final Report in Accordance with the Comments of the Nicaraguan Government	End of July, 1994

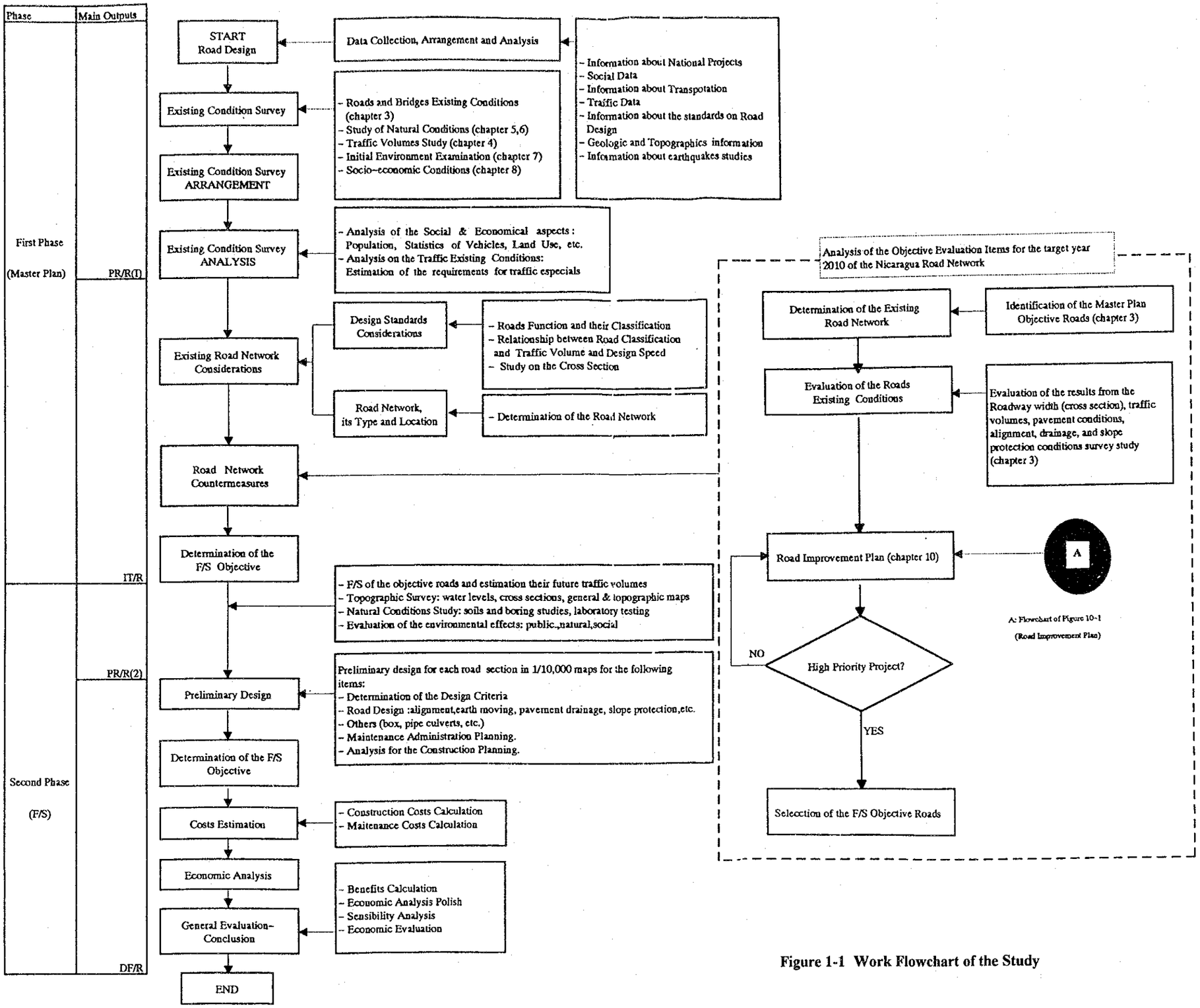


Figure 1-1 Work Flowchart of the Study

1.5 STUDY ORGANIZATION

The organization chart is shown in Figure 1-2.

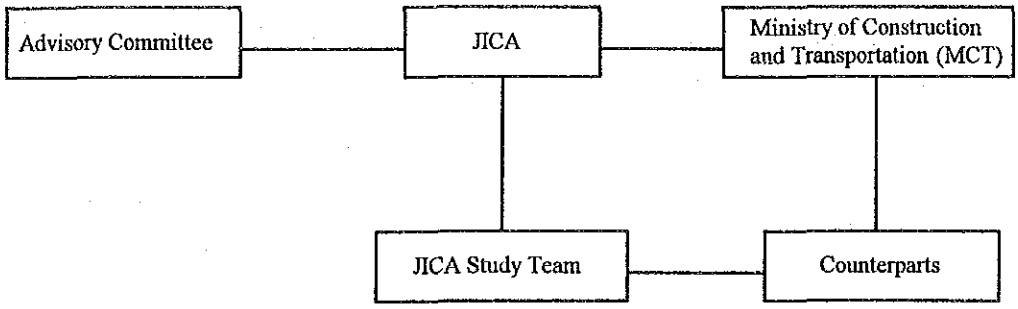


Figure 1-2 Organization Chart for the Study

The advisory committee members are as follows;

- Chairman : Mr.Takashi Yamanaka
  Manager of Engineering Management
  Division, Engineering Department,
  Honshu-Shikoku Bridge Authority

- Member : Mr.Toshichika Hattori
  Acting Section Manager,
  Road Project Coordination,
  Road Department,
  Chubu Regional Construction Bureau,
  Ministry of Construction of Japan

- Member : Mr. Takeshi Yoshida
  Chief Engineer,
  Pavement Division, Road Department,
  Public Works Research Institute,
  Ministry of Construction of Japan

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CHAPTER 2

PRESENT CONDITION OF THE STUDY AREA

CHAPTER 2 PRESENT CONDITION OF THE STUDY AREA

2.1 NATIONAL ECONOMIC CONDITIONS

2.1.1 Economic Outlook of Nicaragua

Between 1980 and 1984, the Sandinista government nationalized the banking and insurance sectors as well as many private firms, and forced those firms to increase investment to about 20 percent of the GDP. However, owing to the inefficient economic activities of nationalized firms, burden of huge defense expenditures to conduct the war with opposition political groups, the trade embargo and suspension of assistance from U.S.A. and other countries, the government's plan to boost the country's economy failed. In order to finance its fiscal deficit, the government increased the money supply, a more that led to hyper inflation. The introduction of economic packages to bring government spending under control began in 1984, leading to a reduction of inflation at the cost of further economic recession.

Since the establishment of the Chamorro government in 1990, the country's centralized economy has been changing towards a free market as firms nationalized by the former government have been privatized. The new government issued a stabilization and structural adjustment plan to reestablish fiscal discipline, in order to stabilize the currency and restore links to the international community. However, the government still faces many difficult problems, including political instability, a deteriorated infrastructure, and dependence on a handful of agricultural commodities.

2.1.2 GDP

As of 1993, the current GDP is estimated at 10,520.8 million Córdobas; however, consumption surpasses the GDP by about 800 million Córdobas as shown in Table 2-1. Investment amounts to only 20% of consumption. In addition imports are 2.5 times greater than exports. Moreover, per capita income on dollar basis, as of 1992 was US$ 459. This value has been decreasing since 1970's (in the early 1970's per capita income was about US$ 1,503 in Nicaragua). This fact suggests that the Nicaraguan economy is substantially supported by foreign assistance. Table 2-1 gives no information on real economic growth since the figures are shown in nominal terms.

Table 2-1 GDP

(Unit: Million Córdobas)

Year	1990	1991	1992	1993*1
GDP	1,564.4	6,940.7	8,428.8	10,520.8
Consumption	1,551.6	7,648.6	9,971.0	11,335.4
Investment	301.3	1,452.5	1,707.8	2,395.6
Export	390.4	1,552.5	1,518.0	2,185.7
Import	678.9	3,713.0	4,768.0	5,396.0
Per Capita Income (1987 US$)*2	645	513	459	n.a.

Note : *1 Projection
Source : Banco Central de Nicaragua
*2: Banco Central de Nicaragua world table(1992)
Bank staff calculation

The real past economic situation of Nicaragua is shown in Table 2-2 and in Figure 2-1 together with that of other Central American countries. The Nicaraguan economy has considerably deteriorated since the breakout of the civil war in 1983, and has continued to weaken since then. Moreover, to make matters even worse, the Nicaraguan economy was damaged by a severer hurricane in 1988. As a result, the Nicaraguan economy has remained far behind that of other Central American countries.

Table 2-2 Real GDP Growth Rates

(Unit: %)

Country	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Guatemala	5.3	3.5	1.0	-3.5	-2.7	0.6	-0.6	0.3	3.3	3.5	4.0	3.5
EL Salvador	-1.5	-9.6	-8.3	-5.6	0.8	2.3	2.0	0.6	2.6	0.5	1.1	3.4
Honduras	6.7	2.6	1.5	-2.0	-0.2	2.8	3.2	3.1	4.2	3.8	2.1	-1.0
Nicaragua	**-25.8**	**4.6**	**5.4**	**-0.8**	**4.6**	**-1.6**	**-4.1**	**-1.0**	**-0.7**	**-10.9**	**-2.9**	**-5.7**
Costa Rica	4.9	0.6	-3.6	-7.3	2.9	8.0	0.7	5.5	5.1	3.4	5.5	3.6
Central America	0.1	1.0	-0.9	-4.1	0.1	2.4	0.2	1.6	3.5	2.2	2.9	2.1

Source : Central Banks and Ministries of Planning

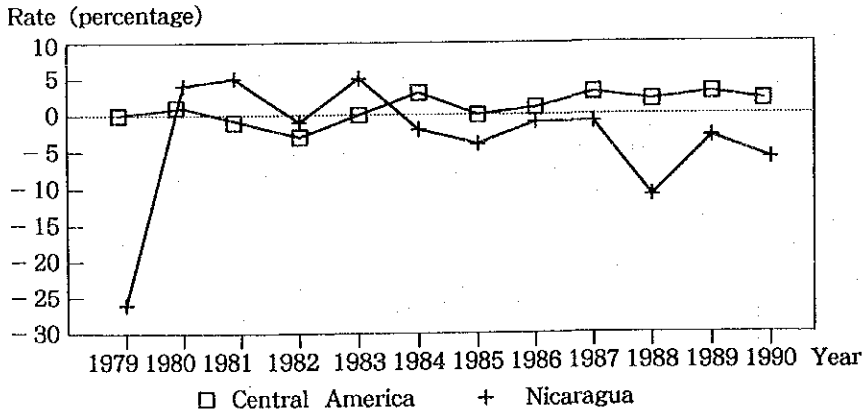


Figure 2-1 Real GDP Growth Rate

However, as can be seen from the past trends of the economic situation, which are shown in real terms in Tables 2-3 and 2-4, a positive growth rate of 0.8% was recorded in 1992 for the first time in the past decade. Moreover, a positive growth rate of 2.1% is expected in 1993. Owing to the government's austerity measures implemented with various economic packages in 1993, the Nicaraguan economy is expected to surpass its 1988 level.

Looking at Table 2-3, primary industries account for only 24.0% of GDP although the Nicaraguan economy is heavily dependant on agriculture. On the other hand, as shown in Table 2-4, investment including inventory accounts for only 15.7% of total expenditures. Therefore, in order to develop the Nicaraguan economy further hereafter, the government will have to push for much more investment and increase not only agricultural production but also the activities of secondary industries.

Table 2-3 GDP (Production)

(Unit : Million Córdobas in 1980 prices)

	GDP (Production)						Growth Rate(%)				
Year	1988	1989	1990	1991	1992	1993*	1989	1990	1991	1992	1993*
GDP	18,473.0	18,159.4	18,113.3	18,049.3	18,192.4	18,580.1	-1.7	-0.3	-0.4	0.8	2.1
Primary	4,108.6	4,486.7	4,478.2	4,303.6	4,436.2	4,453.6	9.2	-0.2	-3.9	3.1	0.4
-Agriculture	2,656.8	2,902.1	2,887.0	2,741.5	2,771.7	2,710.2	9.2	-0.5	-5.0	1.1	-2.2
-Livestock	1,347.7	1,468.5	1,490.9	1,438.8	1,526.3	1,593.5	9.0	1.5	-3.5	6.1	4.4
-Fishery	56.3	66.1	49.6	72.1	86.4	97.0	17.4	-25.0	45.4	19.8	12.3
-Others	47.8	49.5	50.7	51.2	51.8	52.9	3.6	2.4	1.0	1.2	2.1
Secondary	4,958.5	4,815.6	4,667.3	4,865.7	4,690.0	4,957.7	-2.9	-3.1	4.3	-3.6	5.7
-Manufacture	4,167.6	4,089.0	4,025.8	4,283.8	4,060.3	4,247.1	-1.9	-1.5	6.4	-5.2	4.6
-Construction	693.9	589.8	534.9	476.8	506.6	582.6	-15.0	-9.3	-10.9	6.3	15.0
-Mining	97.0	136.8	106.6	105.1	123.1	128.0	41.0	-22.1	-1.4	17.1	4.0
Tertiary	9,405.9	8,857.6	8,967.8	8,880.0	9,066.2	9,168.8	-5.8	1.2	-1.0	2.1	1.1
-Commerce	3,204.9	3,113.8	3,122.6	3,260.1	3,367.5	3,384.1	-2.8	0.3	4.4	3.3	0.5
-Public Services	2,675.9	2,238.5	2,316.9	2,026.7	2,028.2	2,028.2	-16.3	3.5	-12.5	0.1	0.0
-Transport	905.1	879.4	881.9	920.7	951.0	955.7	-2.8	0.3	4.4	3.3	0.5
-Finance	614.0	607.2	600.4	588.9	588.9	600.7	-1.1	-1.1	-1.9	0.0	2.0
-Energy	477.4	498.6	538.0	539.7	556.4	601.5	4.4	7.9	0.3	3.1	8.1
-Housing	780.7	774.8	751.5	757.2	761.6	773.0	-0.8	-3.0	0.8	0.6	1.5
-Others	747.9	745.3	756.6	786.7	812.5	825.7	-0.3	1.5	4.0	3.3	1.6

Note : * Projection

Source : Banco de Central de Nicaragua

Table 2-4 GDP (Expenditure)

(Unit : Million Córdobas in 1980 price)

Year	GDP (Expenditure)						Growth Rate(%)				
	1988	1989	1990	1991	1992	1993*	1989	1990	1991	1992	1993*
GDP Expenditure	18,473	18,159	18,113	18,049	18,192	18,580	-1.7	-0.3	-0.4	0.8	2.1
- Consumption	19,678.9	17,070.4	16,380.1	17,671.9	17,825.0	17,354.0	-13.3	-4.0	7.9	0.9	-2.6
*Public	6,206.1	4,901.9	6,038.7	3,937.9	3,779.1	3,699.1	-21.0	23.2	-34.8	-4.0	-2.1
*Private	13,472.8	12,168.5	10,341.4	13,734.0	14,045.9	13,654.9	-9.7	-15.0	32.8	2.3	-2.8
- Investment	3,292.1	2,800.9	2,410.9	2,661.2	2,565.5	2,914.7	-14.9	-13.9	10.4	-3.6	13.6
*Fixed Inv.	3,538.9	2,897.0	2,568.2	2,338.4	2,566.5	2,950.2	-18.1	-11.3	-8.9	9.8	15.0
*Machinery	1,994.4	1,584.2	1,377.6	1,269.7	1,439.8	1,390.7	-20.6	-13.0	-7.8	13.4	-3.4
*Construction	1,306.0	1,110.1	1,006.8	897.1	958.8	1,102.6	-15.0	-9.3	-10.9	6.9	15.0
*Others	238.5	202.7	183.8	171.7	167.9	456.9	-15.0	-9.3	-6.6	-2.2	172.1
- Inventory	-246.8	-96.1	-157.4	322.7	-1.0	-35.5					
Exports	3,176.0	4,205.1	4,970.3	4,153.2	4,797.0	4,648.0	32.4	18.2	-16.4	15.5	-3.1
Imports	7,674.0	5,917.0	5,648.0	6,437.0	6,995.2	6,336.6	-22.9	-4.5	14.0	8.7	-9.4

Note : * Projection

Source : Banco Central de Nicaragua

2.1.3 Central Government Finance

The central government has recorded deficits over the past decade as shown in Table 2-5. The fiscal deficit reached about 26.6% of the GDP in 1988 as a result of the cost of the escalating civil war. Over that time, defense expenditures rose to approximately 50% of the budget. However, in 1992 due to a cut in overall expenditures, the elimination of subsidies, and the implementation of a successful economic package, the deficit is believed to have dropped to approximately 4.5% of the GDP.

Table 2-5 Composition of Central Government Finance

(Unit : % of GDP)

Year	1985	1986	1987	1988	1989	1990*
Current Revenue	32.1	32.0	27.7	21.5	20.6	14.0
Current Expenditures	48.0	41.4	39.5	42.1	23.7	27.5
Current Savings	-15.8	-9.4	-11.8	-20.6	-3.1	-13.5
Capital Expenditures	4.7	6.1	4.6	6.5	2.7	1.2
Balance	-21.3	-14.5	-16.0	-26.6	-2.9	-13.5

Note : * Estimates

Source : Economic and Social Progress in Latin America, 1990

2.1.4 Inflation

The average consumer price rate was 28.7% between 1981 and 1984; however, after that the rate accelerated as shown in Table 2-6 and Figure 2-2. In 1988 the rate of inflation reached 33,647.3% per annum, the highest in the Nicaraguan history. Even in 1990 the rate was still 13,490.3%. However, after the new government was established, inflation

was brought under control by the government's austerity policy (except in the first year of the new government), bringing the monthly average down to 1.8%.

Table 2-6 Inflation Rates

(Unit : %)

Country	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Guatemala	11.5	10.7	11.4	0.2	4.7	5.2	31.5	25.7	10.1	10.0	17.9	59.6
EL Salvador	8.0	17.4	14.7	11.7	13.1	9.8	31.9	30.3	19.6	18.2	23.5	19.3
Honduras	8.8	18.8	9.4	9.0	8.3	3.7	4.3	3.2	2.9	4.5	9.8	36.4
Nicaragua	48.2	-7.7	23.9	22.2	32.9	50.2	334.3	747.5	1,347.2	33,647.3	1,689.1	13,490.3
Costa Rica	9.2	18.1	37.1	90.1	32.6	17.3	10.9	15.4	16.4	25.3	9.9	27.3

Note : Variation as of December of each year
Source : Central Banks of Area

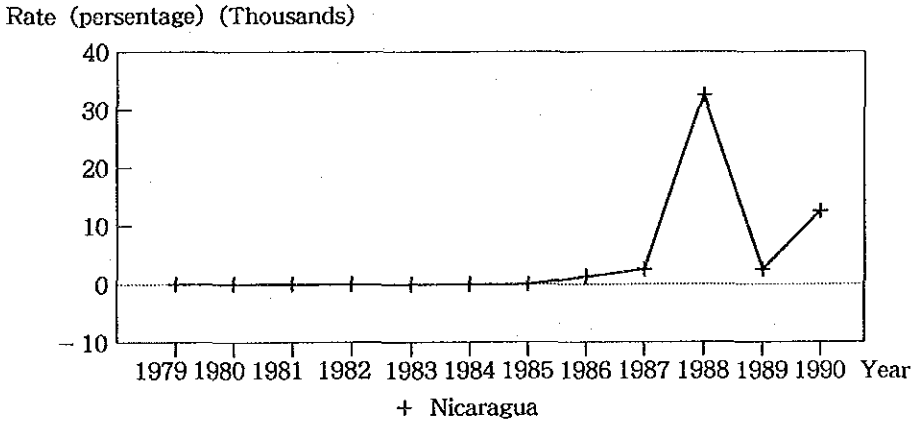


Figure 2-2 Annual Inflation Rate

2.1.5 Foreign Public Debt

As shown in Table 2-7 and Figure 2-3, external debt has been growing since 1979 due to the country's chronic trade deficit and non-payment of interests. The total external deficit increased from US$ 1.3 billion in 1979 to US$ 8.6 billion in 1990. The deficit reached more than 2-3 times that of other Central American countries. Of this deficit about 10-12% is said to be interest payment arrears. During this period Nicaragua needed to borrow money heavily, but under the Sandinista government, the country failed to come to terms with the IMF. As a result, the main sources of new finance were credit from COMECON and Western European governments. Since then, however, the Chamorro government has renewed contacts with multilateral institutions and USAID.

