CONSTRUCTION PLAN AND COST ESTIMATE

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CHAPTER 18 CONSTRUCTION PLAN AND COST ESTIMATE

18.1 General

The following work items will be taken up in this chapter:

- Clarification of assumptions for making cost estimates
- Estimate of quantities for each prevention spot
- Examination of the unit rate for each prevention countermeasure
- Drawing up of construction costs for each prevention spot
- Drawing up of maintenance costs for each Study route

The lifespan of road disaster prevention measures, which take into account the probability of road-related disasters occurring, are as described below.

- Permanent disaster prevention measure: Effective for 20 years
- Temporary disaster prevention measure: Effective for 10 years

18.2 Cost Estimate Assumptions

Construction unit rates obtained from MTI were first reviewed and adjusted as necessary. The Study team then examined unit rates for new work items. As part of this work, the Study team requested unit rate quotations from three general contractors.

Construction costs for each prevention spot are estimated as a direct cost. Note that direct cost includes direct variable cost, which consists of costs for temporary facilities and is greatly dependent on the conditions of a particular spot. Therefore, construction cost is estimated by averaging direct costs.

18.3 Unit Rates

Unit rates for different types of work and their corresponding work items are as shown in Table 18.3.1

Unit rates, which are based on the costs derived in Chapter 7, are revised in the Feasibility Study by considering additional work items and disaster prevention measures. Note that the types of prevention measures are the same as those in Chapter 7. The revised unit rates of the work items, the additional work items and the additional measures are shown in below.

- Work items with a revised unit rate are marked with a \bigcirc and are as follows:
 - (7) Rock-fall prevention device: Net
 - (9) Riverbank protection: Concrete revetment
- Additional work items are marked with a \Box and are as follows:
 - (4) Structure: Concrete cribwork
 - (9) Riverbank protection: Concrete cribwork for riverbed
- Additional measures are as follows:
 - (11) Bridge structure
 - (12) Box culvert

Type of Work	Work Item	Remarks	Unit	Unit Rate	Reason for Modifying - Unit Rate
	Shotcrete	T=10cm	m ²	48.30	Vegetation is used to
(4) Structure	Concrete cribwork	0.3×0.3 @2.0m	m^2	100.00	harmonize with a nearby natural park.
	Gabion mat		m ³	43.67	•
(7) Rock-fall	Prevention net O		m ²	8.53	Estimate changed to
prevention	Barrier with gabion mat		m ³	97.49	reflect prices from three local construction
device	Barrier with concrete wall		m^3	625.13	companies instead of just
	Concrete revetments O		m ³	654.95	Estimate based on prices from two local
(9) Riverbank protection	Gabion mat		m ³	97.49	construction companies was changed to one based on prices from four local construction companies.
r	Stone riprap with mortar		m ³	66.91	Concrete cribwork adopted
	Concrete cribwork for riverbed \bigcirc		m ²	39.49	for rapid river flows.
	Steel bridge with concrete slab		m ²	406.24	Bridge is considered as an
(11) Bridge	Gravity-type abutment		m ³	37.15	alternative.
structure	Reversal T-type abutment(RC)		m ³	197.26	
(12) Box culvert	Cast in place	3m×2m	m	1740.6	Box culvert type is considered as an alternative.

Table 18.3.1 Unit Rates

THE STUDY ON VULNERABILITY REDUCTION FOR MAJOR ROADS IN THE REPUBLIC OF NICARAGUA PAGE 18-2 ORIENTAL CONSULTANTS CO., LTD. in association with

JAPAN ENGINEERING CONSULTANTS CO., LTD.

18.4 Spot Specific Construction Plans

The main types of equipment used for construction at each of the disaster prevention spots are as shown in tables 18.4.1 and 18.4.2.

278220000108688888888888888888888888888888		10.4.1 Wiam Equipment Lis			haitantatat				T CALLED CARLED	a a tarente care
D. No	Type of Disaster	Type of Countermeasure	Bulldozer	Back hoe	Pick hummer	Shotcrete achine	Truck crane	Vibration roller	Jumbo Breaker	Boring machine
N001A290	R.F	Recutting + Prevention net + Drainage		0	0		0			
N001A280	R.F	Horizontal drainage								0
N001A240	R.F	Recutting + Prevention net		0	0		Ö			
N001B230	R.C	Recutting + Prevention net		0	0	-	0			
N001B170	R.C	Recutting + Drainage		0	0		[-	0	
N001B150	R.C	Recutting + Shotcrete + Drainage		0	0	0			1	
N001B120	R.C	Recutting + Drainage		0	0				Q,	
N003B400	R.C	Recutting + Drainage		0	0					
N003B370	R.C	Recutting + Drainage		0	0				0	
N003B320	ĨR.C	Embankment + Concrete retaining wall + Vegetation	0	0	0			0	0	
N003C230	S.S + R.C	Recutting + Cribwork +Drainage Embankment + Vegetation + Drainage	0	0	0		0	0	0	
N003E170	D.F + R.C	Dam Recutting + Drainage	0	0	0		0	0	0	
N003C150	S.S + R.C	Recutting + Drainage Embankment +Vegetation	0	0	0			0	0	
N003C140	S.S + R.C	Recutting + Drainage Embankment +Concrete retaining wall + Vegetation + Drainage	0	0	0	-	0	0	0	
N005A010	R.F	Recutting + Drainage		0	0				0	
N026A060	R.F	Recutting + Shotcrete + Drainage		0	0	0				
N026B140	R.C	Recutting + Horizontal drainage + Drainage		0	0				0	0
N026A150	R.F	Recutting +Drainage		0	0				0	
N026B160	R.C	Recutting + Prevention net		0	0		0			

Table 18.4.1 Main	Equipment List for	Slope Damage Repair
	wearphicate 1960 101	Diope Damage Mepull

Note) R.F: Rock-fall/collapsing; R.C: Rock collapsing; S.S: Slope Slide; D.F: Debris flow

		~ ~	-					
	Bridge Name	Type of Disaster	Type of Countermeasure	Bulldozer	Back hoe	Concrete breaker	Truck crane	Jumbo breaker
C TURCLOPIC CONSTICUTION	Junquillal	Bridge	Gabion mat	224010.0000	0		0	
	San Nicolas	Bridge	Gabion mat		0		10	
	Las Chanillas	Bridge	Concrete block		0		0	
NIC.1	San Ramon	Bridge	Gabion mat		0	0	0	
	Inali	Bridge	Gabion mat Revetment +Stone masonry		0	0	0	
	Tapacali	Bridge	Gabion mat Revetment		0	0	0	
NIC.3	Guayacan	Bridge	New bridge construction	0	0	0	0	0
	Solis	Bridge	Stone riprap with mortar Gabion mat		0		0	
NIC.26	Papalon	Bridge	Stone riprap with mortar Gabion mat		0		0	
	San Juan de Dios	Bridge	Gabion mat		0		0	_
	La Banderita	Bridge	Stone riprap wall Gabion mat		0		0	

Table 18.4.2 Main Equipment List for Bridge Damage Repair

Note) Bridge: Scouring of foundation

18.5 Work Quantities

18.5.1 Summary of Work Quantities

The 30 disaster prevention spots of the six routes of the Study consist of 11 bridges and 19 slopes. The work quantities for the disaster prevention spots are estimated based on the types of countermeasures adopted and the drawings in this study. A summary of the work quantities is shown in Table 18.5.1.

	Table 18.5.1 Summary		unics	-			
Type of Work	Work Item	Remarks	Unit	Quantities			
				Slope	Bridge	Total	
	Crest ditch	0.5×0.5 1:1	m	2,758	• 0	2,758	
(1) Surface drainage	Berm ditch	U-0.3×0.3	m	4,115	0	4,115	
	Toe ditch		m	2,934	400	3,334	
	Vertical ditch	U-0.3×0.3	m	1,321	0	1,321	
(2) Horizontal drainage	Horizontal drain hole	PVC PIPE f 0.04	m	546	0	546	
(3) Vegetation	Seed spraying with pump		m ²	7,551	0	7,551	
	Shotcrete	t=10cm	m ²	3,856	0	3,856	
(4) Structure	Concrete cribwork		m²	711	0	711	
	Gabion mat		m ³	0	490	490	
(5) Structural support	Stone riprap wall		m ²	0	1126	1,126	
	Gravity-type retaining wall		m ³	164	0	164	
	Gabion wall		m ³	0	0	0	

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Table 18.5.1 Summary of Work Quantities

Type of Work	Work Item	Remarks	Unit	Quantities			
		ACCURATING AS	Cun	Slope	Bridge	Total	
	T-shaped retaining wall		m ³	1,077	0	1,077	
	Removal		m ³	0	0	0	
	Rock cutting		m ³	60,011	0	60,011	
(6) Earth work	Rock pre-splitting	Rock blasting	m ³	0	108	108	
	Soil cutting		m ³	40,394	0	40,394	
	Embankment		m ³	27,354	3500	30,854	
	Prevention net		m ²	26,032	0	26,032	
(7) Rock-fall prevention device	Prevention fence		m ²	0	0	0	
	Barrier with gabion mat		m ³	0	0	0	
	Barrier with concrete wall		m ³	0	0	0	
(8) Anchoring	Rock bolt		each	0	0	0	
	Concrete revetments		m ³	0	2107	2,107	
	Gabion mat		m ³	812	3327	4,139	
(9) Riverbank protection	Stone riprap with mortar		m ³	0	122	122	
	Concrete cribwork for riverbed		m ²	0	0	0	
(10) Abutment & pier protection	Gabion foot protection		m ³	0	0	0	
	Steel bridge with concrete slab		m ²	0	500	500	
(11) Bridge structure	Gravity-type abutment		m ³	0	58	58	
	Reversal T-type abutment(RC)		m ³	0	487	487	
(12) Box culvert	Cast in place	3m×2m	m	14	0	14	

18.5.2 Spot Specific Work Quantities

Work quantities for each disaster prevention spot are as shown in Table 18.5.2- Table18.5.8.

1) NIC.1

ID. No.	Type of Disaster	Type of Countermeasure		Unit	Quantity
N001A290	R.F	Recutting + Prevention net + Drainage	T	m^2	23,286
N001A280	R.F	Horizontal drainage	P	m	100
N001A240	R.F	Recutting + Prevention net	T	m^2	950
N001B230	R.C	Recutting + Prevention net	T	m^2	228
N001B170	R.C	Recutting + Drainage	i P	m ³	36,028
N001B150	R.C	Recutting + Shotcrete + Drainage	P	m ²	252
N001B120	R.C	Recutting + Drainage	P	m ³	10,655

Table 18.5.2 Work Quantities for Countermeasures for Slope Damage

Note) R.F: Rock-fall; R.C: Rock collapsing; P: Permanent countermeasure; T: Temporary countermeasure

Location	Type of Disaster	Type of Countermeasure		Unit	Quantity
113+190	Bridge	Gabion mat	Т	m^3	435
135+640	Bridge	Gabion mat	T	m^3	114
150+330	Bridge	Concrete block	T	m^3	288
151+850	Bridge	Gabion mat	T	m^3	86
226,800	Bridge	Gabion mat		m^3	1,138
226+890		Revetment +Stone masonry	1	m^2	1,758
222.045	Bridge	Gabion mat	; ; ; TP	m^3	238
233+245	-	Revetment		m ²	640

Table 18.5.3	· Work (Juantities for Countermeas	ures for	Bridge 1	Foundation	Scouring
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Note) Bridge: Scouring of foundation; T: Temporary countermeasure

2) NIC.3

		C			9
Location	Type of Disaster	Type of Countermeasure		Unit	Quantity
N003B400	R.C	Recutting + Drainage	P	m^3	290
N003B370	R.C	Recutting + Drainage	P	m^3	1,676
N003B320	R.C	Embankment + Concrete retaining wall + Vegetation	Р	m ³	3,168
N003C230	S.S + R.C	Recutting + Cribwork +Drainage Embankment + Vegetation + Drainage	Р	$\begin{array}{c} m^2 \\ m^3 \end{array}$	638 4,934
N003E170	D.F + R.C	Dam Recutting + Drainage	Р	m m ³	20 2,670
N003C150	S.S + R.C	Recutting + Drainage Embankment +Vegetation	P	• m ³	9,221 16,076
N003C140	S.S + R.C	Recutting + Drainage Embankment +Concrete retaining wall + Vegetation + Drainage	Р	m ³	5,408 3,176

