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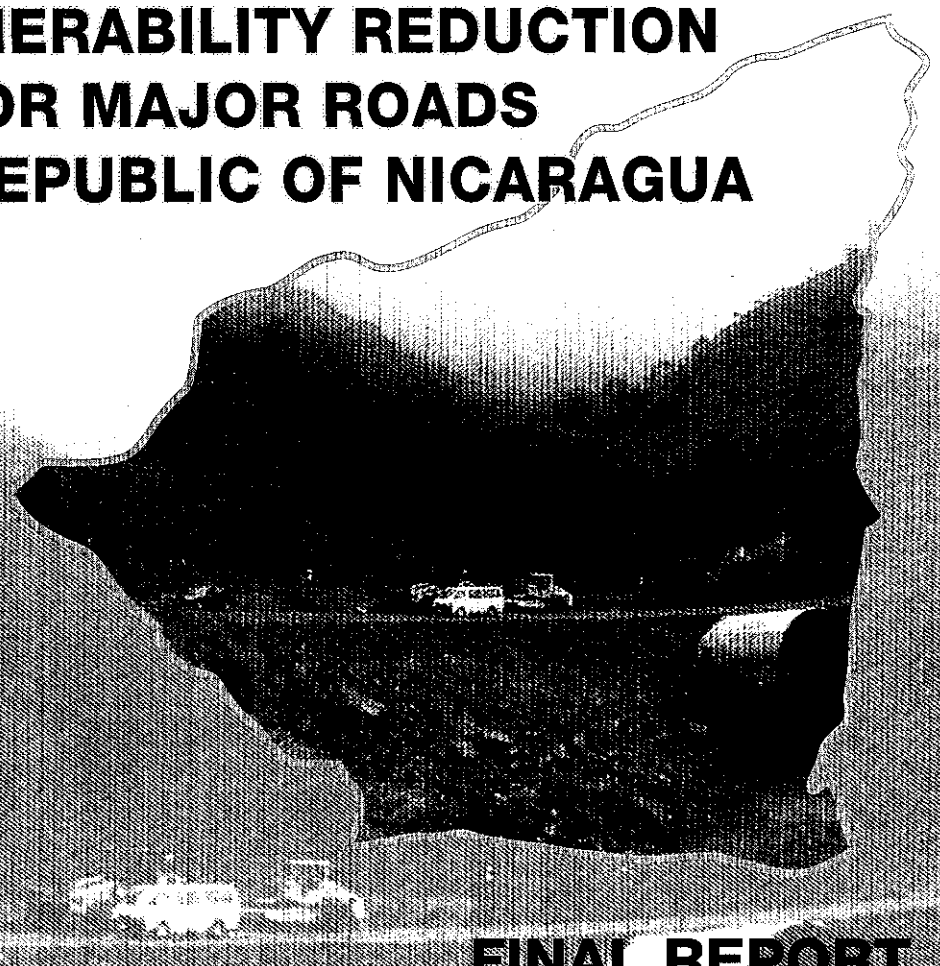
No.

JAPAN INTERNATIONAL
COOPERATION AGENCY (JICA)

MINISTRY OF TRANSPORT AND
INFRASTRUCTURE
REPUBLIC OF NICARAGUA

THE STUDY ON VULNERABILITY REDUCTION FOR MAJOR ROADS IN THE REPUBLIC OF NICARAGUA



FINAL REPORT

Volume 5 of 5 (2/4)

PLANNING MANUAL

January 2003

Oriental Consultants Company Limited

Japan Engineering Consultants Company Limited

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List of Abbreviations
(In alphabetical order)

AADT	:	Annual Average Daily Traffic
AASHTO	:	American Association of State Highway and Transportation Officials
AHP	:	Analytic Hierarchy Process
ASTM		American Society for Testing and Materials
B/C	:	Benefit to Cost ratio
BH		Boring Hole
BHN	:	Basic Human Needs
BIT		Central American Development Bank
DID		Densely Inhabitant District
EIA	:	Environmental Impact Assessment
GDP	:	Gross Domestic Product
GRN	:	The Government of Republic of Nicaragua
ID		Identification
IDF	:	Rainfall Intensity Duration Frequency
IEE	:	Initial Environmental Examination
INETER	:	Institution of National Territorial Study
IRR	:	Internal Rate of Return
JICA		Japan International Cooperation Agency
MARENA	:	The Ministry of Natural Resources and Environment
MTI	:	The Ministry of Transport and Infrastructure
OD	:	Origin and Destination
PRSP	:	Poverty Reduction Strategy paper
QV	:	Volume capacity
ROW	:	Right of Way
STRADA		System for Traffic Demand Analysis
VAT		Value Added Tax
VOC	:	Vehicle Operation Cost
WB		World Bank
pcu	:	Passenger Car Unit

The following foreign exchange rate is applied in the study :

1 US dollar = 14.40 Cordovas = 125.00 Japanese Yen (October 2002), or

1 Cordovas = 8.68 Japanese Yen

CHAPTER 1 INTRODUCTION

1.1 General

This manual has been produced for the Ministry of Transport and Infrastructure (MTI), who will manage the road disaster prevention of major and rural roads in Nicaragua, by the Japan International Cooperation Agency (JICA). The Direction of Road Maintenance, General Direction of Road, in MTI (DRM) has managed and been responsibility for the maintenance works of all roads controlled by MTI. Therefore, in order to achieve the reliable maintenance works, all roads under DRM should be maintained in accordance with this manual.

Maintenance works for road disaster prevention are one of the fundamental factors in increasing the socio-economic performance of a nation. Therefore, activation of the populace and safety control of the road users are dependent on the results of the premeditated maintenance. Efforts that every day does not slacken are important for securing the stable transportation of products. Due to his duty, DRM, Engineers, inspectors, technicians and maintenance staffs should execute road maintenance work based on same policy and methods.

This series of road disaster prevention manual are composed of four parts as follow.

Part I : Inspection Manual
Part II : Planning Manual
Part III : Design/ Execution Works Manual
Part IV : Maintenance Manual

This is Part II "Planning Manual".

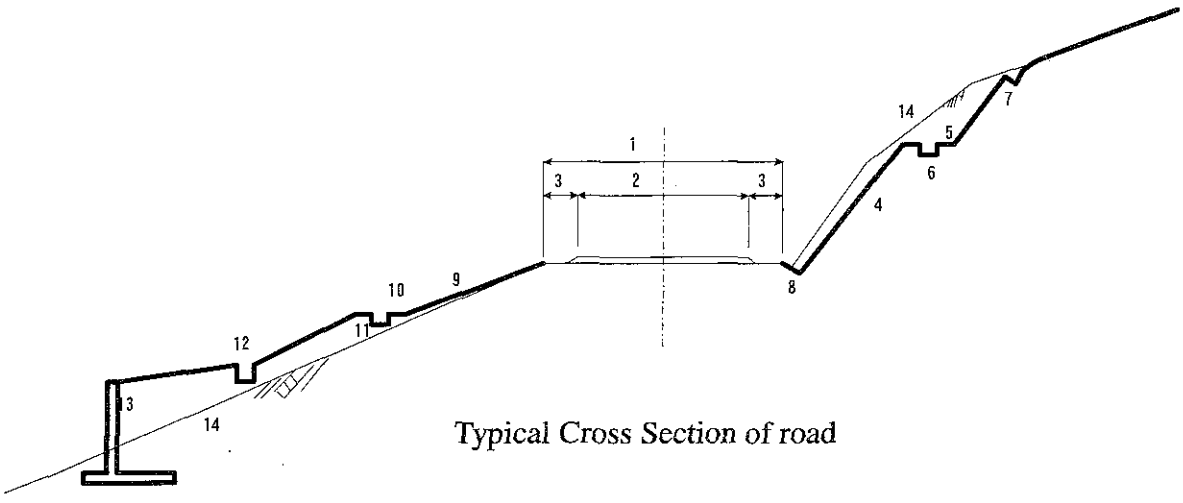
This Manual has taken account of natural conditions, road geometries and environmental condition. Engineers, Inspectors, Technicians and maintenance staffs should be kept on doing maintenance.

1.2 Glossary of Terms

This Chapter contains a glossary of terms that are used in this manual.

1.2.1 Cross section

The typical road cross section is as the following figure. Almost cut slopes, embankments and ditches, etc. are not enough safeguard against failure. Therefore, this manual contains proposals shown in following figure as bold lines.



Typical Cross Section of road

Key;

1. Roadway
2. Carriageway
3. Shoulder
4. Cut Slope
5. Berm
6. Berm Ditch
7. Crest Ditch
8. Roadside Drain
9. Embankment Slope
10. Berm
11. Berm Ditch
12. Berm Ditch
13. Structure
14. Existing Slope

1.2.2 Glossary of Terms

The main "Glossary Terms" are as follows.

AHP	This is one of evaluation method for selecting the high priority disaster spots. AHP is an abbreviation of the Analytic Hierarchy Process.
Catchment Area	The area from which water runs off by gravity to a collecting point.
Culvert	A duct, usually rectangular or circular, for carrying surface water under the road.
Gabion	The steel mesh cage filled with cobble stone or crushed stone. This is mainly used for revetment, foot protection and rockfalling protection.
Disaster Critical Spots	Disaster critical spots should be defined in consideration of the following items to the disaster potential spots: - Disaster scale/ records at area of spots, - Necessary spots for emergency, - Critical spots for third persons, - Topographic data by preliminary topographic survey, and - Sketch of site condition.
Disaster Potential Spots	Disaster potential spots are defined when there are: - boulders on slope surfaces, - many cracks on rock surfaces, - small rock fallings, and - historical disaster records regarding rock-fall, rock collapsing, slope slide, scouring of bridge foundation.
Disaster Prevention Spot	Where countermeasures against disaster are proposed, Which addressed the following: - Stability level of damage spots, - Traffic volume of objective road, - Environmental evaluation, - Natural condition, - Benefits/ Rough cost estimate, - Restoration level of damaged spot, and - Development situation.
Emergency Countermeasure	- It means that a serious and dangerous spot must be improved immediately. - The lifetime of countermeasures should be until the next rainy season or less than a half year. - It is necessary to decide upon the implementation of temporary countermeasures or permanent ones during the lifetime of the emergency countermeasures.

Emergency Inspection

<Time of Year>: The Emergency Inspection must be carried out just before any forecast hurricane or heavy rain.

<Spots> : Slope spots previously damaged, seepage water spots on slope and severe scouring spots at bridge foundations, must be carefully inspected and be written on the survey sheets by Inspectors.

<Frequency> : Just before hurricane or heavy rain.

Inspector

Inspector means a member of Inspection Team. Inspection team is composed of a Engineer and two assistants.

Periodic Inspection

<Time of Year>: The Periodic Inspection must be carried out before the rainy season (usually around September) or after earthquake occurred.

<Spots> : At least, whole slopes of disaster potential spots, and around the bridges at disaster potential spots must be inspected and be written on the survey sheets by Inspectors.

<Frequency> : Once every year

Permanent Countermeasure

- The lifetime of countermeasures should be least twenty (20) years during the maintenance work.
- An adequate budget for permanent countermeasures should be safeguarded at all times.

