CHAPTER 9

ENVIRONMENT SURVEY

CHAPTER 9 ENVIRONMENTAL SURVEY

9.1 Environmental Preservation in Nicaragua

9.1.1 Environmental Management

1) Environmental Management Organization

MARENA (Ministry of Natural Resources and Environment: see Figure 9.1.1) functions as an umbrella organization for managing the environment in Nicaragua. That is, MARENA draws up laws on the environment and manages it with related ministries. Screening with regards to project execution, such as Environmental Impact Assessments, is the purview of the General Division of Environmental Quality of MARENA.

The General Division of Environmental Administration and Technical Control of the Ministry of Transport and Infrastructure (MTI) is responsible for the construction and maintenance of roads (see Figure 9.1.2) and manages environment-related issues regarding road construction as well as preparing technical guidelines. However, because the total staff in this division consists of only nine people (including the secretary), technical work is farmed out to consultant companies.

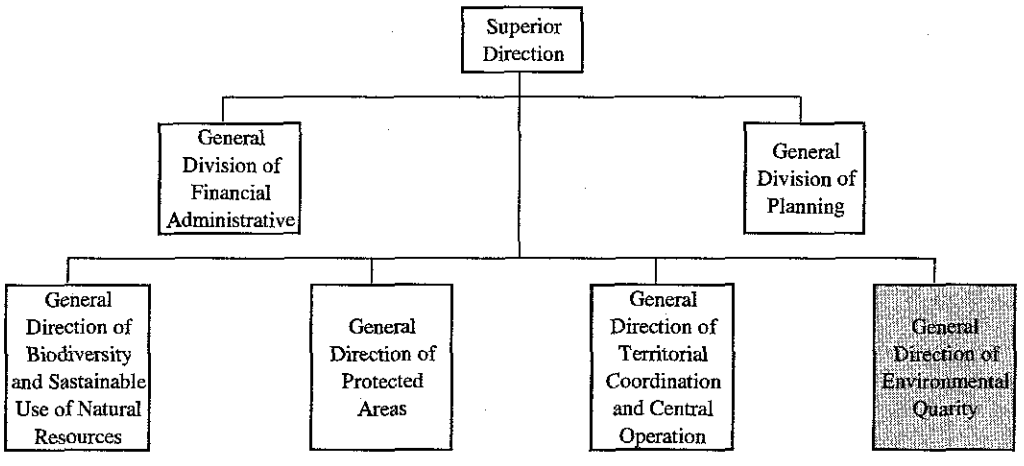


Figure 9.1.1 Organizational Chart of MARENA

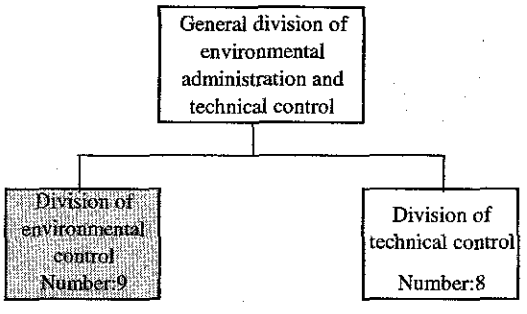


Figure 9.1.2 Organization of Division of Environmental Administration and Technical Control

2) Environmental Laws and Standards

MTI established NIC2000 as the standard for road construction. Environmental standards, together with construction standards, are also contained in NIC2000. The goals of NIC2000 are as follows:

A) To have road construction in Nicaragua carried out on the basis of Law NO.217 and its regulations, as well as in accordance with extant environment-related regulations.

B) To ensure basic environmental standards are executed properly for road construction work by supervisors, environmental administrators and contractors.

Law NO.217 (i.e., the General Law of Environment and Natural Recourse) was enacted in 1996 and serves as the foundation for all environmental legislation. The objectives of Law NO.217 are as listed below.

1. To regulate, adjust and prevent the causes and effects that harm the environment and eco-systems.
2. To establish the method, form and time of rational development of natural resources considering social equity, justice and cultural diversity, whilst furthermore respecting the rights of the Autonomous Regions of the Atlantic Coast and local authorities.
3. To develop the country properly through a national development plan that recognizes the protection of the environment and natural resources as the base for the development of various human activities.
4. To establish a national system for the natural conservation of areas to protect biodiversity and resources.
5. To enforce the legitimate utilization and management of catchment areas and water resources and to ensure their durability.
6. To encourage and aid environment-related education so that society may be in harmony with nature.
7. To create a healthy environment so as to contribute to the health and prevention of illness of the Nicaraguan people.
8. To motivate and support the various activities and plans needed to implement said law.

Environmental standards and acts related to road construction, including Law No.217, are shown in Table 9.1.1.

Table 9.1.1 List of Environmental Standards and Acts for Road Construction

No	TITLE	No.and Decree Date	No. and date of LA GACETA
1	Legal Documents and the Trade of the Project (DLC)	-	-
2	General Law of Environment and Natural Recourse (MARENA)	Law No 217 (27-03-96)	105 (6-6-96)
3	Regulations of the General Law of Environment (MARENA)	9-96 (25-7-96)	163 (29-8-96)
4	Permit Regulations and Evaluation of Environmental Impacts (MARENA)	45-94 (28-1094)	203 (Octuber,94)
5	Law of Administrative Contracts of the State, Decentralize Entity and Municip	809-81 (28-08-81)	202-81 (7-9-81)
6	General Regulations of the Law of Administrative Contracts of the Central Goverment	60-91 (6-11-91)	
7	Sanitary Disposal (MINSA)	394 (30-09-88)	200 (21-10-88)
8	Sanitary Inspection Regulations (MINSA)	432 (10-04-89)	71 (17-04-89)
9	Norms and Ministerial Resolutions on the Basic Disposition of Hygiene and Security in Work Places (MITRAB)	1-90 (21-04-90)	165 (01-09-93)
10	Civil Code of the Republic of Nicaragua	2 edicion, 1997	
11	Centroamericano Agreement of Roads Circulation	8-59 (11-3-59)	226 a 32 7 a 14 (October 59)
12	Ministerial Resolution (MCT) on Fine for Violation of Decree 01-96	01-96 (25-1-96)	-
13	Ministerial Resolutions (MCT) on Increases in Vehicle Weight	17-95 (28-3-95)	-

The types of projects intended for an environmental impact assessment in the above table (i.e., item NO.6) are listed in items a through m below. Reconstruction work on existing roads, which is the subject of this project, is not covered. However, regardless of the size of the project, the permission of MARENA is necessary for all projects. In the case of a private project, private firms submit an application to obtain permission, while related government agencies carry it out the in case of a public project. The evaluation process for a project is shown in Figure 9.1.3.

According to Article 5 of the Law of Permit Regulations and Evaluation of Environmental Impacts, investigations on environmental impacts and the submission of supporting documents are necessary to acquire permission for the following projects and activities:

a) The prospecting and mining of gold, zinc, copper, iron, silver, hydrocarbon and other subterranean heat resources.

b) For other minerals, the prospecting and mining of a lode that exists in a fragile biological area or one protected by the law.

c) Intensive or semi-intensive shrimp farms and intensive or semi-intensive farms of other marine life.

d) The change of land use in forest areas, the change of forest facilities for an area greater than 5,000 ha, forestry use covering areas with an inclination of 35% or more, and the construction of all-weather forest roads.

e) Energy production plants, of every kind, above 5MW and power cables of 69KW or more.

f) Ports, airports, and airports for agricultural chemical spraying, mineral, hydrocarbon and terminals of source products.

g) Railways and new trunk roads.

h) Laying of oil pipe lines, gas pipe lines and mineral pipe lines.

i) Construction of large drainage systems, water purification plants, sewage systems, sewage pipes and dams (including small dams).

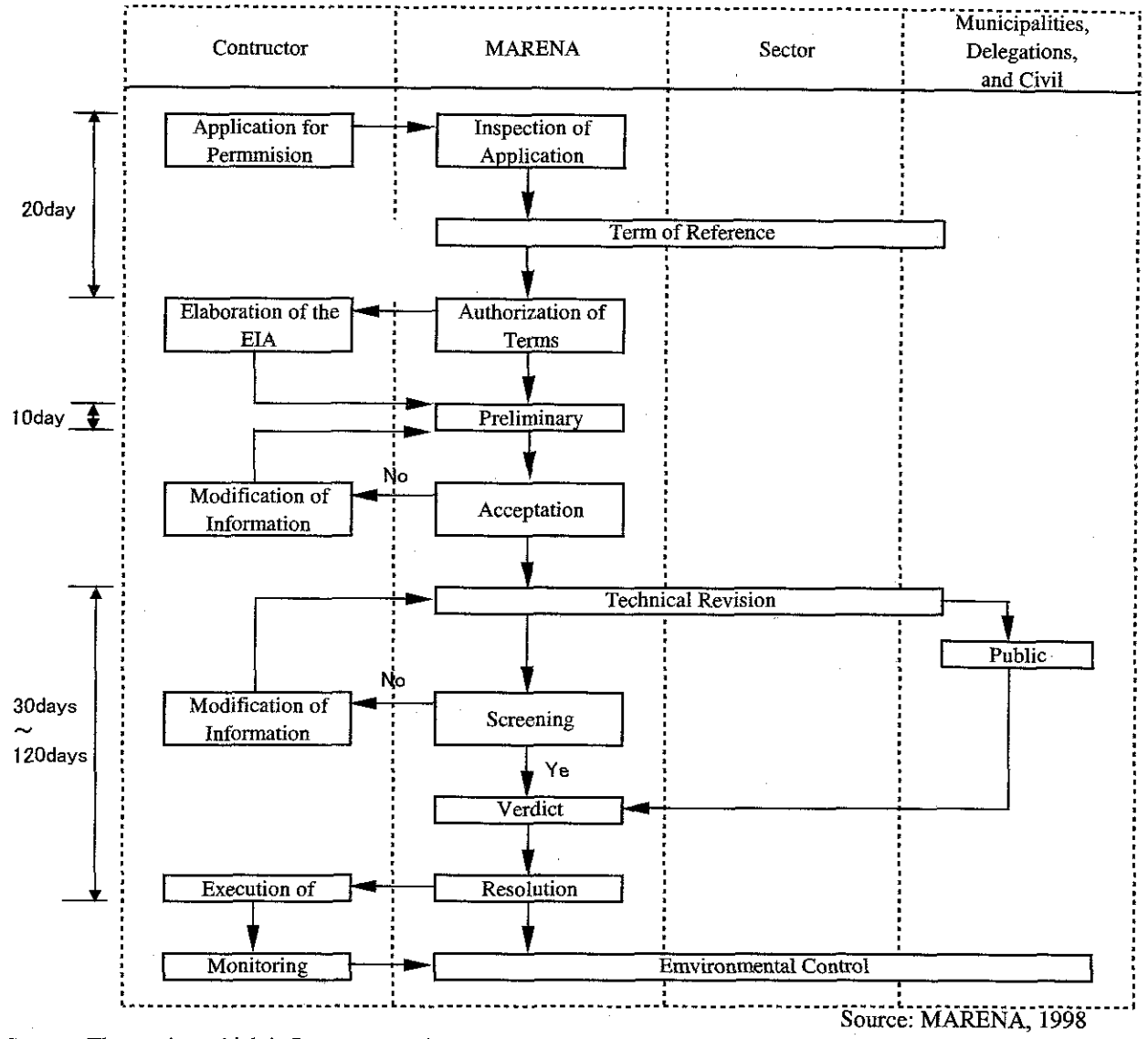
j) Dredging construction and the changing of the flow channel of surface running water.

k) Management and reclamation of an incinerator for industry, and incinerators for chemical material, poisonous and other materials.

l) Reclamation, compound facilities for sightseeing, building, and sport facilities in fragile biological areas or those protected by the law.

m) Construction of fishing compound facilities or plants, large slaughterhouses, food and drink factories, sugar manufacturing factories and alcoholic distillation plants, fiber and sewing factories, tanneries, agricultural chemical factories, paint and lacquer solvent factories, petroleum refineries, ironworks, metallurgy factories, chromium factories, chemical and petrochemical factories, cement works and battery manufacturing facilities.