 Table 18.5.4
 Work Quantities for Countermeasures for Slope Damage

Note) R.C: Rock collapsing; S.S: Slope Slide; D.F: Debris flow; P: Permanent countermeasure

Table 18.5.5	Work C)uantities for	r Countermeasures	for Bridge	Foundation	Scouring
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119+050	Bridge	New bridge construction	Р	m^2	500
Location	Type of Disaster	Type of Countermeasure		Unit	Quantity

Note) Bridge: Scouring of foundation; P: Permanent countermeasure

3) NIC.5

Table 18.5.6 Work Quantities for Countermeasures for Slope Damage

Location	Type of Disaster	Type of Countermeasur	'е	Unit	Quantity (m ²)
N005A010	R.F	Recutting + Drainage	P	m^3	10,760

Note) R.F: Rock fall; P: Permanent countermeasure

4) **NIC.26**

Location	Type of Disaster	Type of Countermeasur	• • •	Unit	Quantity
N026A060	R.F	Recutting + Shotcrete + Drainage	P	m ²	3,604
N026A140	R.C	Recutting + Horizontal drainage + Drainage	Р	m ³	11,495
N026A150	R.F	Recutting +Drainage	Р	m ³	2,113
N026B160	R.C	Recutting + Prevention net	T	m ²	1,568
Note) R.F: Rock fal	l; R.C: Rock c	ollapsing; Permanent countermeasure;	T: Tempora	ry counte	rmeasure

Table 18.5.7 Work Quantities for Countermeasures for Slope Damage

Table 18.5.8 Work Quantities for Countermeasures for Bridge Foundation S
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Location	Type of Disaster	Type of Countermeasu	ıre	Unit	Qty
107+533	Dridaa	Stone riprap with mortar		m ³	72
107+533 Bridge	Gabion mat	1	111	546	
100,151	Bridge	Stone riprap with mortar	F	m ³	50
108+154	-	Gabion mat	T	111	408
155+785	Bridge	Gabion mat	T	m ³	115
170.050	Bridge	Stone riprap wall	т	m ²	162
170+952	-	Gabion mat	1	m^3	375

Note) Bridge: Scouring of foundation; P: Permanent countermeasure

Summary of Spot Specific Costs 18.6

18.6.1 NIC.1

Costs for each disaster prevention spot are as shown in Table 18.6.1-Table18.6.7.

ID. No	Type of Disaster	Type of Countermeasure		Unit	Qty	Cost (US\$1090)
N001A290	R.F	Removal + Prevention net + Drainage	T	m²	23,286	335
N001A280	R.F	Horizontal drainage	P	m	100	10
N001A240	R.F	Removal + Prevention net	Т	m^2	950	26
N001B230	R.C	Removal + Prevention net	T	m^2	228	6
N001B170	R.C	Recutting + Drainage	Р	m ³	36,028	.1,590
N001B150	R.C	Recutting + Shotcrete + Drainage	P	m ²	252	27
N001B120	R.C	Recutting + Drainage	P	m ³	10,655	814
Total	1					2,808

m 11 40 / 4	a , , a		
	I onstruction I os	t tor Countermogenro	s for Siona Rainra
EXTRE TO U. I	- CARIISLI BULIUR CAUS	t for Countermeasures	

Note) R.F: Rock fall; R.C: Rock collapsing; P: Permanent countermeasure; T: Temporary countermeasure

ID. No	Type of Disaster	Type of Countermeasure		Unit	Qty	Cost (US\$1000)
Junquillal	Bridge	Gabion mat	T	m ³	435	42
San Nicolas	Bridge	Gabion mat	Т	m ³	114	25
Las Chanillas	Bridge	Concrete block	T	m ³	288	189
San Ramon	Bridge	Gabion mat	Т	m ³	86	9
Inali	Bridge	Gabion mat Revetment +Stone masonry	Т	${f m}^3 {f m}^2$	1,138 1,758	828
Tapacali	Bridge	Gabion mat Revetment	Т	m^3 m^2	238 640	282
Total					1,375	

Table 18.6.2	Construction Cost for	Countermeasures for	or Bridge Fou	ndation Scouring
	•••••••			

Note) Bridge: Scouring of foundation; T: Temporary countermeasure

18.6.2 NIC.3

Table 18.6.3 Construction Cost for Countermeasures for Slope Failure

ID. No	Type of Disaster	Type of Countermeasure		Unit	Qty	Cost (US\$1000)
N003B400	R.C	Recutting + Drainage	P	m ³	290	40
N003B370	R.C	Recutting + Drainage	P	m ³	1,676	175
N003B320	R.C	T-shaped retaining wall +Refilling+ Vegetation+ Drainage	Р	m ³	3,168	239
N003C230	S.S + R.C	Recutting + Cribwork + Vegetation+ Drainage Embankment + Vegetation + Drainage	P	m² m³	638 4,934	328
N003E170	D.F + R.C	Concrete dam + Box culvert Recutting + Drainage	P	m m ³	20 2,670	310
N003C150	S.S + R.C	Recutting + Drainage Embankment +Vegetation+ Drainage	Р	m ³	9,221 16,07 6	918
N003C140	S.S + R.C	Recutting +Horizontal drainage + Drainage Embankment +T-shaped retaining wall + Vegetation + Drainage	Р	m ³	5,408 3,176	749
Fotal	·	¥		I		2,759

Note) R.C: Rock collapsing; S.S: Slope Slide; D.F: Debris flow; P: Permanent countermeasure

Table 18.6.4 Construction Cost for Countermeasures for Bridge Foundation Scouring

ID: No	Type of Disaster	Type of Countermeasure		Unit	Qty	Cost (US\$1000)
El Guayacan	Bridge	New bridge construction	; P	m	500	1,379

e: Scouring of foundation; P. Permanent countermea

18.6.3 NIC.5

Table 18.6.5 Construction Cost for Countermeasures for Slope Failure

Note) R.F: Rock fall; P: Permanent countermeasure

18.6.4 NIC.26

Table 18.6.6 Construction Cost for Countermeasures for Slope Failure

ID. No	Type of Disaster	Type of Countermeasur	те	Unit	Qty	Cost (US\$1000)
N026A060	R.F	Recutting + Shotcrete + Drainage	Р	m²	3,604	316
N026A140	R.C	Recutting + Horizontal drainage + Drainage	Р	m ³	11,495	904
N026A150	R.F	Recutting +Drainage	P	m ³	2,113	210
N026B160	R.C	Removal + Prevention net +Drainage	Т	m^2	1,568	13
Total					1,443	

Note) R.F: Rock fall; R.C: Rock collapsing; P: Permanent countermeasure; T: Temporary countermeasure

Table 18.6.7	Construction Cost for	Countermeasures for	Bridge Foundation Scouring
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ID. No	Type of Disaster	Type of Countermeasu	re	Unit	Qty	Cost (US\$1000)
Solis	Bridge	Stone riprap with mortar Gabion mat	Т	m ³	72 546	66
Papalon	Bridge	Stone riprap with mortar Gabion mat	Т	m ³	50 408	51
San Juan de Dios	Bridge	Gabion mat	Т	m ³	115	5
La Banderita	Bridge	Stone riprap wall Gabion mat	Т	m ² m ³	162 375	31
Total		· · · · · · · · · · · · · · · · · · ·				153

Note) Bridge: Scouring of foundation; P: Permanent countermeasure

18.6.5 Total Cost

Total construction cost for each route is as shown in Table 18.6.8.

Objective	Cost (US\$1000)				
Route	Slope	Bridge	Total		
NIC.1	2,808	1,375	4,183		
NIC.3	2,759	1,379	4,138		
NIC.5	389	0	389		
NIC.26	1,443	153	1,596		
Total	7,399	2,907	10,306		

Table 18.6.8 Total Construction Cost by Route

US\$1=C\$14.4 (exchange rate as of October 14, 2002)

CHAPTER 19

ENVIRONMENTAL IMPACT ASSESSMENT

CHAPTER 19 ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

19.1 Method of EIA

19.1.1 Target Spot of EIA

The EIA covers the thirty spots specified in Chapter 14.

19.1.2 Method of EIA

The EIA assesses the level of consideration given by countermeasures to the environmental negative factors selected for each spot in Chapter 9. Validity of the method of environmental consideration is judged based on "The summary of general matters for environment observance in the construction stage" (Chapter 5 of NABCV in NIC 2000). As for items that are difficult to assess and environmental considerations under construction, it is suggested that these be compiled as carryover items to the next step.

19.2 Evaluation of Environmental Consideration

19.2.1 Resettlement

Resettlement (a hotel under construction) was originally forecast at one spot (Nic3) among the target spots. However, this was averted by revising works as shown in Table 19.2.1.

Spot No.	Countermeasure		
Shor we	Initial Idea	Final Idea	
	It was forecast that the hotel would fall		
N003B320	on in the excavation line due to cutting	ensure backfilling at the rear	
	works.		

Table19.2.1	Consideration	Items for Avoi	dance of Resettlement
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Acquisition needs to be carried out at the spots indicated in Table 19.2.2. However, there are no spots where expropriation causes a trouble judging from present conditions of use. And, land acquisition is done in accordance with the Nicaraguan law.

Table19.2.2 Consideration Items for Avoidance of Resettlement

NIC 1

No,	Owner of the land	Land use	Countermeasure
N001B120	No information available	Shrub and second	Re-cutting, Concrete frame + Cobble,
		growth vegetation	Drainage, Removal of Bolders
N001B150	Paulo Gonzalez	Pasture land	Slope fairing, Shotcrete, Drainage
N001B170	Paulo Gonzalez	Pasture lands	Slope fairing, Concrete frame +
			Vegetation, Drainage, Removal of
			Bolders
N001A280	Nicasia Gutierrez	Pasture land	Re-cutting, Vegetation, Drainage
N001A290	Carlos Rodriguez	Pasture land, corn,	Barrier with wall, Drainage, Removal of
		wood	Bolders

NIC3

11200			
No.	Owner of the land	Land use	Countermeasure
N003B400	Rafael Rayos Torres	Pasture land	Re-cutting, Concrete frame + Vegetation,
			Drainage,
N003B370	No information available	Pasture land	Re-cutting, Concrete frame + Vegetation,
			Drainage,
El	José Antonio Hernandez	Pasture land	Re-construction of Bridge
Guayacan	Gonzalez,	Family house	
	José Manuel Gustamante		
N003B320	Roger Castillo Palma	Recreation	Cantilever Retaining Wall, Back Fill
N003C230	Francisco Frey Gonzalez	Pasture land, forest	Re-cutting, Concrete frame + Vegetation,
		(pine)	Drainage, Re-embankment
N003E170	Erick Kuhl (dueño del	Horticulture	Dam, Re-cutting, Concrete frame +
	hotel Selva Negra),		Vegetation, Drainage
	Felipe Lopez		
N003C150	Jorge Salazar	Coffee plantation	Re-cutting, Concrete frame + Vegetation,
			Drainage, Cantilever Retaining Wall
N003C140	Manuel Lanzas Ponce	Pasture land	Re-cutting, Concrete frame + Vegetation,
			Drainage, Cantilever Retaining Wall

NIC5

No. Owner of the land Land use Countermeasure			
N005A010	Nicolas Lopez	Horticulture	Re-cutting, Concrete frame + Vegetation,
			Drainage

NIC26

No.	Owner of the land	Land use	Countermeasure
N026A060	Fabian y José Altamirano	Corn and others	Slope fairing, Shotcrete, Drainage
N026B140	Abraham Mairena	Pasture land	Re-cutting, Concrete frame + Cobble, Drainage
N026A150	Abraham Mairena	Pasture land	Re-cutting, Concrete frame + Cobble, Drainage
N026B160	Pedro Urritia (father and	Pasture land,	Prevention Net, Removal of Bolders
	son)	sometime corn	

19.2.2 Economic Activity

Concern was raised over the impact on economic activities at four of the spots; however, measures were taken at each spot to avert this economic impact as indicated in Table 19.2.3.