Routine Inspection

<Time of Year>: The Periodic Inspection must be carried out as general inspection throughout the year.

<Spots> : Whole slopes and bridges on the objective major road is inspected and be written on the survey, if some abnormality occur.

<Frequency> : Once for a week

Screening

The objective of screening is as follows:
- Objective inspection of vulnerable spots,
- Early detection of vulnerable spots, and
- Characteristic grasp of vulnerable spots.

Temporary Countermeasure

The lifetime of countermeasures should be at least ten (10) years during the maintenance work.

1.3 Relating Law

Each regulation for construction work of disaster critical spots is described in this Section. There are two regulations for construction work and for its transportation of materials and machines.

1.3.1 Law 337

National Committee has managed the National system for the Prevention, Mitigation and Disasters in Nicaragua. The following contents have extracted from the Creator Law of National system.

Chapter 1: General Dispositions

Art. 3 Basics Definitions

Numeral 7 Disasters:

In all situations that cause intense alterations for the social, physical, ecological and cultural society components, taking to imminent danger the human life and the personal and national goodness, surpass the local answer capacity to give efficiently attention to the consequences; it could be from a natural origin or caused by the man.

Numeral 8: Natural Disasters

This damages are caused by any natural phenomenon, this could be a hurricane, a twister, storm, high tide, inundation, tsunami, earthquake or volcanic eruptions, land slide, forest fire, agriculture blight, dried and others that as result will affect the population, the infrastructure and some productive sectors from the different economical activities, in a high scale that overcome the capacity for local answers and require the regional help; at the request of one or more of the affected parts to complete the able resources efforts on it, so that the damages and the loss could be mitigate.

Numeral 12. Disasters Prevention

It is call to the group of activities and measures from a technical and legal character that has to be done in a Socio- economical development Planning process, so that the loss of humans life and damages on the economy could be avoid as a consequence of the natural disasters.

Art. 7 National System Functions

Part 1.
Design, ratify and execute the disasters prevention plan.

Part 10

To establish the agreement for Scientific-Technical cooperation for countries with more experience on it.

Chapter II

From the National Commitment of the National System for Prevention, Mitigation and disasters attention

Art. 9. National Commitment of the National System.

The national commitment of the National system, from now on is call National Commitment; it is the ruling instance and the one who can establish the political, planning, direction and the system coordination all over their activities.

Art. 10. National Commitment integration.

The national commitment joint to the State ministries or their represent, is going to be presided by the president of the republic or the vice president. This National Commitment has a permanent character.
The sessions works of the national commitment have to be on the running time at least two times in the year and they will regulated themselves with the Rules established on the present law. This commitment is going to be conformed as follows:

1. President of the Republic or a representative
2. Secretary of Defend , companied with the Chief of the national army
3. Secretary of Interior , companied with the chief of the national police.
4. Secretary of state
5. Secretary of Treasure and public credit.
6. Secretary of Foment, Industry and business.
7. Secretary of health
8. Secretary of Transport and Infrastructure
9. Secretary of environment and Natural resources
10. Secretary of the Family

11. Secretary of Education, Culture and sport.
12. Director of Territorial Study institute.

Art. 11 Commitment functions

For the present law and their ruling, it is function of the National commitment the following aspects:

1. Definitions of the national system politics
2. Approve the national plan for the national system
3. Propose to the president of the republic the declaration of the disaster conditions.
4. Approve the annual purpose for the national disaster fond.

Propose the adoption of required measures and instruments to make useful the objectives of the national system, such as territorial order and education, and more.

5. Creation of the procedures on instruments for the control and distribution of the international help.
6. Approve the norms and regulation propose of the territorial order for the disasters prevention.
7. Convoke, such as adviser, to the governmental and non governmental organisms.
8. Approve the items and contents of the study that has to be include on the education programs of the Department of Education, culture and Sports, such as the others institutions of the technical education and superior, about prevention, mitigation, and disasters attention.

In the Department of Transport and Infrastructure exist a technical joint unity for disasters that are direct dependant from the Superior direction of the MTI and in case that disasters occur is attended by the General Director of Constructions Norms and urban Development.

1.3.2 NIC 2000

Sub division 100
Section 105 Work reach

1. General

105.07 Dispositions about the Traffic Control

The contractor can not close to the traffic for any reason publics routs or stretch or bridge without a previous writing approve by the engineer. Neither can start with the constructions works that for any reason left the public road on non adequate conditions for the traffic flow, with out a previous temporary construction approved by the engineer based on the commodity and security aspects.

Other wise it is arrange on a different way on the draws, preventive signs should be installed far away from the project limits, at least 150 meters from each side. And at least 150 m form another project site where the constructions works interfere with the public traffic that use the route.

During the night should be working flashing beacon, lanterns. Electrical and reflective instruments and any other approved light sign in the places where it is necessary.

Where it is necessary and the places where the engineer said, should be use a standard bearer , or pilots cars or routs savers with the purpose to guide and arrange the traffic and pedestrian circulation. The workers should be wearing uniforms or specials jackets and pennant or manual signs so that they could be easily seen by the drivers during the day and the night.

When the works are done on adjacent areas of lanes to open traffic areas, the borders of the lanes or of the pavement should be defined trough portable definers placed on the whole length and parallel to the border.

105.06 Traffic Maintenance

1. Construction of the Road by band.

Specially in case of paving or re-paving, the contractor could, if the engineer approve, proceed to work with band, leaving free a space with a enough wide for the secure and comfortable traffic pass and controlling trough the standard bearer or pilots car; on both opposites routs of traffic circulation.

Ruling for the load control and dimensions of the load carrying vehicles that transit on the Road network of Nicaragua (MTI) March 2002

Art. 9 It is establish that the carried load should respect the following aspects.

1. No load could be more than 1.0 m from the back side of a vehicle.
2. Any loaded or unloaded vehicle could exceed the follow dimensions:

Wide: 2.60 m.
Height: 4.15 m. (starting form the running surface)
Length: a) 2 axes : 11.0m.
b) 3 axes: 12.0 m.
c) half tow truck : 17.35m.
d) others combinations: 18.3 m.

Art. 19

When for any reason of general interest, had to be occasionally transported, heavy machines or other invisibles objects, on load carry vehicles allowed to use the country road network which load and dimensions exceed the indicated on appendix that are stipulated on this ruling, a special permission is granted by the Road General Direction at the request of the owner of the special load at least previously 3 days before the carry of the load, which has limited urgency just for the particular trip.

Art. 20

In each special permission it is going to be specify the type of load, the rout that is going to follow and the appropriate time, the circulation speed on the roads and specially on bridges, accompaniment of radio squad and others protections measures of the road network and safety of the others users.

Art. 42

Motorized vehicles or their combinations should have pneumatic tires or dispositives with enough elastic surface. It is prohibit to use metallic objects that are prominent on the running surface of the tire. The tires pressure on none case can exceed the load of 8.4 kg/cm^2. It is prohibit to circulate with chains or metallic bands.

1.3.3 Law for Vehicles and Traffic

Art. 61

It is totally prohibit to carry objects that are prominent from the external sides of vehicles and every time that they are prominent form the posterior side of the vehicle, they should be provide with a red scarf, if it is during the day; or a red light if it is during the night.

Note: Law approved on may 10, 1938

CHAPTER 2 ASSESSMENT METHODS OF ROAD DISASTER PREVENTION SPOTS

2.1 General

At disaster critical spots it is necessary to identify the need for urgent countermeasures, either temporary or permanent in nature. Countermeasures at these spots should be planned in consideration of the following items :

i) Hydrological conditions for evaluating bridge foundation scouring,
ii) Geological conditions for evaluation of rock weathering or collapsing or seepage water,
iii) Environmental conditions for evaluating of environmental items,
iv) Future traffic demand, and
v) Benefit to cost ratio for evaluating value for money.

The identification of disaster prevention spots on roads should take into account the evaluation indices for the factors: stability level, traffic volume, environment of the surrounding area, development plans in the surrounding area, natural conditions, economic benefit and restoration level

2.2 Selection Technique of Road Disaster Prevention Spots

2.2.1 Outline of Selection Techniques

The evaluation scores of disaster critical spots depends on the scale and type of potential disaster. For the purposes of prioritizing spots it is necessary to take account of all the evaluation items.

In this Manual, the Analytic Hierarchy Process (AHP) is used to identify the priority order for disaster prevention spots. The AHP technique converts human judgement into numerical values for uncertain situations under various criteria. The AHP formulates a hierarchical structure of the decision making with the "evaluation criteria" between "purpose" and "alternative spots" such as shown in Figure 2.2.1

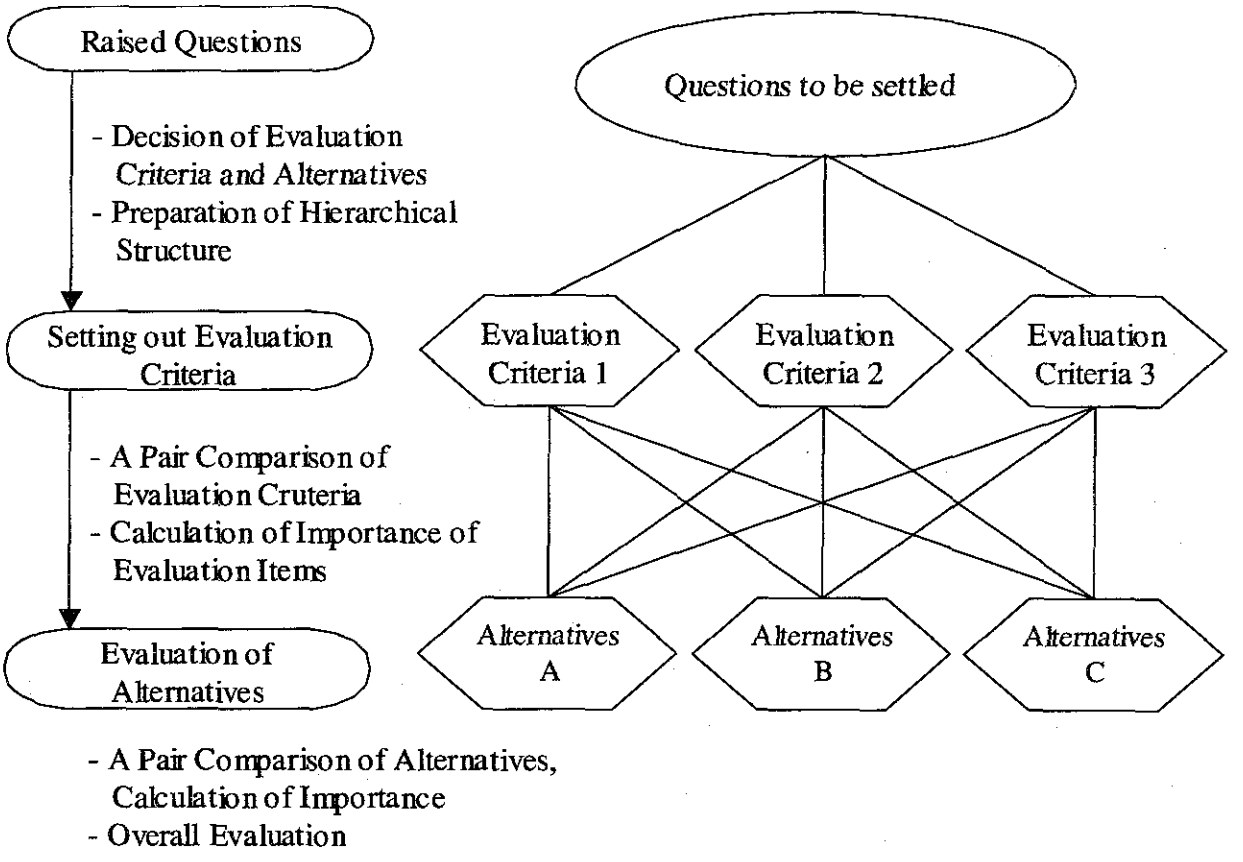


Figure 2.2.1 Concept of Decision Making by AHP

2.2.2 Priority Level for Disaster Prevention Spots

Priority levels for disaster prevention spots are determined by a 2-step process in the AHP, described below.

a) Step 1 (Setting of evaluation criteria)

Seven evaluation criteria are used in Step One, as described in the Table 2.2.1. For each of the evaluation criteria there is a detailed explanation of development and scoring later in this section.