Table 2-7 Central America Disbursed Foreign Public Debt Balances

(Unit : US$ in Millions)

Country	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Guatemala	602	820	1,385	1,841	2,149	2,505	2,612	2,688	2,700	2,595	2,700	2,686
EL Salvador	597	1,030	1,392	1,517	1,706	1,763	1,805	1,782	1,743	1,769	1,965	2,210
Honduras	864	971	1,162	1,552	1,766	2,041	2,529	2,742	2,793	3,338	3,351	3,560
Nicaragua	**1,331**	**1,825**	**2,566**	**3,139**	**3,788**	**4,362**	**5,056**	**5,760**	**6,270**	**7,220**	**8,081**	**8,613**
Costa Rica	1,424	2,140	2,315	2,807	3,188	3,524	3,709	3,644	3,914	3,834	3,800	3,138
Central America	4,818	6,786	8,820	10,856	12,597	14,195	15,711	16,616	17,420	18,756	19,897	20,207

Source : Central Banks and Ministries of Planning

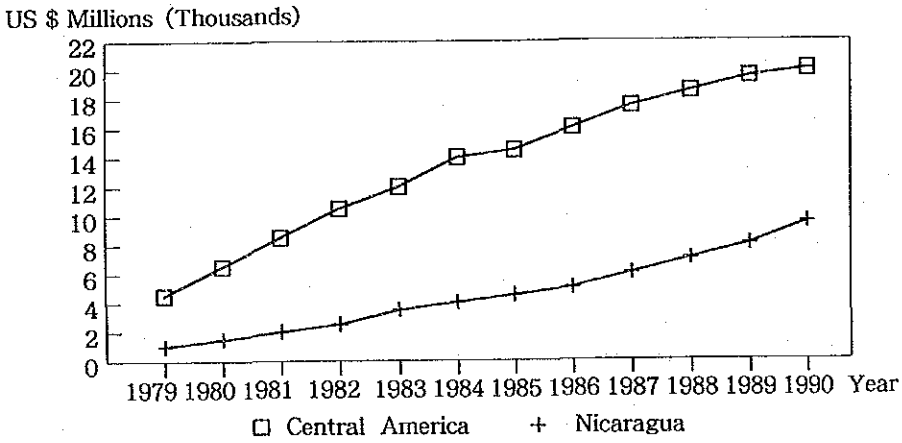


Figure 2-3 Foreign Public Debt

2.1.6 Exports and Imports

As shown by the GDP, Nicaragua's exports and imports totaled 1.5 billion Córdobas and 4.8 billion Córdobas in 1992, respectively. Imports account for about 57% of the GDP, which means that there is almost no industry in Nicaragua. Therefore, Nicaragua is forced to buy everyday goods from foreign countries. This means that the country urgently needs to foster some export-oriented industries.

Table 2-8 and Figure 2-4 list the country's import and export trading partners. As can be seen exports to the U.S.A decreased drastically as part of the latter's political strategy. However, since the new government was established, exports to the U.S.A have been steadily increased.

Table 2-8 Import and Export Countries

(Unit : %)

Imports				Exports			
Country	(1) 1976-80	(2) 1988-89	(3) 1990-91	Country	(1) 1976-80	(2) 1988-89	(3) 1990-91
U.S.A.	36.9	-	38.7	U.S.A	40.8	-	17.7
Venezuela	16.7	-	-	Germany	14.9	25.5	24.1
Costa Rica	11.0	8.6	10.9	Japan	10.7	16.4	14.1
Guatemala	10.5	-	6.1	Costa Rica	9.7	7.1	5.6
Japan	9.1	6.8	9.9	Guatemala	6.2	-	-
Germany	7.1	34.8	5.3	Netherlands	5.1	4.7	2.1
Spain	3.8	8.3	-	Belgium	4.4	-	-
Mexico	2.5	5.6	3.9	Italy	4.2	-	-
United Kingdom	2.4	-	5.2	Canada	2.1	31.0	23.9
France	-	6.5	5.8	Austria	-	-	5.3
Italy	-	13.2	6.6	France	-	2.1	4.8
Netherlands	-	8.3	3.7	Mexico	-	2.3	2.4
Canada	-	7.9	3.9	Spain	1.9	6.8	n.a.
				Switzerland	-	4.1	-
Total	100.0	100.0	100.0	Total	100.0	100.0	100.0

Source: Ibid

(1):nine countries represent 78.9% of total imports
(2):nine countries represent 45.9% of total imports
(3):eleven countries represent 51.4% of total imports

(1):ten countries represent 77.1% of total exports
(2):nine countries represent 63.9% of total exports
(3):nine countries represent 66.0% of total exports

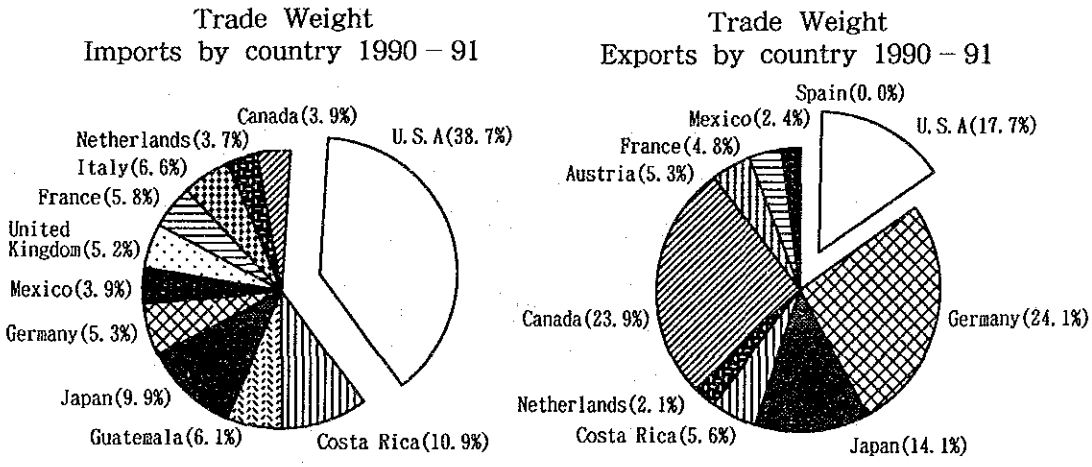


Figure 2-4 Composition of Import and Export Countries

Looking at the composition of imports for 1992, which is shown in Table 2-9 and Figure 2-5, it will be noted that intermediate goods account for 26%, followed by petroleum, which accounts for 27%. Table 2-10 and Figure 2-6 show the composition of exports. As of 1993, of all export goods, coffee was accounting for most of the country's foreign currency, which accounted to a quarter of the 1977 figure. Moreover, the export of cotton

drastically decreased to only US$ 2 million. However, as of 1990, the export of seafood has once again begun to increase.

Table 2-9 Main Import Goods (1988-1993)

(Unit : US$ in Thousand - CIF)

Item	1988	1989	1990	1991	1992	1993*
Total Importations	730,674.2	559,745.9	533,263.7	586,171.4	654,317.4	574,473.4
Consumer Goods	102,023.5	71,430.7	100,700.9	130,182.2	168,005.8	117,003:4
- Non Durable	81,262.6	59,777.4	82,112.4	104,032.8	140,044.0	97,827.7
- Durable	20,760.9	11,653.3	18,588.5	26,149.4	27,961.8	19,175.7
Petroleum	204,645.7	161,501.1	175,120.9	169,353.2	174,447.7	145,655.4
- Crude Petroleum	124,609.3	137,968.4	147,345.0	149,375.1	147,658.8	124,992.8
- Fuel and Oil	77,949.0	23,399.5	26,161.6	14,775.1	24,623.6	20,662.6
- Electricity	2,087.4	133.2	1,614.3	5,203.0	2,165.3	0.0
Intermediate Goods	224,499.8	168,378.4	119,669.6	159,615.8	167,471.7	172,410.1
- For Agriculture	70,937.0	51,332.6	26,200.6	32,213.9	11,931.9	15,861.5
- For Industry	135,284.6	99,004.1	78,276.1	107,019.8	130,377.6	128,957.7
- Construction Materials	18,278.2	18,041.7	15,192.9	20,382.1	25,162.2	27,590.9
Capital Goods	199,443.6	158,422.2	137,764.8	126,966.0	143,983.0	139,068.6
- For Agriculture	22,421.7	22,421.7	8,604.6	9,317.9	10,399.5	10,664.0
- For Industry	87,531.1	68,827.2	55,166.9	62,029.6	80,391.7	79,200.5
- Transport Equipment	89,490.8	67,173.3	73,993.3	55,618.5	53,191.8	49,204.1
Miscellaneous	61.6	13.5	7.5	54.2	409.2	335.9

Note : * Projection

Source : Central Bank of Nicaragua

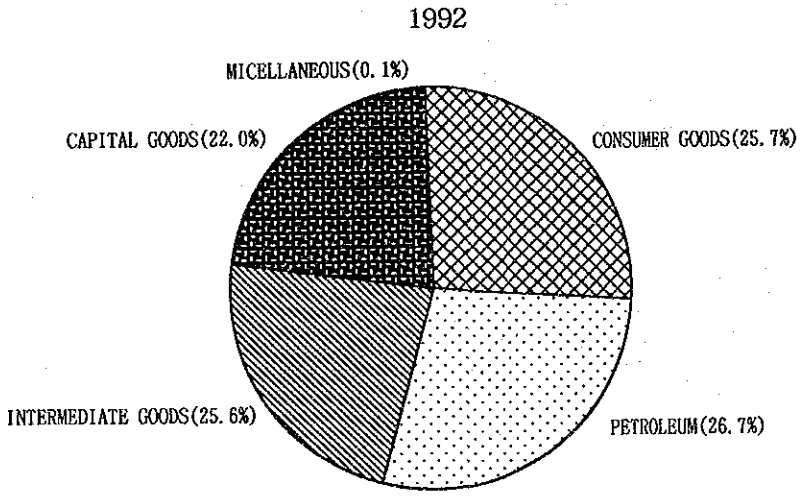


Figure 2-5 Composition of Import Goods

Table 2-10 Main Export Products (1977-1983)

Products	1977	1987	1988	1989	1990	1991	1992	1993 *5
Sesame								
- Value (US$ 1,000)	1,762.0	2,941.0	2,249	2,922.5	6,532.2	7,306.9	4,335.3	7,956
- Volume (1,000 Quintal)	59.0	68.0	57	57	111.5	211	114	168.8
- Unit Price (US$)	29.9	43.3	39.5	51.3	58.6	34.6	38	45
Cotton								
- Value (US$ 1,000)	150,612.0	44,938.0	50,605.9	27,990.9	37,251.1	44,372	26,218.5	2,000
- Volume (1,000 Quintal)	2,531.0	1,106.0	756.6	539.2	535.2	592.6	514.1	34.2
- Unit Price (US$)	59.5	40.6	66.9	51.9	69.6	74.9	51	
Sugar								
- Value (US$ 1,000)	27,842.0	19,653.7	5,420.6	17,189.7	38,572.2	31,335.7	19,102.6	20,757
- Volume (1,000 Quintal)	2,157.0	1,091.8	751.4	1,693.1	2,531	2,472.9	1,893.3	1,887
- Unit Price (US$)	12.9	18.0	7.2	10.2	15.2	12.7	10.1	11
Banana								
- Value (US$ 1,000)	4,474.0	14,131.3	14,681.5	20,128.7	27,079.8	28,690.4	9,975.6	26,144
- Volume (1,000 boxes) *1	5,677.0	3,985.7	3,859	4,032.4	5,227.3	6,142.9	3,089.9	6,536
- Unit Price (US$)	0.8	3.6	3.8	5	5.2	4.7	3.2	4
Coffee								
- Value (US$ 1,000)	198,790.0	115,056.0	81,361.8	104,620.4	71,022.4	36,221.2	45,294.6	52,500
- Volume (1,000 Quintal)	1,076.0	813.0	679	935.7	848.7	478.2	808.5	700
- Unit Price (US$)	184.7	141.5	119.8	111.8	83.7	75.7	56	75
Meat								
- Value (US$ 1,000)	37,278.0	12,814.0	13,446.7	33,636.3	56,983.8	37,460.4	40,815.8	44,000
- Volume (1,000 lb.)	58,114.0	15,067.0	14,619	36,250.8	55,667.7	32,357.1	38,889.9	40,000
- Unit Price (US$)	0.6	0.9	0.9	0.9	1	1.2	1	1.1
Molasses								
- Value (US$ 1,000)	2,951.0			713.6	1,465.6	3,313	4,644.8	4,400
- Volume (1,000 Metric Tons) *2	63.0			20	35.7	58.3	105.9	100
- Unit Price (US$)	46.8			35.7	41.1	56.8	43.9	44
Seafood *3								
- Value (US$ 1,000)	22,049.0	12,383.0	7,192.5	11,552	8,704	12,861.7	15,485.3	25,051.5
- Volume (1,000 lb.)	11,982.0	2,190.0	1,830.2	2,818.3	1,905	3,661.7	2,756	3,745
- Unit Price (US$)	1.8	5.7	3.9	4.1	4.6	3.5	5.6	6.7
Gold *4								
- Value (US$ 1,000)	3,816.0	12,073.7	13,270.9	20,845.9	14,078.1	10,204.2		12,920
- Volume (1,000 Troy Ounces)	61.0	27.2	30.5	55.3	36.7	28.3		38
- Unit Price (US$)	62.6	443.9	435.1	377	383.6	360.6		340
Silver *4								
- Value (US$ 1,000)	404.0	188.5	139.3	237.2	48.1			
- Volume (1,000 Troy Ounces)	174.0	26.8	21.6	50.2	10			
- Unit Price (US$)	2.3	7.0	6.4	4.7	4.8	14.6		
Total Value (US$ 1,000)	449,978.0	234,179.2	188,368.2	239,837.2	261,737.3	211,765.5	165,872.5	195,728.5

Note : *1 Boxes of 42 pounds each
*2 1 Metric Tons = 22.05 Quintal
*3 Includes Shrimp and Lobster
*4 With the Nationalization of mines in 1980, the values show real market prices
*5 Projection

Source : 1977 - 1987, Central Bank of Nicaragua (CBN)
1988 - 1989, Ministry of Economy, Industry and Trade
1990 - 1993, General Direction of Foreign Programming

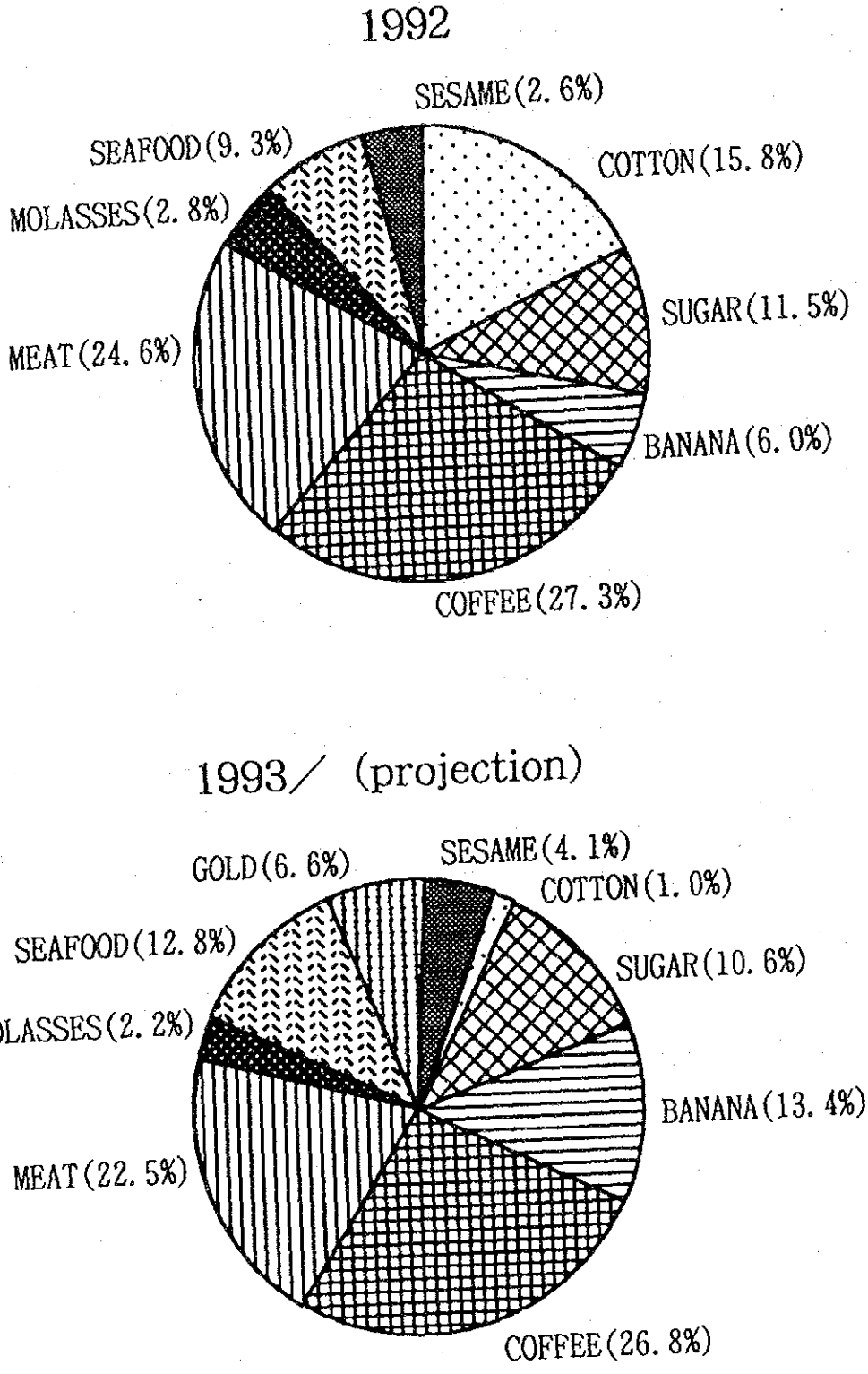


Figure 2-6 Main Export Products (1992 and 1993)

2.2 NATURAL CONDITIONS

2.2.1 Topography

The country is divided topographically into three regions: the Caribe Sea Region, the Central Mountainous Region, and the Pacific Region. The Caribe Sea Region occupies approximately 30 % of country's land, and mainly consists of plains under 100 m in elevation and lagoons along the major rivers (Coco O Segovia, Wawa, Prinzapolka, Grande De Matagarpa, Kurinwas and Escondido).

The Central Mountainous Region occupies approximately 45% of the country and ranges from 200 m to 2,000 m in elevation. The Cordillera De Dipilto y Jalapa, Cordillera Isabelia and Cordillera Dariense mountains run from northeast to southwest. Mt. Mogoton, the highest mountain in Nicaragua (2,107 m above sea level), is located on the border of Honduras. The main watershed of the region is lied in the western side of the mountains.

The Pacific Region has complicated topographic features, and is subdivided into three zones: lowlands associated with the lakes, volcanic areas and coastal zones. Volcanoes such as Cosiguina, San Cristobal, Sasita, Telica, Rota, El Hoyo, Momotombo, Masaya, Mombacho, Concepción and Maderas run from northwest to southeast.

Figure 2-7 shows the hypsographic map in Nicaragua.

2.2.2 Geology

The object area is mainly divided into the Bocay Sedimentary Region, the Pacific Litoral Sedimentary Region, the Continental Sedimentary Region, the Tertiary Volcanism Region, the Quarternary Volcanism Region, the Quarternary Alluviam Region, the Intrusive Region, and the Metamorphic Region as shown in Figure 5-4.

The Bocay Sedimentary Region located in the northern part of the country consists mainly of sedimentary rocks. The Pacific Litoral Sedimentary Region and the Continental Sedimentary Region are situated in the southern and northern parts of the country, respectively.

The Tertiary Volcanism Region, located in the central and eastern parts of the country, consists mainly of acidic to basic volcanic rocks interlayered with sandstone and mudstone. The Quarternary Volcanism Region, located in the western part of the country, consists mainly of dacitic, andesitic and basaltic volcanic rocks.