Spot No.	Countermeasure		
obor we	Initial Idea	Final Idea	
	An influence on the service water for	It is the plan to secure the service water	
Junquillal	rice fields on the downstream side was	by half-section construction.	
(Nic1)	forecast by the shutoff of water under		
	the construction.		
N003B320	As mentioned in the Table 19-1.	As mentioned in Table 19-1.	
	It was forecast that a coffee field under	It is the plan to avoid an influence by the	
N003C140	the embankment will be affected by	wall.	
	the construction.		
	A coffee field was confirmed at the top	Influence was minimized by	
N003C150	of the slope as a result of the site	countermeasures matched to the existing	
	re-survey.	slope as much as possible.	

19.2.3 Ground Water

Concern was raised over the impact on three shallow wells that utilize non-artesian ground water. As for the N026B160 point, since the shallow well was found to have a depth 98-foot (about 30m) and to use artesian water, it is deemed there will be no impact. As for the remaining two points, a percolation layer existed under the thin weathering layer as a result of the geological survey. Therefore, countermeasures were devised to minimize impact on the water catchment volumes shown in Tables 19.2.4 and 19.2.5.

Spot No.	Counter Initial Idea	rmeasure Final Idea
N005A010	Re-cutting + Vegetation + Drainage	Concrete Frame + Vegetation + Drainage (permeation catch pit)
N026B140	Re-cutting	Concrete Frame + Cobble + Drainage (permeation catch pit)
N026B160	Judgment as use of the non-artesian water	

Table 19.2.4 Consideration Items f	for Ground	Water
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Table19.2.5 The Drainage Structure in Consideration of the Underground Permeation

e.g. Structure	General Outline
Basse Bassa	Permeation Catch Pit
Filler	Permeation catch pit is the structure composed of catch pit that it has perforations on the side and the bottom, and filling material on the circumference. And, rainwater is made to permeate from the sides and bottom to the ground.
Penetration Sheet	Permeation Trench
Filler	Permeation trench is the structure composed of permeation pipe and filling material of the circumference. And, rainwater is made to permeate from the sides and bottom to the ground.
Penetration Sheet	Permeation Side Ditch
Filler	A permeation side ditch is the structure composed of sides and bottom made from permeable or perforated concrete, and circumference made from filling material. And, rainwater is made to permeate from the sides and bottom to the ground.

19.2.4 Lake and River

Concern was raised over the impact on the river (river use) in one place. However, the structure was revised so that impact on river flow was avoided as shown in Table 19.2.6.

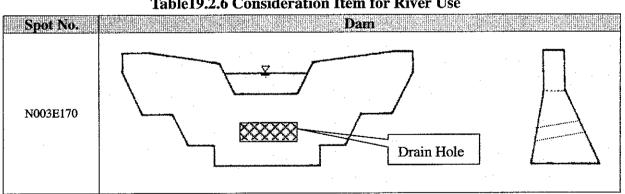


Table19.2.6 Consideration Item for River Use

19.2.5 **Fauna and Flora**

Concern was raised over the direct and indirect impact on the national conservation area (precious animals and plants) in the following two spots. However, it is the plan to avoid any influence as shown in Table 19.2.7.

Spot No.	Pending Issue	Measure
San Nicolas (Nic1)	There was concern that water supply to the animals will decrease due to shutoff of water by the construction to the Cerro Tomabu national conservation area on the downstream side.	Carry out construction in the dry season without resorting to water shutoff.
N003C230	Because the spot was located in Cerro El Arenal national conservation area, countermeasures had to take vegetation regeneration into consideration.	It is the plan to regenerate vegetation by doing planting in the concrete frame. (Refer to Fig. 19.2.1) The planting is carried out using native species or latent natural seedings. And, the embankment is planted with trees to harmonize with the surrounding landscape.

Table19.2.7 Consideration Items for Fauna and Flora

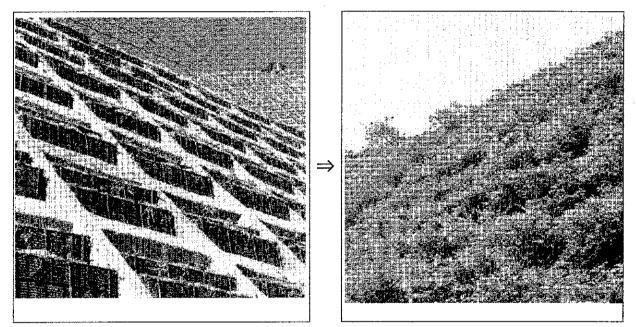


Figure 19.2.1 e.g. Planting in the Concrete Frame

As shown in Chapter 9, as for trees that are cut down by the construction, an alternative spot is secured in accordance with the mitigation measures (refer to Table 19.2.8) as for other spots as well. On this occasion, suitable species are selected to match with the surrounding environment.

•	Table19.2.8 Method of Mitigation	
Echelon	Explanation	
Avoiding	Avoidance of biotope	Avoidance from biotope and movement zone.
Minimizing	Avoidance of core biotope Acceptance of the structure that minimizes impact	Avoidance from core biotope. Minimization of embankment and cut.
Balancing	Acceptance of structure that secures he animal movement zone	An impact is made to balance in the same point.
Restoration or Compensating	Natural regeneration of lost biotope	It alternates the impact elsewhere. An alternative spot is secured elsewhere. Unavoidable impact is compensated for. *Four tree-planting duties for one felling by the guidance of MARENA are contained here.

Table19.2.8 Method of Mitigation

19.2.6 Landscape

N003C230, where countermeasures are enforced directly in the national conservation area, was made the target for careful consideration to the landscape. As was mentioned above, it is planned to take countermeasures here that give careful consideration to vegetation that matches with the surrounding natural landscape. And, vegetation of the embankment by tree plantation and lawn seed coating is planned as early as possible in accordance with progress of the construction to achieve harmony with the landscape of the circumference.

19.3 The Points to Concern for The Next Step

Concerning responsibility to the legal environment in the construction contract stage, the section 108 of NIC2000 must be referred to. And, as for the points of concern with the environment in the stage of the basic design, the detailed design and the construction, it is important to confirm the mentioned items of NABCV fully.

Concern here is only directed to items that should be considered in the construction stage, and these are evaluated by the detailed construction plan in the environment impact factors selected with IEE including the correspondence with NIC2000.

19.3.1 Living and Transportation Facilities (Refer to Nic2000 108.14, NABCV 5.1)

Effort shall be made not to influence the social infrastructure and access to work places. Moreover, the construction work must not hinder the economical activities of inhabitants. In cases where the above points are unacceptable, a contractor must provide equal facilities to those that are affected.

19.3.2 Waste (Refer to Environmental Basic Law, Chap.3)

1) General

Generally surplus soil is used for holes around roads, gully erosion, and reclamation of borrow pits. There must be no damage to surrounding vegetation and arable land, and moreover it cannot be disposed or used to pollute rivers and the environment. Disposal on slopes is also prohibited. Landowner's permission must be obtained in advance when disposing on private land.

Waste material must be taken to the disposal site that is specified from the construction spot at once. On this occasion, the quantity and kind of the waste materials are specified, and permission must be obtained from the related organization in advance. (Note: In advance, an interview with the city mayor is given in advance to explain about the effect and the purpose of the construction.) And, consideration must be taken to ensure that conveyance of the waste

materials doesn't become an expensive cost item in the project.

As for the removed asphalt waste, it shall be recycled for use as road sub-base.

Waste oil shall be collected by a special enterprise, and carried to the treatment plant for recycling. Adjustment with these enterprises about taking back waste oil from the workshop is necessary.

The waste materials of concrete and the stone block shall be used in protection walls of embankment, slope and the erosion points. And, they can be buried in the road circumference area under the approval of the adjustment organization about the environment and the natural resources, MARENA, the cities public office and the landowner in advance. In cases of disposal inside rights of way, the permission of MTI is necessary.

2) Control Method of Waste Material

Every kind of waste must be controlled as mentioned in Table 19.3.1.

	IDICITY, J. ICUMII OI MICHIOU OI WASIC MIAICITAI
Category	Method
Waste Oil	 Waste oil such as lubricating oil and fuel is collected by special hydrocarbon handling enterprise. The contractor must adjust it properly between the nearest fuel stores of the construction site so that those enterprises may carry waste oil to the receiving refinery. 1) The contractor must prepare the workshop or the place of the oil exchange installed with a transport pipe to oil tank or waste oil collection tank. 2) That place is made waterproof, and it must be controlled fully so that waste oil may not leak outside. 3) Generally that equipment is made by masonry with overcoat. 4) The contractor must store up waste oil in secrecy containers of 55 gallons for collection by the recycling company.
4 · · · ·	5) Waste oil is used for lumber curing for the pattern frame. The precise control of the waste oil is necessary because of that.
Surplus Soil	 Generally surplus soil is separated into inorganic substance and organic substance. Disposal of waste materials, surplus soil and the excavation materials is critical from the economic and environmental viewpoints. Therefore, as for specification of the place and the operation, characteristics in drainage, and physical and geographical factors must be taken into consideration fully in each place. 1) The surplus soil of inorganic substance is used for the reclamation of the area with no vegetation, gullies and bog holes. Or it used for the reclamation of bog holes collected embankment materials. 2) When any kind of waste including the surplus soil is disposed in private land, landowner's permission should be necessary. 3) It is prohibited to throw solid waste away in the flow of the water and the mountainside slope . 4) Waste materials are removed from the construction site at once, and they must be carried to the final disposal place. 5) The surplus soil of the inorganic substance must not be accumulated on unstable areas and important areas from the viewpoint of environment and agricultural production sites.

Table19.3.1Control Method of Waste Material

THE STUDY
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PAGE 19-8

Category	Method
	waste is carried under the advance understanding of the cities. Generally
	the layer of organic matter which forms the surface of the soil is mixed
	with plant waste or useful microorganisms which support the ventilation
	of the soil.
	The plant layer abounds in nutritious elements resulting from elements of
	the organic matter and corrosion acid.
	1) A layer of organic matter has indispensable biological and physical
	resources as to the development of the creature activities, the natural
	regeneration and re-greening of the land where it was exposed.
	Therefore, it must be kept in the place where it is selected in advance.
	2) A layer of organic matter is used for the natural regeneration of slope
	which is formed by construction in the construction stage.
	3) A surface must be made flat with less than 2 m height to prevent that
	from being compacted while it keeps the layer of organic matter.
	4) It is desirable to mix it with the remaining plants to increase the
	content of organic material or the seed.
	Generally asphalt waste materials are recycled by a contractor as
	roadsub-base. These waste materials are put on the reclaimed land
	approved by surrounding cities. Because the landscape is hurt and soil and
Removed Asphalt	arable land are polluted, asphalt waste materials must not be put by the
	side of the road.
	If suitable technology exists, recycling of the asphalt layer is a wonderful
	substitutive technology.
	Generally concrete waste materials occur from removal of the existent
	road or the concrete blender. This debris is used for the boundary of camp
	· · · ·
	yards or roads, and embankment protection. And, it can be disposed of in
Removed Concrete	city-managed sites, too. Or, it can be buried in private land under the
	permission of landowners and MARENA, too. It is used for small drywall
	construction of embankment protection so that some of these waste
· · · · · · · · · · · · · · · · · · ·	materials may minimize the progress of the erosion.
	Generally pieces of lumber are used as the timber pile of the topographic
	survey. The pieces of the lumber are kept in order. Then, they are
Lumber	delivered for use by inhabitants around the construction site as firewood.
Lumoci	Because it has the possibility to induce fire, it isn't suitable to burn up the
	lumber. It is sent to the city-managed sites and can be disposed in final
	disposa sites too.
	Remaining crushed stone is disposed in vacant lots of excavation or
	cutting soil in quarries. It can also be handed over to municipal or village
Stone	public offices .
	The stone that appeared from excavation or cutting soil can be used for
	the drywall for embankment protection.
	The waste water produced in the washing process of the aggregate also
	makes sediment occur. This water is channeled to grit tank through the
	waterway, and it is used as washing water again. The mud which
	accumulates in the grit tank is carried regularly to the drying place, and
	carried to the final disposal area of surplus soil permitted in advance. As
Waste Water	for polluted water such as that from stone washing not done under sanitary
	management in advance, river disposal is not permitted under any
	circumstances. Construction campsites must be provided with septic
	tanks for the sewage treatment to promote accumulation and the resolution
	of the mud. This mud is dried regularly, and it must be locked up in the
	hole specified by environment supervisor of the project.