Table 2.2.1 Setting Evaluation Criteria

Evaluation Criteria	Section in Manual	Priority Order	Evaluation Source
1. Stability Level	2.3.2	When the stability score is large, the priority is high.	Stability levels from the survey results form
2. Traffic Volume	2.3.3	When the traffic volume is large, the priority is high.	Traffic volumes from database or special surveys
3. Environmental Evaluation	2.3.4	When the score is low, the priority is high.	Evaluation result of the environmental issues.
4. Development situation	2.3.5	More intense development of road side area gives a higher priority.	Development of roadside areas from site visits and plans.
5. Natural Condition	2.3.6	When the critical level is large, the priority is high.	Critical levels are based on the results of the natural condition survey of geology, hydrology (including effects of rainy season).
6. Benefit/Cost	2.3.7	When the B/C is large, the priority is high.	Benefit calculations and countermeasure costs.
7. Restoration Level	2.3.8	When the level of difficulty (restoration time, restoration yard spaces and necessity of special restoration machines) is high, the priority is high.	The level of difficulty of restoration should be evaluated based on the worst disaster to be assumed.

b) Step 2 (Pair-wise comparisons of evaluation criteria)

i) Magnitude and definition of importance

The seven evaluation criteria are paired with each other. The degree of relative importance between the two criteria is assessed. The degree of relative importance between the first element of the pair and the second is given a value, from Table 2.2.2. Intermediate values can also be used.

Table 2.2.2 Relative Importance Scores

Magnitude of relative importance between first evaluation criteria and second	Definition
1	Both criteria are equally important
3	First criteria is weakly more important than the second
5	First criteria is strongly more important than the second
7	First criteria is very strongly more important than the second
9	First criteria is absolutely important
1/9	First criteria is absolutely not important
1/7	First criteria is very much less important than the second
1/5	First criteria is less important than the second
1/3	First criteria is a little less important than the second

For example, when the stability level is weakly more important than the traffic volume, the magnitude is 3. Conversely, therefore, the traffic volume is a little less important than stability and the magnitude is 1/3, (i.e. the reciprocal value).

ii) Magnitude of Pair Comparison

The magnitude of the pair-wise comparison for evaluation criteria is entered into a table, an example of which is shown as Figure 2.2.2.

	Stability level	Traffic volume	Environment evaluation	Natural condition	Benefit B/C	Restoration level	Development situation	Weight
Stability level	1	3	5	3	7	3	9	0.36676
Traffic volume	1/3	1	3	1	5	1	7	0.16733
Environment evaluation	1/5	1/3	1	1/5	3	1	7	0.08395
Natural condition	1/3	1	5	1	5	1	7	0.18000
Benefit B/C	1/7	1/5	1/3	1/5	1	1/5	3	0.03826
Restoration level	1/3	1	1	1	5	1	7	0.14303
Development situation	1/9	1/7	1/7	1/7	1/3	1/7	1	0.02068
								1.00000

Figure 2.2.2 AHP Pair-Wise Comparison of evaluation criteria

The usual method is to enter values for all the cells above the leading diagonal. Reciprocal values are then automatically generated for the cells below the leading diagonal. A sum is then calculated for each of the rows of the table (each evaluation criteria). The sum has the general formula :

$$Ti = (V_{i1}*V_{i2}*V_{i3}*V_{i4}*V_{i5}*....V_{in})^{\wedge}(1/n)$$

Where Ti = Row total for row i

V_{i1} = Value for cell in row i, column 1, etc

n = total number of evaluation criteria

A weight for each evaluation criteria is calculated as follows :

$$Wi = Ti / \quad Ti \ (i=1,n)$$

2.3 Method of Emergency Assessment of Road Disaster Preventions

2.3.1 General

Emergency assessment of road disaster prevention should be decided by taking account of the traffic volume on the objective road, stability level of slopes and bridges, restoration levels and the surrounding environment. Emergency assessment of road disaster prevention measures is defined using the following items in this manual.

2.3.2 Stability Level

Stability level refers to slope stability and the stability of bridge foundation scouring.
It should be evaluated taking account of the progress of weathering, collapsing and seepage of water at the slope surface. Regarding bridges, stability evaluation should consider the scouring. Stability level is evaluated by the Score of Stability Survey Sheet (See Planning Manual).

2.3.3 Traffic Volume

The identification of traffic levels on road potentially affected by natural disaster is an important part of the overall assessment. Traffic levels are continually growing in Nicaragua, and traffic patterns change as a result of new and rehabilitated roads. Therefore up-to-date traffic data are required. Traffic data can be taken from :

i) Regular traffic counts, taken by MTI on main roads, if available; or
ii) Special traffic surveys, if above data are not available.

A typical traffic count form is shown as Figure 2.3.1. It allows data to be collected on traffic volumes by vehicle type, for 15 minute periods over a 12-hour working day. Traffic counts should be converted to an Average Annual Daily Traffic (AADT) figure using the factors developed by Lavial SA. AADT's enable direct comparisons to be made of traffic volumes for any time of the year. The factors are :

12 hours to All-day : Multiply by 1.31

Table 2.3.1 Factors to Convert to an Average Day

Day	Conversion Factor to average weekday	Day	Conversion Factor to average weekday
Sunday	1.30	Thursday	1.10
Monday	0.80	Friday	0.74
Tuesday	1.15	Saturday	1.15
Wednesday	1.04		

Table 2.3.2 Factors to Convert to an Average Month

Month	Conversion factor to average month	Month	Conversion factor to average month
January	1.00	July	1.25
February	1.03	August	1.20
March	1.05	September	1.20
April	1.05	October	1.20
May	1.05	November	0.91
June	1.05	December	0.89

Traffic should be split into 6 vehicle types : cars, camionetas, buses, light goods, medium goods, and heavy goods. These have different annual growth rates.

Table 2.3.3 Percentage Annual Growth Rates for Traffic

Vehicle Type	Up to 2005	2005 to 2010	2010 to 2015	2015 to 2002
Car	5.8	5.8	7.2	7.2
Camioneta	5.8	5.8	7.2	7.2
Bus	3.3	3.2	5.5	5.0
Goods (Agriculture)	7.0	6.5	5.7	5.4
Goods (Other primary)	2.3	2.3	4.0	1.8
Goods (Industry)	7.0	6.2	5.5	5.0
Goods (Construction)	6.5	6.4	6.4	5.4
Goods (Vacant, other)	6.5	6.0	5.5	5.0

If a link in the road network is affected by a natural disaster such that traffic cannot pass, then vehicles will be forced to find an alternative route. The potential alternative routes in the locality of the potential disaster site should be identified by:

i) Reviewing existing mapping; and
ii) Site visits

The following data for each of the minor roads in the locality are required :

i) Length
ii) Average speed
iii) Capacity
iv) Restrictions on any types of vehicles

There are two ways to assess the traffic impact of a disaster :

i) Manually; or
ii) Using the JICA STRADA model

The manual method can be used when it is clear that there is only one available alternative route for traffic to use, if a natural disaster forces a link to close. Table 2.3.4 shows the approach to be taken. For each vehicle type the changes in distance time are calculated from the input link length and speed data.

CONTEO DE TRÁFICO - RECORDING SHEET

Número de Estación 4	Nombre de la Estación San Ishidoro, NIC 26	Numero de Hoja
Dirección de Tráfico	Nombre de Contador	
Fecha	Clima	

Periodo de Tiempo		Vehículo de Pasajeros	Minibus	Autobus	Camión Paqueño	Camión Pesado	Camión Articulado	Motocicleta	Bicicleta	Tractor	Camioneta	Otros
Empezar	Fin											
		Nota 1	< 25 asientos	>25 asientos	2 ejes	3 ejes	5 y 6 ejes			(y remolque)	Nota 2	
7:00	7:15											
7:15	7:30											
7:30	7:45											
7:45	8:00											
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Por ejemplo **Nota 1** **Vehiculo de Pasajeros(Sédan)** : Toyota Corolla; Mitsubushi Lancer; Nissan Sentra
Nota 2 **Camióneta (Utilitario)** : Toyota Hilux, Land Cruiser; Mitsubishi Montero; Nissan Samurai

Figure 2.3.1 Typical Traffic Counting Form

Table 2.3.4 Manual Method for Calculating Traffic Effects

	Traffic Volume	Affected Link		Alternative Link		Additional Daily	
	AADT	Length	Average Speed	Length	Average Speed	Vehicle Km	Vehicle hours
Cars	300	5	60	8	50	900	23
Camionetas	400	5	60	8	50	1200	31
Buses	100	5	60	8	50	300	8
Light Goods	100	5	60	8	50	300	8
Medium Goods	100	5	55	8	50	300	7
Heavy Goods	50	5	50	8	50	150	3
Total	1050					3150	79

Input Data

Where the road network is more complicated and there are more one alternative route, it is better to use the JICA STRADA traffic model. The same data needs to be collected and is input to the model using the Network editor module.

These data should be entered into the JICA STRADA Model using the Network Editor module and *add* or *modify* link icons.