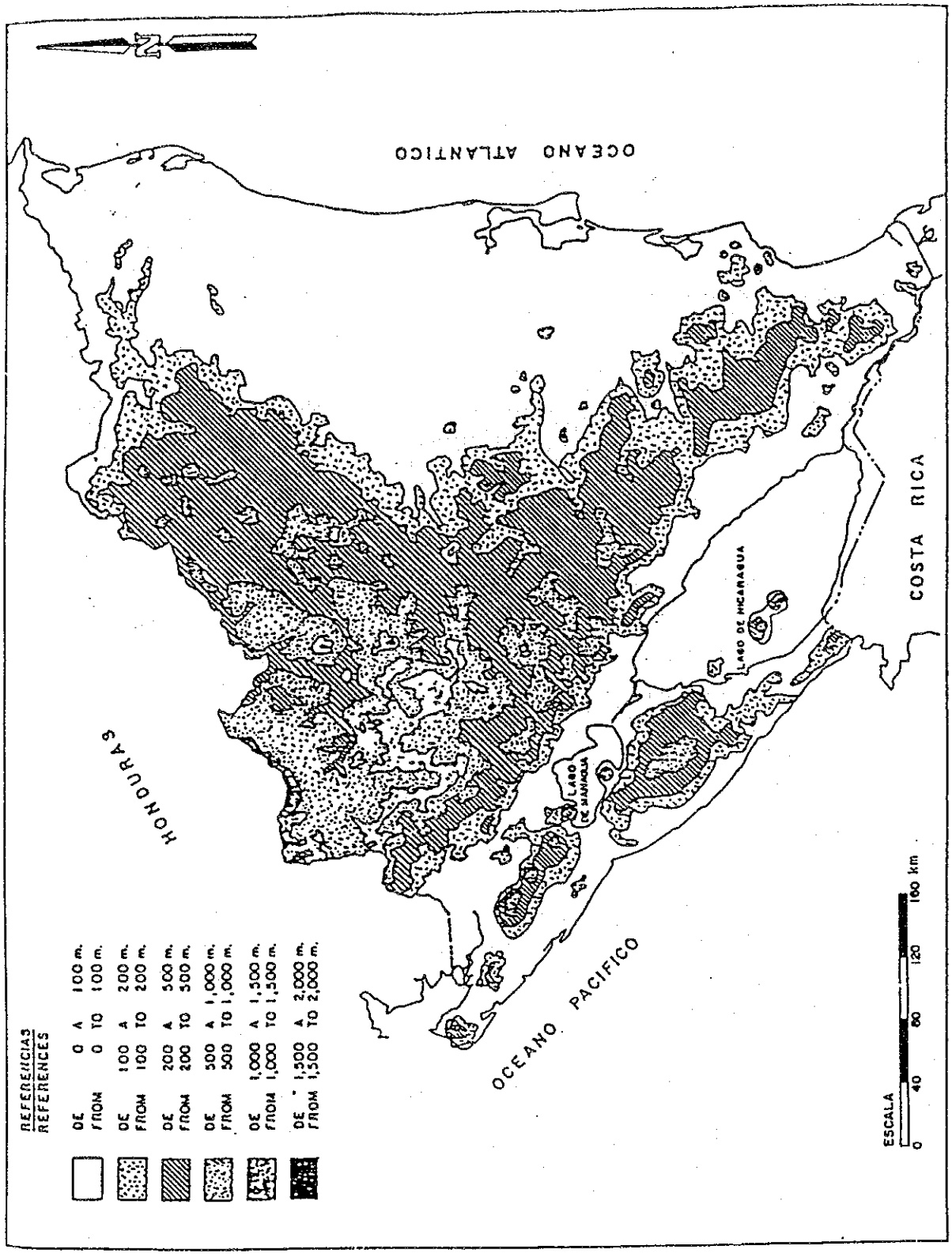


Figure 2-7 Hypsographic Map of Nicaragua

The Quaternary Alluviam Region, located in the eastern part of the country, consists of recent sediment. The Intrusive Region is located in the limited area on the border of Honduras. The Metamorphic region, located in the northern part of the country, surrounds the Intrusive Region.

2.2.3 Meteorology

The climate in Nicaragua can mainly be classified into four types in accordance with the W. Koppen method as shown in Figure 2-8: Tropical Savannah (Aw), Tropical Savannah in the Highlands (AwH), Tropical Monsoon (Am), and Tropical Forest (Afl).

(1) Tropical Savannah (Aw)

The Tropical Savannah is located in the Pacific and western foothills of the central mountains. It is characterized by mild temperatures of 21 to 30°C, and a typical dry season of 5 to 6 months between November and April. The volume of precipitation in this zone is 700 to 2,000 mm a year. The mean temperatures and mean relative humidity per year in major cities in the Aw zone are as follows:

City Name	Mean Temperature	Relative Humidity
Managua	27°C	60%
León	26°C	88%
Granada	28°C	86%
Chinandega	25°C	84%
Matagalpa	23°C	82%

(2) Tropical Savannah in the Highlands (AwH)

The Tropical Savannah in the Highlands is located in the northern mountainous part of the Aw zone, which corresponds with a limited area of more than 1,000 m in elevation. Annual precipitation ranges from 1,200 to 1,600 mm. The mean temperatures and mean relative humidity per year in the major cities in the Awh zone are as follows:

City Name	Mean Temperature	Relative Humidity
Jinotega	19°C	70%
Estelí	21°C	90%

(3) Tropical Monsoon (Aw)

The Tropical Monsoon spreads widely in the lowlands of the eastern part of the country, and on the eastern slopes of the mountains. It is characterized by a nine-month rainy season and a shorter dry season, usually between February and April. Annual precipitation is between 1,800 to 2,000 mm, reaching 3,000 mm on the eastern slopes of the mountains. This area's mild temperature ranges between 25 to 30 degrees centigrade, which is generally approximately 4 degrees less than that in the Afi zone.

(4) Tropical Forest (Afi)

The Tropical Forest is located in the lowlands (Atlantic Coast) of the eastern and southeastern parts of the country.

Maximum temperature does not exceed 37°C, while the median temperature in the coldest month does not drop below 18°C. The country is characterized by uniform weather throughout the year, although there is an intense rainy season between July and August and a short dry season in March. Annual precipitation totals 4,000 to 6,000 mm.

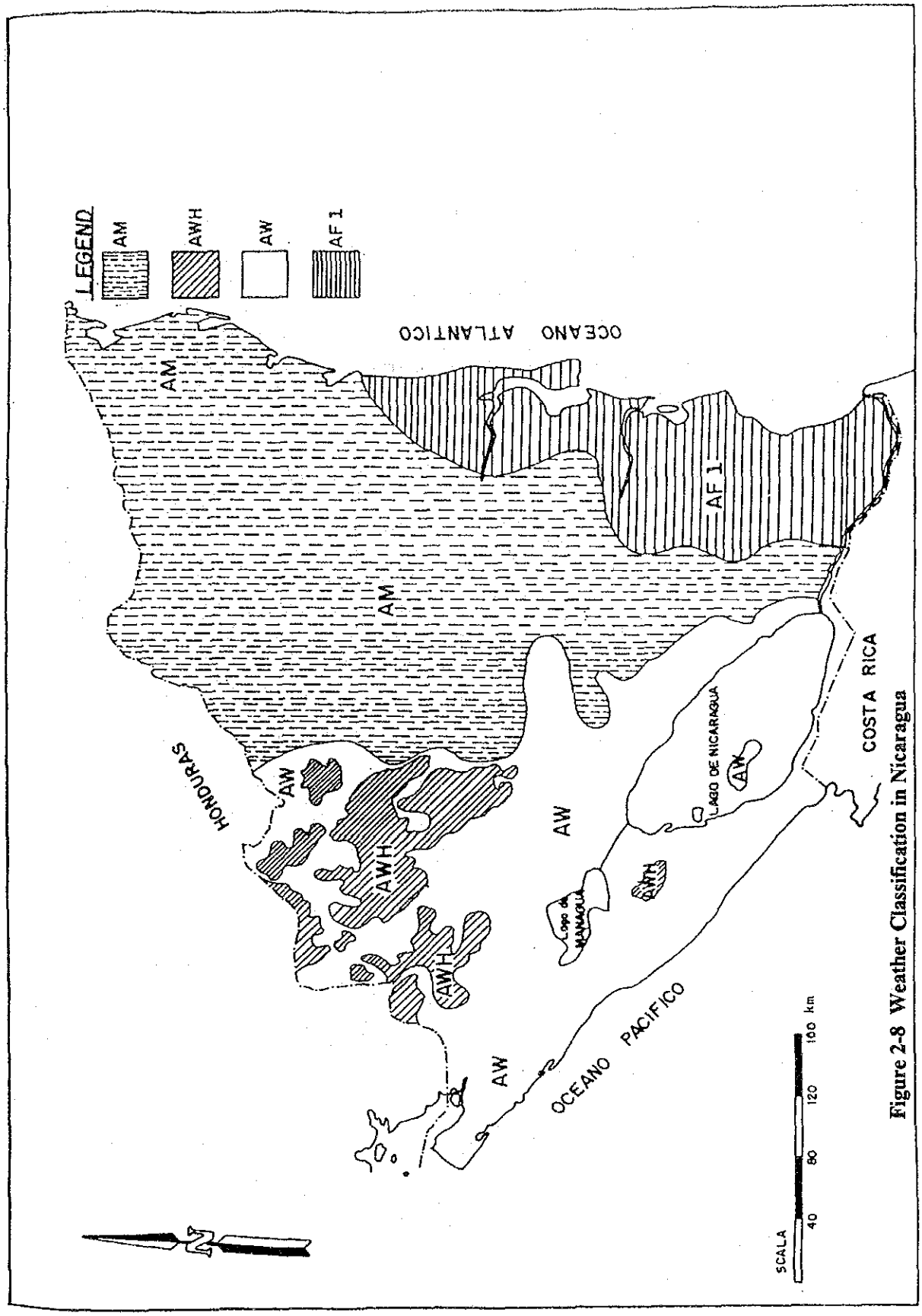


Figure 2-8 Weather Classification in Nicaragua

2.3 PRESENT TRANSPORTATION SYSTEM

2.3.1 Conditions of Transport Subsectors

(1) Roads

According to the road inventory published by the MCT in March 1993, the total length of the country's roads was 15,011.2 km in 1992. By surface type, paved roads account for only 10.9% of all roads, while earth roads, most of which are not passable in the rainy season, account for a much higher ratio of 38.0%. Road conditions by surface type are summarized in Table 2-11.

Table 2-11 Existing Roads by Surface Type in Each Region (1992)

(Unit : km)

Region	Asphalt	Surface Treatment	Gravel	Earth	Total
I	169.6	384.7	697.5	709.5	1,961.3
II	398.2	158.9	938.4	978.1	2,473.6
III	324.3	180.3	234.1	765.2	1,503.9
IV	312.2	118.0	724.7	1,363.7	2,518.6
V	258.6	568.5	648.4	796.4	2,271.9
VI	178.4	602.0	1,276.1	878.2	2,934.7
VII	0.0	686.7	307.0	130.0	1,123.7
VIII	0.0	0.0	0.0	0.0	0.0
IX	0.0	72.8	71.5	79.2	223.5
Total	1,641.3	2,771.9	4,897.7	5,700.3	15,011.2

Source : Inventario de la Red Vial 1993, MCT

(2) Railways

The railway network of Nicaragua was primarily located in the Pacific Coastal Regions and had a total length of 343.5 km as shown in Table 2-12. The main line connected Granada and Corinto, the major port in Nicaragua, via Managua, León and Chinandega, and there were several branch lines.

However, of these lines, the León-Chinandega-Corinto section and Masaya-Diriamba section ceased operations due to hurricanes damage in 1982 and 1989. Eventually, the whole railway system was abandoned at the end of 1993 due to the financial difficulties suffered by the Nicaraguan Railway.

Table 2-12 Railway Network in 1993

Section	Length	Condition
Granada-Managua - León	132.5 km	Operating
Leon-Chinandega - Corinto	56.0 km	No operation
Masaya - Diriamba	44.0 km	No operation
León - Río Grande	86.0 km	Operating
Ceiba Mocha - Puerto Sandíno	25.0 km	Operating
Total	343.5 km	

Source: Diagnostico del Transporte Ferroviario, 1990, MCT.

As shown in Table 2-13, both passengers and cargo transported by rail have rapidly decreased in the last five years. Therefore, railways played a much smaller role as a mode of transportation.

Table 2-13 Past Trend of Railway Transport

Year	Passenger Transport (1000 person) (1000 person•km)	Cargo Transport (1000 ton) (1000 ton•km)
1988	1,784	65
	28,420	800
1989	1,601	54
	25,770	660
1990	898	13
	14,460	160
1991	885	9
	14,250	110
1992	486	10
	7,820	120

Source: Diagnostico del Transporte Ferroviario, MCT.

(3) Air Transport

There are one international airport and 12 domestic airports in Nicaragua. Moreover, eight of the domestic airports are located in the Atlantic coast regions. In addition, only August C. Sandino Airport in Managua and Puerto Cabezas Airport can accommodate commercial jets. The general characteristics of these airports are shown in Table 2-14.

Table 2-14 Existing Airports in Nicaragua

Grade	Region	Airport Name	Runway			Max. Size of Aircraft
			Length (m)	Width (m)	Type	
International	III	August C.Sandino, Managua	2,442	45	Asphalt	B-707
Domestic	III	Carlos Ulioa, Managua	915	24	Asphalt	DC-3
Domestic	II	Fanor Urroz, León	929	25	Asphalt	PZL M-18
Domestic	II	German Pomares, Chinandega	757	39	Asphalt	PZL M-18
Domestic	VIII	Bluefields	1,850	30	Asphalt	AN-26
Domestic	VIII	Corn Island	950	30	Macadam	AN-26
Domestic	VII	Puerto Cabezas	2,500	45	Asphalt	B-727
Domestic	VII	Siuna	1,100	30	Macadam	C-46
Domestic	VII	Bonanza	1,430	30	Macadam	C-46
Domestic	VII	Rosita	2,000	30	Macadam	DC-3
Domestic	VIII	Nueva Guinea	1,000	30	Macadam	DC-3
Domestic	IX	San Carlos	950	25	Macadam	C-212
Domestic	III	Montelimar	2,036	48	Asphalt	C-212

Source: Diagnóstico del Transporte Aereo, 1989, MCT.

Domestic air flights are operated mainly between Managua and the Atlantic coast regions where roads are less developed. However, the number of passengers and the volume of cargo transported by air have decreased as shown in Table 2-15. This is believed to be the result of an increase in road transport due to construction of new roads in the Atlantic regions, such as the Matagalpa-Puerto Cabezas Road.

International air flights operate from Managua to the U.S.A.,as well as neighboring countries. As shown in Table 2-15, the amount of international air travel and cargo transport has been increasing.

Table 2-15 Transition of Air Transport

Year	Domestic			International		
	Passengers (person)	Cargo (lb.)	Post (kg)	Passengers (person)	Cargo (lb.)	Post (kg)
1988	45,683	4,112,360	3,606	233,628	10,873,713	205,105
1989	39,796	2,385,435	7,306	237,427	6,252,621	202,826
1990	48,004	1,703,585	4,997	290,208	6,769,354	112,236
1991	38,914	2,014,504	3,776	354,523	11,593,852	57,204
1992	24,426	374,658	546	353,637	15,465,771	105,442

Source: Diagnostico del Transporte Aereo, 1989 and latest data from MCT.

(4) Seaports

The main seaports in Nicaragua are Corinto, Puerto Sandino and San Juan Del Sur on the Pacific coast, and El Bluff, Arlen Siu and Puerto Cabezas on the Atlantic coast. As shown in Table 2-16, the loading and unloading of cargo for import/export in Corinto and Puerto Sandino accounts for almost half of the total in Nicaragua. On the other hand, the share of the three ports located on the Atlantic coast is smaller due to this area's limited access to the other regions. In addition, the volume of cargo handled has been decreasing as shown in Table 2-16.

Table 2-16 Transition of Loading/Unloading at Seaports

(Unit : Metric Tons)

Port Name		1988	1989	1990	1991	1992
Corinto	Import	728,000	444,000	448,000	302,000	262,000
	Export	223,000	302,000	357,000	361,000	336,000
	Sub-total	951,000	746,000	805,000	663,000	598,000
Puerto Sandino	Import	615,286	674,747	664,224	645,179	707,188
	Export	3,620	65,302	29,618	21,445	0
	Sub-total	618,906	740,049	693,842	666,624	707,188
San Juan del Sur	Import	51,539	33,568	49,392	27,382	48,872
	Export	14,962	10,148	18,369	9,200	0
	Sub-total	66,501	43,716	67,761	36,582	48,872
El Bluff	Import	5,388	33,101	12,392	13,372	13,158
	Export	190	270	287	664	229
	Sub-total	5,578	33,371	12,679	14,036	13,387
Arlen Siu	Import	-	-	7,292	32,928	45,064
	Export	-	-	2,378	10,474	10,198
	Sub-total	-	-	9,670	43,402	55,262
Puerto Cabezas	Import	14,900	16,772	8,362	9,217	9,382
	Export	588	0	132	5,258	1,251
	Sub-total	15,488	16,772	8,494	14,475	10,633
Total of 6 ports	Import	1,415,113	1,202,188	1,189,662	1,030,078	1,085,664
	Export	242,360	377,720	407,784	408,041	347,678
	Total	1,657,473	1,579,908	1,597,446	1,438,119	1,433,342

Source: MCT

(5) Inland Waterways

The inland waterways of Nicaragua are clearly divided into two systems as shown below. In the Atlantic coast regions, in particular, inland waterways still play a major role in transport despite the recent development of the Matagalpa-Puerto Cabezas road.

- Central Lakes and River System:
  - Lake Managua
  - Tipitapa River
  - Lake Nicaragua

- Frio River
- San Juan River

• Atlantic Coast System:
- Punta Gorda River
- Cukra River
- Bluefields Bay
- Escondido River
- Bread Fruit River - Cukra River - Silico Creek - Moncada Canal
- Peral Lagoon
- Kurinwas River
- Grand River of Matagalpa
- Prinzapolka River
- Wounta Lagoon
- Kukalaya River
- Karatasca Lagoon
- Wawa River
- Coco River

2.3.2 Role of the Road Subsector

The roads in the Pacific coast and the central regions provide the main means of transportation. On the other hand, in the Atlantic coast regions, roads only play a complementary role. The following roads provide important connections between the Atlantic coast regions and other regions, since there are few flights between these two regions:

- The road between Managua and El Rama via San Benito linked to the inland water transport along the Escondida River between El Rama and Bluefields.
- The seasonal roads in the northern part of the Atlantic coast region connecting Puerto Cabezas and the other regions.

Secondly, as a connection to the neighboring countries, the roads have potentially become very important as the main mode of transportation under the following circumstances:

- The Central American Highways have historically been defined as the main international routes for through traffic between Costa Rica and Honduras.
- Since the construction of a permanent bridge at Guasaule on the border with Honduras, the coastal route of the Central American Highway (CA-3) via Managua, León, Chinandega and Guasaule, has been utilized by the international through traffic, since it is the shortest route, and since it makes it possible to avoid driving in hilly areas.

CHAPTER 3

ROAD NETWORK EVALUATION

CHAPTER 3 ROAD NETWORK EVALUATION

3.1 PRESENT ROAD NETWORK IN NICARAGUA

3.1.1 Development of the Road Network

The road network in Nicaragua has been developed as shown in Table 3-1. However, the total length of this network was drastically decreased after 1980 due to the destruction of roads by natural disasters such as hurricane Aleta in May 1982 (most of the earth roads were destroyed) and hurricane Joan (a total length of 651.5 km of road was damaged). Therefore, alternative/subsidiary links as well as countermeasures (slope protection etc.) to protect roads in areas prone to disasters are necessary.

Table 3-1 Development of the Road Network

(Unit : km)

Year	Paved Road	Unpaved Road	Total
1940	52	149	201
1945	206	252	458
1950	235	355	590
1955	280	3,407	3,687
1960	669	5,468	6,137
1965	811	5,664	6,475
1970	1,235	11,742	12,977
1975	1,505	15,448	16,953
1980	1,560	16,577	18,137
1985	1,569	13,428	14,997
1988	1,598	13,689	15,287
1992	1,641	13,370	15,011

Source : Boletin Vial 1989, and Inventario de la Red Vial 1993, MCT

As shown in Table 3-2, the road density in the Atlantic regions (Regions VII, VIII and IX) is extremely low compared with other regions. This is mainly because there is a lack of north-south links in those regions, which indicates that transportation in the Atlantic regions still depends on other transport modes such as inland waterways, as stated in 2.3.

3.1.2 Functional Classification of the Road Network

The functional classification of the road network was defined on the basis of the former National Transportation Study in 1976. The classifications are defined into the following five categories:

Table 3-2 Road Density by Region (1992)

Region	Area (km^2)	Road Length (km)	Road Density (km/km^2)
I	7,060	1,961.3	0.28
II	10,033	2,473.6	0.25
III	3,672	1,503.9	0.41
IV	4,724	2,518.6	0.53
V	10,622	2,271.9	0.21
VI	18,278	2,934.7	0.16
VII	32,159	1,123.7	0.03
VIII	27,407	0.0	0.00
IX	7,473	223.5	0.03
Total	121,428	15,011.2	0.12

Source - Area: La Gaceta 1989; Road Length: Inventario de la Red Vial 1993
Road Density: Estimated by the JICA Study Team on the basis of the above figures.

a) Troncal Principal (T.P.)

To serve as a corridor for long-distance trips, covering, for example, inter-departmental or inter-regional traffic. To connect urban centers with populations of more than 50,000.

- Traffic volume : more than 1,000 vehicles/day
- Velocity : up to 100 km/hr

b) Troncal Secundaria (T.S.)

To connect urban centers with populations of between 10,000 and 50,000.

- Traffic volume : average 500 vehicles/day
- Velocity : up to 80 km/hr

c) Colectora Principal (C.P.)

To connect urban centers with populations of between 4,000 and 10,000.

- Traffic volume : average 250 vehicles/day
- Velocity : 40 to 60 km/hr

d) Colectora Secundaria (C.S.)

To mainly connect districts with populations of less than 4,000 and upper road class.

- Traffic volume : 100 to 200 vehicles/day
- Velocity : 30 to 50 km/hr

e) Caminos Vecinales (C.V.)

To serve access to districts with populations of less than 1,000.

- Traffic volume : less than 50 vehicles/day
- Velocity : 5 to 40 km/hr

The latest road classification by MCT is shown in Table 3-3. The length of Troncal Principal, Troncal Secundaria and Colectora Principal are extremely limited, compared with the Colectora Secundaria on both a national and regional basis.