Category	Method
	Cement bags discarded in concrete and masonry preparation areas are also
	subject to control.
Others	

19.3.3 Water Pollution (Refer to NIC2000 108.31,205)

The contractor must put all necessary plans in action to protect rivers, lakes, lagoons, ponds, swamps, bays and coast against the harmful materials of fuel and oil, bituminous materials, calcium chloride and others. Then, the plan that minimizes the precipitation of that liquid material must be integrated into that operation.

The contractor submit the program which prevents the pollution of the water effectively to the technician before the working start of the project, and the contractor must get that approval.

19.3.4 Noise and Vibration (Refer to NIC2000 108.31, NABCV 5.3)

A contractor must formulate rules and a control system concerning all work that generates noise which disturbs or causes menace to the peace and health of workers and inhabitants. Noise and vibration shall be reduced on construction sites, and sources of noise shall be removed or reduced as far as it is possible. The rough finishing of road surfaces must be avoided to reduce noise from tires in fragile environmental areas. The contractor must keep passage of large trucks as far away from areas of residence as possible, especially at night. As for tranquil residential areas in city suburbs, machines which cause noise beyond 70 dB in Level A (the measurement of a distance 15m) can't be used from 6 p.m. until 7 a.m. However,

exceptions shall be made in emergencies or when there is technician's special permission. When sterner local standards exist in comparison with this standard, local standards take precedence in all cases.

note: Level A

A-Weighted sound pressure level. It is written with L_A , and units are unified in dB.

19.3.5 Air Pollution (Refer to NIC2000 108.31, NABCV 5.3)

The following items must be observed about the air pollution.

- The motors of construction machines shall be maintained s that the discharge of carbon monoxide or the hydrocarbon is minimized.
- Avoid burning of plant waste from road site felling, root removal and plant clearing.

on quarries and campsites as far as possible except where MTI or MARENA standards permit.

- Use dust collector machines in asphalt and concrete plants and other dusty plants.
- Avoid the discharge of the dust at the time of earth excavation and embankment construction by sprinkling with water to the unstable material so far as it is possible.
- Stabilize conveyance roads by sprinkling with water or additive.
- Observe the law and the applicable rules concerning the control of paints used for the construction, dilution medicine, the concrete and the curing compound for the asphalt, and so on.

These measures are strictly applicable when construction is carried out just near cities or villages. And, the special permission of MARENA must be sought before doing that work when powdered dust of at least 4.5kg scatters in the atmosphere.

19.3.6 Other Precautions

Before the execution of the construction, MTI shall submit the documents shown in Appendix-B2 to MARENA, and EIA needs and other environmental considerations shall be confirmed. After EIA and so on is carried out if necessary, environmental permission containing general and/or independent precautions about the prevention and reduction measures which a contractor should take, will be handed over to the client.

19.4 Evaluation at Present

It is judged that adequate countermeasures are being taken with respect to items that are immediately pertinent to minimization of environmental impact. Final evaluation of every site is shown in Table 19.4.1.

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s	4	Waste	в	B	В	в	в	в	в	в	в	в	в	в	B	B	в	B	B	B	B	В	В	B	В	в	в	в	в	в	в	В
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Table19.4.1 Evaluation of Each Spot for Environmental Impact

*: Existance of Particular Condition.

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Note : GM (Gabion Mat) CM (Concrete Mat) BR (New Bridge) GW (Gabion Wall) CW (Concrete Wall) CH (Concrete Mat) BR (Shourerete Mat) BR (New Bridge) GW (Gabion Wall) CH (Concrete Fame) R (Recutting) S (Shotcrete) PN (Prevention Net) BR (Boulder Removal) CW (Counter Weight) D (Dam) V (Vegitation) C (Culvert) SD (Surface Drainage) GD (Ground Drainage) RW (Reconstruction Wing Wall) RE (Re-embankment) SF (Slope Fairing) BP (Bank Protection)

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ORIENTAL CONSULTANTS CO., LTD. in association with JAPAN ENGINEERING CONSULTANTS CO., LTD.

CHAPTER 20 IMPLEMENTATION PLAN

CHAPTER 20 PROJECT EVALUATION

20.1 General

As noted in Chapter 13 the traffic benefits that would result from disaster prevention measures are evaluated by calculating the dis-benefits to traffic of a disaster occurring. It is assumed that at each site a disaster would result in the closure of that particular link in the network and the need for traffic to re-route. When traffic re-routes to avoid the closed link it potentially incurs two types of dis-benefit;

- increased vehicle operating costs due to additional distance; and
- increased passenger time costs.

These two parameters are evaluated by the JICA STRADA model by running the model for two cases : with the affected link in place (a common base), and without the link in place. The aggregate differences over the network, for each vehicle mode, of vehicle-kilometres and vehicle-hours are calculated.. These are converted to monetary benefits using the parameters developed in the Chapter 11 and set out in Table 20.1.1.

	- F	, 8
Vehicle type	Operating Cost per 1000 km,	
	USS	hour
Car	185.5	2.84
Utility	215.1	1.09
Average Bus	529.7	14.90
Light Goods	549.1	1.04
Medium Goods	768.2	1.04
Heavy Goods	878.5	0.75

Table 20.1.1 Vehicle Operating Costs and Passenger Costs, Nicaragua 2002

Source : NIC2000 Transport Plan and year 2002 prices

The costs of disaster prevention measures are expressed in terms of the capital cost of works (assumed to be incurred in 2003) and the continued maintenance cost of the link. The costs of temporary prevention measures are assumed to recur every twelve years. Permanent measures incur a single capital cost, but annual maintenance costs thereafter. Costs of preventative measures have been revised since the Interim Report. These preliminary engineering costs, prepared in Chapter 18, have been uprated by a factor of 1.23 to give the full costs. The additional cost factors are shown in Table 20.1.2. Revised costs are set out in Table 20.1.3.

Locations of vulnerable sites are shown in Figure 20.1.1.

Component	% of Engineering Works
Engineering works	100.0
Design	5.0
Construction Supervision	7.5
Client Costs	0.9
Transport of materials	5.0
Contingency	5.0
Total	123.4

 Table 20.1.2 Full Cost Breakdown of Countermeasures

Source : International norms

Road	Site no.	Site ID	Full Economic
NIC.1	1	N001A290	Cost (US \$)
NIC.1	1 2		413,370
	3	N001A280	12,339
NIC.1		Junquillal	51,825
NIC.1	4	San Nicolás	30,849
NIC.1	5	Las Chanillas	233,215
NIC.1	6	San Ramón	11,105
NIC.1	7	N001A240	32,082
NIC.1	8	N001B230	7,404
NIC.1	11	N001B170	1,961,965
NIC.1	12	N001B150	33,316
NIC.1	13	N001B120	1,004,427
NIC.1	18	Rio Inalí	1,021,702
NIC.1	19	Rio Tapacalí	347,971
NIC.3	24	003B400	49,358
NIC.3	25	003B370	215,940
NIC.3	26	El Guayacán	1,701,604
NIC.3	27	N003B320	294,912
NIC.3	29	N003C230	404,732
NIC.3	30	N003E170	382,521
NIC.3	32	N003C150	1,132,757
NIC.3	33	N003C140	924,221
NIC.5	35	N005A010	480,003
NIC.26	44	N026A060	389,925
NIC.26	45	La Banderita	38,252
NIC.26	49	N026B140	1,115,482
NIC.26	50	N026A150	259,127
NIC.26	51	N026B160	16,041
NIC.26	52	San Juan de Dios	6,170
NIC.26	54	Papalón	62,931
NIC.26	55	Solís	81,440
Total			12,716,988

Table 20.1.3 Costs of Countermeasures by Site

Source : Tables 18.6.1 to 18.6.7, and Table 20.1.2

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

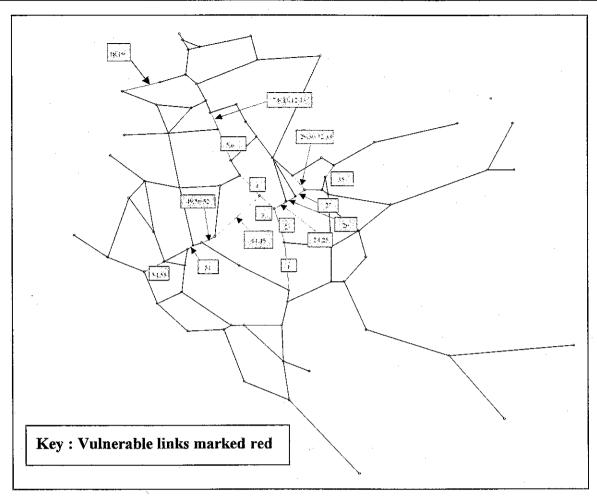


Figure 20.1.1 Locations of 30 Vulnerable Road Sites for Evaluation

Table 20.1.4 lists the parameters used in the economic evaluation.

Parameter	Value	Source
Discount Rate	10%	International Norm
Discount period	18 years	2003 to 2020
Maintenance cost for permanent works	2% of capital cost per year	Assumption
Implementation of counter measures	2003	Assumption
Start year of benefit flow	2004	Assumption

Table 20.1.4 Economic Evaluation Parameters

20.2 Economic Analysis

The economic evaluation relies on quantifying disadvantages that flow from road closures due to a natural disaster. The scale of the disbenefits is a function of the amount of traffic, and the length and quality of alternative routes available to traffic.

However, the disaster prevention spots are requested the emergency. Furthermore, it is not

PAGE 20-3

able to fix the disaster occurrence probability because natural disasters occur frequently on the project roads. In Nicaragua, the "rainy" season (which includes the onslaught of typhoons) lasts from April to October. As a result of this six-month period of rains, it is unavoidable that some roads will become impassable due to land and rock slides, severe scouring of bridge foundations, etc. For this reason, it has been decided that the frequency of disasters should be derived applying past data that experienced the heaviest rains. Maximum hourly rainfall data for the past 20 years are as shown in Table 20.2.1. As the table indicates, there are variations in the figure. For example, the figure for maximum hourly rainfall in the year that experienced Hurricane Mitch is abnormally large as compared to the figures for the previous and following years. Accordingly, after much consideration, the Study has selected 200 mm/h of rain or more as the figure for when rock foundations experience cracking due to water infiltration, land and rock slides occur, etc. Based on this, it can be seen that there were seven times that this figure was exceeded over the twenty year period from 1980 to 2000, meaning that every three years a road disaster would occur at the locations requiring disaster prevention measures.

Year	Amount of Rainfall (mm/h)	Comments
1980	283.3	· · · · · · · · · · · · · · · · · · ·
1981	98.9	
1982	85.1	· · · · · · · · · · · · · · · · · · ·
1983	37.3	
1984	48.5	
1985	245.9	· · · · · · · · · · · · · · · · · · ·
1986	50.1	
1987	47.5	
1988	and an an 217 has to be sug	· · · · · · · · · · · · · · · · · · ·
1989	50.0	
1990	143.6	••••••••••••••••••••••••••••••••••••••
1991	96.3	
1992	57.6	
1993	129.4	
1994	112.4	
1995	324.9	
1996	340.4	
1997	157.7	
1998	888.4	Hurricane Mitch
1999	215.0	1.11
2000	82.6	

 Table 20.2.1 Maximum Annual Hourly Rainfall for the Past 20 Years

In addition, as described in Chapter 18, the lifespan of disaster prevention measures shown below are reflected in investment costs.