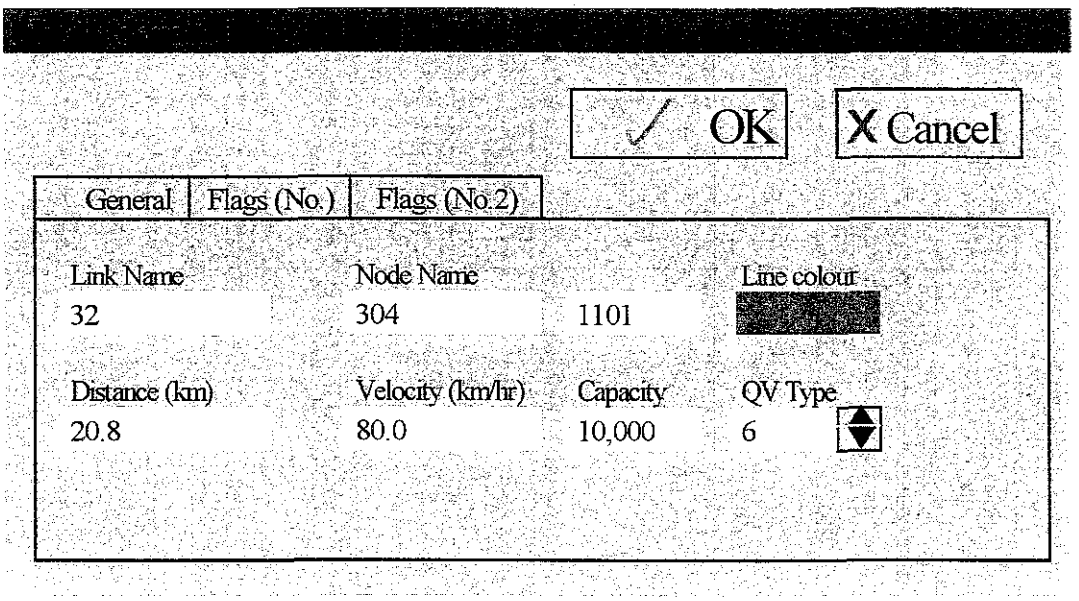


Figure 2.3.2 Extract from Network Editor in JICASTRADA

Check if Origin-Destination information exists for the link in question. Currently, traffic data for NIC1, NIC3, NIC5, NIC15, NIC 24, and NIC26 are based on surveyed (2002) data. If the link does is not listed above, then an origin-destination survey should be carried out, at the same time as the traffic volume count. The police should be contacted as only they have the authority to stop traffic to be interviewed by field surveyors. A target sample rate of 30 % to 40% of vehicles should be aimed at. The numbers of surveyors needed depends on the amount of traffic and a guide is shown in Table 2.3.5

Table 2.3.5 Interviewer Requirements for O-D surveys

Traffic volume (12 hours)	Number of interviewers (including spare)
Up to 1000	3
2000	4-5
3000	6-8
4000	8-10

A typical interview sheet is shown as Figure 2.3.3

Origins and destinations of traffic have to be allocated to traffic zones. These are described in Appendix P2.

FORMATO DE ENCUESTA DE CARRETERA ORIGEN-DESTINO

Numero de | Nombre de Estación

Dirección de Tráfico | Nombre de Encuestador

Fecha | Clima

Tiempo (p.e. 07.12)	Modo de Viaje (1)	Numero de Pasajeros	Origen		Destino		Proposito del Viaje (3)	Frecuencia de viaje (4)	Tipo de Carga (5)	Carga (Tonnes)
			Pueblo y Department (2)	Code	Pueblo y Department (2)	Code				

(2) Si exterior, escribo el pais yiudad grande

NOTAS

(1) Modo de Viaje	
Vehiculo de pasajeros	1
Minibus (< 25 asientos	2
Autobus (> 25 asientos)	3
Camión Pequeño (2 ejes)	4
Camión Pesado (3 ejes)	5
Camión Articulado (4,5 y 6 ejes)	6
Motocicleta	7
Bicicleta	8
Tractor (y remolque)	9
Camioneta	10
Otros	11

(3) Proposito del Viaje	
Al trabajo/De Negocios	1
Al Escuela/Colegio/Universidad	2
Comprar/Privado	3
Tourismo	4
Deportivo y reunión amigos	5
Otros	6

(4) Frecuencia de viaje	
5-7 por semana	1
3-4 por semana	2
1-2 por semana	3
0-1 per semana	4

(5) Tipo de Carga	
Aciete, Petróleo	1
Algodón	2
Arroz	3
Azucar	4
Bananas	5
Café	6
Cemento	7
Construcción	8
Ganado	9
Grano	10
Madera	11
Metales	12
Químicos	13
Sésamo, Ajonjolí	14
Tabaco	15
Vaca, Carne vaca	16
Solo pasajeros	17
Otros comida, comestible	18
Otros no comida	19
Vacios	20

Figure 2.3.3 Example Survey Form

Traffic allocated to zone-zone (origin destination) pairs can be input to the traffic demand matrices used in JICASTRADA, using the Matrix Manipulator module. Currently there are 4 full demand matrices for 2002, 2003, 2010 and 2020. Each matrix is composed of 6 separate tables for cars, camionetas, buses, light goods, medium goods, and heavy goods. These are stored in the relevant directories as shown in Figure 2.3.4

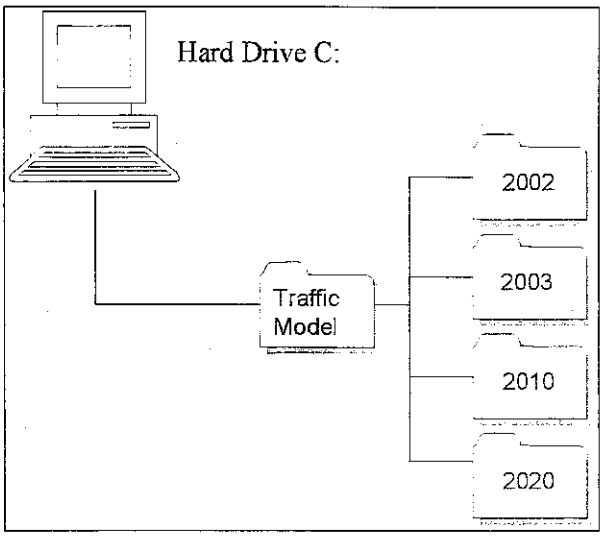


Figure 2.3.4 Directory Structure for JICASTRADA Traffic Model

Networks and parameter files are also stored in the respective directories as shown in the figure above. Networks should be reviewed and amended from time to time to reflect changes to the road infrastructure on the ground, and changes to plans and programs for new roads and road improvements.

MTI staff has been instructed in the operation of JICA STRADA. The model can be run for 2 cases: a base of full network, and a case with a link removed to reflect a natural disaster. Traffic volumes on alternative routes can be viewed with the Highway Reporter module. Vehicle-kilometers and vehicle-hours on the networks need to be extracted using the Evaluation Indices icon in the Highway Report module, shown in Figure 2.3.5.

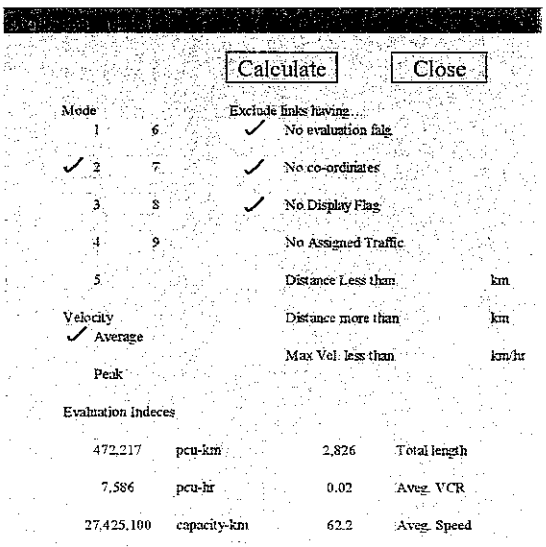


Figure 2.3.5 Evaluation Indices in JICASTRADA

2.3.4 Initial Environmental Examination

1) Objective of Environmental Examination

The environmental concern that it is symbolized by a global warming in recent years causes the long-term concern that it influences a future generation on a global scale. Activity against these concerns is being done in each country and the international level.

Even Nicaragua had established the "Permit regulation and evaluation of the environment impact" under the "General law of environment and natural recourse". And, as for the large-scale project (ref. Appendix-1), the execution of the environmental impact assessment is required.

On the other hand, as for the project which swerve from object of environmental impact assessment, It gets the permission of MARENA, and that is carried out. Therefore, an influence on the environment by the execution of the project is evaluated through the environment survey, and it is important to enforce the countermeasure that an impact to the environment is avoided and or reduced as needed.

2) Flow of environmental examination

This environment examination is carried out in accordance with the following flow.

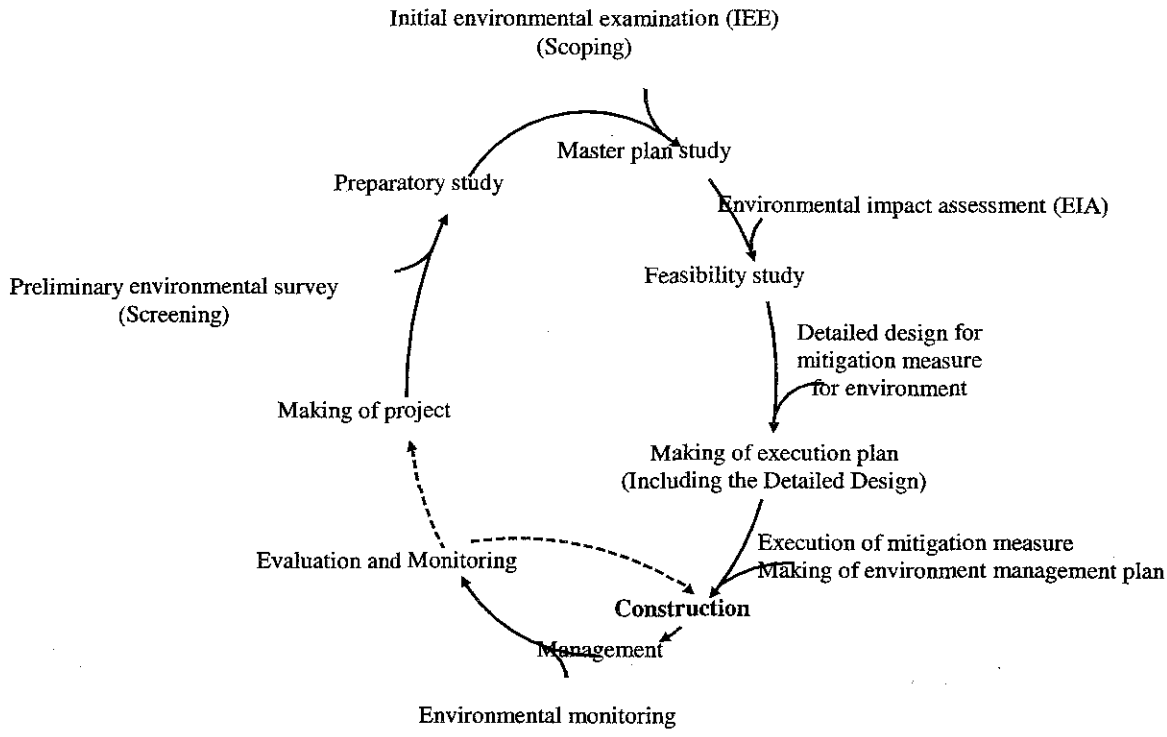


Figure 2.3.6 Flow of Environment Examination

Screening: To make a judgment on whether to be the project which environment impact assessment is necessary for. As for the Nicaraguan country, refer to " Section five of Permit regulation and evaluation of the environment impact

Scoping: An important environment impact factor is extracted, and the item of the environment impact assessment (EIA) is cleared.