Table 3-3 Present Road Length by Region and Functional Classification (1988)

(Unit : km)

Region	T.P.	T.S.	C.P.	C.S.	C.V.	Total
I	117.6	43.7	138.5	505.0	1,165.1	1,969.9
II	218.8	73.7	126.9	714.4	1,352.7	2,486.5
III	172.2	22.3	72.6	387.8	833.7	1,488.6
IV	207.9	0.0	144.9	603.2	1,540.0	2,496.0
V	0.0	239.6	297.4	1,048.7	922.0	2,507.7
VI	55.6	82.6	463.5	925.0	1,460.1	2,986.8
ZE1	0.0	0.0	320.1	461.5	342.1	1,123.7
ZE2	0.0	0.0	0.0	0.0	0.0	0.0
ZE3	0.0	0.0	109.4	42.1	76.0	227.5
Total	772.1	461.9	1,673.3	4,687.7	7,691.7	15,286.7

Source : Boletín Vial 1989, MCT

Note : T.P - Troncal Principal
T.S. - Troncal Secundaria
C.P. - Colectora Principal
C.S. - Colectora Secundaria
C.V. - Caminos Vecinales
ZE1-ZE3 - Regional names used before 1991

3.2 ESTABLISHMENT OF THE OBJECTIVE ROAD NETWORK

The objective roads shall comprise with national primary and secondary roads according to the study objectives. The Troncal Principal and Troncal Secundaria are to be regarded as primary and secondary roads, respectively, with respect to road classification in Nicaragua.

According to the present criteria, Troncal Principal the primary road, and Troncal Secundaria, the secondary road, are defined as follows;

- Troncal Principal

  A road connecting urban centers with populations of more than 50,000.

- Troncal Secundaria

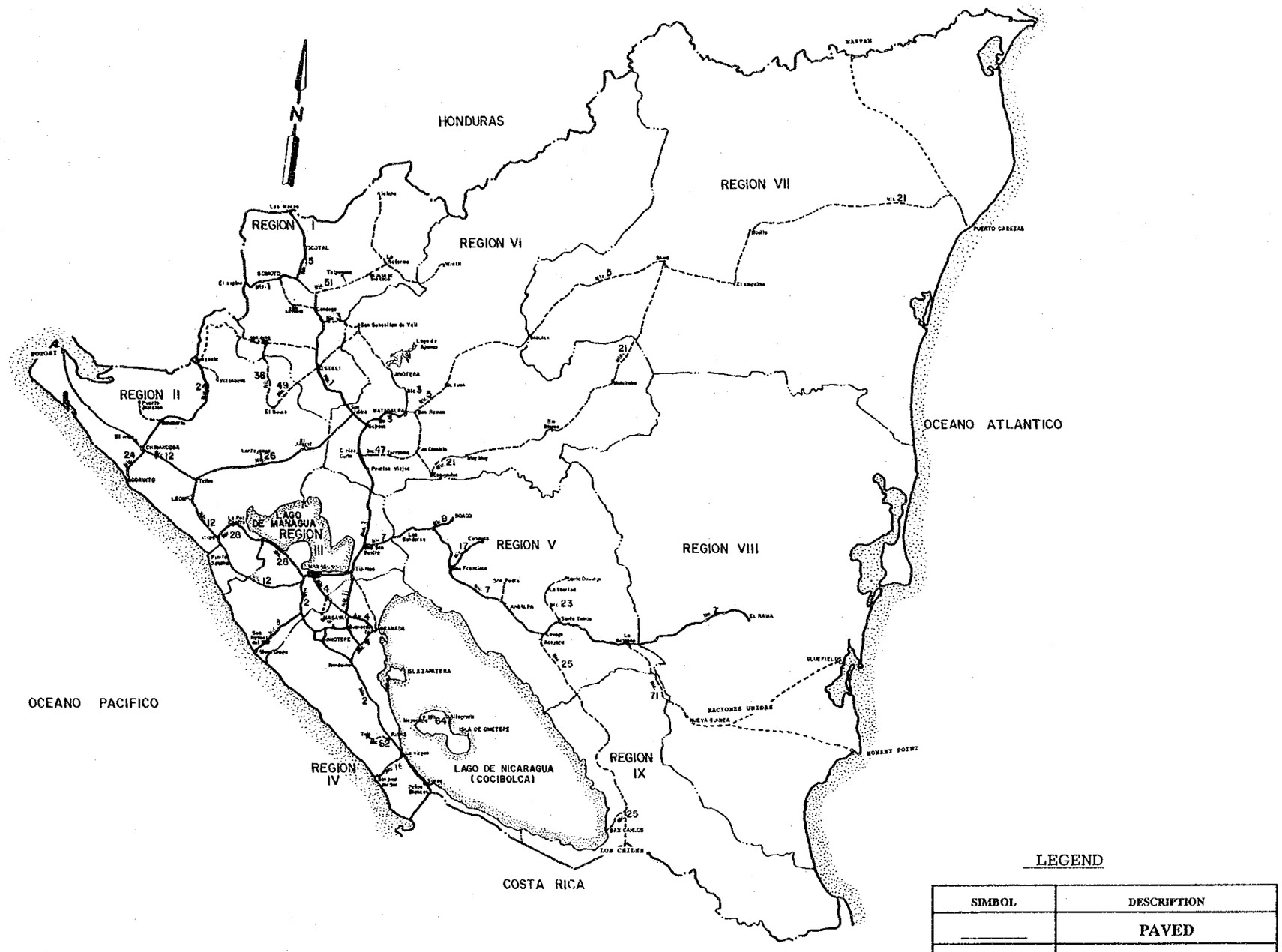
  A road connecting urban centers with populations between 10,000 and 50,000.

Therefore, the objective roads are identified as existing roads linking urban centers with populations of more than *10,000* (Refer to Appendix 3-1), using the latest road map of 1001.

The identified objective roads are shown in Table 3-4 and Figure 3-1.

Table 3-4 Objective Road Network

Objective Road	Length (km)	NIC No.	No. in the Study	Remarks
Nandaime-El Espino	265.90	NIC 1/2/4/11	A-1~A-11	CA-1
Peñas Blancas-Nandaime-Guasaule	342.40	NIC 2/12/24	B-0~B-12	CA-1, CA-3
Granada-Masaya-Managua	47.00	NIC 4	C-1~C-2	
San Benito-El Rama	260.10	NIC 7	D-1~D-5	
Guanacaste-Granada	10.80	NIC 4	A-101	
Masatepe-Sm-Las Esquinas	19.60	NIC 18	A-102	
San Marcos-Jinotepe	6.20	NIC 20	A-103	
Granada-Int. Tipitapa	28.90	NIC 27	A-104	
Sébaco-Matagalpa	26.90	NIC 3	A-105	
Matagalpa-Yali	76.60	NIC 3	A-106	
Estelí-Yali	60.70	NIC 35	A-107	
Yalaguina-Ocotal	29.20	NIC 15	A-108	
Ocotal-Las Manos	24.00	NIC 15	A-109	
Managua-Tipitapa	21.00	NIC 1	A-104-1	
Ciudad Dario-Las Mulukuku	192.90	NIC47-21	A-104-2	
San Dionisio-San Ramon	24.30	NIC 19	A-104-3	
Matagalpa-Siuna	115.70	NIC 5	A-105-1	
Puerto Cabezas-Waspan	137.50	NIC 21	A-105-3	
Estelí-El Sauce	44.60	NIC 49	A-107-1	
El Sauce-Ach-La Sirena	73.00	NIC 38	A-107-2	
Yali-Condega	42.40	NIC 3	A-107-3	
Condega-P. N1-Somoto	34.50	ND	A-107-4	
Palacaguina-Wiwili	107.70	NIC 51	A-107-5	
La Reforma-Jalapa	55.10	NIC 29	A-107-6	
La Virgen-San Juan del Sur	18.30	NIC 16	B-102	
Rivas-Tola	13.10	NIC 62	B-103	
El Crucero-Masachapa	21.30	NIC 8	B-105	
Nejapa-Mateare-Izapa	60.10	NIC 28	B-106	
Izapa-Puerto Sandino	9.60	NIC 52	B-107	
Telica-La Cruz de la India	73.70	NIC 26	B-110	
La Cruz de la India-Int. San Isidro	23.10	NIC 26	B-111	
Chinandega-Corinto	20.00	NIC 24	B-114	
Chinandega-El Viejo-Potosi	76.20	NIC 12	B-115	
Somotillo-Cinco Pinos-San Juan de Limay	68.00	NIC 68	B-117	
Int. Telica-Larreynaga	6.40	ND	B-110-1	
Puerto Morazan-Rancherias	19.80	NIC 50	B-116-1	
Monte Grande-Boaco	14.00	NIC 9	D-101	
Acoyapa-Los Chiles	134.30	NIC 25	D-102	
Nueva Guinea-Cukra River-Bluefields	95.20	NIC 71	D-103	
San Francisco-Comoapa	21.00	NIC 17	D-101-1	
Las Lajitas-San Pedro	15.30	NIC 37	D-101-2	
Cukra River-Monkey Point	56.00	NIC 23	D-102-1	
Total Length	3,126.60			



LEGEND

SIMBOL	DESCRIPTION
————	PAVED
- - - - - - - -	UNPAVED

Figure 3-1 Objective Road Network

3.3 EXISTING ROAD NETWORK CONDITIONS

3.3.1 General

Basically, existing road conditions were evaluated by a procedure shown in Figure 3-2.

The road network was divided into two groups. The first group was make up of the western road network covering Regions II, III, and IV. The roads in this group were directly inspected by the Study Team. The second group was made up of the central and eastern road network covering Regions I and VI (i.e. restricted area), and Regions VII, VIII, and IX. The roads in the second group were inspected by the MCT counterparts and were assessed by the Study Team.

The second part of the inspection consisted of bridge inspections and the preparation of a bridge inventory.

The procedures and findings of these visual inspections are presented in this chapter.

3.3.2 Objective Road Network to Be Evaluated

The objective road network mentioned in 3.2 is made up of the National Road and Departmental Road according to present design criteria. In addition, out of these roads, the major trunk roads belonging to the Central American Highway are also included as part of the objective road network.

The road network selected for the evaluation is shown in Figure 3-3.

3.3.3 Evaluation of Existing Road Conditions

(1) Visual Inspection Procedures

Prior to the field survey, the basis of the inspection and its procedure, as well as the evaluation method were determined by the Study Team. Then, the purpose of inspection, schedule, definition of technical terms, inspection items and method of completing the inspection form were clarified by the Study Team at a meeting, so that visual inspections would be conducted in a systematic and organized manner.

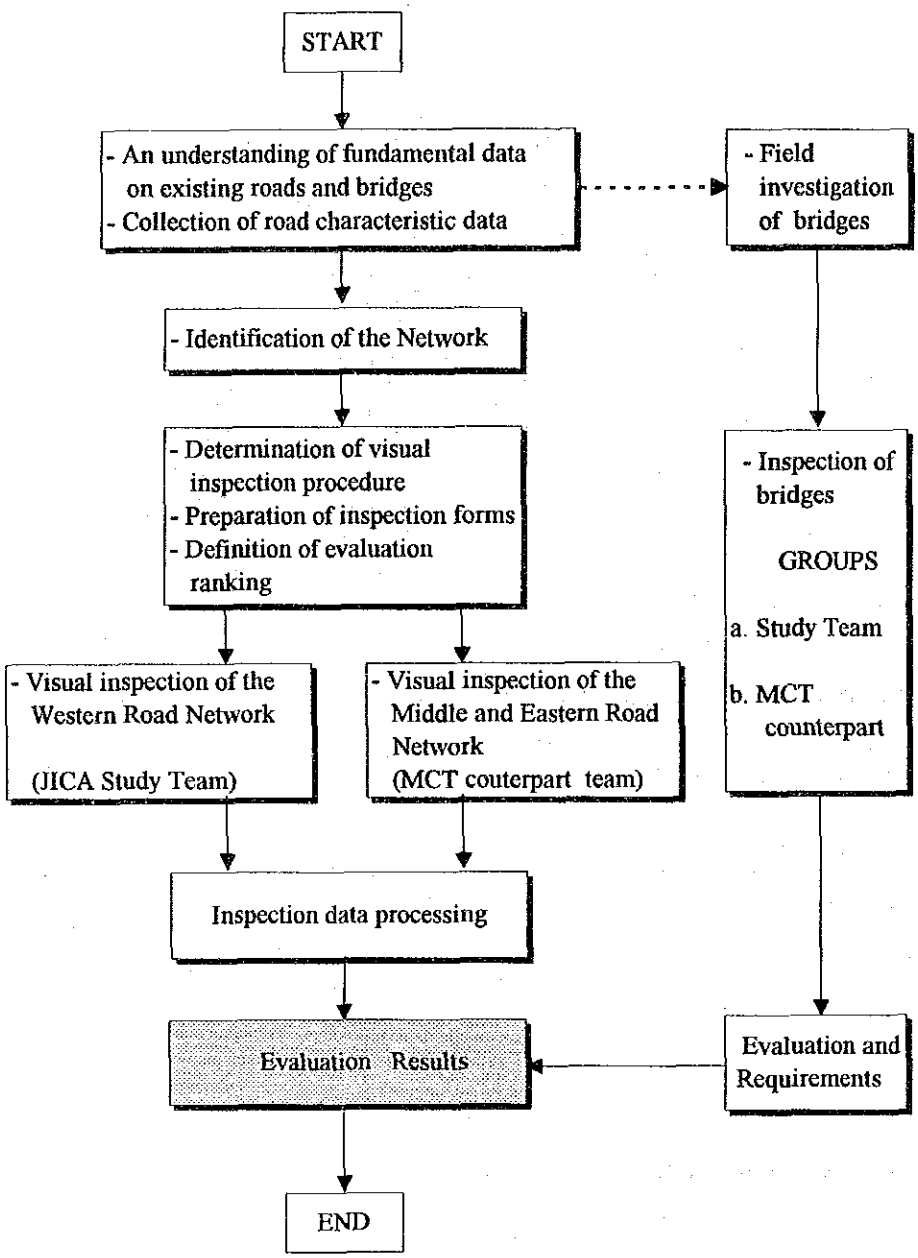


Figure 3-2 Process of Evaluating Existing Road Conditions

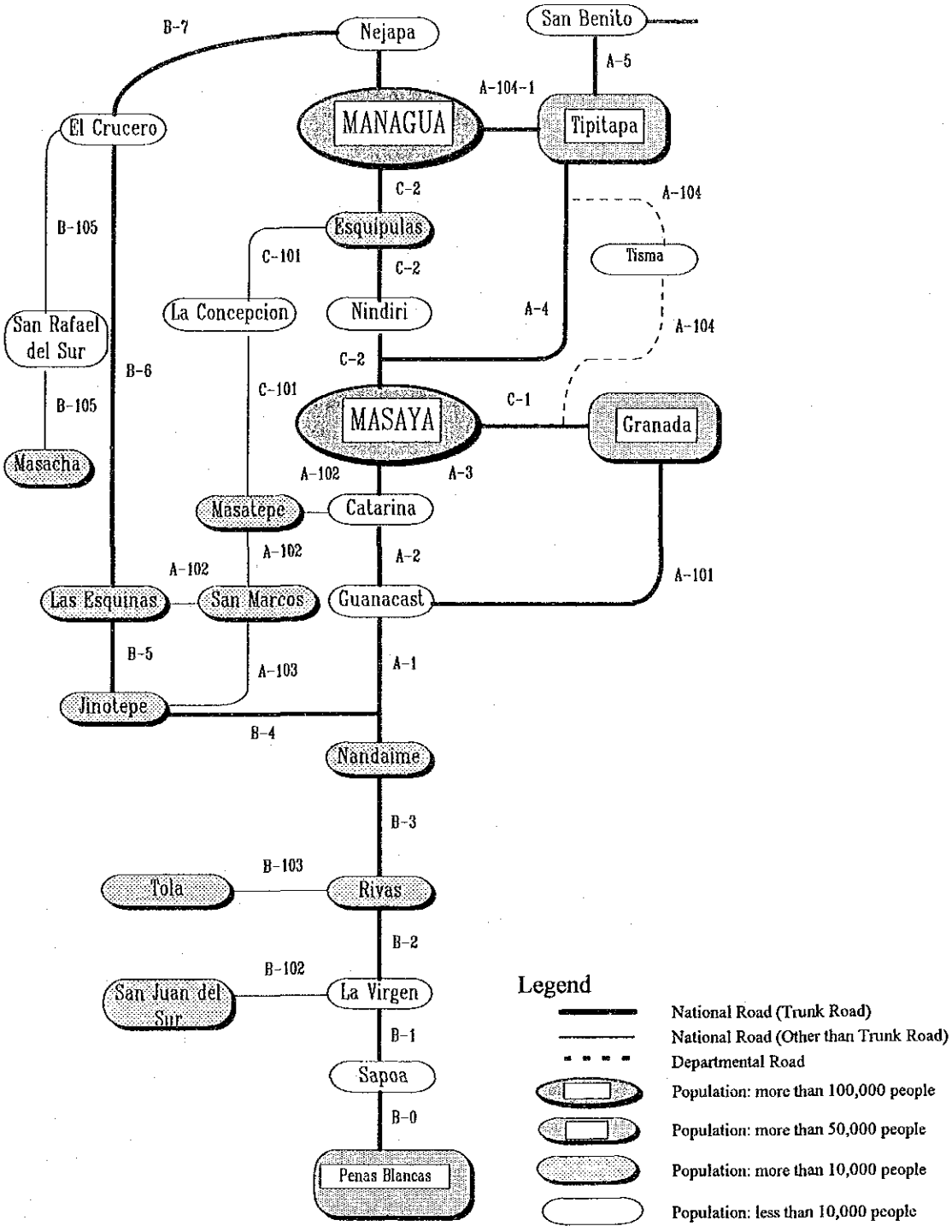


Figure 3-3 Existing Road Network Charts (1)

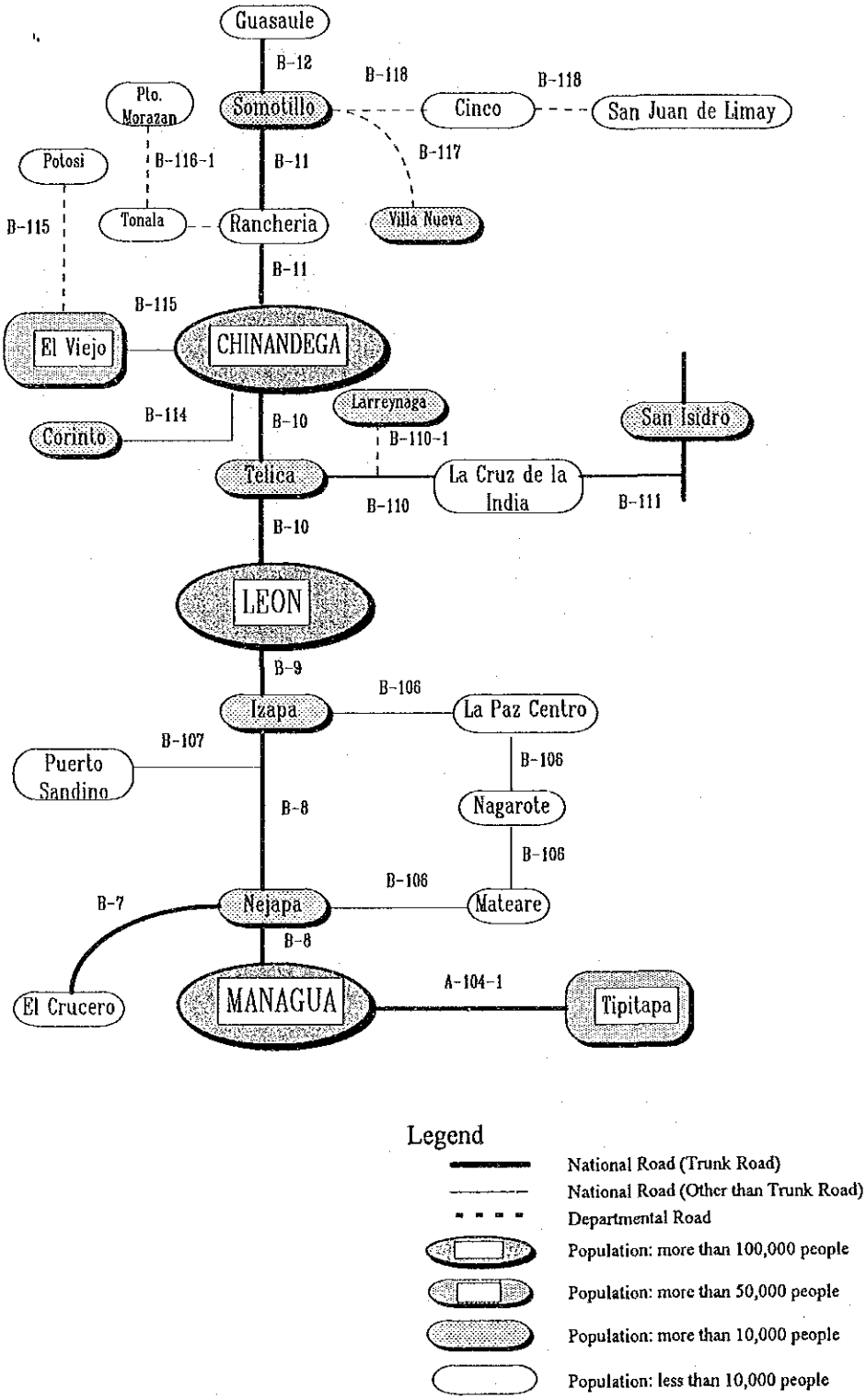


Figure 3-3 Existing Road Network Charts (2)