- Permanent disaster prevention measure: Effective for 20 years
- Temporary disaster prevention measure: Effective for 10 years

The construction period required for implementing road disaster prevention measures (With Project) and the costs for road restoration when no measures are implemented (Without

Project) are as shown in Table 20.2.2. Furthermore, note that there are substantial variations in the construction period required for prevention measures depending on the scale and content of the work involved. For example, installation of the netting to prevent rocks from falling on to the surface a road requires little time, while re-cutting a slope or reinforcing embankments at certain locations will require up to two years.

The costs for road restoration for the "Without Project" case consists of the investment needed to restore a road to its previous condition prior to a disaster. In this case, it is assumed that there is no road closure, and the costs and scale for restoration work will vary depending on whether or not one lane of the existing road can be used or if a temporary detour road has to be built. For example, the use of locally available rock to deal with the scouring of bridges is an inexpensive method of restoration.

Item No.	Site	Construction Period	Road Restoration Costs
		(Days)	(US\$)
1	N001A290	195	2,000
2	N001A280	449	2,000
3	Junquillal	1663	1,000
4	San Nicolás	596	1,000
5	Las Chanillas	296	1,000
6	San Ramón	1023	1,000
7	N001A240	223	2,000
8	N001B230	213	2,000
11	N001B170	26	2,000
12	N001B150	204	2,000
13	N001B120	43	7,000
18	Rio Inalí	2	5,000
19	Rio Tapacalí	4	1,000
24	003B400	715	2,000
25	003B370	351	2,000
26	El Guayacán	59	1,000
27	N003B320	309	2,000
29	N003C230	44	3,000
30	N003E170	52	2,000
32	N003C150	22	2,000
33	N003C140	27	2,000
35	N005A010	33	2,000
44	N026A060	32	2,000
45	La Banderita	73	1,000
49	N026B140	32	2,000
50	N026A150	92	2,000
51	N026B160	1211	2,000
52	San Juan de Dios	198	1,000
54	Papalón	357	1,000
55	Solís	371	1,000

Table 20.2.2 Construction Period for Road Disaster Prevention Measures (With Project) & Road Restoration Costs (Without Project)

In the future, some of the main roads in Nicaragua will be upgraded, along with some of the minor roads. Table 20.2.3 shows the planned highway improvements, their status and indication of the effect they have on the economic analysis for this study.

Two schemes have been incorporated into the future year JICA STRADA model tests as commitments : the upgrading of the San Benito to San Lorenzo section of NIC.7, (Managua and Boaco) and the resurfacing of the Santa Cruz to San Nicolas link in Esteli. The implementation of these schemes result in lower journey times on the alternative routes to potential disasters at sites 1 and 4 respectively.

The proposed rehabilitation and improvement of the Guayacan to Jintoega link poses problems for the economic evaluation. At the time of drafting of this report, the status of this scheme is not known. It has a major effect on the benefits of disaster prevention measures on NIC.3 on the section Jinotega-Matagalpa-Guayacan. At the same time, the implementation of measures on NIC.3 will affect the economic evaluation of the Jintoga-Guayacan link. As result, a special evaluation of these sites on NIC.3 was undertaken, in which the economic benefits of disaster prevention measures vary depending when the improvements to the Jinotega-Guayacan link are carried out.

The results of the economic evaluation are shown in Table 20.2.4. In this table, it is assumed that the Jinotega-Guayacan link has not been improved.

Figures 20.2.1 and 20.2.2 show how the benefit/cost ratios of schemes on NIC.3 are affected by the opening date of the Jinotega-Guayacan link. Figure 20.2.2 reveals how sensitive are the cost benefit ratios for sites 29, 30, 32, and 33 to the opening date of improved link. Furthermore, these four sites are all within a short distance (7.2 km) on the same part of NIC.3. Consequently, it is important that all four sites are addressed at the same time, otherwise road failure at just one site would erode all the benefits of any prevention works undertaken at the other sites. The benefit to cost ratio of all four sites takes account of the benefits of maintaining the road open and the costs of all four schemes.

Funding Agency	Road Improvement Scheme	Date	Effect on Economic Analysis	Note
World Bank	Pacayita-Pacaya	July 2002	None	
World Bank	Los Sabogales-La Hermita	July 2002	None	
World Bank	Masaya-Los Flores	September 2002	None	
World Bank	El Jicaro-Jalapa	September 2002	None	
World Bank	Ocotal Jalapa	September 2002	None	
World Bank	Somoto-San Lucas	September 2002	Very minor effect on sites 18,19 (NIC.1)	*
World Bank	Santa Cruz-San Nicolas	September 2002	Effect on site 4 (NIC.1)	**
World Bank	Muhan to El Rama	May 2002	None	
Government of	El Guasaule Bridge	August 2002	None	<u> </u>
Japan	_			
Government of	San Benito to San	August 2002	Effect on Site 1	**
Denmark	Lorenzo		(NIC.1)	
Government of Denmark	Yalaguina to Los Manos	November 2002	None	
BID	San Lorenzo to Muhan	October 2002	None	
OPEP	Tipitapa to Las Flores		None	
Government of Spain	Managua to Masaya to Granada	May 2003	None	
BCIE	Chinandega to Guasaule	Short -term	None	
European Union	Guayacan to Jintoega	Short-term	Major effect on sites 29,30,32,33 and 27 (NIC.3)	***
Government of Spain	Granada to Tecolostote	Medium-term	None	
Government of Spain	La Paz Centro to Villa 15 de Julio	Medium-term	Minor effect on Sites 54 and 55 (NIC.26)	*
Government of Spain	Managua to Las Nubes	Medium-term	None	
BCIE	Santa Clara to El Jicaro	Medium-term	None	
Government of Japan	Bridges at Las Banderas	Medium-term	Very minor effect on Site 1(NIC.1)	*
Government of Taiwan	Corinto to Chinandega	Medium-term	None	
Government of Taiwan	Chinandega to Potosi	Medium-term	None	
Government of Spain	Las Flores to Nandaime	Long-term	None	
Government of Venezuela	Rio Blanco to Siuna	Long-term	None	
Government of Kuwait	Siuna to Puerto Cabezas	Long-term	None	
Government of Taiwan	Acoyapa to San Carlos	Long-term	None	

Table 20.2.3 Road Improvement Schemes

Source : Ministry of Transport and Infrastructure, Development Plan for the Road Network, 2002-2006

		Cost (US4)	24)	Boardfro(\$11CM)	¢HCHA					100 A	
Site No.	D No		T-1-1 Die		+0.011/	Benefits - Cost	Net Present Value	ġ		Average	88
5 1 2	jan 1	Total Cost (US\$)	counted Cost	Total Benefits	counted Benefits	(\$U\$)	(\$U\$)	CITH	2 0	EIRR	B/C
-	N001A290	959,018	616,618	6,747,338	3,276,470	5,788,319	2.659.851	4%	5.31		
8	N001A280	16,535	14,190	516,136	454,254	499,601	440,064	44%	32.01		
ო	Junquillaf	120,235	77,307	2,189,560	1,091,941	2,069,325	1,014,634	12%	14.12		
4	San Nicolas	71,569	46,016	1,141,730	584,712	1,070,161	538,695	12%	12.71		
S	Las Chanillas	541,058	347,883	1,015,448	510,686	474,390	162,803	0.4%	1.47		
G	San Ramon	25,765	16,566	1,015,448	510,686	989,684	494,120	30%	30.83		
~	N001A240	74,431	47,857	1,855,991	937,770	1,781,559	889,914	19%	19.60		
80	N001B230	17,176	11,044	472,346	241,134	455,169	230,091	24%	21.83		
F	N001B170	2,629,033	2,256,222	2,670,153	2,401,084	41,120	144,861	0.3%	1.06		
42	N001B150	44,644	38,313	823,606	730,977	778,962	692,664	24%	19.08		
13	N001B120	1,345,933	1,155,072	1,589,184	1,394,328	243,252	239,256	0.5%	1.21		
18	Rio Inati	2,370,350	1,524,059	857,206	420,114	-1,513,143	-1,103,945	%0	0.28		
19	Rio Tapacali	807,293	519,064	454,892	223,324	-352,401	-295,740	%0	0.43	13.1%	12.3
24	N003B400	66,139	56,760	2,022,393	1,809,886	1,956,254	1.753,125	41%	31.89		
25	N003B370	289,359	248,326	1,023,196	910,609	733,837	662,283	4%	3.67		
56	El Guayacan	2,280,149	1,956,812	10,398,159	9,353,209	8,118,010	7,396,397	5%	4.78		
27	N003B320	395,182	339,143	531,581	468,155	136,400	129.012	69%	1.38		
29	N003C230	542,341	465,435	662,039	580,433	119,698	114,999	0.5%	1.25		
8	N003E170	512,579	439,892	785,681	696,845	273,102	256,952	1.0%	1.58		
32	N003C150	1,517,894	1,302,649	1,547,361	1,382,357	29,467	79,708	0.3%	1.06		
33	N003C140	1,238,456	1,062,837	1,276,078	1,138,202	37,621	75,365	0.3%	1.07	15.1%	5.8
35	N005A010	643,204	551,994	1,051,918	936,458	408,714	384,464	1.1%	1.70	1.1%	17
44	N026A060	522,500	448,406	734,632	650,901	212,132	202,494	0.8%	1.45		
45	La Banderita	51,258	43,989	188,552	161,995	137,294	118,006	4%	3.68		•
49	N026B140	1,494,746	1,282,783	2,132,684	1,909,148	637,938	626,365	%6.0	1.49		
20	N026A150	347,231	297,992	475,861	418,007	128,630	120,015	0.7%	1.40		-
51	N026A160	37,216	23,928	1,528,606	774,707	1,491,390	750,778	33%	32.38		
25	San Juan de Dios	14,314	9,203	466,350	236,538	452,036	227,335	26%	25.70		
54	Papalon	146,000	93,873	4,004,273	2,057,405	3,858,273	1,963,531	21%	21.92		
55	Solis	188,941	121,483	2,008,137	1,031,535	1,819,196	910,052	<u>%∠</u>	8.49	11.7%	12.1
		19,310,546	15,415,719	52,186,537	37,293,870	32,875,991	21,878,151			12.8%	10.2
Sou	Source : Cost/Benefit Spreadsheets	preadsheets									

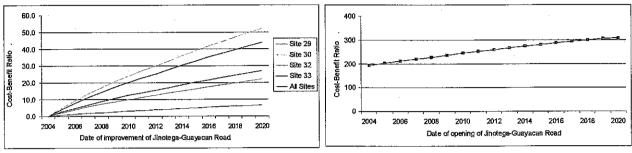
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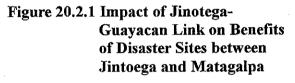
Table 20.2.4 Result of Economic Evaluation

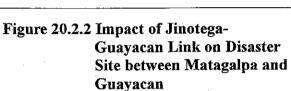
THE STUDY ON VULNERABILITY REDUCTION FOR MAJOR ROADS IN THE REPUBLIC OF NICARAGUA

ORIENTAL CONSULTANTS CO., LTD. in association with JAPAN ENGINEERING CONSULTANTS CO., LTD. The benefit/cost ratio for all four schemes (Sites 29, 30, 32, and 33) taken together is relatively low and;

- Benefits of any disaster prevention works become insignificant as soon as the Jinotega-Guayacan link is improved; and
- Disaster prevention measures should not implemented if the Jinotega-Guayacan link is improved before 2006.







Source : Cost/Benefit Spreadsheet

The benefit to cost ratio of site 27 (shown in Figure 20.2.2) is much less sensitive to the improvement of the Jinotega-Guayacan link. This is because if the link between Matagalpa and Guayacan were closed through natural disaster, then traffic is much less dependent on the road between Jinotega and Guayacan as an alternative route.

From Table 20.2.4, there are five sites which provide 80% of the total EIRR, costing around 3% of the total cost. These high priority sites are listed in Table 20.2.54.