3) Examination Item for IEE

IEE is carried out in the following item. Environment impact assessment (EIA) is enforced about the extracted important negative impact. It is shown about the general environment spread factor along with the road construction as a reference in the table 2.3.6-2.3.7.

Table2.3.6 Examination Item for IEE

Environmental Item			Judge	Examination Item
Social Environment	1	Inhabitants Transfer		Landowner survey (Register book survey)
	2	Economic Activity		Land use (agricultural area, industrial area, etc)
	3	Facility for Life and Traffic		Influences on the transport, hospital, school etc.
	4	Area Severance		Ground and movement Severance with construction
	5	Historical place/Cultural asset		Influences on Historical place/Cultural asset (influences on the indigenous people)
	6	Water Right/ Common Right		Influences on water right, fishing rights, common rights.
	7	Health/Hygiene		Aggravation of the health and hygiene with waste and vermination
	8	Waste		Construction waste
	9	Disaster (Risk)		Increase of risk such as slope collapse, etc
Natural Environment	10	Geography/Geology		Loss of precious geographic and geology with excavation work, etc
	11	Soil Erosion		Loss of surface soil with felling and land improvement, etc
	12	Groundwater		Water depletion for excavation or drainage work
	13	Lake and river		Change of water volume or riverbed level with construction
	14	Coast/Sea area		Erosion and deposition of sea area with change of hydrographic condition and reclamation, etc
	15	Fauna/Flora		Inhibition of breeding or extinction of spices for the change of the natural habitat
	16	Weather		Change of temperature and wind with ground improvement or construction of large scale structure
	17	Landscape		Change of geography with project, inhibition of the harmony by artificial structure
Pollution	18	Air pollution		Pollution by emission gas, noxious fume of car and factories
	19	Water pollution		Pollution by sediment discharge or factory disposal, etc
	20	Soil pollution		Pollution by dusty, agrichemical, etc
	21	Noise, Vibration		Generation of noise and vibration with construction or increase of car (influences on school, hospital, etc.)
	22	Ground Subsidence		Subsidence by changes of the ground conditions, and with pumping, etc
	23	Afoul smell		Generation of auto emission or bad-smelling fumes, etc

(Note) Judge Classification

A: Foreseeing the big impact

B: Foreseeing some impact

C: Unclear

D: Non-intended object of EIA (Evaluation of the environmental impact)

Table2.3.7 Matrix which is useful for Scoping

			Activity	Road Construction					
				Under Construction			After Construction		
			The act which impact on an environment	General	Geography Alteration/ Space Occupancy	Operation of Construction Equipment	Space Occupancy	Vehicle Movement	Accumulation of Commodity and People
Social Environment	1	Inhabitant Transfer		◎	◎				
	2	Economic Activity		○			○		○
	3	Facility for Life and Traffic		○				○	
	4	Area Severance		○			○		
	5	Historical Place/ Cultural Asset		○	○			○	○
	6	Water Right/ Common Right		○			○		○
	7	Health/Hygiene							
	8	Waste		○	○				○
	9	Disaster (Risk)		○	○				
Natural Environment	10	Geography/ Geology		○	○				
	11	Soil erosion		○	○				
	12	Ground Water		○	○				
	13	Lake/Liver		○	○		○		
	14	Coast/Sea area		○	○		○		
	15	Fauna/Flora		◎	◎	○	◎	○	
	16	Weather							
	17	Landscape		○	○		○		
Pollution	18	Air Pollution		◎		○		◎	
	19	Water Pollution		○	○			○	
	20	Soil Pollution		○				○	
	21	Noise/Vibration		◎		○		◎	
	22	Ground subsidence							
	23	Afoul smell							

◎: Along of the size of the impact and the propriety of the countermeasure, the environment item which influences the existence of the project. The item that it is especially careful.
○: Along of the scale of the project and the conditions of the target area, the environment item that an influence grows large.
No mark: Because an impact is small, a usually detailed investigation and examination shouldn't be necessary

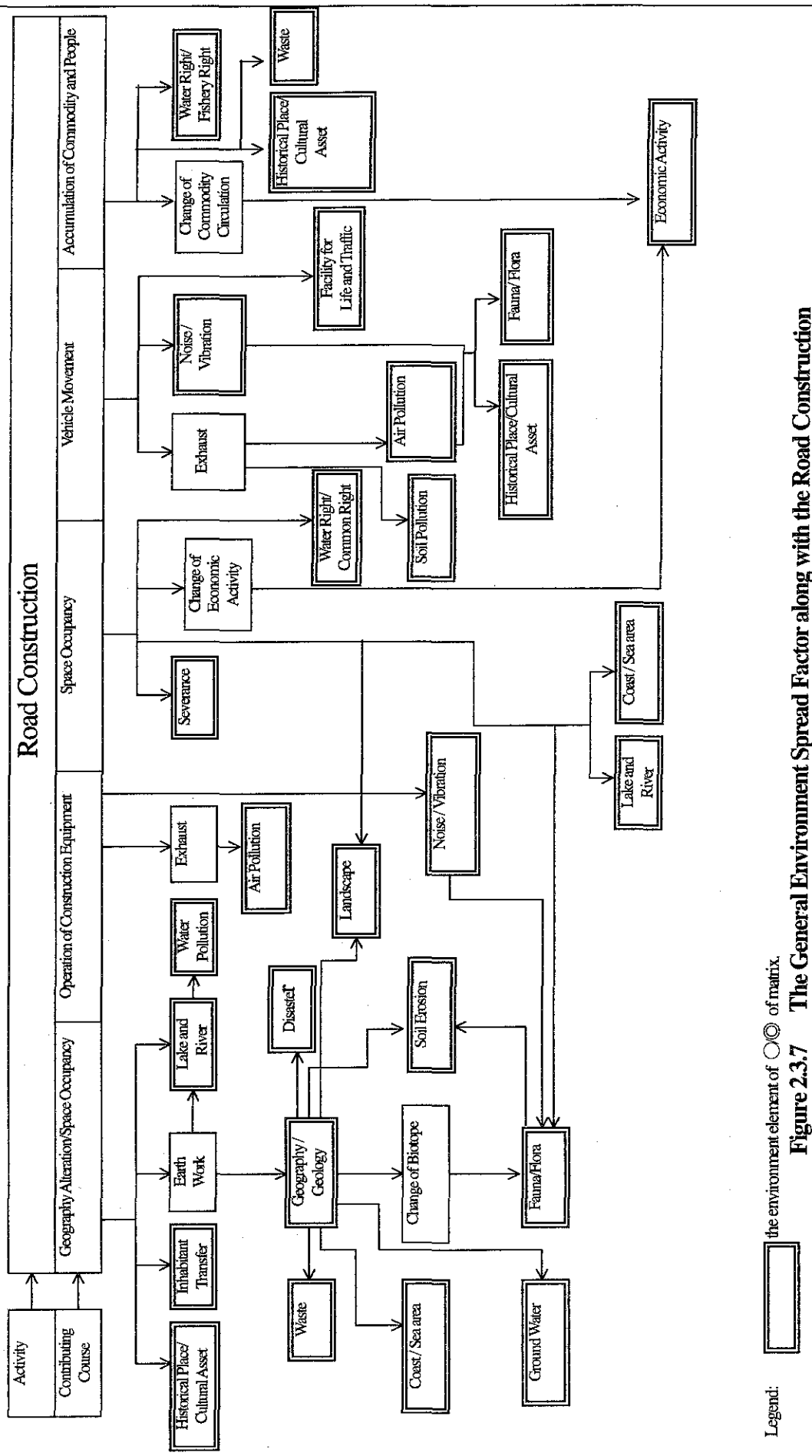


Figure 2.3.7 The General Environment Spread Factor along with the Road Construction

2.3.5 Development Situation

Discontinuation progress or Reduction of the effect of a related project as shown below that is caused by Slope collapse or Bridge Foundation Scouring must be avoided.

i) Transportation infrastructure project such as road improvement
ii) Medical and Educational project such as hospital construction or school construction
iii) Industrial promotion project

It is necessary to examine into the situation of the improvement project for the road and development project that related with the Disaster Potential Spots.

In investigation of these plans, the contents, a scale, enforcement time, and importance shall be investigated, and relevance with the improvement project for Slope collapse or Bridge Foundation Scouring shall be grasped.
And these related projects are taken into consideration to selection of Road Disaster Prevention Spots.

In evaluation of a development project, By quantifying the related importance of a project and the related grade of influence, pair comparison of each object part is performed easily. An example of evaluation criteria is shown in Table 2.3.8.

Table 2.3.8 Example of Evaluating

Evaluation Criteria	Score
The improvement plan of the road under which Potential Spots exists is already advancing, and is completed within one year.	5 /Project
The bridge on the road where Potential Spots exists is improved.	2 /Place
The improvement plan of a road under which Potential Spots an object part exists is decided.	3 /Project
The rehabilitation project for the bridge on the road under which Potential Spots exists is decided.	1 /Spot
The improvement plan of the branch road of a road under which Potential Spots exists is already advancing, and is completed within one year.	3 /Project
The improvement plan of the branch road of a road under which Potential Spots exists is decided.	1 /Project
In the circumference of the Potential Spots, Medical project, Education project or the urban development project is under advance or it has completed.	2 /Project
In the circumference of the Potential Spots, Medical project, Education project or the urban development project is decided.	1 /Project

2.3.6 Natural Conditions

1) General : Survey target, Scope of Survey, Survey Items, Method of Survey

a) Survey Target

A natural condition is investigated for the selection of the road disaster prevention spots.
Refer to "Method of selecting 2.2 disaster prevention spots" for the selection to be investigated method. To advance the investigation smoothly, the ID code is put on the object part. The method is as follows.

When the investigation object is decided after screenings, the ID code is applied to the object part according to the standard (outside application when the ID code already exists).
When the ID code is not decided, the position of the object spots is recorded by the region, the district, and K display, etc. , and an expedient serial number is put.
Hereafter, it explains how to put the ID code. See Table 2.3.9.

Table 2.3.9 Example of ID Code

	(a)			(b)	(c)		(d)
N	0	0	1	A	2	4	0

i) Route Number:
"N" is put on the head for the national road.
The slash is pulled in case of the other.
Hereafter, the route number is filled in.
For example, it becomes N001 for NIC.1. It becomes N026 for NIC.26.

ii) Road Disaster Type:
The sign is filled in according to the disaster.

Rock-fall・Collapsing	A	Rock Collapsing	B
Slope Slide	C	Debris Flow	E
Bridge Foundation Scoring	Bridge or H		

iii) Site Number :
The Site number of each route is put. The starting point side of the route is assumed to be the first usually. It is easy to manage at the following when it is made to apply 2 and 3 sequentially.

iv) Local Serial number in Site

Besides, 0 is filled in when there is no object.