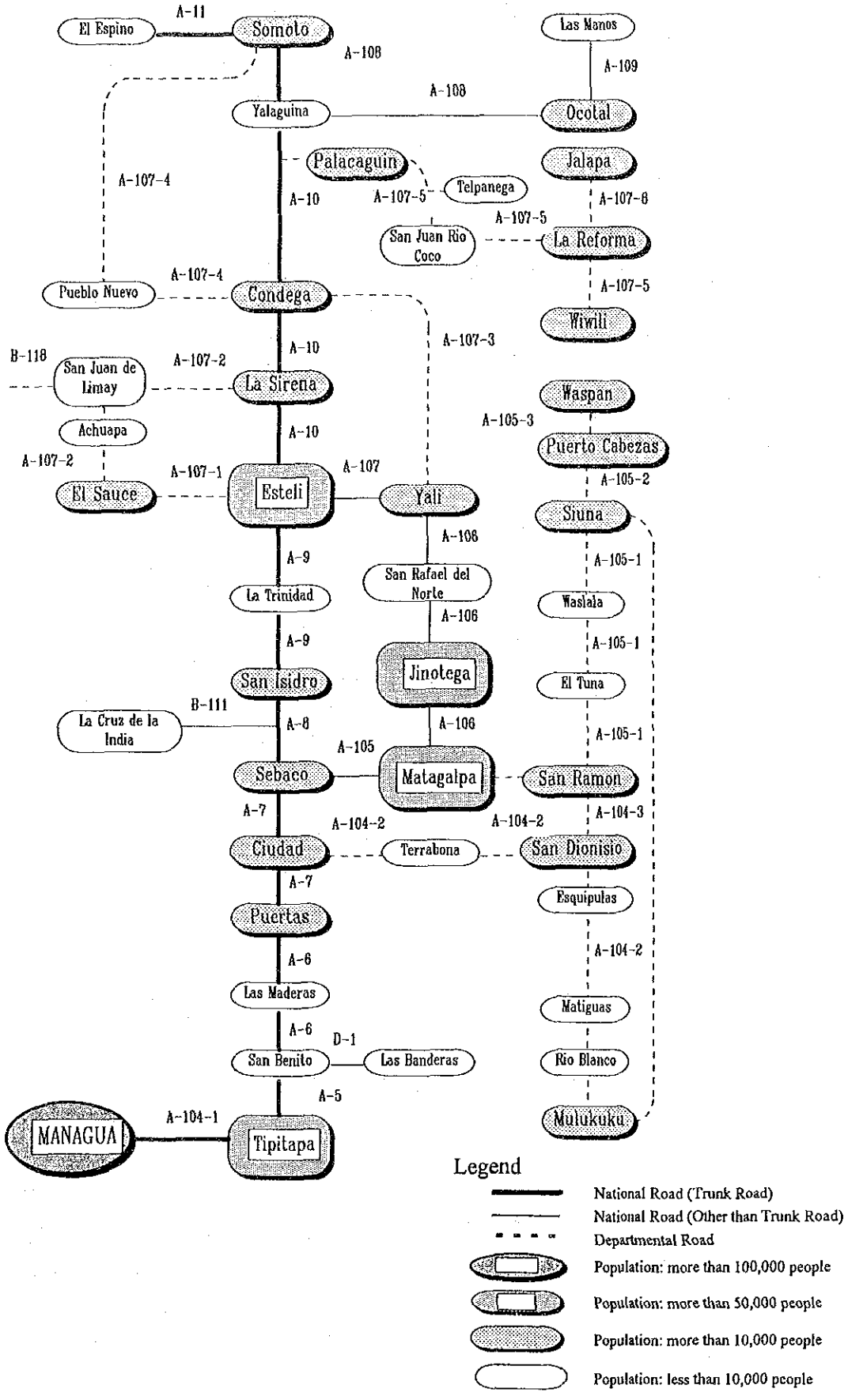


Figure 3-3 Existing Road Network Charts (3)

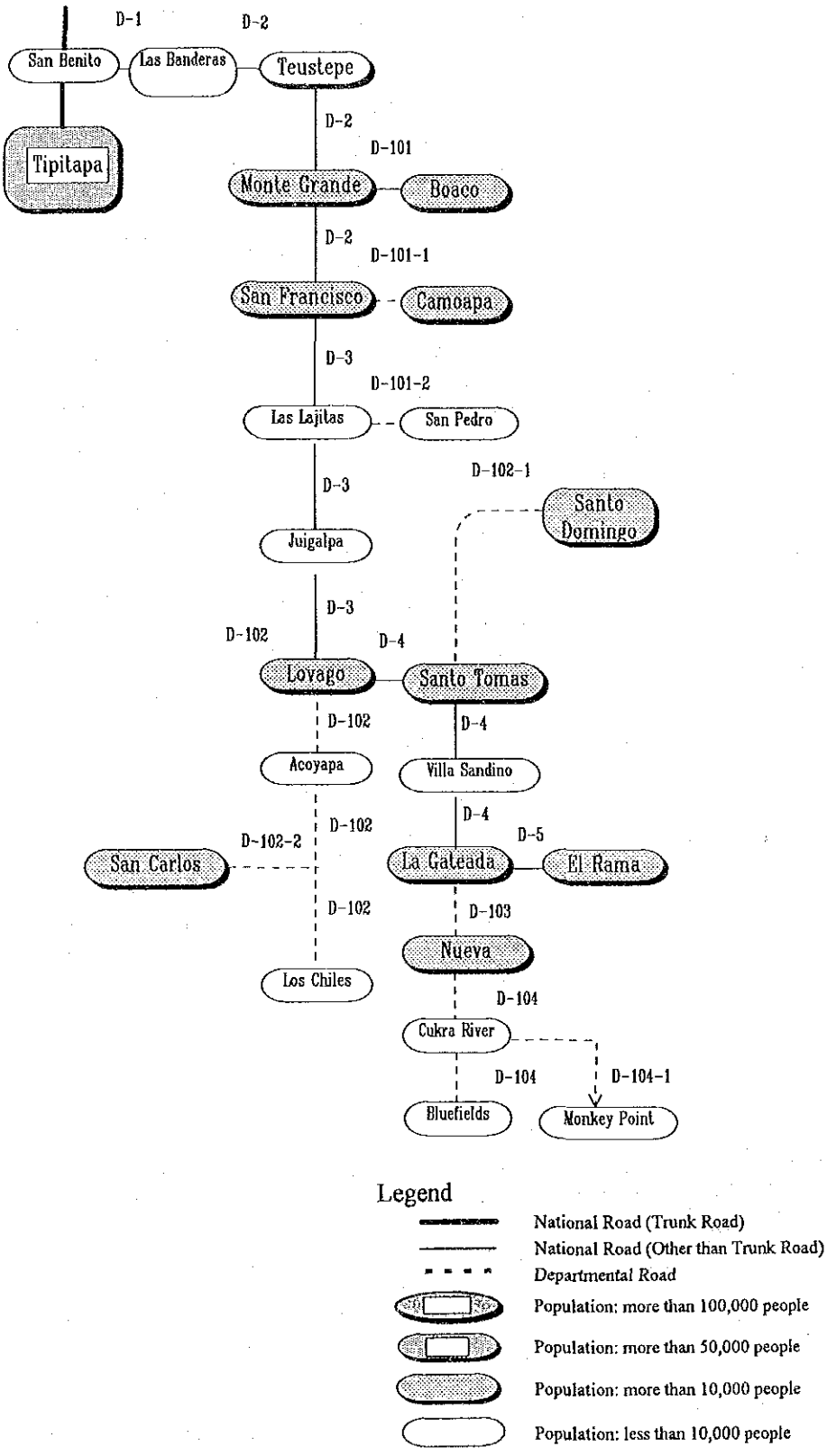


Figure 3-3 Existing Road Network Charts (4)

(2) Rating and Evaluation of Items

Taking into account the main inspection objective, which is to evaluate present road network conditions, the following inspection items were selected:

- Road (pavement) structure
- Drainage
- Slope
- Horizontal and vertical alignment
- Cross-sectional composition

To this end, it is necessary to use an appropriate and reasonable rating or ranking method to evaluate each item based on criteria that takes into account standards for road construction and maintenance, and the rehabilitation management system.

For this purpose, the following ranks and definitions were applied to the evaluation of existing road conditions.

Table 3-5 Evaluation Ranks and Definitions

Rank	Definition
A	Critical
B	Progressive
C	Slightly progressive
D	Fair
E	Good

The present condition of each section was evaluated by an engineer or inspector applying one of these ranks as the representative condition rank for the whole inspected section in a global context.

In order to apply the above definitions to the evaluation, especial aspects were considered in evaluating the pavement, drainage, and cross-sectional composition of the roads.

a) Structural condition of the pavement

The present pavement conditions were evaluated taking into account damage to the pavement surface as well as to the base and sub-base courses. All evaluations were made by applying the ranks and definitions described in Table 3-6. A general list of the major problems encountered on Nicaraguan roads is shown in Appendix 3-2.

Table 3-6 Ranks for Evaluating Pavement Structure Conditions

Rank	Definition	Distress Type	Damage Degree
A	Critical	- Alligator cracking - Corrugations - Streaking cracks - Depressions - Potholes - Patching deterioration - Lane/shoulder drop-off or joint separation - Pumping and water bleeding	Almost whole road sections are damaged. Damage deeply affects traffic flow.
B	Progressive	- Block cracking - Transversal and longitudinal cracking - Slight depressions - Small potholes - Patching deterioration - Lane/shoulder drop-off or joint expansion - Local pumping - Raveling - Polished aggregate - Joint reflection cracking from the PCC slab	Large road sections are damaged. Damage causes a reduction in the velocity of traffic
C	Slightly progressive	- Block cracking - Small potholes - Short transverse and/or longitudinal cracking - Bleeding	Road sections are partly damaged. Accident or risk index increases.
D	Fair condition	- Small bleeding - Small transverse and/or longitudinal cracking	Damage can be observed, but does not affect traffic flow.
E	Good condition	No problems	Traffic conditions are normal.

b) Drainage System

Drainage conditions were evaluated considering the general condition of gutters and waterways by applying the ranks and definitions described in Table 3-7.

Table 3-7 Drainage Condition Evaluation Ranks

Rank	Definition	Description
A	Poor condition	Drainage is completely deteriorated and obstructed
B	Poor-fair condition	Drainage is partially deteriorated and obstructed
C	Fair condition	Partial drainage deterioration and obstruction is progressing
D	Fair-good condition	Some obstruction can be observed
E	Good condition	Drainage system works properly

c) Slope protection

Slope protection was evaluated in a general context by applying the previously defined basic ranks. For this purpose, an engineer or inspector selected a rank to represent the general condition of the entire inspected section.

d) Cross-sectional evaluation

Cross-sectional conditions were evaluated by comparing present transverse dimensions and a section's degree of deterioration degree with a typical cross-section in good condition, and by observing some noteworthy details related the shoulder conditions and considering their effect on traffic capacity and pedestrian safety. For this purpose, the evaluation ranks used are defined in Table 3-8.

Table 3-8 Cross-Sectional Evaluation Ranks

Rank	Definition	Description
A	Poor condition	Effective roadway size is critically reduced. Traffic conditions are seriously affected.
B	Poor-fair condition	Shoulders and traffic lane widths are insufficient. Shoulder and pavement deterioration reduce effective roadway widths.
C	Fair condition	Shoulder base and pavement base courses are damaged due to lack of appropriate drainage or slopes. Shoulder widths are inappropriate.
D	Fair-good condition	No shoulder surfacing is provided. Crown and shoulder slopes are inappropriate.
E	Good condition	Cross-section is maintained in accordance with the standard.

e) Horizontal and vertical alignment

Horizontal and vertical alignment conditions were evaluated by an engineer or inspector judging sight distance adequacy along the whole section. Evaluation results were recorded on the basis of the percentage of the total section having alignment problems.

(3) Inspection

After determining the inspection procedure and evaluation ranking definitions, an inspection was conducted by two teams in order to cover two road network groups. Furthermore, photographs were taken to verify all data.

(4) General Evaluation Ranks

Representative ranks for a general evaluation of each road section were determined after considering the following:

- Case 1 : Road sections with two different ranks

  Select a majority rank, or a higher rank if the number of the two ranks is equal.
- Case 2 : Road sections with three or more ranks

Select a medium rank.

- Case 3 : Road sections with a characteristic calling for special
  Select a rank attached to the particular characteristic.

(5) Evaluation Results

The detailed inspection results are shown in Appendix 3-3, and the respective evaluation results are summarized in Table 3-9. Moreover, these results are illustrated using evaluation charts, which are provided Annexes 3-4. The evaluation results indicate that approximately 1,296.3 km of roads (41% of the road a total network extending 3,126.6 km) were in critical conditions. This group included the following parts of trunk roads:

① Sapoa-La Virgen and Guanacaste-Catarina-Masaya-Managua
(part of the major north - south trunk road)

②Somotillo-San Juan de Limay-La Sirena
(one of the east-west trunk roads)

③San Romon-Sivna-Puerto Cabezas
(part of the Sébaco-Puerto Cabezas route, and an east-west trunk road connecting the Central Region and the Atlantic Region)

④Las Banderas-San Francisco and Lovago-La Gateada-El Rama
(part of the San Benito-El Rama route, and an east-west trunk road connecting the Central Region and the Atlantic Region)

In addition, approximately 1,002.4 km of roads (32% of the total road network) were progressively deteriorating, including the following parts of trunk roads;

① Nandaime-Guanacaste and Managua-Tipitapa
(part of the major north-south trunk road)

② Nandaime-Jinotepe-Nejapa
(part of the major north-south trunk road)

③ Chinandega-Guasaule
(part of the major north-south trunk road)

④ Telica-San Ishidro
(an east-west trunk road)

⑤ Puertas Viejas-Sébaco-Estelí-Somoto-El Espiño
(part of the major north-south trunk road)

⑥ San Francisco-Juigalpa-Lovago
(part of the San Benito-El Rama route, and an the east-west trunk road connecting the Central Region and the Atlantic Region)

Table 3-9 Existing Road Network Conditions (1)

Section	Location			Distance	Width	Present Traffic Volume	Surface Type	Evaluation ranks of the actual condition of existing trunk roads						Ranks of the general evaluation of actual condition
	from:	~	to:	(Km)	(m)	(veh/day)	(1993)	Road Structure	Drainage	Slope	Alignment(%) Horizontal	Alignment(%) Vertical	Cross Section	
A- 1	Nandaime	~	Guanacaste	9.10	9.10	1,900	Asphalt	C	B	B	0.0	0.0	B	B
	Nandaime	~	S-1	5.00	8.90			C	B	B	0.0	0.0	B	
	S-1	~	Guanacaste	4.10	9.40			C	C	C	0.0	0.0	B	
A- 2	Guanacaste	~	Catarina	8.90	9.30	1,850	Asphalt	A	B	C	0.0	6.7	C	A
	Guanacaste	~	S-1	3.00	9.20			A	B	C	0.0	0.0	C	
	S-1	~	S-2	4.10	9.30			B	B	C	0.0	0.0	C	
	S-3	~	Catarina	1.80				D	C	C	0.0	33.3	D	
A- 3	Catarina	~	Masaya	9.10	9.70	3,200	Asphalt	A	B	-	0.0	3.3	B	A
A- 4	Int.Masaya	~	Tipitapa	22.10	8.50	550	Asphalt	C	C	B	1.4	8.1	B	B
	Int.Masaya	~	S-1	3.90	8.50			B	C	B	7.7	15.4	A	
	S-1	~	S-2	1.10	8.50			B	C	B	0.0	0.0	A	
	S-2	~	S-3	5.00	8.60			C	C	B	0.0	0.0	B	
	S-3	~	S-4	5.00	8.10			C	C	C	0.0	0.0	C	
	S-4	~	S-5	5.00	8.90			C	C	C	0.0	18.0	C	
	S-5	~	Tipitapa	2.10	8.90			C	C	C	0.0	14.3	C	
A- 5	Tipitapa	~	San Benito	13.30	11.30	4,000	Asphalt	C	C	C	2.3	0.3	C	C
	Tipitapa	~	S-1	5.00	11.60			B	C	C	0.0	0.0	C	
	S-1	~	S-2	4.50	11.30			D	D	C	0.0	0.0	D	
	S-2	~	S-3	2.30	11.00			C	C	C	0.0	0.0	C	
	S-3	~	San Benito	1.50	11.00			C	C	C	20.0	2.7	C	
A- 6	San Benito	~	Puertas Viejas	36.70	10.00	2,350	Asphalt	C	C	C	0.8	3.3	C	C
	San Benito	~	S-1	5.00				C	C	C	0.0	18.0	C	
	S-1	~	S-2	5.00				B	C	C	0.0	6.0	C	
	S-2	~	S-3(Las Maderas)	5.70				D	C	C	5.3	0.0	C	
	S-3(Las Maderas)	~	Puertas Viejas	21.00				D	C	C	0.0	0.0	C	
A- 7	Puertas Viejas	~	Sebaco	32.40	10.00	2,350	Asphalt	B	B	B	-	-	B	B
	Puertas Viejas	~	S-1	5.00				C	C	C	-	-	C	
	S-1	~	S-2	5.00				D	D	D	-	-	D	
	S-2	~	S-3	5.00				C	B	B	-	-	B	
	S-3	~	S-4	5.00				A	B	B	-	-	B	
	S-4	~	S-5	5.00				A	B	B	-	-	B	
	S-5	~	S-6	5.00				B	B	B	-	-	B	
	S-6	~	Sebaco	2.40				B	B	B	-	-	B	
A- 8	Sebaco	~	San Isidro	13.60	10.00	1,400	Asphalt	C	B	B	-	-	B	B

Table 3-9 Existing Road Network Conditions (2)

Section	Location			Distance	Width	Present Traffic Volume	Surface Type	Evaluation ranks of the actual condition of existing trunk roads						Ranks of the general evaluation of actual condition
								Road Structure	Drainage	Slope	Alignment(%)		Cross Section	
	from:	-	to:	(Km)	(m)	(veh/day)	(1993)				Horizontal	Vertical		
A- 9	San Isidro	-	Esteli	31.30	10.00	1,250	Asphalt	B	B	C	-	-	B	B
	San Isidro	-	S-1	7.00				B	C	C	-	-	C	
	S-1	-	S-2	5.00				B	C	B	-	-	B	
	S-2	-	S-3	5.00				B	B	C	-	-	C	
	S-3	-	S-4	5.00				C	C	C	-	-	C	
	S-4	-	S-5	5.00				B	B	C	-	-	B	
	S-5	-	Esteli	4.30				B	C	C	-	-	C	
A- 10	Esteli	-	Somoto	67.80	10.00	800	Asphalt	B	B	B	-	-	B	B
	Esteli	-	S-1	5.00				A	B	B	-	-	B	
	S-1	-	S-2	5.00				A	A	A	-	-	A	
	S-2	-	S-3	5.00				B	C	C	-	-	C	
	S-3	-	S-4	5.00				B	B	C	-	-	B	
	S-4	-	S-5	5.00				C	C	C	-	-	C	
	S-5	-	S-6	5.00				B	B	B	-	-	B	
	S-6	-	S-7	5.00				C	C	C	-	-	C	
	S-7	-	S-8	5.00				B	B	B	-	-	B	
	S-8	-	S-9	5.00				B	B	B	-	-	B	
	S-9	-	S-10	5.00				B	B	B	-	-	B	
	S-10	-	Yalaguina	6.00				B	B	B	-	-	B	
	Yalaguina	-	Somoto	11.80				B	A	C	-	-	A	
A- 11	Somoto	-	El Espino	21.60	10.00	10	Asphalt	B	A	B	-	-	B	B
	Somoto	-	S-1	5.00				C	B	B	-	-	A	
	S-1	-	S-2	5.00				A	A	C	-	-	B	
	S-2	-	S-3	5.00				D	C	C	-	-	C	
	S-3	-	El Espino	6.60				C	B	A	-	-	B	
A-101	Guanacaste	-	Granada	10.80	8.00	100	Asphalt	D	B	C	0.0	0.0	C	C
A-102	Catarina-Masate	-	SMarc-LasEsqui	19.60	7.00	450	Asphalt	A	B	D	4.6	9.2	B	A
	Catarina	-	S-1	5.00				A	C	D	0.0	18.0	C	
	S-1	-	S-2	5.00				A	C	D	0.0	12.0	C	
	S-2	-	S-3	5.00				A	C	D	18.0	0.0	C	
	S-3	-	Las Esquinas	4.60				D	B	C	0.0	6.5	B	
A-103	San Marcos	-	Jinotepe	6.20	7.00	400	Asphalt	C	C	C	0.0	0.0	C	C
A-104	Granada-Tisma	-	Int.Tipitapa	28.90	4.00	-	E/G	A	A	A			A	A
	Granada	-	Tisma	24.10	4.00		Earth	A	A	A	-	-	A	A
	Tisma	-	Int.Tipitapa	4.80	9.70		Gravel	C	C	C	0.0	0.0	C	C

Table 3-9 Existing Road Network Conditions (3)