Site No	Site ID	Potential Disaster	Cost of prevention measures (\$)
27	N003B320	Rock Collapse	294,912
2	N001A280	Rock Fall	12,339
24	N003B400	Rock Collapse	49,358
51	N026A160	Rock Collapse	16,041
6	San Ramon	Bridge Scouring	11,105
Total			383,755

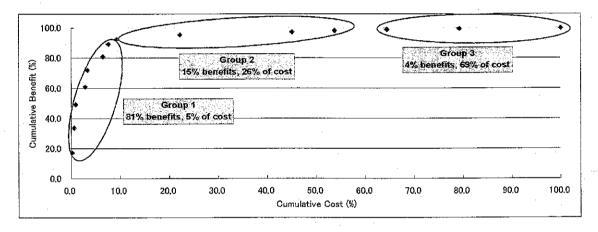
Table	20.2.5	High	Priority	Sites	(EIRR)	for	Disaster	Prevention	Measures
Labiv		111211					TAPERSTOL	T T C T C TA CA CA CA	TITOTOTIC

20.3 Budget Priorities

The analysis of a potential budget for disaster prevention measures has been carried out in two stages;

- i) The creation of prioritised packages of work that maximise benefits, whilst minimising cost;
- ii) Linking the funding packages to potential funding sources.

Table 20.3.1 and Table 20.3.2 list the schemes by ranked according to EIRR and to benefit to cost ratio. In this table the cumulative costs and benefits are listed. This data is also shown in Figure 20.3.1. The schemes can be seen to fall into three distinct groups, which indicate the priorities for investment.



Source : Table 20.2.4

Figure 20.3.1 Scattergram of Ranked Schemes by Link

The groups of EIRR are : **Priority Group 1** : Contains 12 sites. These provide 81% of the total benefits for 5% of the total cost; **Priority Group 2** : Contains 7 sites . These provide 15% of the benefits for 26% of the total cost; and **Priority Group 3** : Contains 11 sites. These provide 4% of the benefits for 69% of the total cost.

These groups therefore provide the basis for prioritising investment, and creating work packages. The schemes in each group are set in Table 20.3.3.

Average B/G					Priority	Group 1					23.8			Priority	Group2			4.2	· · · · · · · · · · · · · · · · · · ·	_				Priority	Groups					1.1	10.2
BZG	32.38	32.01	31.89	30.83	25.70	21.83	21.92	19.60	19.08	14,12	12.71	8,49	5.31	4.78	3.67	3.68	1 70	1.58	1.49	1,47	1,45	1.40	1.38	1.25	1.21	1.07	1.06	1.06	0.43	0.28	
EIRR	33%	44%	41%	30%	26%	24%	21%	19%	24%	12%	12%	2%	4%	5%	4%	4%	1.1%	1.0%	0.9%	0.4%	0.8%	0.7%	69%	0.5%	0.5%	0.3%	0.3%	0.3%	0%0	%0	
Net Present Value (\$US)	750,778	440,064	1,753,125	494,120	227,335	230,091	1,963,531	889,914	692,664	1,014,634	538,695	910,052	2,659,851	7,396,397	662.283	118,006	384.464	256,952	626,365	162,803	202,494	120,015	129,012	114,999	239,256	75,365	79,708	144,861	-295,740	-1,103,945	21,878,151
Benefits - Cost (\$US)	1,491,390	499,601	1,956,254	989,684	452,036	455,169	3,858,273	1,781,559	778,962	2,069,325	1,070,161	1,819,196	5,788,319	8,118,010	733,837	137,294	408,714	273,102	637,938	474,390	212,132	128,630	136,400	119,698	243,252	37,621	29,467	41,120	-352,401	-1,513,143	32,875,991
ILISM) Total Dis- counted Benafils	774,707	454,254	1,809,886	510,686	236,538	241,134	2,057,405	937,770	730,977	1,091,941	584,712	1,031,535	3,276,470	9,353,209	910,609	161,995	936,458	696,845	1,909,148	510,686	650,901	418,007	468,155	580,433	1,394,328	1,138,202	1,382,357	2,401,084	223,324	420,114	37,293,870
Benefits(\$USM) Total Benefits doun	1,528,606	516,136	2,022,393	1,015,448	466,350	472,346	4,004,273	1,855,991	823,606	2,189,560	1,141,730	2,008,137	6,747,338	10,398,159	1,023,196	188,552	1,051,918	785,681	2,132,684	1,015,448	734,632	475,861	531,581	662,039	1,589,184	1,276,078	1,547,361	2,670,153	454,892	857,206	52,186,537
Total D ounted 1	23,928	14,190	56,760	16,566	9,203	11,044	93,873	47,857	38,313	77,307	46,016	121,483	616,618	1,956,812	248,326	43,989	551,994	439,892	1,282,783	347,883	448,406	297,992	339,143	465,435	1,155,072	1,062,837	1,302,649	2,256,222	519,064	1,524,059	15,415,719
Cost (US\$) Total Cost (US\$)	37,216	16,535	66,139	25,765	14,314	17,176	146,000	74,431	44,644	120,235	71,569	188,941	959,018	2,280,149	289,359	51,258	643,204	512,579	1,494,746	541,058	522,500	347,231	395,182	542,341	1,345,933	1,238,456	1,517,894	2,629,033	807,293	2,370,350	19,310,546
10 No.	N026A160	N001A280	N003B400	San Ramon	San Juan de Dios	N001B230	Papalon	N001A240	N001B150	Junquillal	San Nicolas	Solis	N001A290	El Guayacan	N003B370	La Banderita	N005A010	N003E170	N026B140	Las Chanillas	N026A060	N026A150	N003B320	N003C230	N001B120	N003C140	N003C150	NU01B170	Hio Tapacali	Hio Inali	-
Site No	51	~	24	9	52	80	54	~	42	e	4	55	-	26	25	45	35	g	49	ں ا	44	2		P	13	38	32		16	8	