Environmental guidelines for quarries, etc., are currently being considered by MARENA.



Sector : The section which influences a project

Figure 9.1.3 Environmental Evaluation Process

9.2 Condition of Natural and Social Environments

9.2.1 Conservation of Natural Environment

1) Conservation of Forests

The disappearance of rain forests is one of the big environmental problems facing Nicaragua. Therefore, a regulation on forest conservation is being enforced in Nicaragua with Forest Law NO.45-93 (Official Gazette NO.197, October 19, 1993). This regulation is applicable to all forests in the country, and controls development and use in order to prevent the disappearance of the forests. Moreover, because forestry resources of any country need sustainable and rational utilization, it aims to protect biodiversity as well. Although the use of forests is regulated and the owner of a piece of land is recognized as the owner of its forests under the

Forest Law, permission to use forests is issued by INAFOR (i.e., the Forest Institute, previously a subordinate organization of MARENA until three years ago). When tree felling is proposed, each felled tree must be replaced by four new plantings. Costs for these must be included in a project's budget. Locations for newly planted trees are directed by MARENA or INAFOR.

2) Game Preservation

The Hunting Law (statute NO.206: 1956) is the primary legislation aimed at protecting wild life. This law regulates hunting areas, hunting methods, etc. Areas and times for hunting are regulated by Statute NO.2 of IRENA to protect breeding and generally conserve wildlife. The capture of specific species is also prohibited.

3) Conservation of Precious Fauna and Flora (Figure 9.2.1)

A "Red Data Book", which is based on the Washington Treaty, is published with the aim of conserving precious Nicaraguan fauna and flora. Fauna and flora are protected in the following designated eight areas (including historical monuments, etc) where government regulates development. Moreover, eight wetlands are registered in the Ar-Rantha treaty (an international treaty and environmental conservation plan currently being drafted), and the execution of an environmental impact assessment is required in accordance with "the regulations for conservation areas" when development is carried out in one of the designated eight areas.

- National Park (Figure 9.2.2)
- Biological Reserve
- National Monument
- Historical Monument
- Wildlife Reserve
- Genetic Resource Reserve
- Natural Reserve
- Biodiversity Reserve

4) Conservation of Soil

Soil protection on all land is declared to be for the public benefit and the good of society (Statute 1308). This law intends to promote soil protection and prevent erosion. Geography and changes to soil are regulated with Law 217 to preserve soil and prevent erosion in respect to conserving the eco-system balance. Where 35% or more of a piece of land is covered with flora, landowners and land-users are confined to arable uses.

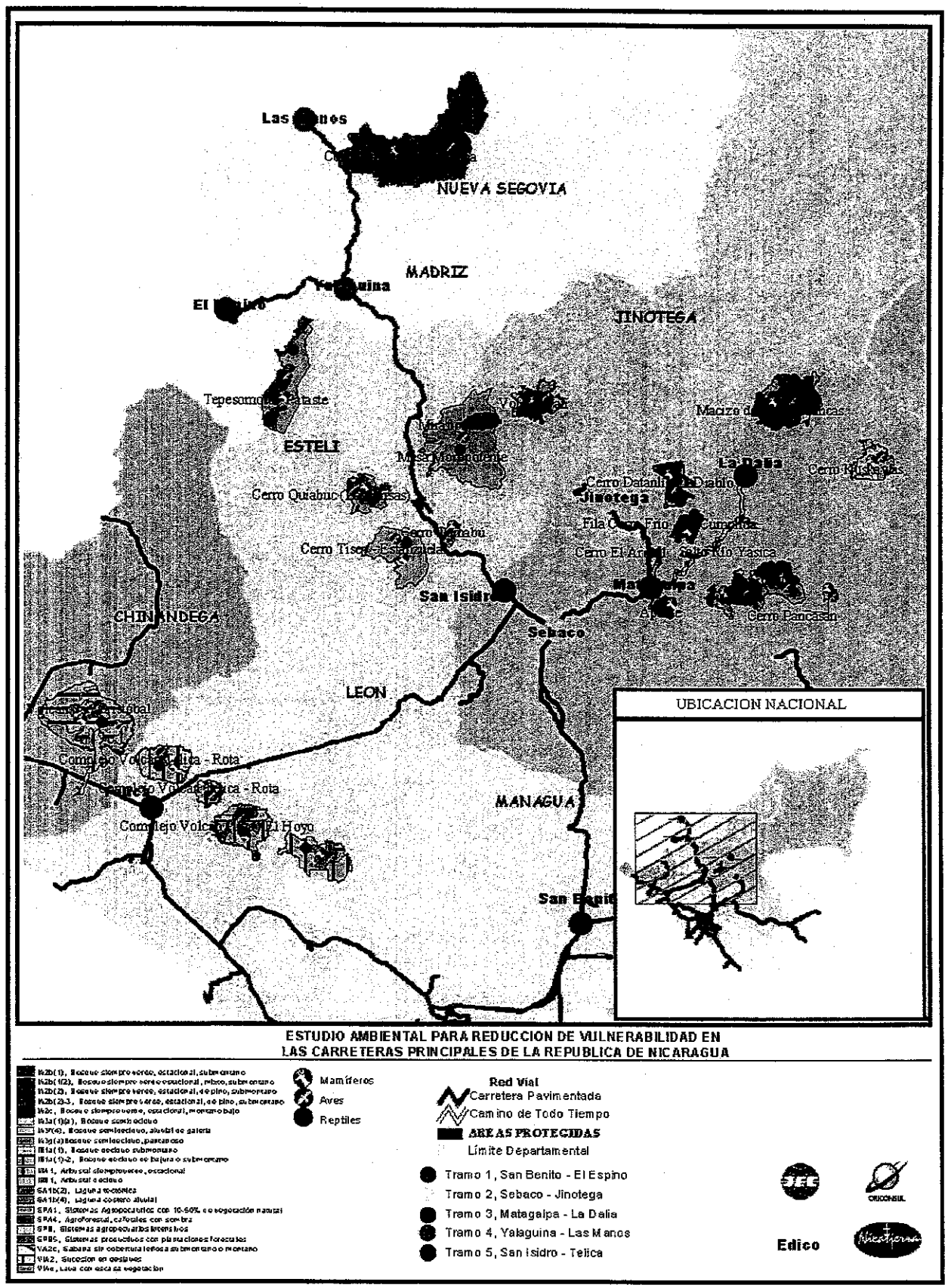


Figure 9.2.1 Conservation of Precious Fauna and Flora

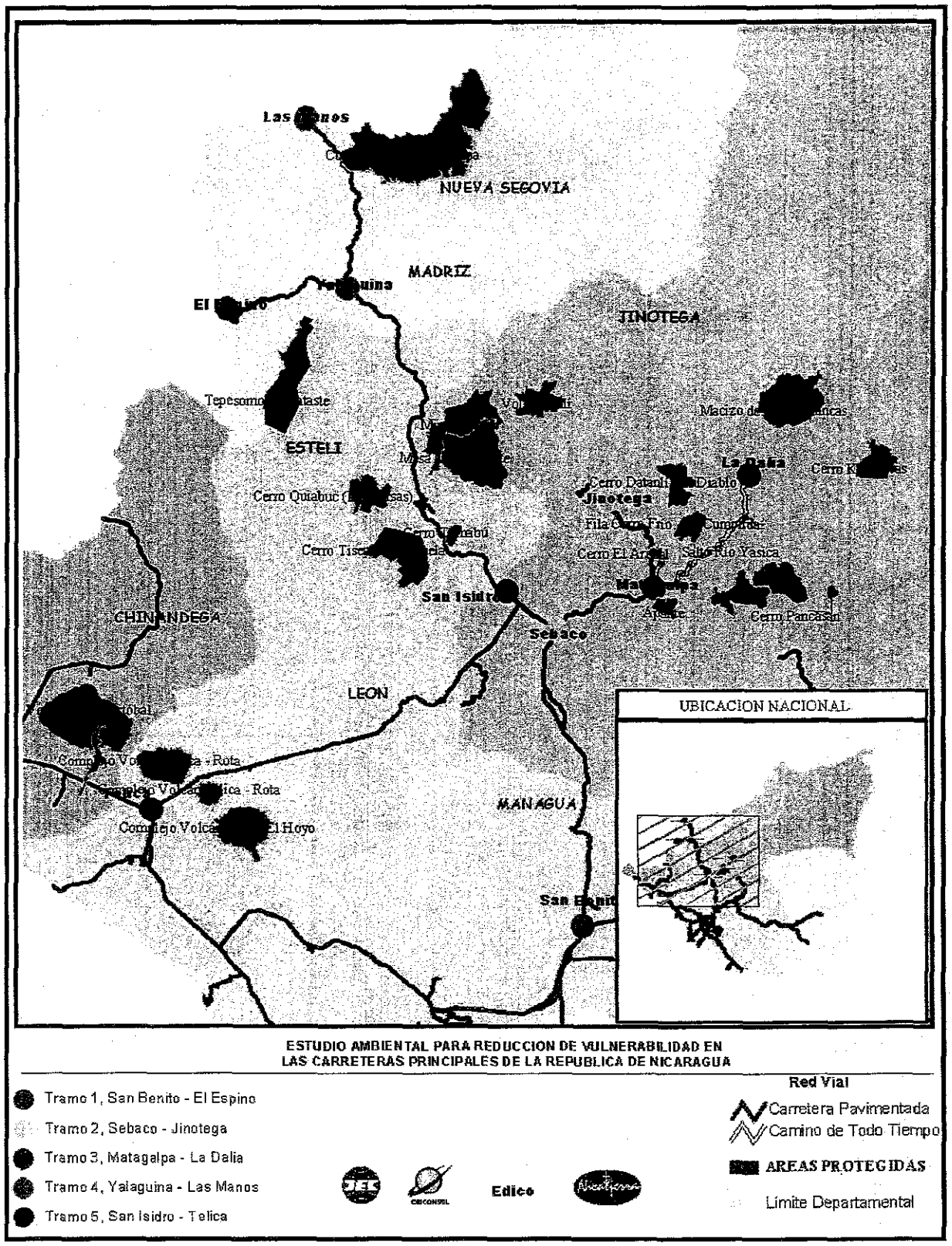


Figure 9.2.2 National Park Map

5) Conservation of Water

Another big environmental problem in Nicaragua is water pollution. Therefore, the cutting down of trees near rivers and valleys which spring water flows into, the branching of water from lakes, natural dams, etc. regardless of water supply to inhabitants, irrigation activities, the use of water to generate electricity, etc. is prohibited by Law No.235 (1974). This law also promotes the rational use of forests in Nicaragua.

9.2.2 Condition of Social Environment

1) Land Ownership

Property ownership is recognized as a right in Nicaragua. According to Clause 44 of the constitution: "Individual ownership is assured for real estate and property and for the means of the production." Under the law, a time limit and use obligation are required of landowners for social reasons as well as for public-sector projects. Real estate can only be acquired by the state at a fair market price. When a landowner's rights conflict with the national interest, land may be expropriated as described in Clause 44 of Statute 229 (1976). Under this law, the landowner can choose to either of the following:

a) To accept offers made for the land in accordance with the law; or
b) Not to accept such offers.