Section	Location			Distance	Width	Present Traffic Volume	Surface Type	Evaluation ranks of the actual condition of existing trunk roads						Ranks of the general evaluation of actual condition
								Road	Drainage	Slope	Alignment(%)		Cross	
	from:	-	to:	(Km)	(m)	(veh/day)	(1993)	Structure			Horizontal	Vertical	Section	
A-105	Sebaco	-	Matagalpa	26.90	6.60	1,700	Asphalt	B	B	B	-	-	B	B
	Sebaco	-	S-1	12.00				B	B	B	-	-	C	
	S-1	-	S-2	8.00				B	C	B	-	-	B	
	S-2	-	Matagalpa	6.90				B		B	-	-	B	
A-106	Matagalpa	-	Yali	76.60	6.00	350					-	-		
	Matagalpa	-	Jinotega	32.60							-	-		
	Jinotega	-	SnRafaelNorte	26.30			Gravel	B	C	C	-	-	C	C
	SnRafaelNorte	-	Yali	17.70										
A-107	Esteli	-	Yali	60.70	6.30						-	-		
	Esteli	-	S-1	34.00			Gravel	A	A	A	-	-	B	A
	S-1	-	Yali	26.70										
A-108	Somoto-Yalagui	-	Ocotal	29.20	8.30	600	Asphalt	B	B	A	-	-	B	B
	Somoto-Yalagui	-	S-1	4.00			Asphalt	B	B	A	-	-	B	
	S-1	-	S-2	5.00				B	B	B	-	-	B	
	S-2	-	S-3	5.00				B	B	B	-	-	B	
	S-3	-	S-4	5.00				C	B	A	-	-	A	
	S-4	-	Ocotal	10.20				C	B	C	-	-	B	
A-109	Ocotal	-	Las Manos	24.00	8.30		Asphalt	C	B		-	-	B	B
	Ocotal	-	S-1	7.00				C	C	B	-	-	B	
	S-1	-	S-2	5.00				B	B	B	-	-	B	
	S-2	-	S-3	5.00				C	B	B	-	-	B	
	S-3	-	Las Manos	7.00				C	B	B	-	-	B	
A-104-1	Managua	-	Tipitapa	21.00	10.00	4,500	Asphalt	B	B	C	-	-	C	B
A-104-2	Ciudad Dario	-	Mulukuku	192.90	6.00		Asphalt							
A-104-3	San Dionisio	-	San Ramon	24.30	7.00		Asphalt							
A-105-1	San Ramon	-	Siuna	115.70	7.00	10	Asphalt	A	A	A			A	A
A-105-2	Siuna	-	Pto.Cabezas	218.50	6.00	50	Asphalt	A	A	A			A	A
A-105-3	Pto.Cabezas	-	Waspan	137.50	5.50	-	Gravel	A	B	-	-	-	A	A
A-107-1	Esteli	-	El Sauce	44.60	3.50	200								
	Esteli	-	La aceituna	21.40	3.50		Earth	A	A	A	-	-	A	A
	La aceituna	-	El Sauce	23.20										
A-107-2	El Sauce-Achua	-	La Sirena	72.50	4.50	300								
	El Sauce	-	Achuapa	24.00	4.50		Gravel	A	A	A	-	-	A	A
	Achuapa	-	La Sirena	48.50										
A-107-3	Yali	-	Condega	42.40	6.30		Asphalt							
A-107-4	Condega-P.Nuev	-	Somoto	34.50	3.50		Asphalt							
A-107-5	Palacaguina	-	Wiwili	107.70	4.50		Asphalt							
A-107-6	La Reforma	-	Jalapa	55.10	4.00		Asphalt							

Table 3-9 Existing Road Network Conditions (4)

Section	Location		Distance	Width	Present Traffic Volume	Surface Type	Evaluation ranks of the actual condition of existing trunk roads						Ranks of the general evaluation of actual condition
							Road Structure	Drainage	Slope	Alignment(%)		Cross Section	
	from:	to:	(Km)	(m)	(veh/day)	(1993)				Horizontal	Vertical		
B- 0	Penas Blancas	- Sapoa	4.00	10.00	550	Asphalt	C	C	D	-	-	C	C
B- 1	Sapoa	- La Virgen	20.80	10.00	550	Asphalt	A	A	B	0.0	0.0	A	A
	Sapoa	- S-1	1.10				A	A	B	0.0	0.0	A	
	S-1	- S-2	5.00				A	A	B	0.0	0.0	A	
	S-2	- S-3	5.00				A	A	B	0.0	0.0	A	
	S-3	- S-4	5.00				A	A	B	0.0	0.0	A	
	S-4	- La Virgen	4.70				A	A	B	0.0	0.0	A	
B- 2	La Virgen	- Rivas	11.10	10.00	550	Asphalt	C	B	D	0.0	8.1	C	C
	La Virgen	- S-1	3.60				C	B	D	0.0	16.7	C	
	S-1	- S-2	5.00				C	B	D	0.0	6.0	C	
	S-2	- Rivas	2.50				C	B	D	0.0	0.0	C	
B- 3	Rivas	- Nandaime	44.10	10.00	1,900	Asphalt	C	C	C	0.0	0.7	C	C
	Rivas	- S-1	4.50				C	C	C	0.0	0.0	C	
	S-1	- S-2	5.00				C	C	C	0.0	0.0	C	
	S-2	- S-3	5.00				C	C	C	0.0	0.0	C	
	S-3	- S-4	3.50				B	C	C	0.0	0.0	C	
	S-4	- S-5	6.50				B	C	C	0.0	0.0	C	
	S-5	- S-6	5.00				C	C	C	0.0	0.0	C	
	S-6	- S-7	5.00				D	D	C	0.0	0.0	C	
	S-7	- S-8	5.00				C	C	C	0.0	6.0	C	
	S-8	- Nandaime	4.60				C	C	C	0.0	0.0	C	
B- 4	Nandaime	- Jinotepe	18.00	10.00		Asphalt	A	C	C	0.0	6.7	C	B
	Nandaime	- S-1	3.40	10.00			D	C	D	0.0	8.8	C	
	S-1	- S-2	5.00				A	C	C	0.0	18.0	C	
	S-2	- S-3	5.00				A	C	C	0.0	0.0	C	
	S-3	- Jinotepe	4.60				B	C	C	0.0	0.0	C	
B- 5	Jinotepe	- Las Esquinas	9.50	10.00	2,900	Asphalt	C	B	-	0.0	0.0	C	B
B- 6	Las Esquinas	- El Crucero	13.00	10.00	2,950	Asphalt	B	B	-	0.0	6.9	C	B
	Las Esquinas	- S-1	0.70				D	B	-	0.0	0.0	C	
	S-1	- S-2	5.00				B	B	-	0.0	0.0	C	
	S-2	- S-3	5.00				B	B	-	0.0	0.0	C	
	S-3	- El Crucero	2.30				C	C	-	0.0	39.1	C	
B- 7	El Crucero	- Nejapa	15.40	10.00	4,300	Asphalt	B	B	C	11.7	11.7	B	B
	El Crucero	- S-1	2.40				C	B	C	0.0	12.5	C	
	S-1	- S-2	5.00				C	C	C	24.0	12.0	C	
	S-2	- S-3	5.00				B	B	C	0.0	6.0	B	
	S-3	- Nejapa	3.00				B	B	C	20.0	20.0	B	
B- 8	Managua	- Nejapa-Izapa	66.40	6.70	4,350	Asphalt	-	-	-	-	-	-	Under Construction

Table 3-9 Existing Road Network Conditions (5)

Section	Location			Distance	Width	Present Traffic Volume	Surface Type	Evaluation ranks of the actual condition of existing trunk roads						Ranks of the general evaluation of actual condition
								Road Structure	Drainage	Slope	Alignment(%)		Cross Section	
	from:	-	to:	(Km)	(m)	(veh/day)	(1993)				Horizontal	Vertical		
B- 9	Izapa	-	Leon	25.50	8.10	4,400	Asphalt	C	B	C	0.0	3.5	C	C
	Izapa	-	S-1	10.00				D	A	C	0.0	3.0	C	
	S-1	-	S-2	10.00				D	B	C	0.0	3.0	C	
	S-2	-	Leon	5.50				C	C	C	0.0	5.5	C	
B- 10	Leon	-	Chinandega	40.00	8.10	3,900	Asphalt	C	B	C	0.0	0.8	C	C
	Leon	-	S-1	10.80				C	B	C	0.0	2.8	C	
	S-1	-	S-2	10.00				D	B	C	0.0	0.0	C	
	S-2	-	S-3	10.00				C	B	C	0.0	0.0	C	
	S-3	-	Chinandega	9.20				C	B	C	0.0	0.0	C	
B- 11	Chinandega	-	Somotillo	68.50	8.10	100	Asphalt	B	B	-	0.0	0.9	C	B
	Chinandega	-	S-1	5.00				B	C	-	0.0	0.0	C	
	S-1	-	S-2	5.00				C	B	-	0.0	0.0	C	
	S-2	-	S-3	5.00				C	A	-	0.0	6.0	B	
	S-3	-	S-4	5.00				C	B	-	0.0	0.0	C	
	S-4	-	S-5	5.00				B	C	-	0.0	0.0	C	
	S-5	-	S-6	5.00				C	C	-	0.0	0.0	C	
	S-6	-	S-7	5.00				C	B	-	0.0	6.0	C	
	S-7	-	S-8	5.00				A	B	-	0.0	0.0	B	
	S-8	-	S-9	5.00				C	C	-	0.0	0.0	B	
	S-9	-	S-10	3.00				C	C	-	0.0	0.0	C	
	S-10	-	S-11	7.00				B	C	-	0.0	0.0	C	
	S-11	-	Somotillo	13.50				B	C	-	0.0	0.0	C	
B- 12	Somotillo	-	Guasaule	6.10	9.70	350	Asphalt	B	B	-	0.0	0.0	B	B
B-102	La Virgen	-	San Juan del Sur	18.30	6.50		Asphalt	D	C	D	0.0	1.6	D	D
	La Virgen	-	S-1	5.00				D	C	D	0.0	0.0	D	
	S-1	-	S-2	5.00				D	C	D	0.0	0.0	D	
	S-2	-	S-3	5.00				D	B	D	0.0	6.0	D	
	S-3	-	San Juan del Sur	3.30				D	B	D	0.0	0.0	D	
B-103	Rivas	-	Tola	13.10	7.50		Gravel	C	B	-	-	-	C	C
	Rivas	-	S-1	5.00				D	B	-	-	-	C	
	S-1	-	S-2	5.00				C	B	-	-	-	C	
	S-2	-	Tola	3.10				D	B	-	-	-	C	
B-105	El Crucero	-	SanRafaeldelSur	21.30	6.00		Concrete	C	B	B	23.5	0.0	B	B
	El Crucero	-	S-1	3.30				C	B	B	100.0	0.0	B	
	S-1	-	S-2	3.40				C	B	B	50.0	0.0	B	
	S-2	-	S-3	3.30				C	C	C	0.0	0.0	C	
	S-3	-	SanRafaeldelSur	11.30				C	C	C	0.0	0.0	C	

Table 3-9 Existing Road Network Conditions (6)

Section	Location from:	- to:	Distance (Km)	Width (m)	Present Traffic Volume (veh/day)	Surface Type (1993)	Evaluation ranks of the actual condition of existing trunk roads						Ranks of the general evaluation of actual condition
							Road Structure	Drainage	Slope	Alignment(%) Horizontal	Alignment(%) Vertical	Cross Section	
B-106	Nejapa-Mateare	- Izapa	60.10	7.50		Asphalt				0.0	2.0		B
	Nejapa-Mateare	- S-1	5.00				C	C	-	0.0	6.0	C	C
	S-1	- S-2	5.00				C	C	-	0.0	0.0	C	
	S-2	- S-3	5.00				C	B	-	0.0	0.0	C	
(B-106)	S-3	- S-4	5.00				B	B	-	0.0	0.0	B	A
	S-4	- S-5	5.00				B	B	-	0.0	0.0	B	
	S-5	- S-6	5.00				A	B	-	0.0	0.0	B	
	S-6	- S-7	5.00				A	C	-	0.0	0.0	B	
	S-7	- S-8	5.00				C	C	-	0.0	6.0	B	C
	S-8	- S-9	5.00				C	A	-	0.0	0.0	B	
	S-9	- S-10	5.00				D	A	-	0.0	6.0	B	
	S-10	- S-11	5.00				D	B	-	0.0	0.0	B	
	S-11	- S-12	5.00				D	B	-	0.0	6.0	B	
	S-12	- Izapa	0.10				D	B	-	0.0	0.0	B	
B-107	Izapa	- Puerto Sandino	9.60	7.00	100	Asphalt	C	A	A	-	-	B	B
B-110	Telica	- LaCruz delaIndia	73.70	7.20	300	Asphalt				9.7	1.6		B
	Telica	- S-1	5.00	8.00			B	B	C	0.0	0.0	C	A
	S-1	- S-2	5.00	6.90			A	B	B	0.0	0.0	B	
	S-2	- S-3	10.00	7.20			A	B	B	3.0	3.0	B	
	S-3	- S-4	5.00	8.20			A	B	B	0.0	6.0	B	
	S-4	- S-5	5.67	7.90			A	A	A	0.0	0.0	A	
	S-5	- S-6	1.34	7.90			B	C	C	0.0	0.0	C	
	S-6	- S-7	2.51	7.90			A	C	C	0.0	0.0	C	
	S-7	- S-8	0.50	8.00			D	C	C	0.0	0.0	C	C
	S-8	- S-9	5.01	6.20			D	C	C	0.0	0.0	B	
	S-9	- S-10	6.18	6.20			D	C	C	0.0	0.0	B	
	S-10	- S-11	6.18	6.50			B	C	C	4.9	0.0	B	B
	S-11	- S-12	2.67	6.50			B	C	B	22.5	11.3	B	
	S-12	- S-13	5.01	6.30			B	C	C	12.0	0.0	C	
	S-13	- S-14	5.01	6.30			B	C	C	18.0	0.0	C	
	S-14	- S-15	5.01	7.00			B	C	C	16.0	0.0	C	
	S-14	- LaCruz delaIndia	3.62	7.00			B	C	C	100.0	8.3	C	
B-111	LaCruzdelaIndia	- Int.San Isidro	23.10	8.10	150	Asphalt	B	B	B	-	-	B	B
	LaCruzdelaIndia	- S-1	4.00				B	C	B	-	-	B	
	S-1	- S-2	5.00				C	B	B	-	-	C	
	S-2	- S-3	5.00				B	B	C	-	-	B	
	S-3	- S-4	5.00				B	B	A	-	-	B	
	S-4	- Int.San Isidro	4.00				A	B	C	-	-	B	

Table 3-9 Existing Road Network Conditions (7)

Section	Location from:	- to:	Distance (Km)	Width (m)	Present Traffic Volume (veh/day)	Surface Type (1993)	Evaluation ranks of the actual condition of existing trunk roads						Ranks of the general evaluation of actual condition
							Road Structure	Drainage	Slope	Alignment(%) Horizontal	Alignment(%) Vertical	Cross Section	
B-114	Chinandega	- Corinto	20.00	6.00	700	Asphalt	B	B	-	0.0	0.0	B	B
	Chinandega	- S-1	5.00				C	B	-	0.0	0.0	B	
	S-1	- S-2	5.00				B	B	-	0.0	0.0	B	
	S-2	- S-3	5.00				B	B	-	0.0	0.0	B	
	S-3	- S-4	5.00				C	B	-	0.0	0.0	B	
	S-4	- Corinto	5.00				C	B	-	0.0	0.0	B	
B-115	Chinandega	- Potosi	76.20	6.51		Asphalt	B	B	-	0.0	0.0	C	B
	Chinandega	- S-1	3.50	9.30		Asphalt	B	B	-	0.0	0.0	C	
	S-2	- El Viejo	3.50	9.30		Asphalt	C	B	-	0.0	0.0	C	
	El Viejo	- S-3	38.40	7.00		Asphalt	C	B	-	0.0	0.0	C	
	S-3	- S-4	15.80	5.50		Gravel	B	B	-	0.0	0.0	B	
	S-4	- Potosi	15.00	5.00		Earth	A	A	-	0.0	0.0	A	
B-117	Somotillo	- Villa Nueva	16.00	4.50		Earth	A	A	A	-	-	A	A
	Somotillo	- S-1	5.00				A	A	A	-	-	A	
	S-2	- Villa Nueva					A	A	A	-	-	A	
B-118	Somotillo	- SnJuanLimay	68.00	5.83		Earth	A	A	-	-	-	A	A
	Somotillo	- S-1	29.80	7.00		Gravel	B	C	-	-	-	B	
	S-1	- S-2	16.00	5.50		Gravel	A	A	-	-	-	A	
	S-3	- SnJuanLimay	22.20	4.50		Earth	A	B	-	-	-	A	
B-110-1	Int.Telica	- Larreynaga	6.40	8.10		Asphalt	B	B	B	-	-	B	B
B-116-1	Puerto Morazan	- Rancherias	19.80	4.50		Earth	A	A	A	-	-	A	A
	Rancherias	- S-1	2.00				A	A	A			A	
	S-2	- Puerto Morazan	17.80				A	A	A			A	
C- 1	Granada	- Masaya	18.00	8.00	4,050	Asphalt	B	C	D	0.0	5.0	C	B
	Granada	- S-1	5.00				B	C	D	0.0	6.0	C	
	S-1	- S-2	5.00				C	C	D	0.0	0.0	C	
	S-2	- S-3	5.00				B	C	D	0.0	6.0	C	
	S-3	- Masaya	3.00				B	C	D	0.0	10.0	C	
C- 2	Masaya	- Managua	29.00	9.20	12,150	Asphalt	A	A	-	0.0	0.0	A	A
	Masaya	- S-1	3.00				A	A	-	0.0	0.0	A	
	S-1	- S-2	5.00				A	A	-	0.0	0.0	A	
	S-2	- S-3	5.00				A	A	-	0.0	0.0	A	
	S-3	- S-4	10.00				A	C	-	0.0	0.0	C	
	S-4	- Managua	6.00				C	C	-	0.0	0.0	C	
C-101	Esquipulas	- Masatepe	31.50	8.00		B/A/E							A
	Esquipulas	- S-1	3.80	7.30		C.Blocks	B	A	D	0.0	0.0	D	B
	S-1	- S-2	4.60	8.50		Asphalt	D	D	C	0.0	0.0	D	D
	S-2	- S-3	9.60	8.50		Asphalt	D	D	C	0.0	0.0	D	
	S-3	- Masatepe	13.50	3.80		Earth	A	A	A	-	-	A	A

Table 3-9 Existing Road Network Conditions (8)

Section	Location			Distance	Width	Present Traffic Volume	Surface Type	Evaluation ranks of the actual condition of existing trunk roads						Ranks of the general evaluation of actual condition
								Road Structure	Drainage	Slope	Alignment(%)		Cross Section	
	from:	-	to:	(Km)	(m)	(veh/day)	(1993)				Horizontal	Vertical		
D- 1	San Benito	-	Las Banderas	11.70	6.60	1,750	Asphalt	C	C	-	0.0	5.1	C	C
	San Benito	-	S-1	5.00				C	C	-	0.0	0.0	C	
	S-1	-	S-2	5.00				C	C	-	0.0	12.0	C	
	S-2	-	Las Banderas	1.70				C	C	-	0.0	0.0	C	
D- 2	Las Banderas	-	San Francisco	50.70	6.60	1,150	Asphalt	B	B	A	-	-	B	A
	Las Banderas	-	S-1	4.00				B	B	B	-	-	B	
	S-1	-	S-2	5.00				A	B	B	-	-	B	
	S-2	-	S-3	10.00				B	B	A	-	-	B	
	S-3	-	S-4	5.00				B	A	A	-	-	B	
	S-4	-	San Francisco	26.70				B	B	B	-	-	A	
D- 3	San Francisco	-	Lovago	72.00	8.00	1,150	Asphalt	B	B	B	-	-	B	B
D- 4	Lovago	-	La Gateada	54.00	7.30	550	Asphalt	A	A	B	-	-	B	A
D- 5	La Gateada	-	El Rama	71.70	7.30	400	Asphalt	A	A	B	-	-	B	A
D-101	Monte Grande	-	Boaco	14.00	6.80	800	Asphalt	A	A	A	-	-	A	A
	Monte Grande	-	S-1	4.00			Asphalt	A	B	B	-	-	B	
	S-1	-	S-2	5.00			Asphalt	A	B	B	-	-	B	
	S-2	-	Boaco	5.00			Asphalt	B	A	A	-	-	A	
D-102	Lovago-Acoyapa	-	Los Chiles	134.30	7.00	150	Gravel	B	B	B	-	-	B	B
D-103	La Gateada	-	Nueva Guinea	62.50	5.50		Gravel	B	A	B	-	-	A	A
D-104	Nueva Ginea	-	Bluefields	95.20	-		-	-	-	-	-	-	-	A
D-101-1	San Francisco	-	Camoapa	21.00	9.00		Earth	C	B	B	-	-	C	B
D-101-2	Las Lajitas	-	San Pedro	15.30	4.00		Earth	A	A	A	-	-	B	A
D-102-1	Santo Tomas	-	Santo Domingo	37.20	4.00		Earth	B	B	A	-	-	B	B
D-102-2	Int.Acoy.LosChi	-	San Carlos	2.50	-		Earth	A	-	-	-	-	-	A
D-104-1	Cukra River	-	Monkey Point	56.00	-		-	-	-	-	-	-	-	A

3.3.4 Bridge Investigation

(1) General

A field investigation of the existing bridges was conducted on the major highways on NIC-2, NIC-4, NIC-12, NIC-24, NIC-26 and NIC-28. This, however, did not include the bridges on routes in off-limit areas (NIC-1, NIC-3, NIC-5, NIC-7, NIC-17, NIC-23, NIC-25, NIC-28, NIC-38, NIC-49, and NIC-51).