Table 20.3.1 Ranked Schemes with B/C

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FINAL REPORT

JICA STUDY TEAM

State (1) D(1) Teal (1) Teal (1) <thteal (1)<="" th=""> <thteal (1)<="" th=""> <tht< th=""><th>Contraction of the local division of the loc</th><th></th><th>(US\$)</th><th>US\$)</th><th>Benefits(\$USM)</th><th>(\$USM)</th><th></th><th></th><th></th><th></th><th>Average</th></tht<></thteal></thteal>	Contraction of the local division of the loc		(US\$)	US\$)	Benefits(\$USM)	(\$USM)					Average
NOORS20 955,126 Statute states Statute states Statute states Statute state Statute state State <t< th=""><th>Site No</th><th>ID No.</th><th>Total Cost (US\$)</th><th>Total Dis-</th><th>Total Benefits</th><th>Total Dis-</th><th>Benefits Cost (\$US)</th><th>Net Present Value (\$US)</th><th>EIR</th><th>L O M</th><th>EIR</th></t<>	Site No	ID No.	Total Cost (US\$)	Total Dis-	Total Benefits	Total Dis-	Benefits Cost (\$US)	Net Present Value (\$US)	EIR	L O M	EIR
NI003B200 155.5 14.100 55.161 55.161 55.01.5 5				COUNTED LOST							
N001A200 1555 1410 56,138 56,703 56,704 4440 32,01 N001B400 57,316 57,80 1,55,866 174,707 1,491,855 4140 32,01 N001B400 57,316 56,700 23,328 1,55,866 174,707 1,491,855 21,92 21,96 23,96 23,96 23,96 23,96 23,96 23,96 23,96 23,96 23,96 23,96 23,96 23,96 23,96 23,96 24,96 23,96 24,96	27	N003B320	395,182	339,143	531,581	468,155	136,400	129,012	69%	1.38	
N00036400 66.136 56.760 2.022.380 1,036,764 7.50,776 7.91 7.30 N00036400 37.16 15.67.60 15.64.60 57.06 19.66.73 24.95 25.70 San Ramon 25.76 15.56.60 1.05.446 57.06 19.66.73 24.96 25.06 San Ramon 25.765 14.344 3.23.23 4.06.350 27.365 24.96 29.06 San Ramon 14.60.0 71.716 3.66.75 24.96 19.96 19.66 No016150 17.416 3.06.73 24.96 21.96 <	2	N001A280	16,535	14,190	516,136	454,254	499,601	440,064	44%	32.01	•
Sunzektion 27/216 128.66 1/4,717 1/4,6136 7/4,707 1/4,6136 7/4,707 1/4,6136 7/4,707 2/6 2/6,768 <t< td=""><th>24</th><th>N003B400</th><td>66,139</td><td>56,760</td><td>2,022,393</td><td>1,809,886</td><td>1,956,254</td><td>1,753,125</td><td>41%</td><td>31.89</td><td></td></t<>	24	N003B400	66,139	56,760	2,022,393	1,809,886	1,956,254	1,753,125	41%	31.89	
San Pamoin 55,76b 1,015,44b 510,666 999,644 44,120 20% 2130 San Juan de Dios 11,716 11,044 472,345 243,553 249,62 273,355 249,62 273,355 249,62 273,35 249,62 273,35 249,62 273,35 249,62 273,35 249,62 273,35 249,62 273,35 249,65 249,62 273,35 249,62 273,35 249,62 273,35 249,62 273,45 249,62 273,45 249,62 213,64 14,47 249,62 213,64 14,47 249,62 213,64 14,47 249,62 149,61 14,47 249,62 149,61 14,47 249,62 149,61 14,47 249,62 149,61 14,47 249,62 149,61 14,47 249,62 149,61 14,47 249,62 149,61 14,47 249,62 149,61 14,41 249,62 149,61 14,41 249,62 149,61 14,41 249,62 149,61 149,61 149,61 149,61<	51	N026A160	37,216	23,928	1,528,606	774,707	1,491,390	750,778	33%	32.38	
San Juan de Dics 1314 9.203 468,550 256,558 455,159 227,335 2266 236,5 NODIB50 44,54 38,313 823,36 211,137 778,952 266,5 246,6 286,5 246,5 2	9	San Ramon	25,765	16,566	1,015,448	510,686	989,684	494,120	30%	30.83	
NOOTB3C0 1/1/16 11/044 472,346 241,134 476,109 230,011 24% 2183 Papalon 146,000 33,313 822,600 750,977 776,922 626,84 211,9 24% 2183 Papalon 146,000 33,313 822,600 1,091,425 2,095,150 1,46,163 3688,273 1,46,163 3688,273 2,004,145 1,41,120 <	52	San Juan de Dios	14,314	9,203	466,350	236,538	452,036	227,335	26%	25.70	Priority
NOUTBISO 44.64 98.313 82.00 756.077 776.662 692.664 24% 190. Papalon 74.641 7.65.077 21.65.00 26.77.405 26.527 1.66.00 21.95.61 21.95.71 21.95.75.71 <t< td=""><th>80</th><th>N001B230</th><td>17,176</td><td>11,044</td><td>472,346</td><td>241,134</td><td>455,169</td><td>230,091</td><td>24%</td><td>21.83</td><td>droup -</td></t<>	80	N001B230	17,176	11,044	472,346	241,134	455,169	230,091	24%	21.83	droup -
	12	N001B150	44,644	38,313	823,606	730,977	778,962	692,664	24%	19.08	
N001A240 T441 47,657 1,855,991 997,770 1,781,556 889,914 19% 1960 1960 Jundialie 120,256 46,016 1,141,750 2,685,660 1,014,624 12% 12/1 San Nicolas 71,589 46,016 1,141,750 2,685,600 1,014,624 12% 14/1 San Nicolas 188,941 121,432 2,006,137 1,007,161 538,665 1,793 12/1 Solis 188,941 121,432,32 2,006,137 1,031,555 1,813,166 79,062 77,96 84,9 94,0 47,13 NOOBS70 289,359 248,326 1,031,516 5,786,31 1,016,52 79,6 4,49 1,19 7,0 NOOBS70 593,536 551,616 9,056,61 1,061,91 5,786,32 1,096 7,56 4,74 1,196 7,0 NOOBS70 522,579 248,406 1,061,91 5,866,951 1,56 7,96 7,56 4,74 4,74 4,74 4,76	54	Papalon	146,000	93,873	4,004,273	2,057,405	3,858,273	1,963,531	21%	21.92	
Junquilet 120,235 77,307 2,189,560 1,061,941 2,069,325 1,014,654 12% 14,12 San Nicolds 1,83,41 1,12,130 2,093,537 1,091,161 533,666 1,2% 12,71 San Nicolds 1,83,41 1,21,430 2,006,137 1,031,537 1,091,161 533,697 7% 8,12 Solid 1,83,41 1,21,430 2,006,137 1,031,537 1,091,161 7,396,397 7% 8,13 7% Solid 5,31 1,014,054 1,21,430 5,31 1,014,052 7% 8,13 7% 8,13 7% 8,13 7% 8,13 7% 8,13 7% 8,13 7% 8,13 7% 8,13 7% 8,13 7% 8,13 7% 8,13 7% 8,13 7% 8,13 7% 8,13 7% 8,13 7% 8,13 7% 7% 8,13 7% 7% 7% 8,13 7% 7% 7% 7%	7	N001A240	74,431	47,857	1,855,991	937,770	1,781,559	889,914	19%	19.60	
San Nicolas 71,569 46,016 1,141,700 554,712 1,070,161 558,666 1,266 1271 Solas 2,003 2,88,911 1,141,730 584,712 1,007,161 558,666 1,277 8,49 8,49 Solas 2,80,13 1,036,133 1,031,535 1,035,535 9,10,600 8,118,106 7,366,397 7% 8,49 5,71 Phi N001A2900 2,80,319 6,6,74,338 3,276,470 5,183,19 2,669,651 4% 5,1 Phi 3,67 9% 3,67 9% 3,67 9% 3,67 9% 3,67 9% 3,67 9% 3,67 9% 3,68 4% 5,19 4% 5,19 4% 5,19 4% 5,19 4% 5,19 4% 5,19 4% 5,19 4% 5,19 4% 5,19 4% 5,19 4% 5,19 4% 5,19 4% 5,19 4% 5,16 4% 5,16 4% 5,16	e	Junquillal	120,235	77,307	2,189,560	1,091,941	2,069,325	1,014,634	12%	14.12	
Solis 188,941 121,433 2.008,137 1,031,535 1,813,196 910,032 7% 8,44 FEIduayatan 2.580,149 1,558,12 0,353,209 5,783,70 5,786,337 5% 4,78 3,67 N001A290 2569,330 2,615,194 615,616 6,747,338 3,253,209 5,783,73 5,96,337 5% 4,78 3,67 N001A290 256,936 2,43,328 1,023,196 6,16,616 6,747,338 3,67 6,09 4,68 3,67 6,09 4,68 3,67 6,09 4,68 3,67 6,09 4,68 3,67 6,09 4,68 3,67 6,09 4,68 4,69 3,67 6,09 4,68 4,75	4	San Nicolas	71,569	46,016	1,141,730	584,712	1,070,161	538,695	12%	12.71	30%
El Gueyacen 2,280,149 1,566,812 10,380,158 9,353,209 8,118,010 7,386,397 5% 4,76 5,31 N001A290 956,018 1,66,618 6,747,338 3,276,470 5,788,319 2,669,651 4% 5,367 4% 5,367 N001A290 956,018 6,147,338 3,276,470 6,788,319 2,669,651 4% 5,367 4% 4% 4% 4% 4% 4% 4% 4% 4% 4% 4% 4% 4% 4% 4% 4% 4% 4%	55	Solis	188,941	121,483	2,008,137	1,031,535	1,819,196	910,052	7%	8.49	
N001A290 959.018 616,618 6,747,338 3,276,470 5,788,319 2,659,851 4% 5,31 Pric N005A3070 51,393 10,233,169 101,600 733,837 662,233 4% 5,1 740 3,67 740 3,67 3,67 4% 5,1 9% 3,67 4% 5,1 9% 3,67 662,233 4% 5,1 9% 3,67 4% 3,67 4% 3,67 4% 3,67 4% 3,67 4% 3,67 4% 3,67 4% 3,67 4% 3,67 4% 3,67 4% 3,67 4% 3,67 4% 3,67 4% 3,67 4% 3,67 4% 1,76 1,76 1,76 1,49 1,76 1,49 1,76 1,49 1,76 1,49 1,49 1,49 1,49 1,49 1,49 1,49 1,49 1,49 1,49 1,49 1,49 1,49 1,49 1,49 1,49 1,49 <td< td=""><th>26</th><th>El Guayacan</th><td>2,280,149</td><td>1,956,812</td><td>10,398,159</td><td>9,353,209</td><td>8,118,010</td><td>7,396,397</td><td>5%</td><td>4.78</td><td></td></td<>	26	El Guayacan	2,280,149	1,956,812	10,398,159	9,353,209	8,118,010	7,396,397	5%	4.78	
N003B370 288,326 1,023,196 1,023,196 910,609 733,837 662,283 4% 3.67 4% La Banderita 51,289 543,989 1,85,522 11,6,016 4% 3.67 4% 3.67 N0056710 512,579 439,892 786,581 1,909,148 273,102 256,952 1,1% 1,7% N0056710 512,570 439,406 7,34,532 265,952 1,1% 1,7% 1,7% N0056710 512,570 439,406 7,34,532 2,132,604 1,909,148 273,132 202,494 0,9% 1,49 N02667160 1,484,746 1,282,783 2,132,604 734,532 212,132 202,494 0,9% 1,49 N02667160 1,484,746 1,282,783 2,135,604 1,360,73 212,132 202,494 0,9% 1,45 1,46 N02667160 1,348,406 734,532 213,132 212,132 202,494 0,9% 1,47 1,47 1,47 1,49 1,47 1,46<	-	N001A290	959,018	616,618	6,747,338	3,276,470	5,788,319	2,659,851	4%	5.31	Priority
La Banderita51,25843,988188,552161,965137,294118,0064%3.68N005A010643,204551,9941.051,918986,458408,714384,4641.1%1.6N005B1401,497,718551,9941.051,918986,458273,102256,9550.9%1.46N005B1401,497,7181,282,7832,132,6841,90011,196857,9380.263,3650.9%1.43N005B1401,497,7181,282,7832,132,6841,9001212,132202,4940.8%1.43N026A160542,3412,297,992475,8611,366,933119,698114,9990.5%1.43N0056A1001,345,9331,155,0721,589,1841,384,328119,6981.44,9990.5%1.43N0036230542,3411,155,0721,589,1841,382,3222,391,3252.39,2560.5%1.47N00362301,345,9331,155,0721,589,1841,382,3222,391,3250.4%1.47Las Chanillas1,128,4561,015,4481,382,3222,43,2522,392,2560.5%1.47Las Chanillas1,128,4581,015,4481,382,3222,507,1630.4%1.476roN00311702,629,0332,437,3611,382,3522,392,2660.3%1.061.67N0031501,57192,377,3631,627,3322,677,1631,481.06N0031501,57191,30,6641,547,3611,382,3572,943,2610.3%	25	N003B370	289,359	248,326	1,023,196	910,609	733,837	662,283	4%	3.67	Group2
N005A010 643,204 551,994 1,051,918 936,458 408,714 11,1% 1,7% 17% <t< td=""><th>45</th><th>La Banderita</th><td>51,258</td><td>43,989</td><td>188,552</td><td>161,995</td><td>137,294</td><td>118,006</td><td>4%</td><td>3.68</td><td></td></t<>	45	La Banderita	51,258	43,989	188,552	161,995	137,294	118,006	4%	3.68	
N003E170 512,579 439,892 785,681 686,845 273,102 256,952 1.0% 1.58 N026B140 1,494,746 1,282,783 2,132,684 1,909,148 637,938 625,955 0.9% 1.49 N026B140 1,494,746 1,282,783 2,132,684 1,909,148 637,938 625,365 0.9% 1.49 N026A160 522,500 448,406 734,632 650,901 212,132 202,494 0.8% 1.49 N026A150 347,231 287,992 475,861 418,007 128,630 1.49 0.7% 1.49 N0026130 542,502 1,156,178 1,156,128 1,158,202 1,14 0.7% 1.28 N0026140 1,345,072 1,514,48 1,015,448 1,138,202 37,621 75,963 0.2% 1,07 0.7% 0.4% 1.41 0.7% 0.4% 1.07 0.4% 1.41 0.7% 0.4% 1.41 0.7% 0.4% 1.41 0.7% 0.4% 0.47 <td< td=""><th>35</th><th>N005A010</th><td>643,204</td><td>551,994</td><td>1,051,918</td><td>936,458</td><td>408,714</td><td>384,464</td><td>1.1%</td><td>1.70</td><td></td></td<>	35	N005A010	643,204	551,994	1,051,918	936,458	408,714	384,464	1.1%	1.70	
N026B1401,494,7461,282,7832,132,6841,909,148637,938626,3650.9%1.49N026B140522,500448,406734,632650,901212,132202,4940.8%1.45N026A150522,500448,406734,632475,861418,007128,630120,0150.7%1.40N026A150542,341297,992475,861734,632650,931119,698114,9990.5%1.45N026A150542,6411,155,0721,569,1841,394,328560,433114,9980.5%1.21PricN003C230547,0583,47,5831,015,448510,686474,390162,8030.5%1.47GroN001B1201,284,4561,062,8371,577,60781,138,20237,62179,7080.3%1.07N001B1702,629,4561,302,6491,547,3611,382,357241,08441,120144,8610.3%1.07N001B1702,629,059519,0641,547,3611,382,357224,0137,62179,7080.3%1.06N001B1702,628,059519,0641,547,3611,382,357223,40129,46779,7080.3%1.06N001B1702,6360,5%1,547,3611,382,357223,24437,62137,6210.3%0.0%0.3%N001B1702,577,8030,5%1,547,3611,382,357223,24437,62137,6210.3%0.0%0.3%N00351501,517,8941,577,6031,	30	N003E170	512,579	439,892	785,681	696,845	273,102	256,952	1.0%	1.58	4%
N026A060522,500448,406734,632650,901212,132202,4940.8%1.45N026A150347,231297,992475,861418,007128,630123,0150.7%1.40N026A150347,231297,992465,435662,039580,433119,698114,9990.5%1.26N026A150542,341465,435662,039580,4331,19,698114,9990.5%1.26N003C230541,0581,155,0721,589,1841,384,328243,222239,2560.5%1.47N003C1401,288,4561,062,8371,276,0781,188,20237,62175,3650.3%1.07N003C1401,517,8941,062,8371,276,0781,188,20237,62175,3650.3%1.07N003C1501,517,8941,302,6491,547,3611,382,3572,401,08441,1200.3%1.06N003C1501,517,8941,302,6491,547,3611,382,357235,40129,46779,7080.3%1.06N003C1501,517,8941,547,3611,382,357235,40129,46779,7080.3%1.06N003C1501,517,8941,547,3611,582,357235,40129,46779,7080.3%1.06N003C1501,517,8941,577,8922,567,0532,401,08441,1200.3%1.06N003C1501,517,8941,547,3611,582,357235,4012,626,7400.9%0.49N003C1501,50641,547,361 <td< th=""><th>49</th><th>N026B140</th><th>1,494,746</th><th>1,282,783</th><th>2,132,684</th><th>1,909,148</th><th>637,938</th><th>626,365</th><th>0.9%</th><th>1.49</th><th></th></td<>	49	N026B140	1,494,746	1,282,783	2,132,684	1,909,148	637,938	626,365	0.9%	1.49	
N026A150347,231297,992475,861418,007128,630128,630120,0150.7%1.40N003C230542,341465,435662,039560,433119,698114,9990.5%1.25N003C230542,341465,4351,550,721,569,1841,384,328243,225239,2560.5%1,21PricN003C1201,345,9331,155,0721,569,1841,384,328247,390162,8030.4%1,47GroLas Chanilias541,058347,8831,015,448510,686474,390162,8030.4%1,47GroN003C1401,238,4561,062,8371,276,0781,188,20237,62175,3650.3%1,07GroN003C1501,517,8941,302,6491,547,3611,382,3572,401,08441,120144,8610.3%1,06N003C1501,517,8941,302,6491,547,3611,382,357233,32429,46779,7080.3%1,06N003C1501,517,8941,547,3611,382,357233,32429,46779,7080.3%0.643N003C1501,517,8941,547,3611,382,357233,32429,46779,7080.3%0.66N003C1501,517,8941,577,892235,324235,40121,639,450.9%0.64N003C1501,517,8941,577,9920.57,6060.57,6060.57,6070.9%0.64N003C1501,517,8941,577,9920.76,6730.57,6160.57,6170.9% </th <th>44</th> <th>N026A060</th> <th>522,500</th> <th>448,406</th> <th>734,632</th> <th>650,901</th> <th>212,132</th> <th>202,494</th> <th>0.8%</th> <th>1.45</th> <th></th>	44	N026A060	522,500	448,406	734,632	650,901	212,132	202,494	0.8%	1.45	
N003C230542,341465,435662,039550,433119,698114,9990.5%1.25PricN001B1201,345,9331,155,0721,589,1841,394,328243,222239,2560.5%1,21PricLas Chanilias541,058347,8831,015,448510,686474,390162,8030.4%1,47GroN003C1401,238,4561,062,8371,276,0781,188,20237,62175,3650.3%1,07N003C1401,288,4561,062,8371,276,0781,188,20237,62175,3650.3%1,07N003C1501,517,8941,302,6491,547,3611,382,3572,401,08441,1201,44,8610.3%1,06N003C1501,517,8941,302,6491,547,3611,382,357236,46779,7080.3%1,06N003C1501,517,8941,547,3611,382,357236,4012,957,400.3%1,06N003C1501,517,8941,547,3611,382,357235,401-295,7400.%0.43N003C1501,517,89415,47,506420,114-1,513,143-1,103,9450%0.63N003C1501,530,5461,517,89237,203,875,99121,03,9450%0.63N003C1501,530,5461,516,53737,293,87791,513,143-1,103,9450%0.63N003C1501,547,5461,513,143-1,103,9450%0%0%06N003C1501,54615,616337,203,87737,203,876 <td< th=""><th>20</th><th>N026A150</th><th>347,231</th><th>297,992</th><th>475,861</th><th>418,007</th><th>128,630</th><th>120,015</th><th>0.7%</th><th>1.40</th><th></th></td<>	20	N026A150	347,231	297,992	475,861	418,007	128,630	120,015	0.7%	1.40	
N001B120 1,345,933 1,155,072 1,589,184 1,394,328 243,252 239,256 0.5% 1,21 Pric Las Chanilias 541,058 347,883 1,015,448 510,686 474,390 162,803 0.4% 1,47 Gro N003C140 1,238,456 1,062,837 1,276,078 1,188,202 37,621 75,365 0.3% 1,07 Gro N003C140 1,288,456 1,062,837 1,276,078 1,188,202 37,621 75,365 0.3% 1,07 Gro N003C150 1,517,894 1,302,649 1,547,361 1,382,357 29,467 79,708 0.3% 1,06 N003C150 1,517,894 1,302,649 1,547,361 1,382,357 29,467 79,708 0.3% 1,06 N003C150 807,293 519,064 454,892 223,324 29,5401 -1,517,40 0.3% 0.643 Rio Tapacali 807,293 1,547,506 420,114 -1,513,143 -1,103,945 0% 0.63 0.43 <th>ଝ</th> <th>N003C230</th> <th>542,341</th> <th>465,435</th> <th>662,039</th> <th>580,433</th> <th>119,698</th> <th>114,999</th> <th>0.5%</th> <th>1.25</th> <th></th>	ଝ	N003C230	542,341	465,435	662,039	580,433	119,698	114,999	0.5%	1.25	
Las Chanillas 541,058 347,883 1,015,448 510,686 474,390 162,803 0.4% 1.47 0.4% N003C140 1,238,456 1,062,837 1,276,078 1,138,202 37,621 75,365 0.3% 1.07 0.4 N003C140 1,517,894 1,062,837 1,276,078 1,138,202 37,621 75,365 0.3% 1.07 N003C150 2,629,033 2,256,222 2,670,153 2,401,084 41,120 144,861 0.3% 1.06 N003C150 1,517,894 1,302,649 1,547,361 1,382,357 29,467 79,708 0.3% 1.06 N003C150 1,517,894 1,302,649 1,547,361 1,382,357 29,467 79,708 0.3% 1.06 Rio Tapacali 807,293 519,064 454,892 223,324 29,5401 0.43 1.06 Rio Inali 2,370,350 1,517,692 807,293 0.45,673 0.35,6413 0.36 0.43 Rio Inali 2,370,350 1,546,892	13	N001B120	1,345,933	1,155,072	1,589,184	1,394,328	243,252	239,256	0.5%	1.21	Priority
N003C140 1,238,456 1,062,837 1,276,078 1,138,202 37,621 75,365 0.3% 1.07 N003C150 2,629,033 2,256,222 2,670,153 2,401,084 41,120 144,861 0.3% 1.06 N003C150 1,517,894 1,302,649 1,547,361 1,382,357 29,467 79,708 0.3% 1.06 N003C150 1,517,894 1,302,649 1,547,361 1,382,357 29,467 79,708 0.3% 1.06 Rio Tapacali 807,293 519,064 454,892 223,324 -352,401 -295,740 0% 0.43 Rio Inali 2,370,350 1,513,143 -1,103,945 0% 0.28 Rio Inali 2,370,350 15,415,719 52,186,537 37,293,870 32,875,991 21,03,945 0% 0% 086 0.28	ۍ	Las Chanillas	541,058	347,883	1,015,448	510,686	474,390	162,803	0.4%	1.47	Group3
N001B170 2,629,033 2,256,222 2,670,153 2,401,084 41,120 144,861 0.3%6 1.06 N003C150 1,517,894 1,302,649 1,547,361 1,382,357 29,467 79,708 0.3%6 1.06 N003C150 1,517,894 1,302,649 1,547,361 1,382,357 29,467 79,708 0.3%6 1.06 Rio Tapacali 807,293 519,064 454,892 223,324 -352,401 -295,740 0% 0.43 Rio Inali 2,370,350 1,524,059 857,206 420,114 -1,513,143 -1,103,945 0% 0.28 Rio Inali 2,370,350 15,415,719 52,186,537 37,293,870 32,875,991 21,878,151 0 0 28	ŝ	N003C140	1,238,456	1,062,837	1,276,078	1,138,202	37,621	75,365	0.3%	1.07	
N003C150 1,517,894 1,302,649 1,547,361 1,382,357 29,467 79,708 0.3% 1.06 Rio Tapacali 807,293 519,064 454,892 223,324 -352,401 -295,740 0% 0.43 Rio Tapacali 2,370,350 1,524,059 857,206 420,114 -1,513,143 -1,103,945 0% 0.28 Rio Inali 2,370,350 1,5415,719 52,186,537 37,293,870 32,875,991 21,878,151 0% 0.28	11	N001B170	2,629,033	2,256,222	2,670,153	2,401,084	41,120	144,861	0.3%	1.06	
Rio Tapacali 807,293 519,064 454,892 223,324 -352,401 -295,740 0% 0.43 Rio Inali 2,370,350 1,524,059 857,206 420,114 -1,513,143 -1,103,945 0% 0.28 Rio Inali 2,370,350 15,415,719 52,186,537 37,293,870 32,875,991 21,878,151 0	32	N003C150	1,517,894	1,302,649	1,547,361	1,382,357	29,467	79,708	0.3%	1.06	
Rio Inali 2,370,350 1,524,059 857,206 420,114 -1,513,143 -1,103,945 0% 0.28 19,310,546 15,415,719 52,186,537 37,293,870 32,875,991 21,878,151 1	19	Rio Tapacali	807,293	519,064	454,892	223,324	-352,401	-295,740	%0	0.43	
15,415,719 52,186,537 37,293,870 32,875,991 21,878,151	18	Rio Inali	2,370,350	1,524,059	857,206	420,114	-1,513,143	-1,103,945	%0	0.28	0.4%
			19,310,546	15,415,719	52,186,537	37,293,870	32,875,991	21,878,151			12.8