If an owner chooses option b), the potential acquirer (e.g., MTI) can expropriate the land at fair-market price.

2) Rights of Way

Rights of way in Nicaragua are as laid down in the Roadside Law (1952) and are as follows.

- International road: 40m
- Pacific Ocean-Atlantic Ocean Road: 40m
- Trunk Road: 20m
- Rural Road: 20m

However, this legislation does not apply to landowners before the law's enactment. Moreover, in cases where right of way is not registered, and where cities may recognize individual registration in a right of way, the law is not enforced.

3) Water Rights/ Fishery Rights/ Common Rights

Water rights are not fully established in Nicaragua. As for fishery rights (commercial fishing), they have been established for the Pacific Ocean, Atlantic Ocean, lakes and two rivers (the TISMA andSAN JUAN rivers). Common rights are not specified under the law, since forests tend to be privately held. Where forests are specified as a natural conservation area, use is

regulated by MARENA.

4) Conservation of Areas for Indigenous People (Figure 9.2.3)

Three areas are specified as conservation areas for indigenous people living on the Atlantic coast. Other conservation areas have not been designated because the residences of indigenous people overlaps with that of other people. In these areas, there is no regulation of development.

5) Historical Locations/Cultural Assets (Figure 9.2.4)

The government designates those areas to be preserved as historical locations, cultural assets, national monuments, and historical monuments. Some historical monuments (including World Heritage sites such as the historical urban structure in Leon) are protected by a cultural institute of the Ministry of Education, Culture and Sport.

6) Solid Waste

Solid waste, another environmental problem facing Nicaragua, is dealt with under the third chapter of Law No.217 in the section on "Non-hazardous Solid Waste" as follows:

> ***129th Clause***
>
> Each local government shall collect and dispose of non-hazardous solid waste in accordance with the standards of the Ministry of Natural Resources and Environment and the Ministry of Health in order to protect the environment and public health.
>
> ***130th Clause***
>
> The government shall encourage and aid the development of the recycling of industrial waste and household waste via sanitary and technical methods as agreed upon with related organizations.

MARENA provides guidance on how to specify waste and the appropriate disposal site of different types of waste in the EIA stage. Therefore, a disposal site can be specified if a project and its waste can be specified. For example, removed asphalt is re-crushed by MTI and re-used as a base course for roads.

7) Noise/ Vibration/ Air Pollution

Environmental standards on noise, vibration, and air pollution (excluding exhaust gas regulations) have not yet been established in Nicaragua. Environmental standards for construction projects, roads under construction, use of plant, etc. are prescribed in NIC2000.

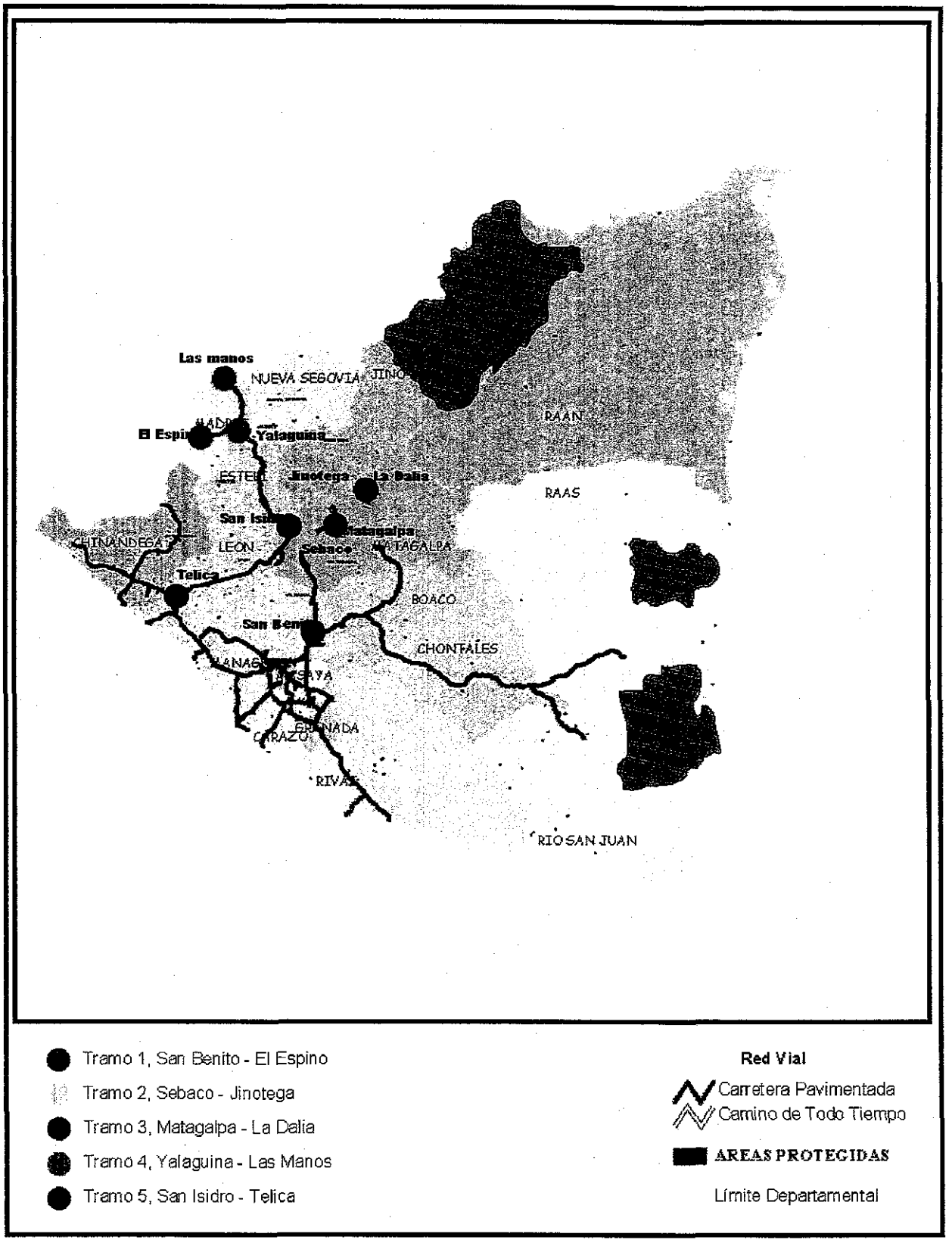


Figure 9.2.3 Conservation of Areas for Indigenous People

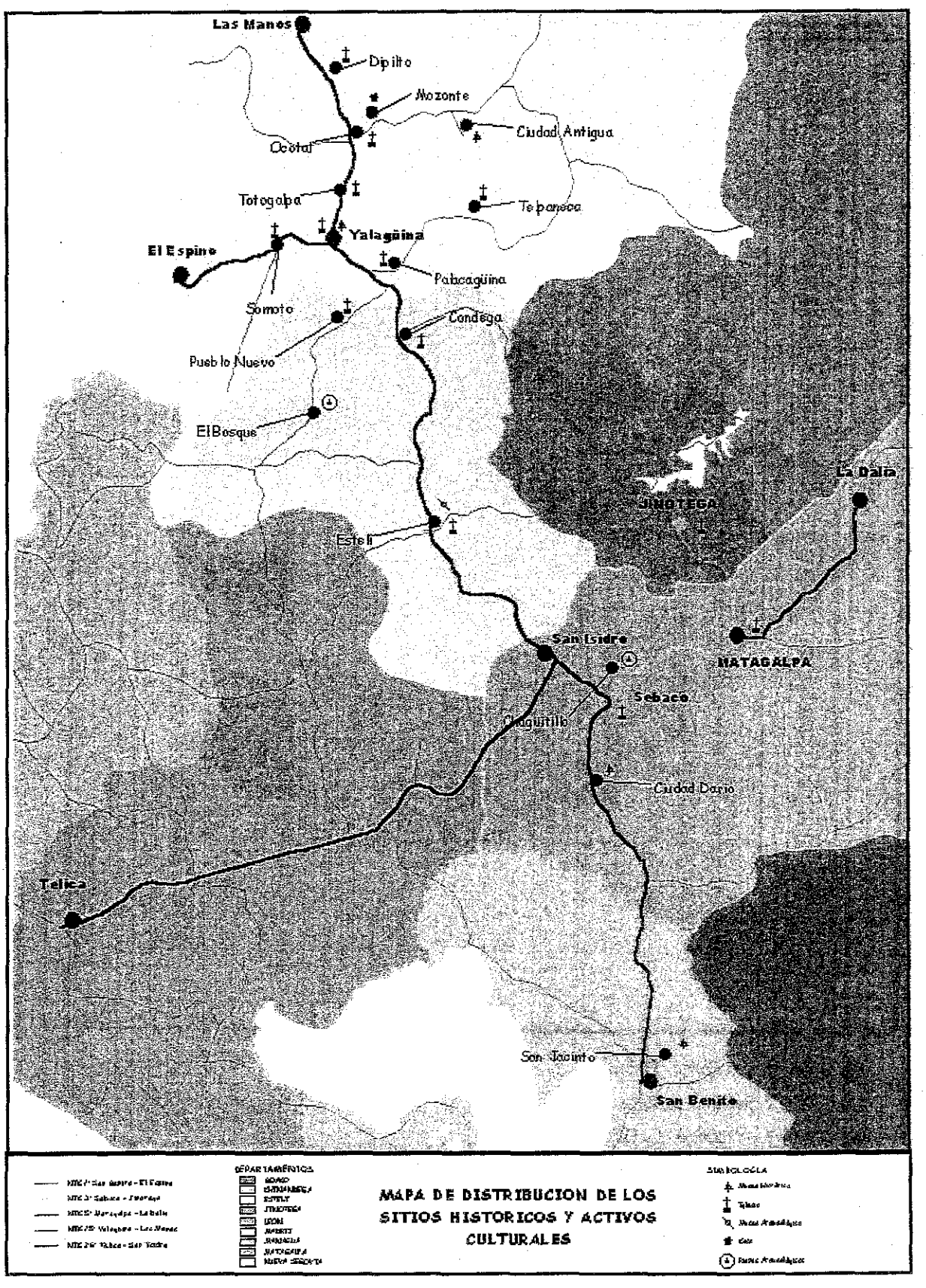


Figure 9.2.4 Historical Locations/ Cultural Assets

9.3 Environmental Impact Factors

9.3.1 Selection and Evaluation Method

Applicable items for environmental impact assessment were selected from factors having an impact on the environment by referring to project contents, field investigations and existing references. An impact rating for each project point is shown in Table 9.3.1. Four scoring impact categories were adopted as follows:

A: Serious impacts anticipated (10 points)
B: Some impacts anticipated (5 points)
C: Unclear (There is no adoption)
D: Out of scope (0 points)

9.3.2 Selection Item (Negative Impact)

Ten items have been selected to evaluate negative impacts: resettlement , economic activity, traffic and public facilities, waste, groundwater, lakes and rivers, fauna and flora, landscape, water pollution, and noise and vibration. Reasons for this selection are described below.

1) Resettlement

For this impact a rating of A or B was assigned to all points, except for sites with bridges, barriers with gabions, and gabion walls. An A rating means a site where inhabitant relocation is expected. When no inhabitant relocation is expected but borrowing or expropriation of land is required, then a B rating is assigned. As described below, there are three sites with an A rating and one site with a D rating point due to special factors

A Rated Sites

No.27: A hotel (scheduled for completion in two years) is located on a slope where construction will take place. Therefore, excavation work on the slope should be avoided.