Information and data on bridges in off-limit areas were obtained through surveys conducted by MCT counterparts and photographs.

(2) Characteristics of Existing Bridges

a) Construction year

Most of the bridges were constructed in the 1960's, although some of them were constructed in the 1940's.

b) Superstructure

The superstructures of these bridges vary from reinforced concrete slabs and T-beams to composite-plate girders and metal trusses.

c) Substructure

Most of the bridges have substructures that consists of reinforced concrete walls used as an abutment and a pier, or rubble masonry walls used as an abutment. The most popular type of substructure includes rubble masonry walls used as an abutment.

d) Bridge length

- Reinforced concrete slabs for bridges less than 10m in length.
- T-beams and composite-plate girders of two to three spans for bridges 10 m to 70 m in length.
- Single-span metal trusses for bridges 40 m to 60 m in length.

(3) Other

Bridges Nos.3, 4, 10 and 15 on route NIC-12 located between Nejapa and Izapa, are now being constructed as part of the Japanese Grant Aid Project.

(4) Investigation Results

Bridge inventory results are shown in Annexes 3-5, and the locations of the surveyed bridges are shown in basic information maps Nos.1, 2 and 3. (Annexes 3-6)

(5) Summary of Existing Bridges

Table 3-10 shows a summary of existing bridges.

Table 3-10 Summary of Existing Bridges

Route	Number of Bridges	Cumulative Length (m)
NIC-1	36	901
2	44	760
3	2	23
4	8	127
5	31	656
7	48	1,462
12	31	510
17	3	34
21	49	955
23	2	59
24	15	870
25	18	267
26	20	327
28	6	93
38	9	183
49	9	97
51	7	49
71	2	96
Total	345	6,679

(6) Evaluation and Requirements

Bridges function as a part of a traffic system. They should therefore be able to cope with existing and future traffic demand.

Structural defects such as shear cracks or tension cracks were not observed on bridges located on the objective roads. Some of long span concrete bridges had their girders reinforced with steel plates with epoxy-bonding agents on both flanges and the bottoms of T-

beams. If long span concrete bridges cannot withstand the load of existing and future traffic demand or if their widths are inadequate, they may be considered to be sub-standard bridges. To handle traffic, it is especially important that bridges are constructed with a sufficient width. Otherwise, traffic will be adversely affected, leading to driving discomfort and accidents. If a bridge proves to be too narrow, it must be replaced or reconstructed in the near future.

Information on the future traffic volume is considerably useful for determining which bridges must be improved or reconstructed. Moreover, structural design load cannot be determined without a comprehensive survey and analysis of the traffic load and volume.

It is difficult to determine the remaining service life of existing bridges, since traffic volume, patterns, and load are changing constantly. Vehicles of different sizes and weights have different operational characteristics, and, these must be taken into consideration before establishing a policy of bridge improvement and reconstruction. A bridge's service life will vary depending on the number of heavy repetitions load. Therefore, the ratio of heavy vehicles to total traffic volume during peak hours should be determined.

If some existing roads are to be reconstructed, the bridges on these roads should fit in with the proposed alignment, profile and width of the approach roads. Such planned highways and road improvements will encourage higher speeds and attract heavier vehicles.

If it is determined that an existing bridge has sufficient structural capacity, it should be reinforced so that tit will be able to handle future traffic demand. In addition, design dimensions should also be subjected to an economic feasibility study, as the cost of reconstruction could be significant because of high unit costs.

In any case, bridges that are too narrow or too weak to handle existing and future traffic loads must either be widened or replaced. In the meantime, all bridges narrower than a standard full-width bridge should be specially treated as narrow bridges. Traffic signs and pavement markings should also be improved.

CHAPTER 4

PRESENT TRAFFIC SITUATION

CHAPTER 4 PRESENT TRAFFIC SITUATION

4.1 EXISTING TRANSPORTATION INFORMATION AND DATA

In Nicaragua, a comprehensive transportation study, entitled "National Transportation Study", was carried out in 1976. Since then Origin-Destination (hereinafter referred to as "O-D") surveys have been conducted a few times within a limited area. However, no comprehensive transportation studies has been undertaken. On the other hand, several studies regarding development of transportation facilities have been conducted with foreign assistance. The following part summarizes major past studies.

4.1.1 Transportation Survey and Study

(1) National Transportation Study of 1976

The major objectives of this study are summarized below.

- Develop a twenty-year national transportation plan based on traffic demand, economic justification, financial capability and national development objectives.
- Prepare a ten-year investment program, setting forth multi-modal transportation needs on a project-by-project basis.
- Recommend a policy framework that will best support the development of an efficient transportation system.
- Consider new transportation organizations to formulate, regulate and coordinate transport planning and policy, to evaluate programs, and to implement the projected infrastructure.
- Establish the priority of the transport sector in relation to other sectors in the national economy.
- Define the relative importance of each mode of transport.
- Evaluate transport in terms of the development of international trade.
- Evaluate transport in terms of strengthening the Central American integration progress.
- Evaluate transport alternatives in terms of regional development programs and decentralization programs within Nicaragua.

The following items were studied:

- Analysis of physical, socio-economic, and traffic factors.
- Analysis of transport modes.
- Determination of transportation demand.

- Determination of future transportation system alternatives.
- 20-year transportation plan.
- 10-year investment program.

In the Study, O-D surveys were conducted at 56 locations in 1975 from May 5 to May 9, and from May 12 to May 19. Each station was surveyed for one day between the hours of 6:00 and 18:00, except Saturdays and Sundays. A total of 20,466 interviews were conducted.

A highway system for 1995 was recommended based on the realization of the following four principal objectives:

- The opening of major surface transportation corridors to the Atlantic coast.
- The providing of access to new areas with agricultural development potential.
- The reduction of gaps and impediments to traffic flow on the national road system.
- The increase of investment in the existing network.

The twenty-year program provides for an average of 477 km of new and reconstructed roads per year. Committed highway projects will crate 802 km of various types of roads. Recommended projects will create 1,399 km, while improving sections where the volume of traffic is heaviest. In addition, new construction projects will create 3,489 km of local and feeder roads.

(2) Comportamiento del Transit en las Carreteras de Nicaragua 1982
(Assessment of Road Traffic in Nicaragua in 1982) - MCT -

In Nicaragua, a survey of traffic volume counting was undertaken by the Ministry of Public Works (MOP) in 1963. This Ministry continued this survey until 1979. However, from 1980 to 1982, the survey was conducted under the auspices of the Ministry of Construction (MICONS, under its new name). In April of 1982 this duty was transferred to the Ministry of Transport (MITRANS). In May of 1988 the Ministry of Transport, the Ministry of Construction and the Ministry of Housing were merged, and the duty of the traffic volume counting survey was transferred to the present MCT.

From 1963 to 1982, annual reports on the traffic situation on the roads of Nicaragua were published. The last report was published by the Traffic Engineering Department of the Ministry of Transport. Since 1983, the reports of traffic volume counting surveys have not been published due to the economic, political and social instability of the country. Therefore, the 1982 report is the latest complete report.

Based on the survey results, which shows hourly, daily, monthly traffic volume, the types of vehicle, etc., this report identified the characteristics of transport demand in Nicaragua. The traffic survey points were 12 stations for "permanent stations" (recording daily measurements year round), 92 stations as "control station (assumed to operate periodically more than two or three times a year) and 162 stations as "summary stations (operating less than three times a year depending on necessity).

The traffic volume at the major survey stations is shown in Figure 4-1.

(3) Project : National Transportation Plan 1989
(Proyecto : Plan Nacional De Transporte 1989) - MCT -

Political instability from the end of 1970 to the beginning of 1980 led the government to neglect traffic data. As a result, this project attempted to collect data and information in order to assess road facilities. The following were comprehensively examined:

- Main characteristics of roads such as their function, width, surface, traffic volume, land, material, etc.
- Road distance (km) by functional classification
- Past growth of the road network
- Analysis and mobility of the road network
- Design criteria
- Bridge inventory

In addition, this report analyzed problems with conditions and future traffic growth. The following problems were indicated.

- Some roads do not have a sufficient capacity to accommodate the increasing traffic volume.
- Most roads cannot accommodate the increasing traffic, since these roads were constructed with lower design criteria.
- Severe weather has damaged roads.
- Road surfaces find it increasingly difficult to accommodate the increasing number of heavy axle load vehicles.
- Road maintenance is being neglected due to the lack of funds for equipment and materials such as asphalt.

Future traffic demand is expected to grow at a considerably moderate rate; therefore, projections are not very different from those given in the traffic survey of 1993 except in the case of roads in the vicinity of Managua. Traffic volume on the road section of Managua-

Masaya Road already totals more than 20,000 vehicles a day. Projection of future traffic volume at main points are shown in Table 4-1.

Table 4-1 Traffic Volume Projection By MCT

Survey Station*	1989	1990	1995	2000	2010	2020	G.W (1)	G.W (2)
100	4,060	4,134	4,505	4,876	5,618	6,360	1.7	1.3
107	1,779	1,805	1,933	2,062	2,318	2,575	1.4	1.4
200	2,624	2,628	2,651	2,673	2,718	2,763	0.2	0.2
400	7,983	7,992	8,037	8,082	8,172	8,262	0.1	0.1
405	1,812	1,842	1,987	2,133	2,424	2,715	1.5	1.2
700	720	962	754	982	1,038	1,094	2.9	0.5
1200	1,182	2,225	2,440	2,653	3,018	3,508	7.6	1.4
1205	5,961	6,030	6,873	7,715	9,401	11,086	2.4	1.8
2800	3,342	3,430	3,869	4,308	5,627	6,066	2.3	1.7

Source : Proyecto - Plan Nacional De Transporte, Diagnostico del Transporte Terrestre
Note : G.W(1) represents the average growth rate from 1989 - 2000 (%)
G.W(2) represents the average growth rate from 2000 - 2020 (%)
* - Refer to Figure 4-1

(4) Project : National Transportation Plan Report on the Preliminary O-D Survey 1990
(Proyecto : Plan Nacional de Transporte "Documento Resultados Preliminares de la Encuesta Origen y Destino por Carreteras 1990)" - MCT -

This report includes the preliminary results of the O-D survey conducted in 1989. The following data is given.

- The number of vehicles by owner.
- Type of cargo carried by trucks.
- Type of fuel used.
- Capacity.
- Trip purpose.
- Vehicle models.
- Year produced.

The Major results are as follows.

a) Modal Split

- Passenger cars and pick-ups	36.90 %
- Light trucks	31.06 %
- Microbuses	1.33 %
- Buses	3.21 %
- Trucks	22.15 %
- Trailers	3.06 %
- Tractors	2.27 %

b) Purpose of Trip

- Going to work	65.7 %
- Going to school	0.8 %
- Business	3.1 %
- Shopping	1.6 %
- Recreation, etc.	4.6 %
- Going to hospital, etc.	0.3 %
- Going to church	0.1 %
- Others	12.8 %
- No information	11.3 %

Regrettably, although an O-D survey was conducted as part of this project, the results have not yet been examined or analyzed.

(5) Development Study for the Transport System of the Atlantic Coast of Nicaragua
1992 - DANIDA -

This project was conducted by DANIDA (Danish International Development Agency) at the request of the Nicaragua Government to give strategic advice on the development of the transport system of the Atlantic regions of Nicaragua.

The Atlantic zone (region) is composed of RAAN (the previous Zona Especial I or Puerto Cabezas) and RAAS (part of the previous Zona Especial II with Bluefields), where agricultural and fishery activities are strongly hampered by a lack of transportation which makes it difficult to commercialize local products and daily goods.

Most of the Atlantic regions are low lying, which means that it floods during the rainy season. Consequently, road construction is very difficult and the primary means of transport is via waterways. Only the western and northern part of RAAN is somewhat dried partly hilly. It, therefore, has a gravel/earth road system, which is an important element of the transport system.

The total population of the Atlantic regions is believed to be around 250,000, while the total area is about 60,000 km^2. The future volume of passenger traffic in the low growth scenario was forecast based on the assumption that individual travel would not increase. Therefore, any expected growth will be the result of an increase in population. It is believed that the population will naturally grow by 3.2% per year, and that a 10% increase will result from the return of refugees. The high growth scenario, on the other hand, assumed an increase in individual travel at a rate of three percent per year from 1990. The resulting forecasts are shown in Tables 4-2 and 4-3.

Table 4-2 Passenger Forecasts (1990 - 2000)

(unit : 1000 persons)

Route	1990	1995	2000
Bluefields - Rama	76 76	84 103	104 140
Bluefields - Bluff	106 106	124 144	145 195
Bluefields -Corn Islands	18 18	21 24	24 32
Bluefields - Kukra Hill	5 5	6 7	7 9
Bluefileds - Laguna de Perlas	14 14	16 19	19 26
Bluefields - Río Grande	5 5	6 7	7 9
Total	224 224	262 304	306 411

Note : Upper case - Low Growth Scenario
Lower case - High Growth Scenario

Table 4-3 Goods Forecasts (1990 - 2000)

(unit : 1000 tons)

Route	1990	1995	2000
Bluefields - Rama	27 27	28 33	33 45
Bluefields - Bluff	4 4	4 5	5 7
Bluefields -Corn Islands	3 4	3 3	3 4
Bluefields - Kukra Hill	2 2	2 2	2 3
Bluefileds - Laguna de Perlas	1 1	1 2	2 2
Bluefields - Río Grande	1 1	1 1	1 1
Total	38 38	39 46	46 62

Note : Upper case - Low Growth Scenario
Lower case - High Growth Scenario

The main conclusions and recommendations of this study of the main routes are:

① Maintain and improve the link between Bluefields and western Nicaragua.

- Short Term

  Río Escondio must be deployed on the Rama-Bluefields route until a replacement vessel becomes available.

- Medium Term

  The existing route via road to Rama and the Río Escondio must be maintained, including the rehabilitation and subsequent maintenance of the road to Rama, the construction of a new passenger quay at Rama, and the rehabilitation of the municipal quay at Bluefields, and the construction of a new regional cargo wharf at Bluefields.

- Long Term

  An all weather road route to Bluefields via Nueva Guinea must be provided.

② The transport link between Bluefields/El Bluff and Puerto Cabezas must be improved.

- Medium Term

  A regular shipping service from Rama/Bluefields/El Bluff to Puerto Cabezas must be provided.
- Long Term

  An intra-coastal canal must be completed.

③ Transport between western Nicaragua, and the mines and Puerto Cabezas must be improved.

- Medium Term

  Rehabilitation of one of the roads linking the mines to western Nicaragua and further on to Puerto Cabezas, including the crossing the Río Wawa, must be completed.

(6) Feasibility Study for Rehabilitation of Nandaime - Rivas - Peñas Blancas Road, Nicaragua 1993 (Estudio de Factibilidad para la Rehabilitación de la Carretera de Nandaime - Rivas - Peñas Blancas, Nicaragua 1993) - DANIDA -

This report comprises a feasibility study for investment in the 82.4 km Nandaime - Peñas Blancas road. This report includes the following:

- Examination of the existing road structure.
- Research on the construction history of the road.
- Collection of all available traffic data, and initiation of additional traffic surveys.
- Estimation of construction costs for alternative construction options.
- Estimation of maintenance costs.
- Traffic forecasting.
- Economic analysis.
- Sensitivity analysis.
- Environmental assessment.

Recommendations are as follows:

- All potholes should be patched both before and after any construction option is implemented.

- The worst 6.8 km of the La Virgen - Sapoa road should be reconstructed as soon as possible.
- Reconstruction of the Nandaime - La Virgen road and the balance of the work for the re-sealing option on the La Virgen - Sapoa road should proceed in the near future, but this is not urgent.
- The pavement structure should be investigated to supplement existing data. This will enable more accurate estimates of the design costs.
- Trees should be planted in an anesthetically pleasing manner within the road reserve, but beyond the shoulder and side drains, where they exist.

(7) Rehabilitation Program for rural roads 1993
(Programa de Rehabilitacion de Caminos Rurales 1993) - BID -

The main purpose of this report is to increase the service level of the rural road network in the central zone of the country, while emphasizing the importance of road maintenance work. In addition, the report stresses the necessity of institutional strengthen to rehabilitate roads on the basis of permanent criteria. The report's major contents are as follows:

- Rehabilitation of approximately 750 km of rural roads.
- Necessity of the consultant service in order to support debtor for the administration works.
- Preparation of the technical, economical, and environmental studies necessary for the road rehabilitation.
- Development and establishment of planning and administration systems for rural road network maintenance.
- Supervision of the execution of civil works.
- Technical assistance for the reorganization of the MCT, and for a subsequent strengthening of environmental management.
- Acquisition of vehicles and equipment that will not cause road conditions to deteriorate.

This project will also have a positive impact on the development of agricultural areas, since it will provide producers (farmers) with better transportation conditions for their agricultural products and other daily goods. Also, it would contribute to improving the living standard of residents living in the rural area, since they will have better access to social services.

4.1.2 Existing Traffic Volume on the Major Roads

As of 1993, reliable traffic volume counting data of major roads is available for 1982 (refer to the above report (2)) and 1989 (refer to the above report (3)). These reports are shown in Table 4-4 and Figure 4-1. The traffic volume increased on major roads in the vicinity of large cities, although it decreased in local areas. The phenomena of the urbanization had already begun by the late 1980's in Nicaragua.

Table 4-4 Traffic Volume in 1982 and 1989

Survey Point	1982	1989
No. 100 (San Benito - Managua)	3,317	3,103
No. 107 (Sébaco - San Ishidoro)	1,587	1,103
No. 200 (Hejapa - El Crucero)	2,592	2,206
No. 400 (Managua - Masaya)	7,442	7,942
No. 405 (Guanacaste - Nandaime)	1,641	1,599
No. 700 (Tecolostote - Managua)	897	-
No. 703 (San Benito - Rama)	-	1,110
No.1200 (León - Managua)	1,843	940
No.1203 (León - Chinandega)	-	4,730
No.1205 (León - Chinandega)	3,668	-
No.2800 (Managua - Matearis)	2,905	-
No.2802 (Las Piedrecitas - La Paz)	-	3,555

Source : "Comportamiento del Transito en las Carreteras de Nicaragua 1982"
"Resultados Preliminares de la Encuestade Origen y Destino por Carretera 1989"

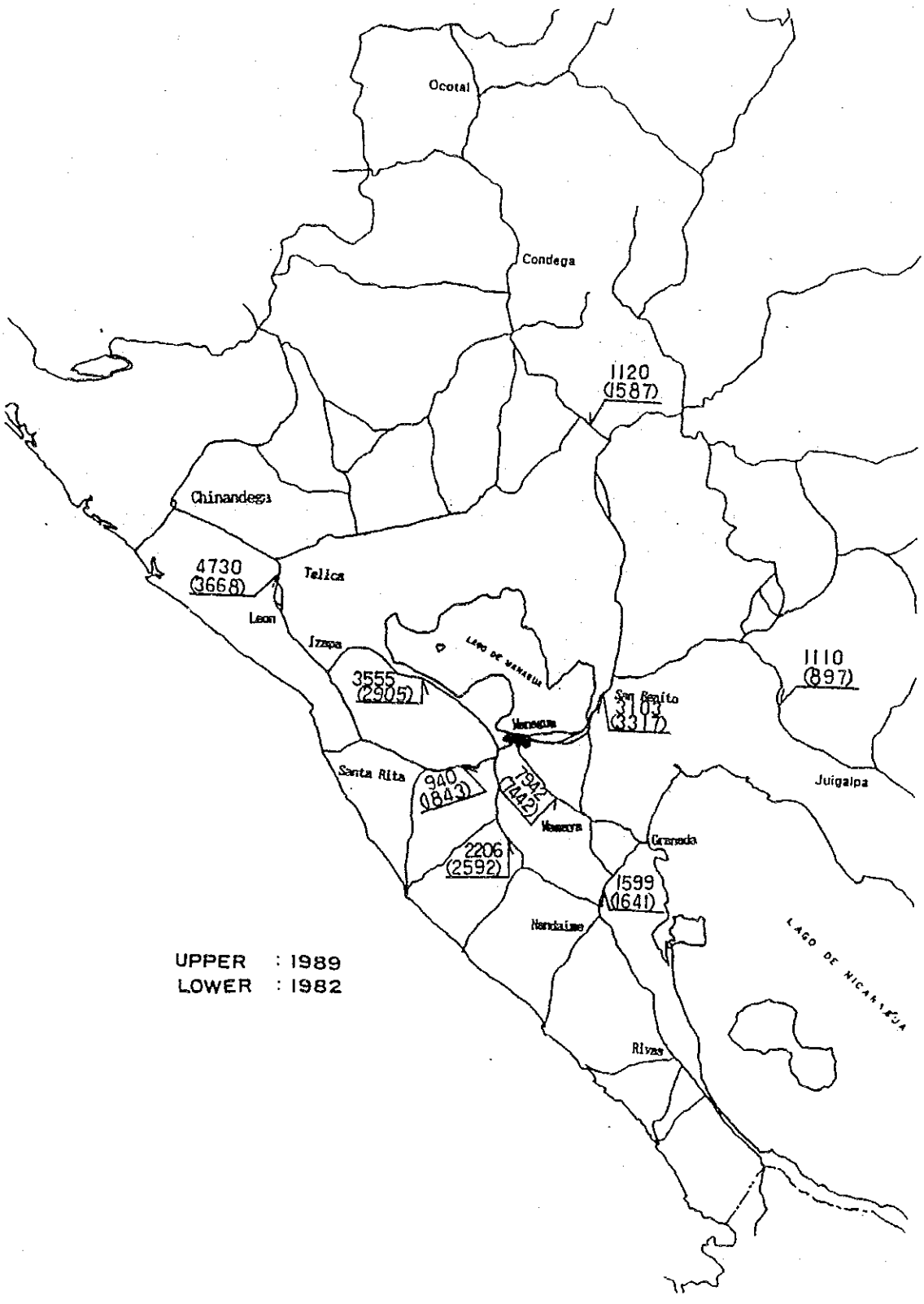


Figure 4-1 Traffic Volume on Major Roads

4.2 TRAFFIC SURVEY

In order to obtain basic information regarding present traffic conditions on primary and secondary trunk highways in the Study Area, the following traffic surveys were conducted.