It is assumed start and 1 respectively, 2, and 3・・・・ n when the plural corresponds and there is n piece object, from the first.

b) Range of Investigation

The natural condition survey begins for each item after deciding the investigation object. The range of the investigation can take room if necessary up and down and more right and left directions than the object part, and plan the plan of the countermeasure enough. Moreover, the adjoining geographical features situation etc. is understood for the evaluation.

c) Survey Item (Content)

As the Survey item, they are the Topographic Survey, the Geological surveys, the Hydrological surveys, and other investigations (presence such as spring water), etc.

d) Research Methodology

When it precedes the site survey, geographical features information on topographical map 1/50,000 and the aero photograph, etc. within the rough range of the object is prepared.
Moreover, it may arrange the meteorological observatory, which is adjacent most within the range of the object to the weather and the rainfall data, etc.
Moreover, the geological map etc. is also effective to understand rough geological features condition.

The research methodology, the result, and the content, etc. when investigating existing data having already executed site are analyzed before the site survey of the investigation object is executed, and an efficient investigation is executed.

When the topographic survey is generally done first because the geographical features can collect data, which is the most basic of the object part, and the geological survey and the hydrological survey are done, it is efficient.

2) Topographic Survey

At first, the position, geographical features, and the range of the outline of the object part are clarified by summary and Preliminary survey about the grasp of the geographical features situation.

When it is not possible to measure it, outline information is collected by the visual inspection. Records of height and the inclination, etc. are suppressed as necessary minimum information the photograph and the sketch. When stability survey of the site is not recorded, it should record newly.

When treating as a selection of the disaster prevention spots, it have to understand a detailed geographical features situation of the object part, it is necessary to execute the detail survey, which uses the transit and the level, etc.

To plan the countermeasure easily, the output is arbitrarily set by the range of the geographical features situation though is about 1/200 the basis of the reduced scale.

To assume the basic material made figure when the countermeasure is examined, the cross-leveling corresponding to the necessity is executed.

Moreover, if the temporary reference point (Bench Mark) connected with public coordinates point for the execution construction of the countermeasure can be set up in each part, it is effective for the construction execution and the maintenance in the future.

When the object part is a bridge, linear profile of the approach road is measured because reconstruction is forecast according to the change in the situation. Moreover, it is effective to execute the river profile leveling around the bridge and the river crossing measurement in several places in preparation for the case when the hydrologic analysis of the river is necessary.

However, the tape, Paul, the hand-level, the compass, and the additional watching investigation, etc. are efficiently done by the team of about three people in operating directly in addition to the data of summary survey of the watching subject when there are neither cost to lie a detail survey nor time enough.

The inclination, height, and the length of the object part are the most important items in necessary local information in the topographic survey.

Additionally, it is investigated whether the knick line is clear, and it is talus cone geographical features whether it is geographical features etc. of the landslide.

The presences etc. of spring water are investigated as an item of other geographical features investigations, and it records.

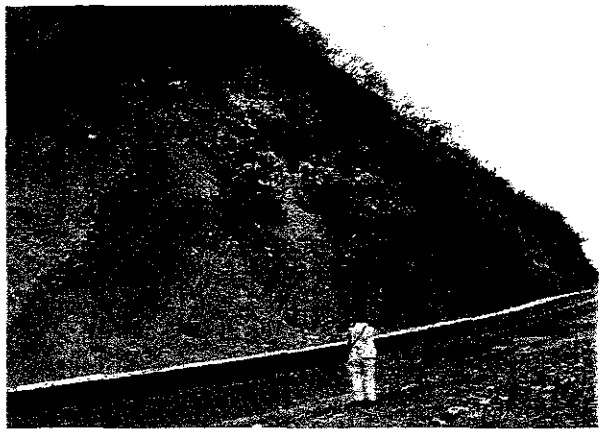


Photo 2.3.1Visual Inspection

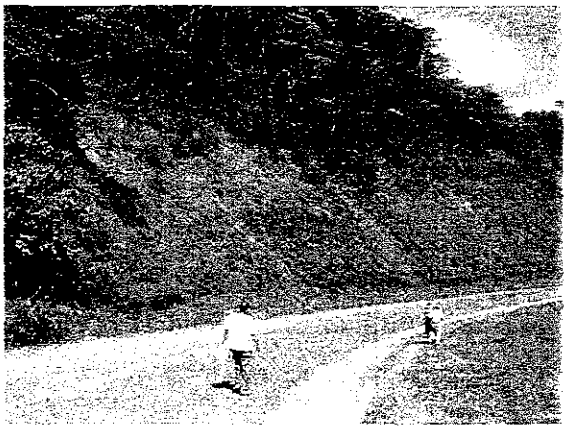


Photo2.3.2 Detailed Topographic Survey

3) Geological Survey

a) General

At first, it does by the visual inspection and the hammer shock investigation though there are methods of variety in the geological survey. The photograph and the sketch govern minimum information of hardness and the rock quality, etc. When the stability survey is not recorded, it should record newly.

When information is not obtained enough by watching the watching investigation the basis of the research methodology, other methods are examined.

Because appropriate and a homogeneous stratified large-scale face of slope is suitable, the volcano deposit can be called general ineffective for the seismic exploration in a Nicaragua country of the subject.

On the other hand, the sounding, especially boring exploration is effective to watch the core sample by sampler by which the stratum can be distinguished and the Standard Penetration Test is effective. Moreover, the laboratory experiment etc. can execute and a detailed characteristic be examined about the sampled sample for the examination of the countermeasure.

In the location, a technical viewpoint is important, and the safety side of the investigator of the execution of carrying and the investigation of the machine is considered by priority. Even when the boring is executed, the situation of the object part is investigated about an overall tendency and the detail using the visual investigation together.

b) Boring

A standard rough when the boring exploration is executed is as follows.

i) Objective (Boring, Sounding and Sampling)
The boring exploration was executed for the face of slope and the bridge location, which had been selected basing the first phase as disaster critical spots. The thing to obtain the basic information, which seemed to be necessary for evaluating the stability of the slope or the entire slope, which included the face of it, a slope location was executed aiming.

Moreover, the thing to obtain the basic information which seemed to be necessary for evaluating the stability of the bed-rock considering the bed morphology of the location of bridge, the river sediment, and the forecast bedrock situation, etc. was executed in the bridge location aiming. Moreover, the basic material was sampled, and the standard penetration test was examined also executing at site.

ii) Survey method
The investigation method in Nicaragua country was not used the methods other than the ASTM law, and assumed doing by this method to be basic. Digging did with the oil pressure type rotary boring machine, and executed the standard penetration test within the range, which could be examined. In the material sampled by sampler, it is good to do the laboratory test to understand the physical property of the object stratum. The laboratory test includes grain size analysis, the specific gravity test of soil particle, the water content test, and the LLPL test, etc.

Moreover, the unconfined compression tests are enforceable to gather the undisturbed sampling easily when there are a lot of clay soils.

Moreover, you may try the rock sample gathered like the core to examine the uniaxial compressive strength with the unit weight test as a mechanics examination and to understand the physical properties value of the bedrock.

It is good to evaluate the geological survey that there are about a lot of kinds of the laboratory experiment.

However, the test at least needed only have to be generally done when aiming at the evaluation of the disaster prevention spots and the plan of the countermeasure.

iii) Selection of boring position

When the position where the boring exploration is executed and the number are decided, the characteristic of the disaster prevention check result and the object part is visually examined closely again, geographical features which affects stability and geological features are considered, and at which position of the object part investigates is decided.

Geographical features which affected stability on that and geological features are considered. At which position of the object part of boring investigated was classified by five stages for the face of slope, and selected for the bridge according to two stages are shown in Table 2.3.10.

The example of the bore arrangement to the object slope is shown in Table 2.3.11.

Table 2.3.10 Classification Item of Boring Exploration

Objective item	Class	Characteristics	Quantity of Boring
Slope	Type-A	Repeatedly because it is a state of the alternation of strata even if it is a single-layer or a combined stratum composition; It is a place where rock faces and weathering are understood easily. When the bore location can be assumed to be one place, and the average stratum composition etc. which affect stabilizing is evaluated.	BH=1
	Type-B	The change is seen in the stratum composition and the state of weathering on site. When the average stratum composition etc. which affect stabilizing can be evaluated by the thing to execute the bore by at least two places.	BH≧2
	Type-C	The degree of the stratum composition and weathering is complex. When the evaluation of the stability of the entire slope, which includes the face of slope, is needed, and the bore in at least three places or more needed. And, when it set up the erosion and torrent control dam aiming at the thing to assume the riverbed inclination of the road crossing location to be 3° or less in the place where the generation of the avalanche of sand and stone is forecast.	BH≧3
	Type-D	For instance, the exposed bedrock omits boring when most information is appreciable in the hard rock etc. by watching for stability.	BH=0
	Type-E	The point that the degree of the geological features composition and weathering is extremely complex because of the alteration of the fault and the volcanic. Things except the above-mentioned.	It depends on the situation. Arbitrariness.
Bridge Foundation Structure Foundation	Type-α	The stratum composition of the point in the bridge: from the distribution of plane geographical features, the crossing geographical features, and the open rock of the river when average geological features and thickness, etc. are appreciable by the bore one place. Especially, when the plain part and the length of bridge were short etc, it applied.	BH=1
	Type-β	The change is forecast from the above-mentioned to the fluvial landscape and the stratum composition, and when average geological features and thickness, etc. are appreciable by the bore in two places or more.	BH≧2

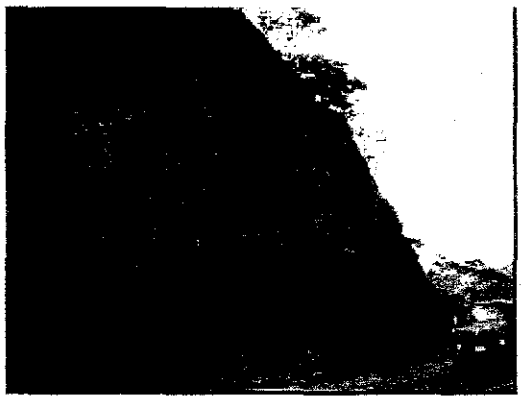
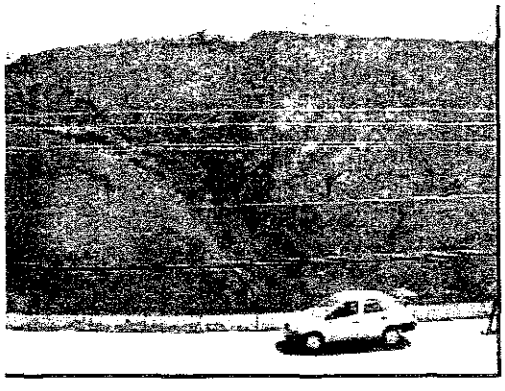
Example of Type-A	Serial-No.8 (ID- No.001B230) Because the composition of the face of slope is large the range where simplicity and the visual investigation can be done, and is also same weathering condition; Especially, the face of slope is not bored. To examine the slope failure, which includes the road, the toe of slope or the road shoulder executes one-place bore.	
Example of Type-B	Serial-No.32 (ID- No.003C150) It is in geographical features of the slope and there are weathering of tuffs, which influence easily and an argillation in a slope movement. And, there is small-scale movement (The flat terrain forms to the leg of the cliff like the belt) in the slope. And, the difference has been generated in the shoulder. The change in the geological features composition is understood by executing the bore in two or more.	
Example of Type-C	Serial-No.35 (ID- No.005A010) Example of inclusion of face of slope collapse shown in Nic-5 of seepage water of stratum composition and lava plateau on back slope and influence on stability of the entire face of slope. Because height the face of slope and width require the examination of stability including the entire road long, plural bores are executed by arrangement to be able to do an overall evaluation.	
Example of Type-D	Serial-No.22 (ID- No.001A010) There is no vegetation and it is a bedrock situation of the entire face of slope and the rock eyes are composed on the mass of agglomerate because of the andesite lava flow of the receiving board. The evaluation of the degree of weathering and stability is possible cases in watching enough.	