No.31: Three private houses exist on a mountainside where work is to take place. Therefore, re-cutting and the use of prevention nets should be avoided. There is also a property on the valley side of the road and measures that do not require the need to relocate residents should be implemented.

No.36: The relocation of private houses of both riverbanks would be necessary depending on the scale of the proposed dam. Therefore, construction should be moved to a point where the influence on these private homes is non-existent.

D Rated Site

No.1: One private house exists but is illegally occupied.

2) Economic Activity

Where facilities that generate income exist, impacts at the target point are evaluated.

A Rated Sites

No.3: Water flows in the river year round and is being used in various ways by the locals (e.g., drainage for rice fields). Therefore, measures should avoid obstructing flow to the down stream by the stopping-up the river etc.

No.27: A hotel (scheduled for completion in two years) is being constructed on a slope. Therefore, excavation of the existing slope should be avoided.

No.31: Three private houses are on the mountainside, and there is arable land on the slopes. A flower stand has been opened by one house along the road. Therefore, excavation of the existing slope should be avoided.

No.33: There is arable land under the valley slope side. Measures that affect arable land should be avoided.

No.36: A brick-kiln made with joint capital investment would be affected by the construction and perhaps by the dam (depending on its scale). Therefore, the location of construction should be changed to a point where the effect on the kiln is non-existent.

B Rated Sites

No.34: Because a restaurant exists on the opposite side of the target point, construction is expected to affect the number of visitors.

3) Traffic and Public Facilities

As for traffic and public facilities, all the target roads carry buses and other public service vehicles. Therefore, all sites were rated Bin consideration of the effects due to lane regulation from the planned construction. But, only No16 was rated B*.

B* rating

No.16: There is a well that exists on the opposite side of the target point that is being used for drinking water by 25 local homes. The installation of a fence, etc., should be considered during construction, because the well is also used by women for washing themselves.

4) Waste

Construction waste will occur at all points where construction is to take place. This must be dealt with in accordance with Law No.217 and with the guidance of MARENA.

5) Groundwater

There are wells close to the points of the proposed work sites. Generally, non-confined water (free flowing water) is being used from all wells, which are around 5-6m in depth, and it is therefore expected that they would be sensitive to even slight changes in geography. Therefore, measures that cover slopes with structures, such as shotcrete, should be avoided. Permeation catchment pits should be considered when a slope is covered by a structure.

Where wells are near bridges, they should not be affected because the foundations for bank protection are shallow and there is a sufficient catchment area.

6) Lakes and Rivers

As for lakes and rivers, 3 points where dams are planned were assigned a B rating. The rivers at these 3 points are used for cleaning dishes by local people. Therefore, structures that do not affect the rivers should be adopted, because a change in the rivers would definitely take place with the construction of the dams.

7) Fauna and Flora

There are many precious fauna and flora and conservation areas (such as national parks) near some of the target roads as shown below. Therefore, when a target point exists in one of these areas, it has the potential to have an adverse impact.

a) Cerro Tomabu Area (No.4: A)

The downstream side is specified as a conservation area. Gabions to prevent scouring of the bridge foundation is planned. Therefore, construction must avoid any decreases in the water supply to fauna.

b) Cerro El Arenal Area (No.28: B, No.29: B)

Replanting of vegetation should be included as a countermeasure here, although both No. 28 and 29 have suffered from slope collapse and there is no existing vegetation. Because the replanting of vegetation is being taken into consideration, the present proposal is for countermeasures at site No.28 in order to preserve the environment. However, proposals for shotcrete at Site 29 should be altered to be consistent with the re-planting of vegetation.

c) Cordillera Dipilto y Jalapa Area (No.36: A, No.37: A, No.38: B, No.39: B)

Dams are planned at both sites No.36 and 37. Because much tree felling is necessary for dam construction, the work should be sited at points where felling is minimized. Countermeasures for replacing vegetation should be implemented. Replanting of vegetation should be included although No38 and 39 also suffer from slope collapse and vegetation is not

visible currently.

8) Landscape

Target points inside conservation areas, except for the bridge foundation countermeasure at Site 4 and Site 16, shall give careful consideration to the landscape. The construction of artificial concrete structures, which can be seen from the roadside, should be avoided, and measures that complement the surrounding environment should be selected. When an artificial structure must be adopted, it should be covered with vegetation.

It is necessary at Site 16 to leave existing vegetation, because the opposite side of the point is a location for women to bathe.

9) Water Pollution

All points are rated B, because some water pollution will occur as a result of measures to protect slope construction and prevent the scouring of bridge foundations. Furthermore, since local residents fish and wash in the rivers around all of the target points, construction should be carried out in the summer (December - April) when water levels are low. If work is carried out in the winter (May - November), measures should be put in place to manage water pollution with facilities for filtration and precipitation.

10) Noise and Vibration

Where schools and hospitals exist close to a target point, a B rating was assigned since these facilities require quiet. Construction work must therefore include the installation of soundproof facilities or use low-noise machinery at these points.

9.3.3 Unselected Items

Thirteen items were not evaluated: severance, historical locations/cultural assets, water rights/common rights/fishery rights, health/hygiene, disasters (risk), geography/geology, soil erosion, coastal areas, weather, air pollution, soil pollution, ground subsidence, and foul smells for the following reasons:

1) Severance

The goals of the project are slope protection and the prevention of scouring of bridge substructures. Therefore, facilities or structures that cause area severance are not being proposed.

2) Historical Locations/Cultural Assets

Historical locations and cultural assets do not exist at any of points where the project is

assumed to have an impact.

3) Water Rights/Fishery Rights/Common Rights

There are no such rights at any of the target sites.

4) Health/Hygiene

Facilities or structures that worsen health and hygiene conditions are not proposed.

5) Disaster (Risk)

The target project aims to prevent disasters. Therefore, no activities or facilities that would induce new disasters are being proposed.

6) Geography/Geology

Valuable geographical and geological points do not exist in the target areas. In addition, because the alteration of geography is slight, there will be no impact on either the geography or geology.

7) Soil Erosion

The target projects reduce soil erosion.

8) Coastal Areas

Target sites are not near any coastal areas.

9) Weather

There are no direct weather impacts.

10) Air Pollution

Though there will be discharges of exhaust gas by construction vehicles, it is very short-term and will have a negligible affect on the atmosphere. In addition, the proposed work is to prevent disasters, so no increase in traffic due to said work is envisaged. Therefore, long-term effects on the atmosphere are also negligible.

11) Soil Pollution

There are no points that have a history of heavy metals. Therefore, activities and facilities that pollute soil during construction and after completion will be avoided.

12) Ground Subsidence

The target projects do not contain measures that would soften the ground due to such activities as the pumping of subterranean water.

13) Foul Smells

The activities and facilities proposed will not produce foul smells during construction or after project completion.

Table 9.3.1 Evaluation of Each Site

		Environment Items	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
			SITES BY PRIMARY SELECTION																																																						
Social Environment	1	Inhabitant Transfer	D*	B	D	D	D	D	B	B	B	B	B	B	B	B	B	B	B	D	D	B	B	B	B	B	B	D	A	B	B	B	A	B	B	B	B	A	B	D	D	B	B	B	B	B	D	D	B	B	B	B	B	D	B	D	D
	2	Economic Activity	D	D	A	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	A	D	D	D	A	D	A	B	D	A	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
	3	Facility for Life and Traffic	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B*	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
	4	Severance	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
	5	Historical Place/ Cultural Asset	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
	6	Water Right/ Fishery Right/ Common Right	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
	7	Health/ Hygiene	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
	8	Waste	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
	9	Disaster(Risk)	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Natural Environment	10	Geography/ Geology	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
	11	Soil erosion	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
	12	Ground Water	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	B	D	D	D	D	D	D	B	D	D	D	D	D	D	D	B	D	D	D	B	D	D	D	D	D	D	D	D	D	D	B	D	D	B	D	B	D	D	D	D
	13	Lake/Liver	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	B	D	D	D	D	D	B	B	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
	14	Coast/ Sea area	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
	15	Fauna/Flora	D	D	D	A	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	B	B	D	D	D	D	D	D	A	A	B	B	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
	16	Wwather	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
	17	Landscape	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	B	D	D	D	D	D	D	D	D	D	D	D	B	B	D	D	D	D	D	D	A	A	B	B	D	D	D	D	D	D	D	D	D	D	D	D	D	B	D	D
Pollution	18	Air Pollution	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
	19	Water Polltion	B	B	B	B	B	B*	B	B	B	B	B	B	B	B	B	B*	B	B*	B*	B	B	B	B*	B	B	B	B	B	B	B	B	B	B	B	B*	B	B	B	B	B	B	B	B	B	B	B*	B	B	B	B	B*	B	B	B	B
	20	Soil Pollution	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
	21	Noise/Vibration	D	D	D	D	B	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	B	B	D	D	D	D	D	D	D	D	D	B	D	D	D	D	D	D	D	D	D	D	D	D	D	B	D	D	D	D
	22	Ground subsidence	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
	23	Afoul smell	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Evaluation Point			15	20	25	25	20	15	20	20	20	20	20	20	20	20	20	30	20	15	15	20	20	20	25	20	20	20	40	30	30	25	40	20	30	25	25	60	50	25	25	20	20	20	20	20	15	20	20	20	25	20	30	15	25	15	15

*: Existance of Particular Condition.

CHAPTER 10

TRAFFIC SURVEYS

CHAPTER 10 TRAFFIC SURVEYS

10.1 Objectives

Traffic surveys were carried out on the study roads for the purpose of developing a traffic model that could be used to assess the impacts of natural disasters on these roads.

The objectives of the surveys were to gather data on both the scale and patterns of movement of traffic.

Survey data were analyzed to determine existing traffic volumes and composition on the objective roads (Section 10.3) and, used together with the economic forecasts (Chapter 11), to provide traffic forecasts (Chapter 12).

10.2 Survey Methodology

Two types of survey were carried out:

i) Direct classified counts; and

ii) Origin-Destination interviews.

Both types of survey were undertaken at the 9 locations set out in Table 10.2.1. Traffic counts were carried out over a 12-hour day (06.00 to 18.00) at all 9 locations, with 24-hour counts undertaken at survey sites 2 and 6. The target interview rate was set at 30% to 50% of all traffic.

Table 10.2.1 Traffic Survey Locations and Dates

Location Number	Road	Location	Dates
1	NIC.24	La Grecia No. 2, km 103.5	11 and 12 June 2002
2	NIC.26,	Telica	11 and 12 June 2002
3.1	NIC.1	Yalaguia, km 207.15	11 and 12 June 2002
3.2	NIC.15	Yalaguia, km 207.2	11 and 12 June 2002
4	NIC.26	San Isidro, 800m from junction with NIC 1	11 and 12 June 2002
5	NIC.1	Santa Cruz, km 138.5	11 and 12 June 2002
6	NIC.1	Sebaco, km 99.1	11 and 12 June 2002
7	NIC.3	Comarca de Chaguitillo, km 107.1	11 and 12 June 2002
8	NIC.1	San Benito, 250m North of junction with NIC.7	11 and 12 June 2002

The classified counts were taken at 15-minute intervals. Ten vehicle types were recorded: car, pick-up, minibus, bus, light goods, medium goods, heavy goods, tractor, motorcycle, and bicycle.