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Table 20.3.2 Ranked Schemes with EIRR

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

ORIENTAL CONSULTANTS CO.,LTD. in association with JAPAN ENGINEERING CONSULTANTS CO.,LTD.

FINAL REPORT

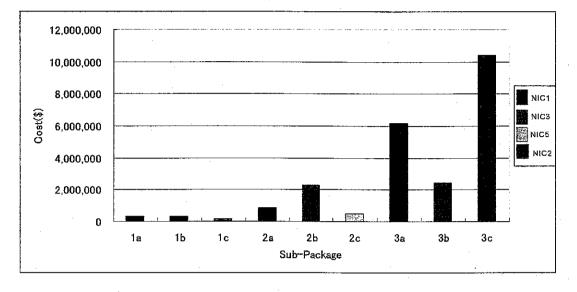
JICA STUDY TEAM

Package No.	Sub Package	Link	Site	Road	Cost (US\$)
		2	N001A280	Nic1	12,339
		3	Junquillal	Nic1	51,825
		4	San Nicolas	Nic1	30,849
	1a	6	San Ramon	Nic1	11,105
4. C. C. C. C. C. C. C. C. C. C. C. C. C.		7	N001A240	Nic1	32,082
		8	N001B230	Nic1	7,404
		12	N001B150	Nic1	33,316
. 1	Cost	· · · · · · · · · · · · · · · · · · ·	· · · · · · · · · · · · · · · · · · ·	1 <u></u>	178,921
		24	N003B400	Nic3	49,358
	1b	27	N003B320	Nic3	294,912
	Cost	· · · · · · · · · · · · · · · · · · ·			344,269
		51	N026A160	Nic26	16,041
	1c -	52	San Juan de Dios	Nic26	
		54	Papalon	Nic26	6,170
	Cost	UT	1 apaton		62,931
Package 1 Cost	0000				85,142
the set to be high state services in (). In Weath of 1991, and the set		a de la companya de la companya de la companya de la companya de la companya de la companya de la companya de l	- Marinary crissions activity of the second second	No. of Concession, State of the State	608,333
Package No.	Sub Package	· Link	Site	Road	Cost (US\$)
	2a Caat	1	N001A290	Nic1	413,370
	Cost	05	100000070		413,370
	2Ъ	25	N003B370	Nic3	215,940
	20	26	El Guayacan	Nic3	1,701,604
2	Cost	30	N003E170	Nic3	382,521
4	2c	35	N0054010	NT: 0	2,300,064
	Cost	30	N005A010	Nic5	480,003
		45	Lo Doudarito	NR-06	480,003
	2d	55	La Banderita Solis	Nic26	38,252
•	Cost	55	50115	Nic26	81,440
Package 2 Cost	0031	<u></u>			119,692
				NO. SALAN AND AND AND AND AND AND AND AND AND A	3,313,129
Package No.	Sub Package	Link	Site	Road	Cost (US\$)
		5	Las Chanillas	Nic1	233,215
	За	11	N001B170	Nic1	1,961,965
	Ja	13	N001B120	Nic1	1,004,427
		<u>18</u> 19	Rio Inali Dia Tananali	Nic1	1,021,702
	Cost	1aI	Rio Tapacali	Nic1	347,971
		29	NIGOSCODO		4,569,280
3	Зb	32	N003C230 N003C150	Nic3	404,732
	<u>.</u>	33	N003C140	Nic3	1,132,757
	Çost	00	110030140	Nic3	924,221
		44	N026A060	Nie ²⁶	2,461,711
	Зс	49	N026B140	Nic26	389,925
	50	50	N026A150	Nic26	1,115,482
	Cost		11020A100	Nic26	259,127
Package 3 Cost					1,764,534
			······		8,795,526
Grand Total					12,716,988
Source : Table 20.2.4					

Table 20.3.3	Priority	Groups o	of Disaster	Prevention	Schemes
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The groups of schemes in Table 20.3.2 were then arranged into work packages. In each work sub-package schemes that are geographically close are grouped. This provides efficiency for the contractor. The work packages are set out in Figure 20.3.2.



Source : Table 20.3.3



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