Figure 2.3.10(1) Example for the Classification Item of Boring Exploration (Slope)

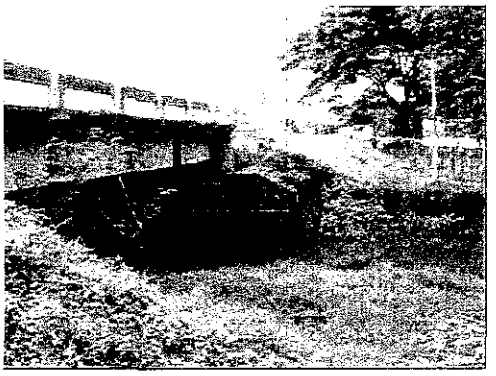
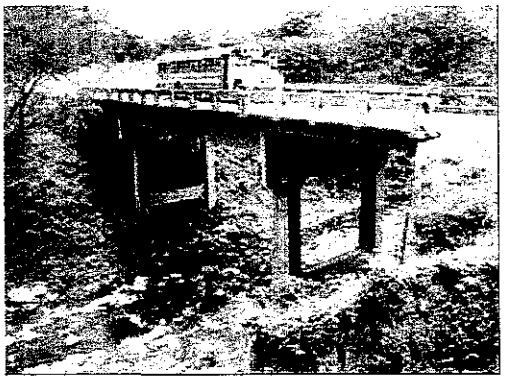
Type- α	Serial-No.4 (ID- San Ramón) It is a bridge in the comparatively short length of bridge laid on geographical features in which the change does not exist in the plain part. As for the stratum composition, a big change need not be assumed in both banks, and a geological features composition and thickness, etc. boring singular average are appreciable.	
Type- β	Serial-No.45 (ID- La Banderita) The bridge exists in sag vertical alignment in the valley of the mountainous area. There is a possibility that there is a change in the stratum composition in the right side shore and left bank in the river. It executes two or more bores and the geological features composition and thickness, etc. are evaluated by doing.	

Figure 2.3.10(2) Example for the Classification Item of Boring Exploration (Bridge)

In the location, a technical viewpoint is important, and the safety side of the investigator of the execution of carrying and the investigation of the machine is considered by priority.

4) Hydrological Survey

a) General

The flow velocity investigation of the bridge where the scour of objects is assumed is effective. Because the execution of the flow velocity investigation is risky, it considers safely. When an enough result is not obtained when flow velocity is investigated, flow velocity and flowing quantity, etc. are understood by hydrologic analysis etc. by the rationality type etc.

As for the correlation of a current bridge and the river, it is convenient to acquire running through in the river and the river crossing for the measurement investigation to execute hydraulic analysis.

Moreover, flood record and the past highest high-water level, etc. are clarified by the struck record and hearing, etc. When the investigation object is "Scour of the bridge foundation", a minimum situation etc. is effective for the photograph and the sketch government.

b) Flow velocity Investigation

It is a principal object to obtain the mean velocity in each section in the river. The flow velocity is measured in the straight-line part where the width of a river and depth are constant. The research methodology has the method with a surface float and a stick float and the method with a current-meter.

Photo2.3.3 Site Survey

Photo2.3.4 Detailed River Velocity Investigation

Because the surface velocity is measured in the method of using the floatage, the surface velocities are usually faster than the mean velocities. At flow velocity, correct the coefficient corresponding to the river situation.

The linear motion of water is changed into the rotational motion as for the current-meter, the error is large at the flood though it is the one to measure flow velocity according to the rotational frequency.

There are various measurements depending on depth, and the observation method with the current-meter measures by 0.1-0.15m under the surface of the water, assumes the surface velocity, puts a necessary coefficient, and obtains the mean velocity when measuring it by one point.

The measurement is executed on two or more days, and the result of seeming as the average or appropriate is adopted. It is recommended to measure it in two days different with a current-meter in the main investigation.

c) Hydrological Analysis

The methodology is applied combination of common hydrological analysis techniques and hydrological model simulation to reach the study goal.

Firstly, the watershed is decided by using the topographical map, which the contour line enters. The topographical map of 1:50,000 are used usually.

After the decision of the watershed, the condition for the selection of the condition of the valley and the river, the geographical features conditions, and flood concentration times and conditions of the altitude, the river inclination, and the run-off coefficient, etc. are decided.

It is necessary to understand the regional characteristic enough based on the data of INETER.

To evade the extreme contradiction between the stations to the data of the weather and the rainfall, a double mass-haul curve etc. are used and analyzed.
It examines by using a general establishment method for the parameter.

A regional rainfall of each watershed is calculated by using the Thiessen method or the Isohyet Map diagram.

The calculation of the establishment rainfall uses and calculates a general method (Gumbel, and ultra value frequency analytical method, etc.).

The amount of the flood peck runoff is calculated by using the rational type in a different year of establishment (return period for 25,50 and 100 years).

$Qp=0.278CIA$

Qp: Peak discharge (m^3/s)
0.278 : Coefficient of Rational Formula
C: Runoff coefficient(dimensionless)
I : Rainfall intensity (mm/hr),

It is computed or estimated from the rainfall intensity-duration-frequency (IDF) curves for each return period with Tc (Flood Concentration Time).
Tc = (Lc^ 3 /(Hmax-Hmin))^ 0.385 (California Formula)
Hmax-Hmin = (Difference of elevation in Watershed)
Lc = River length
A : drainage basin area(Watershed (km^2))

The flood stage (establishment for 25 or 50,100 years) etc. are analyzed by the non-uniform flow calculation etc. for the flood flow of the probability year (establishment for 25 or 50,100 years) calculated by the above-mentioned.

When the embankment is maintained, the flood stage calculation of each river can be inevitably calculated.

However, because there is often no embankment in the river in Nicaragua, a virtual embankment in the slope gradient at 1:2 levels is assumed and calculated in the natural terrain or the river boundary location in the river.

In this case, it is not the one that the flood, which was able to happen before actually maintaining the river, was shown by the river's being maintained because it is a calculation when the embankment is assumed.

The water level rise in the calculation does not happen because water leaks from the unrepair embankment part in the current profile and the range of the flood extends.

Therefore, the calculation result before the river improvement (When the embankment unfinished) notes not the one superior to the flood calendar and the hearing result but handling.

5) Selection Factor and Evaluation Method

a) Evaluation of Natural Condition Investigation, which Lies Face of Slope

It is good to judge the evaluation of geographical features and geological features overall by the visual inspection, and to evaluate dangerous potential of the confirmation of the progress of weathering the state of progress such as weathering and collapses by the result of the bore etc.

These are to the last due to the detailed finding done when not turning out in the evaluation of the stability survey sheets.

The impact, which the result of the progress situation and the hydrologic analysis of the scour give to the main body of the bridge, is had and evaluated.

The evaluation is assumed to be the following five grades in Table 2.3.11.
(However, become six grades when there is an item assumed to be off the subject D).

Table 2.3.11 The Evaluation of Natural Condition Survey for Slopes

Category	Situation	Points
A:	The weathering and collapsing reached a high advanced stage, and the emergency has increased. The potentiality of risk, including the advanced stage of weathering inside of the slopes, is high.	(10 points)
B Plus (B+):	Approximately medium between A and B.	(8 points).
B:	The weathering and collapsing reached a medium stage. The potentiality of risk, including the medium stage of weathering into inner part, is medium	(6 points).
B Minor (B -):	Approximately medium between B and C.	(4 points)
C:	The weathering and collapsing didn't progress so much. The weathering didn't reach at inner part of the slope.	(2 points)
D:	Totally decayed completely. Otherwise, countermeasure was totally accomplished. For that reason, this case is to be excluded from the evaluation.	(0 point)

Note: The above-mentioned is an evaluation to the detailed investigation, which won't turn out in the stability survey sheets.

One example (A rank, B rank, and C rank) in the natural face of slope, condition investigation is shown in Figure 2.3.11 below.

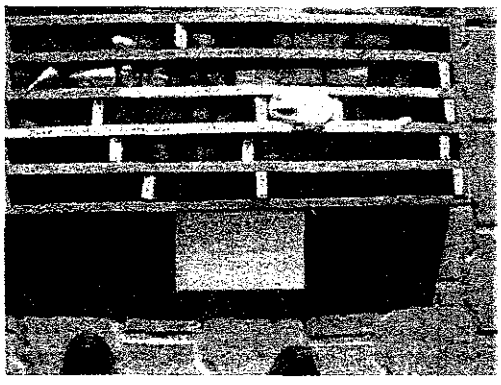
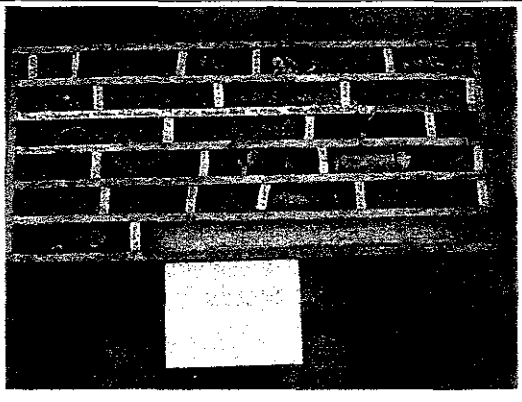
A: (10Points)	The weathering and collapsing reached a high advanced stage, and the emergency has increased. The potentiality of risk, including the advanced stage of weathering inside of the slopes, is high.	
17 N001A050	The tuff has changed into green color. The extent of weathering, physical characteristics, and strength characteristics are unknown. Although the face of slope is long, same stratum exists continuously. One (1) borehole shall be enough to be done.	According to the boring result, altered tuff has been weathered up to near 7 meters depth, and the weathered degree can be judged large. Under the present condition, the slope is very steep, so the preventative measure for weathering and examination of angle of face of slope shall be required.
		
33 N003C140	A decay on the middle section of fill was caused by the penetrating water from mountain side. The decay is remarkable. In order to study the decay including the current road, 2 boreholes shall be selected.	The boring survey result shows that most of tuff has become soil and constitute weathered belt at the fairly deep level. The stability on the whole slope face shall be required.
		