Goods vehicles were classified as follows:

- Light Goods or Small Trucks, including the different types of Cx (C2 and C3), with a capacity of 8, 10 and 12 tons.
- Medium Goods or Big Trucks, including the type Cx (C4), with a capacity up to 14 ton.
- Heavy Goods or Articulated Trucks, including the types Tx-Sx (T2-S1, T2-S2, T2-S3, T3-S1, T3-S2, T3-S3) and all the types Cx-Rx (C2-R2, C3-R2, C3-R3), with a capacity up to 22 tons.

The origin-destination surveys recorded: vehicle type (as above); journey purpose, origin, destination, number of passengers, frequency of journey, type of cargo, weight of cargo. Pre-coded responses were provided to the field surveyors as shown in Table 10.2.2.

Table 10.2.2 Response Codes in Origin-Destination Survey

Code	*Vehicle Type*	*Journey Purpose*	*Frequency*	*Cargo*
1	Private Car	Work, business	5-7 times per week	Oil, petroleum
2	Minibus	Education	3-4 times per week	Cotton
3	Autobus	Shopping	1-2 times per week	Rice
4	Light Goods	Tourism	0-1times per week	Sugar
5	Medium Goods	Sport, social		Bananas
6	Heavy Goods	Other		Coffee
7	Motorcycle			Cement
8	Bicycle			Construction materials
9	Tractor			Livestock
10	Pick-up			Grain
11	Others			Wood
12				Metals
13				Chemicals
14				Sesame seed
15				Tobacco
16				Beef products
17				Passengers only
18				Other food products
19				Other non-food products
20				Empty

Vehicle origins and destinations were recorded by field surveyors and re-coded after the fieldwork. Nicaragua was split into 45 traffic zones and codes allocated as set out in Table 10.2.3.

Table 10.2.3 Origin and Destination Zone Coding

Zone No.	Department	Town/City
1	Nueva Segovia	Santa Maria, Ocotal, Macuelizo, Ococona, Diplito
2	Nueva Segovia	Mozonte, San Fernando, Santa Clara, Jalapa, Murra, Ciudad Sandino, Susucayan, Ciudad Antigua
3	Nueva Segovia	Las Manos
	Honduras	Honduras via Los Manos
4	Madriz	Yalagüina, San Lucas, Las Sabanas, San José del Guaspan
	Esteli	Los Llanos,
5	Madriz	El Espino
	Honduras	Honduras via El Espino
6	Nueva Segovia	Quilali
7	Jinotega	Wiwili, Wamblan, Plan de Grama, Ayapal
8	R.A.A.N	All towns
9	R.A.A.S	El Gallo, Siawas, Chicago, La Cruz del Rio Grande, Casa de Alto, San Pedro del Norte, Copalar, Wasayama, Rio Blanco
10	Jinotega	San Jose del Bocay, El Cua,
11	Matagalpa	Matagalpa Carretaera Yaoska, Rancho Grande, San Antoniio de Kyskawas, El Tuma, La Dalia, San Ramon, Santa Rita
12	Madriz	Palacagüina, Telpaneca, Quinbuto, San Juan del Rio Coco
13	Jinotega	Jinotega, Mancotal, San Pedro de Buculmay, Asturias,
14	Jinotega	Las Praderas, La Concordia, San Rafael, del Norte, San Sebastian de Yali, La Rica
15	Esteli	Condega
16	Esteli	Esteli, La Sirena
17	Esteli	La Trinidad , Santa Cruz, San Nicolas
18	Esteli	El Regadito, San Juan de Limay, el Bosque, Pueblo Nuevo
	Chinandega	Cinco Pinos, San Francisco del Norte
19	Honduras	via Guasaule
	Chinandega	Guasaule, Somotillo, Santo Tomas del Norte, Palo Grande, San Pedro del Norte
20	Chinandega	Villanueva
21	Chinandega	Monte Rosa, Aposentillo, Jiquilillo, El Congo, Potosi, Punta Nata, Puerto Morazan, Tonalá
22	Chinandega	Chinandega, El Realejo, La Grecia, Corinto, Paso Caballos, Chichigalpa, Posoltega
23	Matagalpa	Sebaco, Chiquilillo, San Isidro
24	Leon	Achuapa, Rio Grande, El Sauce
25	Leon	Santa Rosa del Peñon, El Jicaro1
26	Leon	Malpaisillo Mina El Limon, La Reynaga
27	Leon	Leon, Telica, Quezalguagüe, Ponelova, Las Peñitas
28	Leon	Izapa, La Paz Centro, Puerto Monotombo, El Tamarindo, El Transito, El Velero, Puerto Sandino, Salinas Grandes, Nagarote, Soledad, San Lorenzo
29	Managua	Managua, Mateare, Los Brasile, Los Cedros, Villa Carlos Foncersa, San Bartolo, San Cavetano, Santo Domingo, Aeroporto, Montelimar, Masachapa, Pochomil, San Rafeal del Sur, San Marco, Esquipulas, Saban Grande
30	Masaya	All towns
31	Carazo	All towns
32	Granada	Granada, El Paso de Paneloya, Diria, Ditomo
33	Granada	Nandaime, La Conquista
	Rivas	All towns
34	Costa Rica	Costa Rica
35	Managua	Tipitapa, Zona Franca, Zambrano, Granada, San Juan
36	Managua	San Francisco Libre

Zone No.	Department	Town/City
37	Managua	Las Maderas, San Jacinto
38	Managua	San Benito, Las Banderas
39	Matagalpa	Ciudad Dario, Las Calabazas, Terrabona, Puertas Vieias
40	Boaco	All towns
	Granada	Malacatoya
41	Matagalpa	San Dionisio, Esquipulas
42	Matagalpa	Muy Muy, Matiguas, Santa Elsa, Rio Blanco
43	Chontales	All towns
44	Rio San Juan	All towns
45	R.A.A.S.	El Rama, Zelaya Central, Bluefields, Nueva Guinea, Muelle do los Bueves, Buena Vista, Atlanta, San Miguel, Rio Plata, Talolinga, El Cascal, Verdun, Providencia, Nuevo Leon, San Martin

During the execution of the fieldwork, there were some interruptions on the Origin-Destination interviews because of difficulties with police support and weather conditions. For a period on June 11th, there was no police support at Station 01 (Departure Chinandega- El Guasaule district "La Grecia No. 2") and the police also arrived late to the others stations located on Route NIC.1. This was, however, compensated by a higher effort of the interviewers to obtain the required information for the traffic survey. Table 10.2.4 lists the interview sample rates for each vehicle category.

Table 10.2.4 Interview Rates

Vehicle Type	*Interviews*	*Sample Rate (%)*
Car	1102	47.2
Pick-up	2957	59.5
Mini-bus	198	43.2
Bus	782	60.3
Small Truck	1408	82.8
Medium Truck	779	78.8
Heavy Truck	330	51.8
Motorcycle	363	56.8
Bicycle	274	27.9
Tractor	59	57.8
Taxi	132	44.0
Other	136	59.1
Total	8520	58.2

Less than 30% of bicycles were interviewed, but this category is not so important as motorized transport to the study outcome. In every other vehicle category, over 40% of traffic was interviewed, with a total sample rate of well over 50%. This is considered very satisfactory in statistical terms.

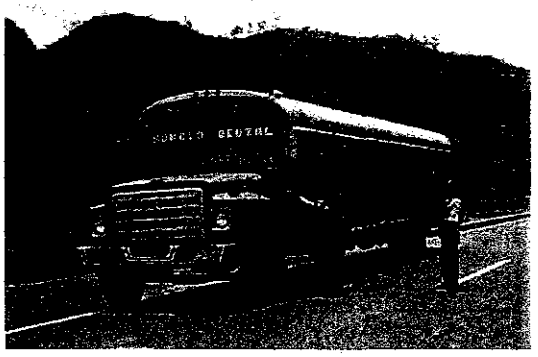


Photo 10.2.1 Interviewing at Yalaguia, Site32

Photo 10.2.2 Interviewing at Telica, Site2

10.3 Aggregate Traffic Count Results

Table 10.3.1 lists the average traffic counts for each site by vehicle type for the two 12-hour periods. These are shown graphically in Figure 10.3.1.

Table 10.3.1 Aggregate Traffic Counts, June 2002, 06.00 to 18.00 Hours

Site	*1*	*2*	*31*	*32*	*4*	*5*	*6*	*7*	*8*
Car	141	160	212	149	87	375	402	280	533
Pick-up	317	300	335	309	288	788	763	711	1160
Minibus	121	36	8	14	19	76	91	47	48
Bus	165	98	83	76	62	168	203	197	248
Light Goods	133	63	105	103	120	173	398	305	303
Medium Goods	158	85	122	38	18	137	137	128	168
Heavy Goods	259	35	66	2	14	67	39	40	118
Motorcycle	99	46	69	100	39	90	85	77	37
Bicycle	266	118	98	90	69	73	141	65	66
Tractor	26	11	1	0	8	8	44	1	5
Taxi	115	5	12	15	10	17	70	33	26
Other	1	1	30	1	0	3	57	135	5
Total	1798	955	1138	894	732	1972	2426	2016	2714

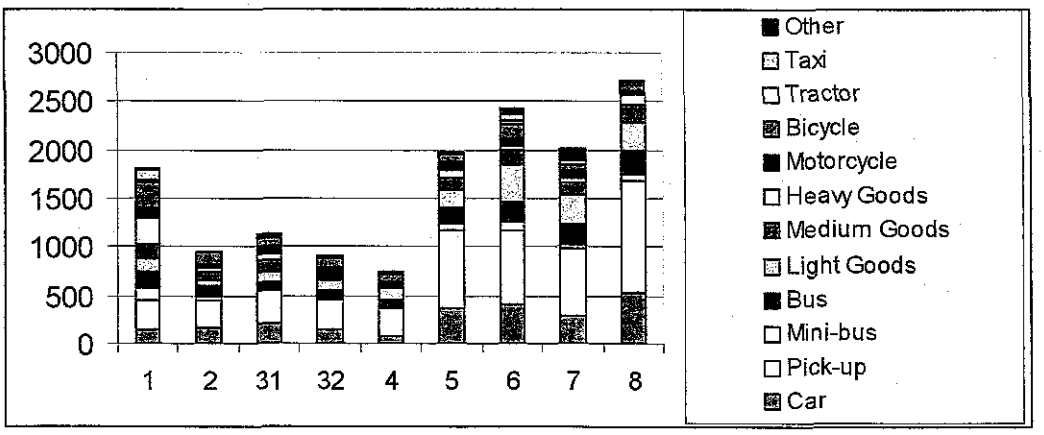


Figure 10.3.1 Aggregate Traffic Counts, June 2002, 06.00 to 18.00 Hours

Figure 10.3.2 shows the hourly profiles over the 12-hour day for each site. Sites 1, 2, 31, 32, 4 and 7 all display relatively flat profiles over the day. However, the sites on NIC 1 tend to have greater variation. Site 5 (Santa Cruz, NIC.1) shows a strong peak in the evening between 16.00 and 17.00 hours. Site 6 (Sebaco, NIC.1) shows a peak in the morning (06.00 to 07.00), and at Site 8 (San Benito, NIC.1) much higher volumes were observed after 12.00 than in the previous six hours.