4.2.1 Roadside O-D Survey

The objective of the Roadside O-D Survey was to assess vehicle movement between the regions of the Study Area. This data will be utilized to create an O-D Table, which will provide the fundamental data for transportation planning in the Study.

(1) Survey Schedule

The O-D Survey was conducted on the 30th (Tuesday) and 31st (Wednesday) of March 1993 between 7 a.m. and 7 p.m. at each survey station.

(2) Survey Location

The JICA Study Team selected the survey locations of the O-D Survey on primary and secondary arterial highways after conducting spot observations and engaging in a series of discussions with MCT counterparts. The list of survey stations for the O-D Survey is shown in Table 4-5, while Figure 4-2 designates the location of each survey station.

These survey stations were selected not only from among those in the permitted regions, but also from those in off-limit regions while taking into account the availability of present traffic data.

(3) Survey Procedure

At each survey station, vehicle drivers stopped by police officers were interviewed. The main contents of the interviews were as follows:

- Origin and destination of trip
- Purpose of trip
- Number of passengers
- Type and volume of cargo

Figure 4-3 shows the survey sheet utilized for the O-D Survey.

Table 4-5 List of O-D Survey Stations

Station No.	Location	Survey Date
1	Chinandega	March 30, 1993
2	Intersection to Chichigalpa	- do -
3	Telica	- do -
4	León	- do -
5	Izapa	- do -
6	Santarita	- do -
7	San Benito (Road to Matagalpa)	- do -
8	San Benito (Road to Rama)	- do -
9	Carretera Nueva León, Entrance of Sandiho Town	March 31, 1993
10	Kirometro 8 Sur, Frente Rest	- do -
11	Carretera Masaya	- do -
12	Carretera Norte, In front of the Agraria University	- do -
13	Carretera Masaya - Tipitapa	- do -
14	Las Conchitas	- do -
15	Granada	- do -
16	Diriomo	- do -
17	Nandaime	- do -
18	Rivas	- do -
19	Juigalpa-Rama	- do -
20	Carretera Matagalpa - Sébaco	- do -
21	Esteli	- do -
22	Condega	- do -
23	Ocotal	- do -

(4) Sample Size

One of the most important factors in any survey is to determine the sample size. Needless to say, the higher the sample rate, the greater the increase in confidence. However, in the case of the roadside O-D survey, it was very difficult to increase the sample size on roads with a heavy traffic volume because of the following reasons:

- Number of surveyors.
- Risks such as traffic accidents.
- Survey costs.
- Traffic congestion at survey points.

However, generally speaking, it is empirically accepted that the minimum sample rate should be 50% or more for peak hour traffic volume at the survey point. Since the peak ratio is 7- 10 % of the total traffic volume per day, the minimum sample rate on a road with a traffic volume of 20,000 vehicles per day (for example, almost corresponding to the road section between Managua and Masaya) is calculated to be 700-1,000 samples.

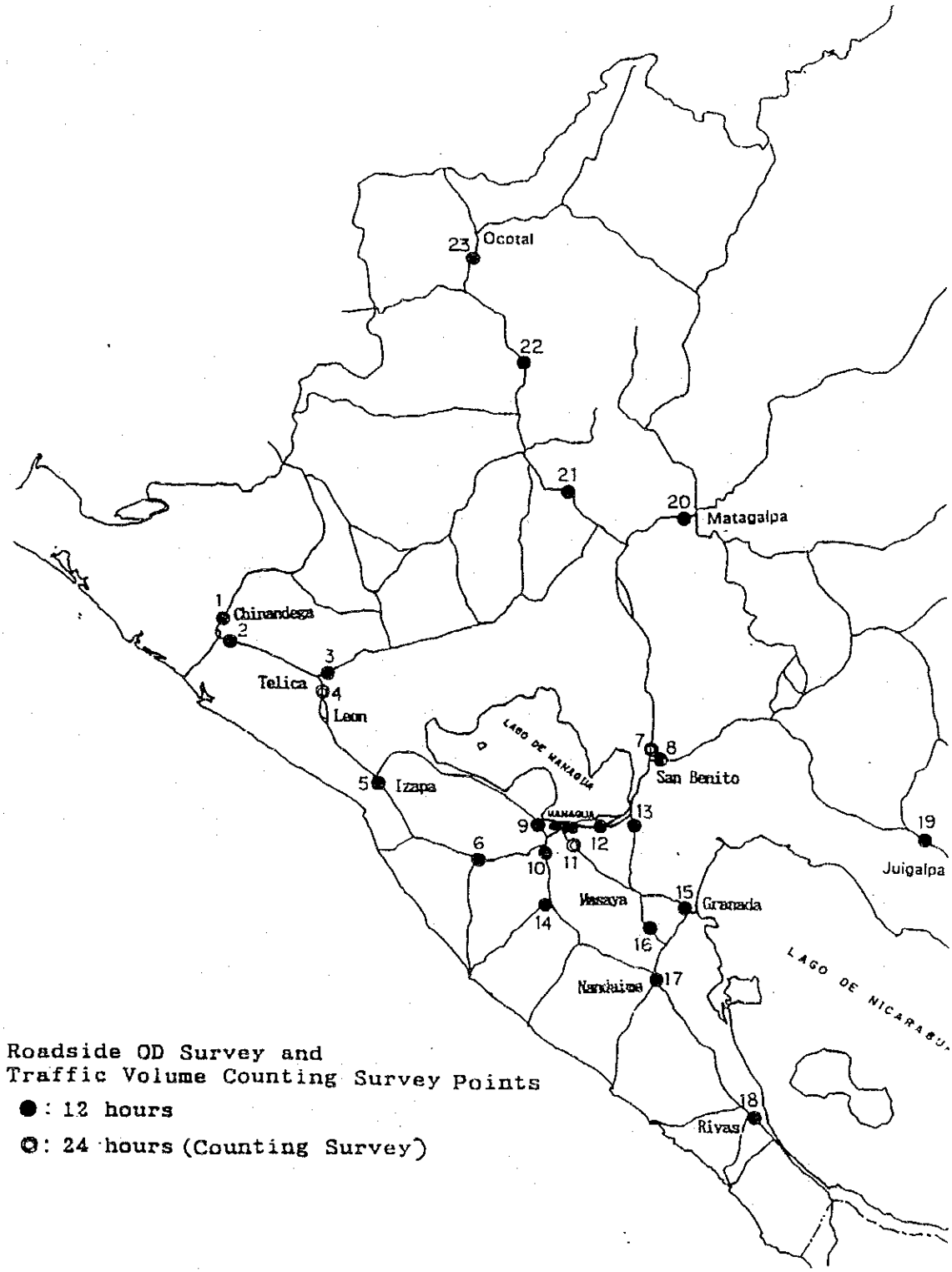


Figure 4-2 Location of Survey Stations

FORMULARIO DE ENCUESTA A LOS CONDOCUTORES

Número de Estación de Encuesta__________ (1. a Managua. 2. de Managua)

1	2	3	4	5	6	7	8	9	10	11
Hora de Encuesta	Clase de Vehículo	Marca del Vehículo	VIAJE		Objeto del Viaje	Capacidad de Carga	Carga Transportada		Número * de Pasajeros	Observacion
			Origen	Destino			Articulo	Quintal o Galones		
AM :	1 4 7				1 4 7					
	2 5 8				2 5 8					
PM :	3 6				3 6					
AM :	1 4 7				1 4 7					
	2 5 8				2 5 8					
PM :	3 6				3 6					
AM :	1 4 7				1 4 7					
	2 5 8				2 5 8					
PM :	3 6				3 6					
AM :	1 4 7				1 4 7					
	2 5 8				2 5 8					
PM :	3 6				3 6					
AM :	1 4 7				1 4 7					
	2 5 8				2 5 8					
PM :	3 6				3 6					
AM :	1 4 7				1 4 7					
	2 5 8				2 5 8					
PM :	3 6				3 6					
AM :	1 4 7				1 4 7					
	2 5 8				2 5 8					
PM :	3 6				3 6					

1. Negocios	4. Sociales	7. Retormo a su vivienda
2. Dirigiéndose al trabajo	5. Turismo, Recuperacion fisica	8. Otros
3. Dirigiéndose a la escuela, colegio, etc.	6. Compras	

1. Vehículos livianos (principalmente de pasajaros)	4. Pick-up	7. Otros
2. Micro bus	5. Camión	8. Motocicletas
3. Auto bus	6. Semi-remorque	

Nota : 'Numero de Pasajeros' no incluye choferes.

Figure 4-3 O-D Survey Sheet

For this survey the sample rate at each survey station was determined before the surveybegan by considering 1.3-1.5 times of the traffic volume obtained by MCT in 1989 to take into account the traffic increase from 1989 to 1993. As a reference, the peak hour traffic volume at each survey station is given in the Appendices.

4.2.2 Traffic Volume Counting Survey

The Traffic Volume Counting Survey was conducted to assess the traffic volume on the major road network in the Study Area. At the same time, such a survey made it possible to determine the expansion factors for the O-D Survey data shown in 4.1.

(1) Survey Schedule and Locations

Traffic Volume Counting Surveys were carried out at the same locations and the same time as the O-D Survey mentioned above. However, traffic volume was counted around the clock (7 a.m. to 7 a.m. in the following morning) at only 3 of these stations (i.e. Stations 4, 7 and 11) in order to identify the day-night ratio of traffic volume.

(2) Survey Procedure

At each survey station, traffic volume was counted by direction and vehicle type, and the obtained data was recorded by the hour. In this survey, vehicles were classified according to eight types as shown below. This classification took the classification employed by MCT and the study purpose into consideration.

- Passenger cars
- Micro buses
- Large buses
- Pick-ups
- Trucks
- Semi-trailers
- Motorcycles
- Others

The vehicle type and the survey sheets utilized for this survey are shown in Figures 4-4 and 4-5, respectively.

Fig. 1
Vehiculos livianos

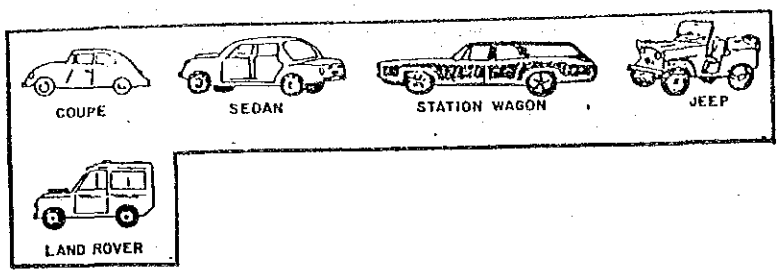


Fig. 2
Micro bus

Fig. 3
Auto bus

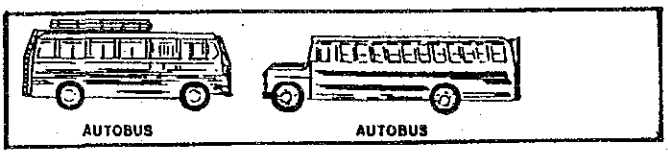


Fig. 4
Pick-up

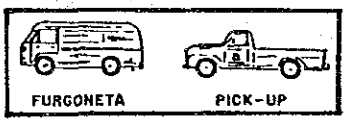


Fig. 5
Camion

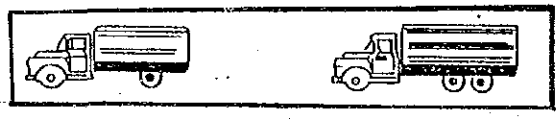


Fig. 6
Semi-remorque

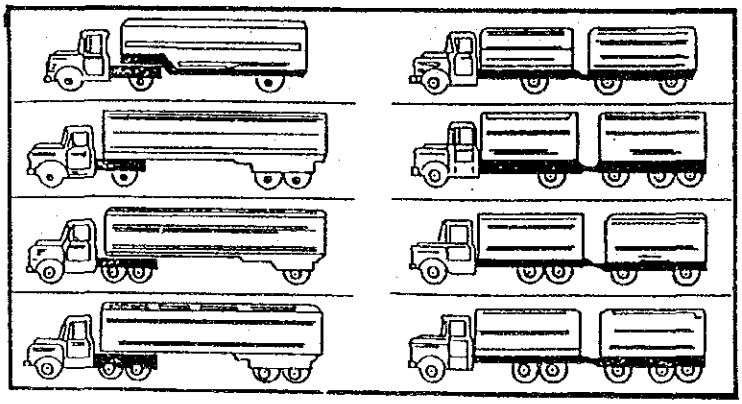


Fig. 7
Otros

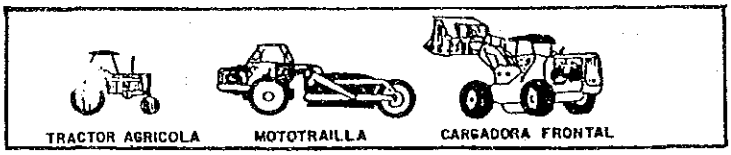


Fig. 8
Motocicletas

Figure 4-4 Type of Vehicle

HOJA DE CONTEO DE VOLUMEN DE TRANSITO

FECHA : PUNTO DE CONTEO:

Direccion								
Tipo	Vehiculos livianos	Micro Bus	Auto Bus	Pick-up	Camion	Semi-remorque	Otros	Motocicletas
Hora	(Fig 1)	(Fig 2)	(Fig 3)	(Fig 4)	(Fig 5)	(Fig 6)	(Fig 7)	(Fig 8)
7:00- 8:00								
8:00- 9:00								
9:00-10:00								
10:00-11:00								
11:00-12:00								
12:00-13:00								
13:00-14:00								
14:00-15:00								
15:00-16:00								
16:00-17:00								
17:00-18:00								
18:00-19:00								

Figure 4-5 Survey Sheet for the Traffic Volume Counting Survey

4.2.3 Travel Speed Survey

The JICA Study Team carried out a travel speed survey on major highways in the Study Area, to collect data that could be used in the determination of the Quantity-Velocity Formula as well as to identify bottlenecks on the existing highway network in the Study Area.

(1) Survey Schedule

Travel speed surveys were carried out on April 21, 1993 (Wednesday). A round trip was made at each of the time periods mentioned below:

- Morning peak period (7 a.m. - 9 a.m.)
- Off-peak period (10 a.m. - 12 a.m.)
- Evening peak period (5 p.m. - 7 p.m.)

(2) Survey Route

The JICA Study Team selected 10 (ten) survey routes for the travel speed survey mainly on the primary and secondary arterial highways in the Study Area. Figure 4-6 illustrates the location of each survey route, while the list of travel speed survey routes is shown in Table 4-6.

Table 4-6 List of Travel Speed Survey Routes

No.	Survey Route	Distance (km)
1	Hermanos Garcia - Entrance of Chinandega	20
2	Entrance of Chinandega - Entrance of Cesar Sandíno	16
3	Entrance of Cesar Sandíno - Entrance of Telica	13
4	Malpaisillo - Entrance of Terica	24
5	Entrance of Telica - Entrance of León	8
6	Entrance of Nagarote - Belmonte	36
7	Entrance of Masaya - Intersection with Central American Highway	22
8	Entrance of San Benito - Camilo Chamorro	26
9	Santa Ana - Entrance of Masaya	24
10	Donald Barra - Rivas	31

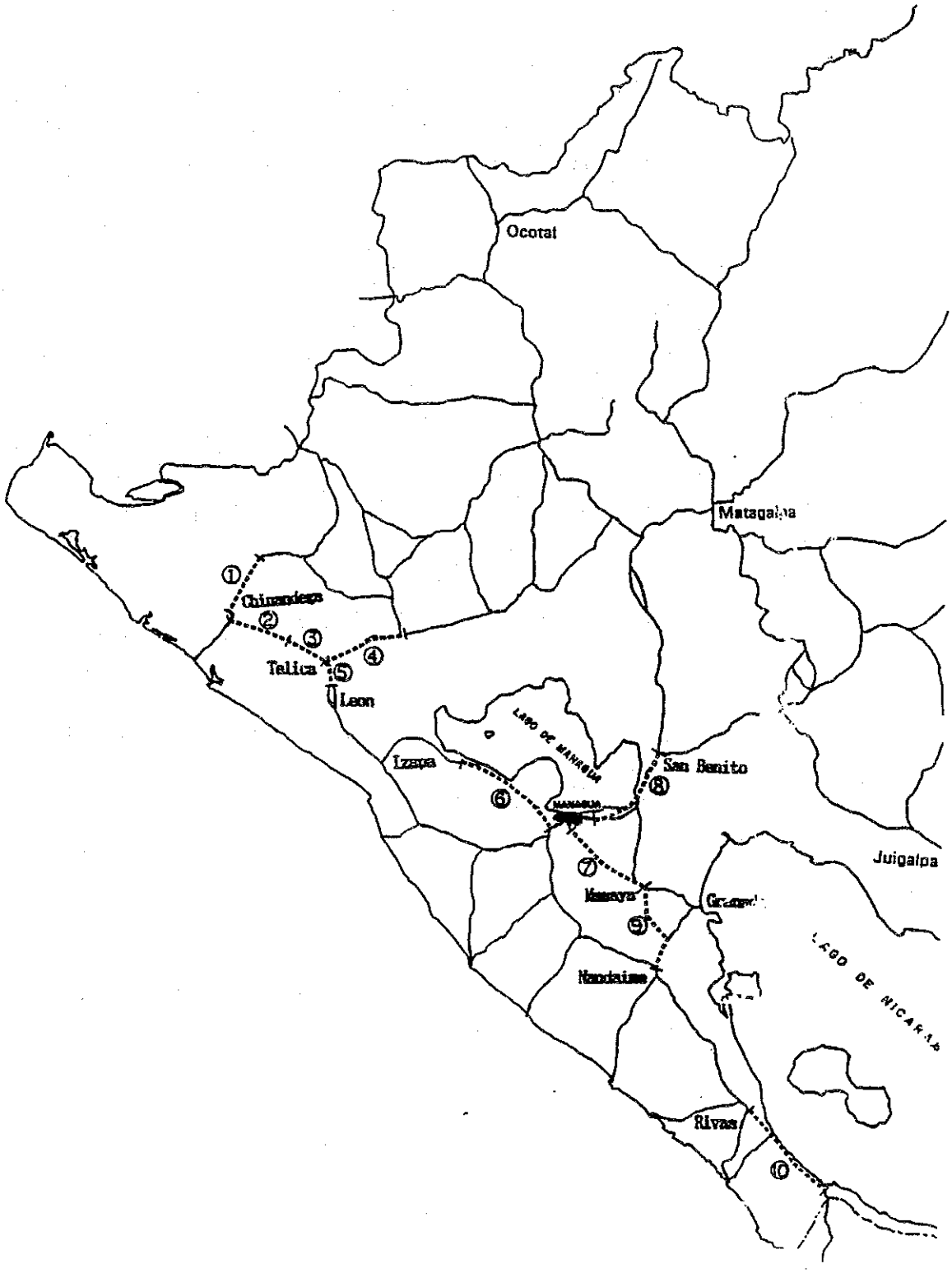


Figure 4-6 Travel Speed Survey Route

(3) Survey Procedure

For the travel speed survey, several check points were established on each survey route, and passing time on each check point was recorded. These check points were established in areas such as the intersections between major highways and road sections where road conditions change drastically.

4.2.4 Axle Load Survey

Several weighing stations for cargo vehicles were set up in the Study Area, and the weight and number of axles of each loaded truck/semi-trailer were identified at those stations.

In order to determine the average axle load of cargo vehicles on major highways in the Study Area, the JICA Study Team obtained data regarding the weight and axle number data from the weighing stations as shown in Table 4-7.

Table 4-7 Location of Weighing Stations

Name of Weighing Station	Location	Obtained Data
1. Corinto	Pasco Caballos, km 145 on Highway to Corinto	Mar. 1992 - Feb. 1993
2. Chilamatillo	Chilamatillo, km 31 on Carretera Norte	March 1993
3. Los Brasiles	Los Brasiles, km 21.7 on Carretera Nueva a León	March 1993
4. Rivas	Sapoa Rivas	March 1993