Figure 2.3.11(1) Evaluation Example of Natural Condition Survey, for Slopes (1/3)

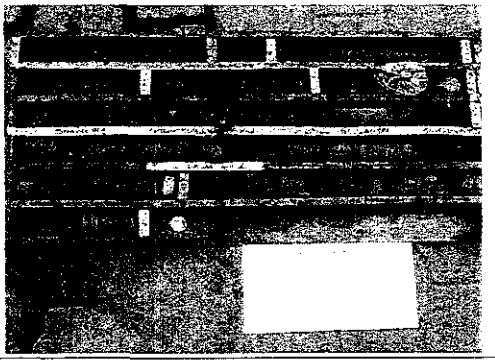
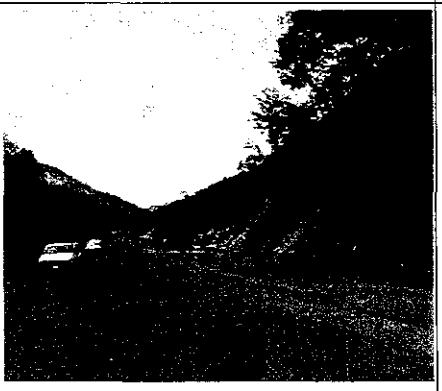
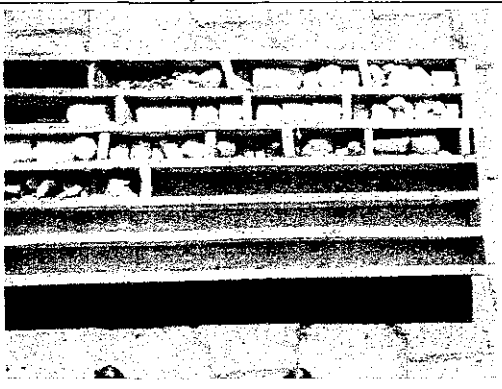
B: (6Points)	The weathering and collapsing reached a medium stage. The potentiality of risk, including the medium stage of weathering into inner part, is medium	
46 N026A100	The geological constitution (composite of tuff, andesite, and volcanic clastic rocks) can be confirmed by visual observation. But the confirmation of weathering degree shall be necessary. One (1) borehole shall be selected.	According to the boring survey result, agglomerate with open cracks exists from 0 to 4 meters depth. Agglomerate, which exists from 4 meters to 8 meters depth is composed, even though it has close cracks. As for the 8 meters of deeper, strata was gathered together firmly. Because the weathering of surface reached an advanced stage and there are many exfoliations and falling stones on the current faced of slope, prevention measure for falling stones shall be necessary.
		
48 N026A130	The tuff which distributes mainly on the face of slope can be confirmed by visual survey, in order to confirm the extent of weathering, one (1) borehole shall be selected.	According to the boring result, the width of topsoil is 40 cm, and there is a weathered tuff belt with hair-cracks from the depth deeper than surface up to around 2 meters. Although, in the level deeper than 2 meters, the number of cracks is increasing, tuff is good condition. Under the present circumstance, the rainy water inflowing from the top of slope generates the gully, and the exfoliations are being repeated. The measure to drainage on the top of slope shall be necessary.
		

Figure 2.3.11(2) Evaluation Example of Natural Condition Survey, for Slopes (2/3)

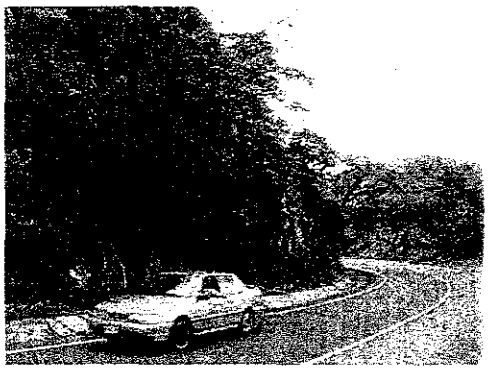
C: (2Points)	The weathering and collapsing didn't progress so much. The weathering didn't reach at inner part of the slope.	
9 N001B200	Most of the face of slope consists from andesite, and outcrop appears on the whole area. Therefore, the extent of weathering and stability can be judged by the visual investigation.	Although the andesite on the face of slope contains many cracks and open to some extent, the strata are stable as a whole. No change is seen in comparison with the survey result of previous investigation..
		
47 N026B110	The extent of weathering of andesite can be confirmed by visual observation.	At this location, there is no continuity among the strata of both andesite and tuff, and this site is isolated. It seems by reason of fault from the circumstance. Although there is exfoliation, it is no difference in weathering progress from the previous investigation.
		

Figure 2.3.11(3) Evaluation Example of Natural Condition Survey, for Slopes (3/3)

b) The evaluation of the natural condition survey for the scouring for bridge foundation

As for the bridges, the evaluation is based on the impact, of the scouring condition and hydrological analysis result, on the bridges themselves. Following five (5) grades (In case with evaluation item that is not applicable, the indicator shall contain six (6) grades) indicated the result of evaluation. The evaluation of the natural condition investigation, which lays the scour of the bridge foundations, is in Table 2.312.

Table 2.3.12 The Evaluation for the Scouring for Bridge Foundation

Category	Situation	Points
A:	The progress of the scour increases and the emergency increases greatly. River channel narrowness section small so on of the bridge part is restricted for flow velocity and flowing quantity remarkably and the progress factor of the scour is extremely large.	(10 points)
B Plus (B+):	Approximately medium between A and B.	(8 points).
B:	The progress of the scour is an medium level. An medium level is restricted for flow velocity and flowing quantity in the bridge part.	(6 points).
B Minor (B -):	Approximately medium between B and C.	(4 points)
C:	There is too no progress in the scour. There is no restriction in the bridge part for flow velocity and flowing quantity.	(2 points)
D:	It is collapse of bridge in complete. Or, because the countermeasure was completely accomplished, it is assumed an evaluation off the subject.	(0 point)

Note: The above-mentioned is an evaluation to the detailed investigation, which won't turn out in the stability survey sheets.

Because various, natural condition item is assumed to the scour of the bridge foundation, an integrated evaluation is examined by the mean etc. of each the following items.

However, an integrated evaluation is assumed to be A in the case where as many as two A grades or more attach according to the situation.

Details	Category	Situation
Velocity	A	Velocity(observed value or calculated value) 5m/ s more
	B	3m/ s -5m/s
	C	Less than 3m/s
Discharge Quantity	A	There is record of overflow above the superstructure in the past. Or, when it extremely underestimates the section to flowing quantity in the calculation.
	B	When a state near the overflow situation happens in the past. Or, when it underestimate the section to flowing quantity in the calculation a little
	C	There is no overflow record at all at all in the past. Or, when it is quite unquestionable in the past, the section in the bridge: to flowing quantity in the calculation.
Soil	A-C	It is the same as the evaluation of the slope.
Scoring	A	When the factor to cause progress is seen by an extreme scour. E.g. The river width narrows extremely in the part of the bridge crossing point. Section change of degradation site etc.
	B	When the factor to cause progress is seen by the scour in some degree.
	C	There is no special cause factor.

One example each grade in the natural condition survey of the scouring of the bridge foundation (A grade, B grade and C grade) is shown in Figure 2.3.12.

26 El Guayacan	An integrated evaluation: A grade (10 points) The progress of the scour and the emergency increases greatly. The river channel section in the bridge part is compared with flow velocity and flowing quantity, and there is a remarkable restriction of the small size etc. and the progress factor of the scour is extremely large. (A rank has a lot of factors about 2 pieces or more and the scour, and a part of the structure of each factor has already collapsed. Therefore, a whole evaluation was assumed to be A.)	
Velocity	The maximum flow velocity in the calculation is 1.07m/s.	C (less than flow velocity 3m/s)
Discharge Quantity	The section in the calculation is lack. In the hearing result, overflow is often recorded.	A (There is overflow records).
Soil	It is topsoil according to the bore result up to about 1m in depth. After that, it is a weathered rock of the tuff breccias. As for depth, both states become excellent.	C (The influence of weathering is a little).
Scoring	The bridge section has blockaded river flow. Bridge is constructed in the curve part in the river. The abutment on the left bank side has collapsed.	A (The factor of an extreme scour two or more has).

Figure 2.3.12(1) Evaluation Example of Natural Condition Survey, for Bridge (1/3)

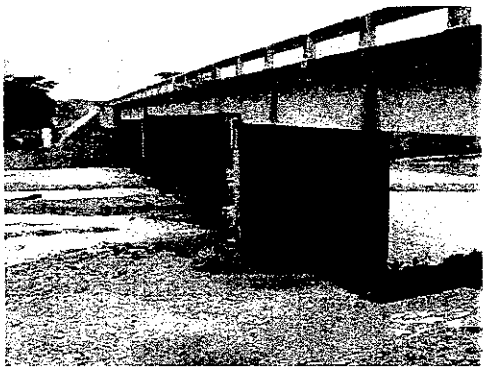
5 Las Chanillas	An integrated evaluation: B grade (6 points) (Average of each factor) The progress of the scour is an medium level. An medium level is restricted for flow velocity and flowing quantity in the bridge part.	
Velocity	The maximum flow velocity in the calculation is 5.34m/s	A (more than flow velocity 5m/s.)
Discharge Quantity	There is no problem in the pass section in the calculation. In the hearing result, no overflow t record.	C (There is no overflow records.)
Soil	Becoming to the soil is advanced up to two bores and about 5m. The state is steady though becoming to the soil is admitted even by the depth of 5m or less along the crack surface.	B^+ (The influence of weathering is about mean plus.)
Scoring	There is no special cause factor.	C (There is no special cause factor.)

Figure 2.3.12(2) Evaluation Example of Natural Condition Survey, for Bridge (2/3)

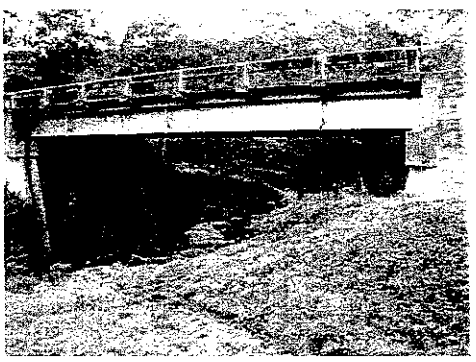
4 San Nicolas	An integrated evaluation: C grade (2 points) (Average of each factor) There is no progress in the scour. There is no restriction in the bridge part for flow velocity and flowing quantity.	
Velocity	The maximum flow velocity in the calculation is 3.77m/s	B
Discharge Quantity	There is no problem in the pass section in the calculation. In the hearing result, overflow is not recorded.	C (There is no overflow records.)
Soil	It is welded tuff (welded tuff) according to the bore result advanced up to about 3m in depth by making to the soil. Weathering is comparatively few in the depth of 3m or more.	C (The influence of weathering is a little.)
Scoring	There is no special cause factor.	C (There is no special cause factor.)

Figure 2.3.12(3) Evaluation Example of Natural Condition Survey, for Bridge (3/3)