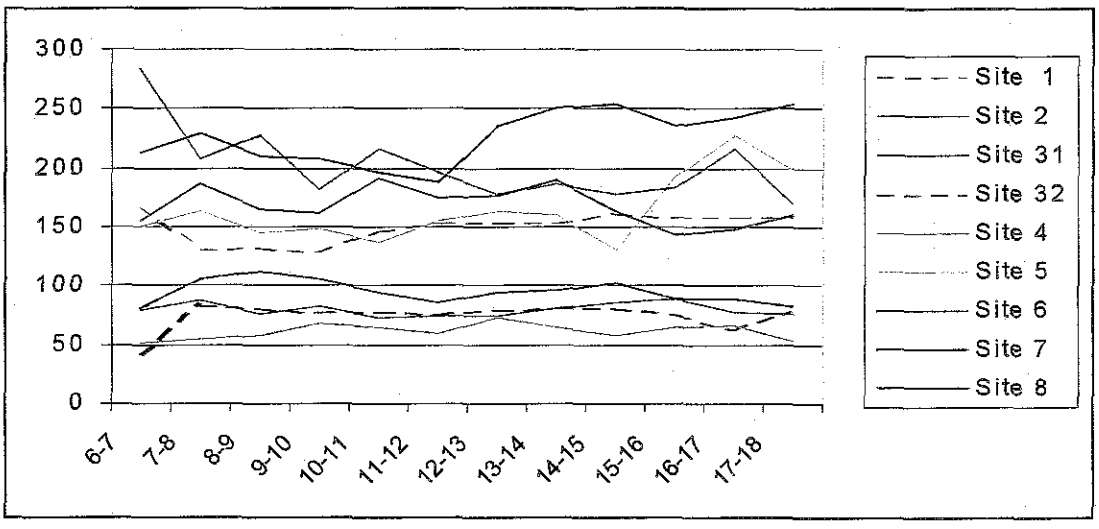


Figure 10.3.2 Hourly Total Traffic Variations, 06.00 to 18.00 Hours, All Sites

Figure 10.3.3 shows the hourly profile of observed traffic at the two sites where 24 counts were undertaken. The peak hour at Site 2 (Telica, NIC.26) was found to be 15.00 to 16.00 hoursand accounted for 7.1% of the total 24-hour traffic observed. The peak hour at Site 6 (Sebaco, NIC.1) was 06.00 to 07.00 hours and accounted for 8.3% of the total 24-hour traffic was observed. At Site 2, 76.5% of the 24-hour traffic was observed during the 12-hour day, whereas at Site 6 it was lower at 70.7%.

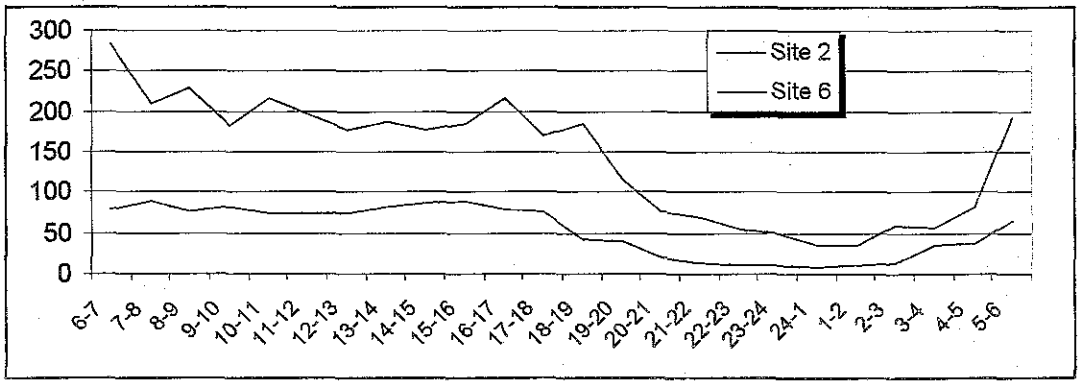


Figure 10.3.3 Hourly Total Traffic Variations, 24 Hours, Sites 2 and 6

Data for converting 12-hour counts to 24-hour counts is available for 20 main roads in Nicaragua for the year 2001, as shown in Figure 10.3.4. The data from the surveyed sites 2 and 6 are also included. The data from Site 2 is seen to be very close to the observed average,

so this latter value has been adopted. The resultant proportion of daily traffic occurring in the 12-hour period is 0.762, and the conversion factor from 12-hours to 24-hours is 1.31.

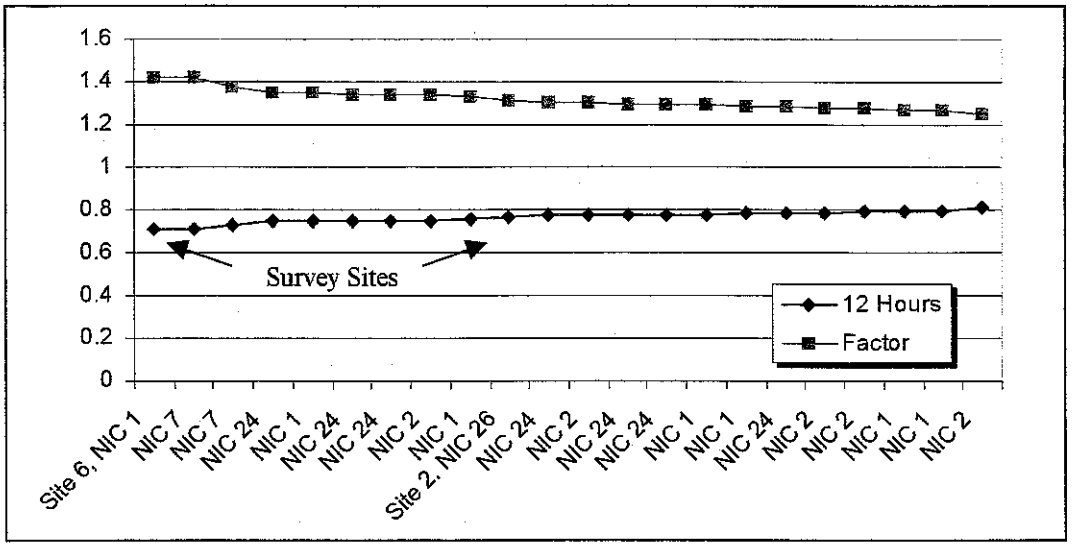


Figure 10.3.4 Observed Relationships between 12-hour and 24-hour Counts

Lavial SA prepared factors to enable average daily traffic to be calculated. These are set out in Table 10.3.3. The factor for converting June traffic to an average month is 1.2.

Table 10.3.3 Daily to Weekly Adjustment Factors

Day	Factor
Tuesday (11 June 2000)	1.15
Wednesday (12 June 2002)	1.04

The application of the above results in a total factor for converting the observed 12-hour flows to Annual Average Daily Traffic (AADT) volumes is summarized in Table 10.3.4. The resultant AADT's are shown in Table 10.3.5.

Table 10.3.4 AADT Conversion Factors

Conversion Item	Factor
12-hour to 24-hour	1.31
Tuesday/Wednesday to Average Weekday	1.0943
June to Average Month	1.05
12-hour to AADT	1.51

AADT's constructed from the surveyed counts have been compared with historic data from MTI for these sites. The estimated AADT's for motorized traffic (excluding bicycles and tractors) are shown in Figure 10.3.5 for the years 1997 to 2002. In aggregate at the nine sites, traffic has grown by an average of 10.4% per year over this 5-year period.

Table 10.3.5 Annual Average Daily Traffic Volumes, Surveyed Sites

Site	*1*	*2*	*31*	*32*	*4*	*5*	*6*	*7*	*8*
Car	236	262	349	246	143	618	661	459	879
Pick-up	523	497	552	509	474	1307	1244	1183	1913
Minibus	205	59	13	23	30	125	152	77	79
Bus	277	162	136	125	107	277	333	324	409
Light Goods	224	103	175	173	198	284	647	501	481
Medium Goods	263	140	200	62	29	225	228	213	276
Heavy Goods	429	57	108	3	21	109	67	65	194
Motorcycle	166	76	113	165	64	148	141	126	62
Bicycle	441	193	163	148	115	120	233	104	109
Tractor	42	18	2	0	12	13	75	1	9
Taxi	190	8	19	24	17	29	116	54	42
Other	1	1	49	1	0	5	96	222	8
Total	2998	1576	1880	1479	1211	3261	3993	3327	4460

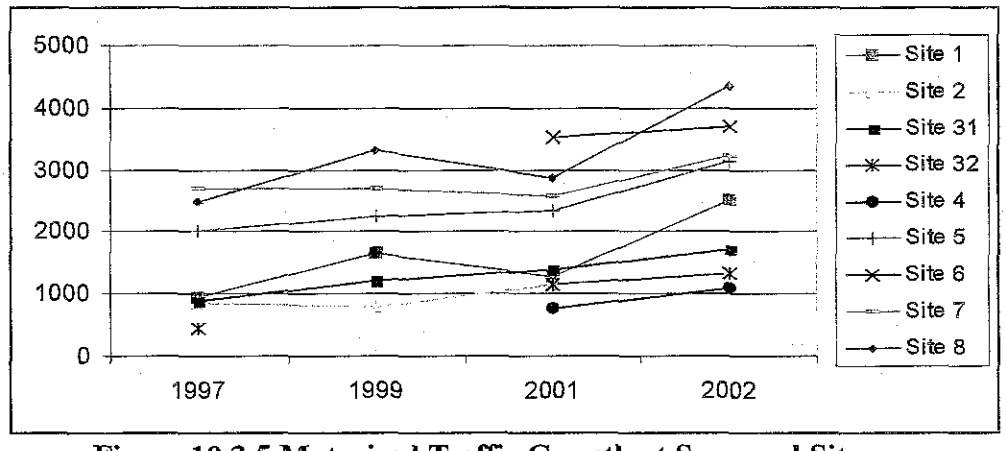


Figure 10.3.5 Motorized Traffic Growth at Surveyed Sites

10.4 Aggregate Interview Results

Table 10.4.1 lists the number of completed interviews carried out at each site.

Table 10.4.1 Total Valid Interviews by Site

Site	Interviews	Site	Interviews
1	535	5	934
2	1347	6	1233
31	635	7	882
32	897	8	1604
4	453	Total	2520

Table 10.4.2 lists average observed occupancies by vehicle type.

Table 10.4.2 Average Observed Vehicle Occupancies

Site	Vehicle Occupancy (including driver)
Car	3.0
Pick-up	2.7
Minibus	9.7
Bus	32.1
Light Goods	2.8
Medium Goods	2.8
Heavy Goods	2.3
Motorcycle	1.4
Bicycle	1.3
Tractor	2.6
Taxi	2.9
Other	2.8

Figure 10.4.1 shows the distribution of cargo weights by type of truck. Table 10.4.3 lists the average loads carried by each type of truck. On average, laden trucks were observed to carry 7.8 tons. Taking into account unladed trucks, the average drops to 4.8 tons. Almost half of light trucks were observed to be running unladed, or with passengers only. This reflects the fact that most of these trucks are operating loaded in one direction only. However, efficiencies for medium trucks are higher, and for heavy trucks highest, with only 23.3% operating unladed. Thus, as vehicle operating costs rise there is a greater incentive to attract return loads.

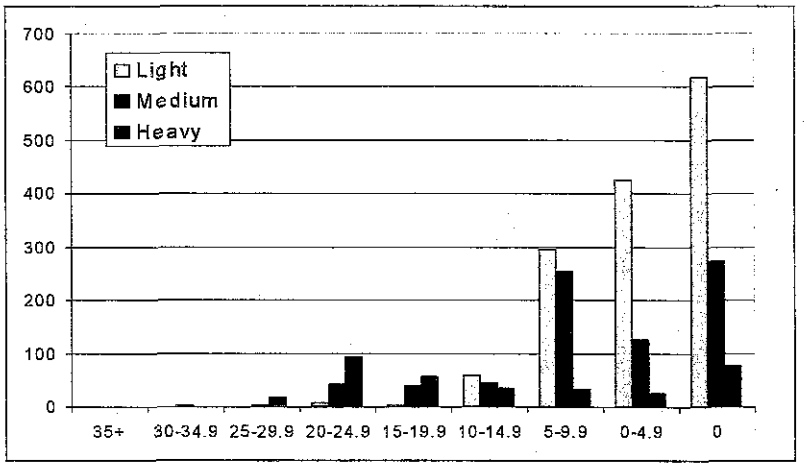


Figure 10.4.1 Distribution of Observed Loads Carried by Truck Type

Table 10.4.3 Average Loads by Truck Type (unit: tons)

Truck	Average load (Laden Trucks)	% Trucks Unladed	Average load (All Trucks)
Light	4.9	43.9	2.8
Medium	8.5	35.0	5.5
Heavy	15.3	23.3	11.7
All Trucks	7.8	38.5	4.8

Types of cargo carried by trucks are listed in Table 10.4.4.

Table 10.4.4 Cargos Carried by Truck Type Surveyed

Type of Cargo	% of Trucks	% Light	% Medium	% Heavy
Other Non-food	24.4	23.8	26.8	21.7
Other Food	21.5	28.4	12.7	15.0
Construction	11.4	10.7	15.7	4.7
Chemicals	8.1	7.7	7.7	10.7
Rice	6.0	7.1	4.2	5.9
Grain	5.0	4.1	6.6	5.1
Cement	3.9	2.6	3.9	9.1
Wood	3.7	2.8	3.0	8.7
Oil, Petroleum	3.1	1.9	5.5	3.6
Livestock	2.9	3.6	2.4	1.6
Metals	2.3	1.3	3.5	3.2
Sugar	2.1	1.0	4.2	2.0
Bananas	1.6	1.5	0.9	3.6
Beef Products	1.3	1.6	1.1	0.4
Coffee	1.0	0.8	0.9	2.4
Tobacco	0.6	0.5	0.4	1.6
Cotton	0.6	0.4	1.1	0.4
Sesame Seed	0.2	0.2	0.0	0.4
Total	100.0	100.0	100.0	100.0

As listed above, the most common cargo carried is "Other Non-food" and includes manufactured goods. "Other Food" products, other than rice, grain, sugar, bananas, beef, and sesame seed, includes dairy products and other processed food and is the second most carried cargo. Construction equipment and materials account for over 10% of total goods vehicle traffic. If cement is included in this category, it accounts for 15.3% of all goods vehicles. The weight limit for a 2-axle truck is 13.5 tons. Only 1.1% of trucks were recorded as overweight. The weight limit for a 3-axle truck is 23 tons and 1.2% of these vehicles were found overloaded. No heavy goods vehicles were recorded as overweight.

Table 10.4.5 lists the main origins and destinations recorded during the surveys. Managua was the most frequently (16.4%) recorded. Towns on study roads, such as Esteli, Sebaco, Ocotal, Somoto, Matagalpa, Chinandega, San Isidro, Cuidad Dario, Jintotega and La Trinidad accounted for a further 49.4% of origins and destinations.

Table 10.4.5 Frequency Distribution of Origins and Destinations

Origin/Destination	Interviews	%
Managua	2793	16.4
Esteli	1898	11.1
Sebaco	1079	6.3
Ocotal	998	5.9
Somoto	944	5.5
Leon	940	5.5
Matagalpa	544	3.2
Chinandega	517	3.0
San Isidro	435	2.6
Cuidad Dario	386	2.3
Jinotega	385	2.3
La Trinidad	283	1.7
Honduras	250	1.5
Yalaguina	233	1.4
El Sauce	144	0.8
El Guasaule	142	0.8
La Grecia	130	0.8
Tipitapa	114	0.7
Telica	109	0.6
Mina El Limon	108	0.6
Masaya	105	0.6
Costa Rica	103	0.6
Santa Cruz	102	0.6
Corinto	100	0.6
Other	4196	24.6

Figure 10.4.2 shows the distribution of journey purposes by site. At every site, interviewed vehicles were dominated by trips to, from and in the course of work. On average, 83% of all trips interviewed gave work as their journey purpose. At Site 1 this figure rose to 92%. Personal business, including shopping, accounted for 7% of respondents.

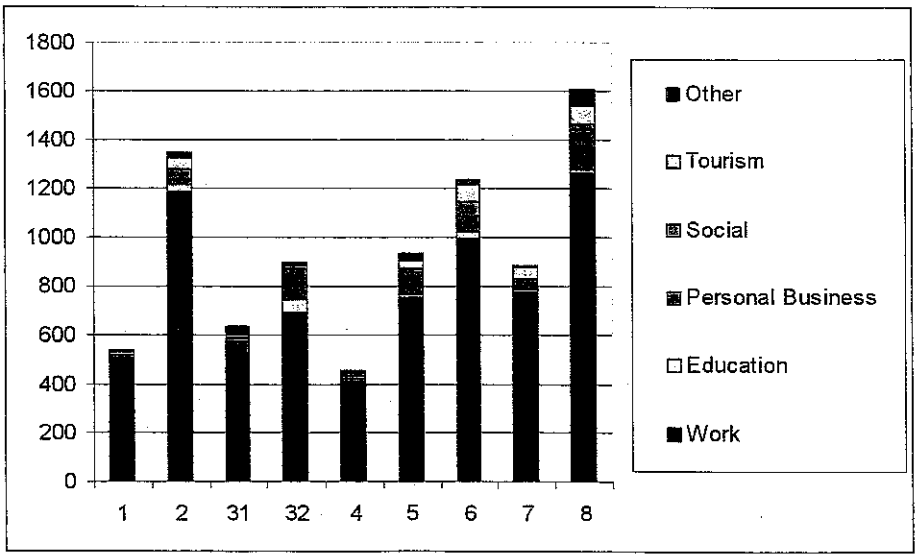


Figure 10.4.2 Number of Interviews at Each Site by Journey Purpose

CHAPTER 11

SOCIO-ECONOMIC FRAMEWORK

CHAPTER 11 SOCIO-ECONOMIC FRAMEWORK

11.1 Objectives and Method

The purpose of this chapter is to establish the socio-economic framework for Nicaragua within which traffic forecasts can be made. In addition, the conditions for estimating economic benefits that flow from investment in highway protection will be established. As a general rule, there is a strong relationship between economic conditions and traffic volumes. The key determinants of traffic growth adopted for this study are as follows:

- Population
- Economic activity and sector growth
- Income levels

There is a strong relationship between income and car ownership. As data on personal incomes are not available, use has been made of Gross Domestic Product (GDP) as a proxy. Research has demonstrated that there is also a strong link between GDP per head and personal car ownership. Table 11.1.1 summarizes the functions used for estimating the growth in traffic demand for this study.

Table 11.1.1 Socio-economic Variables Used to Determine Traffic Growth

Vehicle Type	Main Determinants of Traffic Growth
Cars and Taxis	GDP per head for vehicle ownership. Population for vehicle use
Pick-ups	GDP per head for vehicle ownership. General economic growth for vehicle use
Bus	Population growth. Assumed that increase in trip making is accounted for by higher private vehicle ownership
Goods Traffic	Sector economic growth, dependant upon types of cargo carried
Other	Population growth

Benefits that flow from investment in transport are conventionally measured as the sum of the following:

- Vehicle operating cost savings
- Time savings

Vehicle operating costs have been estimated using the method and data provided for the National Transport Plan for Nicaragua (February 2001). Some prices, e.g. fuels, have been updated for this study.

Time savings have been estimated using the values provided in the National Transport Plan and have not been modified.

11.2 Background Data and Forecasts

Figure 11.2.1 shows the growth in the population of Nicaragua over the period 1980 to 2002. During this period population grew by 87% at an average annual growth rate of 2.9%.

The age structure of the population is extremely skewed towards younger-age groups. As a consequence, population growth in the future is expected to be much higher than in the past. Figure 11.2.2 shows forecast population growth to the year 2020. Growth between 2002 and 2020 is estimated to be 78%, or an annual rate of 3.25%.

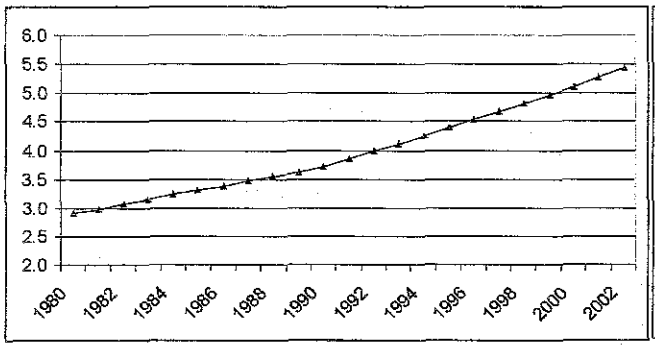


Figure 11.2.1 Nicaragua population, 1980 to 2002, Millions

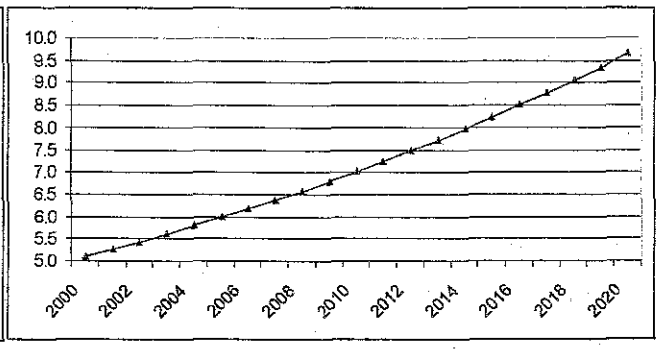


Figure 11.2.2 Forecast population of Nicaragua to 2020, Millions

Table 11.2.1 shows the quinquennial sector contributions to Gross Domestic Product forecast for the period 2000 to 2020. It shows the importance of agriculture to the national economy and reveals that this is forecast to grow from 27.1% in 2000 to 29.0% in 2020. The total economy is forecast to grow by 6.5% per year between 2000 and 2005, by 6.0% per year between 2005 and 2010, by 5.5% annually between 2010 and 2015, and by 5% per year between 2015 and 2020. Figure 11.2.3 shows the annual growth rates by sector and emphasises the high growth rates of the agricultural, construction, industrial and service sectors.

Table 11.2.1 GDP Forecasts by Sector, Nicaragua, 2000 to 2020, US$ Millions

	2000	2005	2010	2015	2020
Agriculture	681.9	951.5	1301	1718.4	2231.6
Other primary	55.3	62	69.2	84.4	92.4
Industry	503.2	706.7	955	1254.1	1608.3
Construction	130.8	179.3	244.5	331.6	432.2
Other Secondary	42.8	51.7	59.9	72.4	68
Services	1102.2	1496.2	1983.9	2568.6	3262.8
Total	2516.2	3447.4	4613.5	6029.5	7695.3

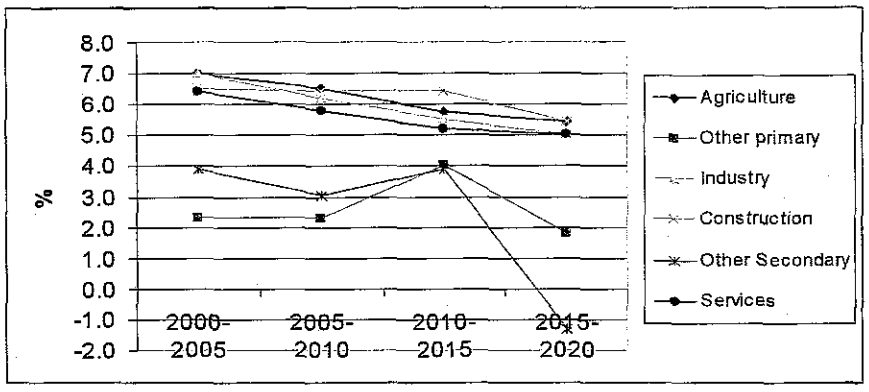


Figure 11.2.3 Annual Growth Rates by Sector of the Economy, 2000 to 2020

Figure 11.2.4 shows GDP per head for the period 1980 to 2000 and the forecast from 2000 to 2020. Average GDP per head fell drastically from the mid-1980s over a 15-year period, leading to one of the lowest figures in the western hemisphere. From 1998, GDP per head began to grow again, and it is now forecast that it will rise by 2.3% per annum until 2020.

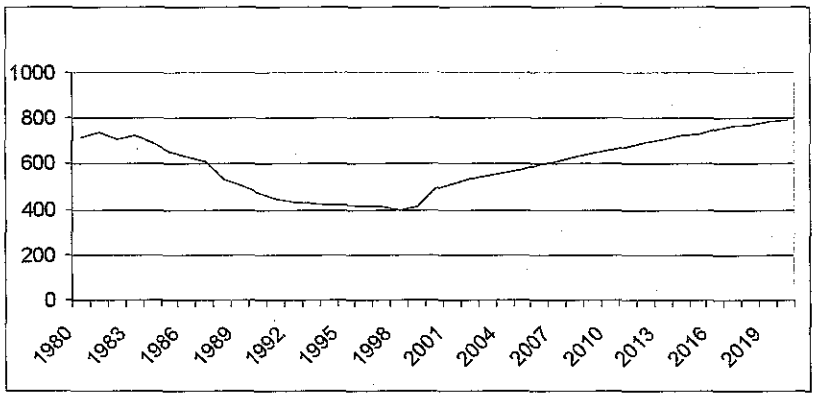


Figure 11.2.4 Average GDP per Head (US$), Nicaragua, 1980 to 2020

Figure 11.2.5 shows car ownership in selected Latin American and Asian countries for 1996. These have been chosen to provide relatively close comparisons with Nicaragua, both above and below. In Figure 11.2.6, these values have been plotted against GDP per head estimates for the same year. This *scatter gram* shows a general relationship between GDP and car ownership that can best be described by the following formula:

y = 0.0349x - 3.4031 where y is car ownership per 1000 population and x is GDP per head

Overall, the relationship between GDP and car ownership can be described as an exponential function, but at the relevant points in the graph (i.e., where GDP per head is low), a linear equation provides sufficient explanation. Using the above relationship, it is forecast that whilst GDP will increase by a factor of 1.62 over the 20 years to 2020, car ownership will increase by a factor of 1.78 over the same period, or an average annual growth rate of 2.9%.

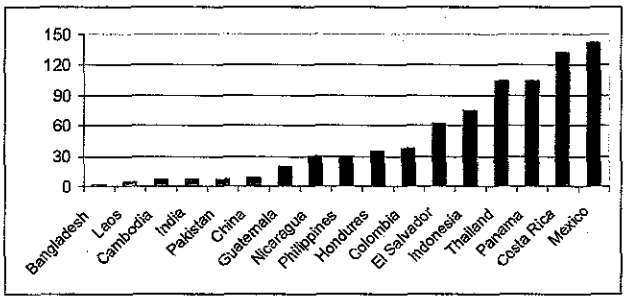


Figure 11.2.5 Vehicle Ownership (per 1000 population)

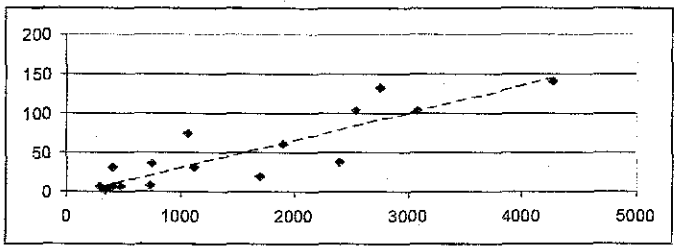


Figure 11.2.6 GDP per Head and Vehicle Ownership per 1,000 Population

11.3 Vehicle Operating Costs

Parameters for vehicle operating costs were taken from the National Transport Plan, 2001. Fuel and lubricant costs were updated to 2002 values. Vehicle occupancies were taken from the 2002 surveys, as they more accurately reflect conditions on the study roads than does the national average. Passenger time values were not included in vehicle operating costs (per 1000 km), but calculated separately and converted to costs per vehicle-hour. In this way, the traffic model output (Chapter 12) can be used to directly estimate passenger time savings and hence costs.

The composition of vehicle operating costs by vehicle type are as shown in Figure 11.3.1. The fuel component of cost tends to be much higher in Nicaragua than in many other countries due to the cost of gasoline (Cordoba 29.99, US$ 2.13 per litre) and the cost of diesel (Cordoba 23.0, US $ 1.64 per litre), as observed in June 2002. Vehicle operating costs per 1000 km and passenger costs per hour are summarised in Table 11.3.1.

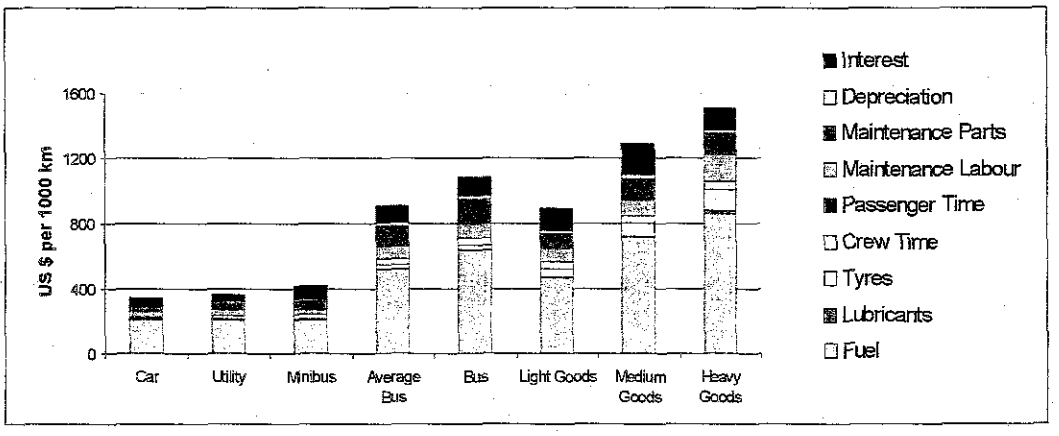


Figure 11.3.1 Vehicle Operating Costs, Nicaragua 2002, US $ per 1000 km

Table 11.3.1 Vehicle Operating Costs and Passenger Costs, Nicaragua 2002

Vehicle type	*Operating Cost per 1000 km, US $*	*Passenger Costs per vehicle hour*
Car	341.9	2.84
Utility	365.6	1.09
Minibus	421.0	5.31
Average Bus	909.8	14.90
Bus	1082.6	18.35
Light Goods	891.9	1.04
Medium Goods	1289.8	1.04
Heavy Goods	1509.8	0.75

A vehicle category of average bus was developed, because there were insufficient survey data on minibuses to provide a robust statistical sample. Hence, in the traffic model a single bus mode has been used. Vehicle operating costs for this mode have been estimated by factoring the costs of minibuses and buses in Table 11.4.1 using the ratio of these vehicles observed in the surveys. Seventy-four percent of all buses observed on the study roads were found to be large buses and 26% minibuses. Note that this factoring is valid only for this study.

11.4 Traffic Growth Factors

For this study two forecast years have been established: 2010 and 2020. The traffic matrices described in Chapter 12 have been factored according to Table 11.4.1 in line with the economic projections above.

Table 11.4.1 Traffic Growth Factors to 2010 and 2020

	Growth 2002 to 2010	Growth 2002 to 2020	Functional Description
Cars	1.57	2.74	Population growth x vehicle ownership growth
Pick-ups	1.57	2.74	GDP growth x vehicle ownership growth
Buses	1.29	1.78	Population
Goods (Agriculture)	1.68	2.87	Agriculture Sector Growth
Goods (Other Primary)	1.19	1.60	Other Primary sector growth
Goods (Industry)	1.66	2.79	Industrial sector growth
Goods (Construction)	1.65	2.91	Construction sector growth
Goods (Vacant, other)	1.62	2.70	Average economic growth

Growth in traffic is very dependant on economic growth. The GDP forecasts are relatively optimistic, predicting a sustained growth in the economy of around 5% over a 20-year period. In order to assess the effects of lower growth, a sensitivity test has been developed. In this test, it is assumed that the economy grows at 60% of the forecast rates in Table 11.2.1 across all sectors equally. When this reduced growth is converted into the traffic growth factors, the values in Table 11.4.2 result.

Table 11.4.2 Traffic Growth Factors (sensitivity test)

	Growth 2002 to 2010	Growth 2002 to 2020
Cars	1.31	1.83
Pick-ups	1.21	1.48
Buses	1.29	1.78
Goods (Agriculture)	1.21	1.48
Goods (Other Primary)	1.07	1.19
Goods (Industry)	1.20	1.45
Goods (Construction)	1.20	1.48
Goods (Vacant, other)	1.12	1.38

11.5 Values of Time and Cost

Values of time are expected to rise in line with average GDP per head. The factors to be applied to passenger costs per vehicle hour (Table 11.3.1) are set out in Table 11.5.1. In the sensitivity test, values of time are forecasted to fall, owing to a decrease in GDP per head, because population is forecast to rise at a higher rate than GDP.

Table 11.5.1 Growth Factors Applied to Value of Time, at 2002 US$ Values

	2002 to 2010	2002 to 2020
Base Case	1.239	0.924
Sensitivity Test	2.678	0.811

Values of cost are held constant at 2002 prices in US Dollars.

11.6 Evaluation Parameters

The costs that would be incurred from a disaster on the study roads are calculated using the changes in gross vehicle-kilometres and vehicle-hours for each mode of vehicle, which is outputted from the JICA STRADA Traffic Model.

Vehicle-kilometers and vehicle-hours are converted into monetary units using the values of time and cost taken from Tables 11.3.1 and 11.5.1. Other evaluation parameters are listed in Table 11.6.1.

Table 11.6.1 Evaluation Parameters

Parameter	*Value*
Base year for evaluation	2002
Price Base	2002, constant prices
Evaluation period	21 years
Road Maintenance Cost, per km, per year	$1,313
Conversion Factor, construction cost to total capital cost (less than $50,000)	1.92
Conversion Factor, construction cost to total capital cost (more than $50,000)	2.05
Capital Cost Expenditure profile (Permanent Works)	100% in 2003
Capital Cost Expenditure profile (Temporary Works)	100% in 2003, repeated every 3 years
Maintenance costs (Permanent Works)	5% of total capital cost annually
Maintenance costs (Temporary Works)	Zero
Discount Rate	10%

In order to take account of the probabilities of disasters occurring, the evaluation combined two considerations:

- Benefits are discounted in accordance with the score (divided by 100) reported in Chapter 5 of the Progress Report of March 2002, and accrue annually from the year after intervention measures *(Score method)*; and
- Benefits accrue only in the year following a disaster. This year is determined by the maximum potential life of a slope or bridge without any intervention measure *(Risk Method)*.

An average Benefit: Cost ratio is calculated using both methods.