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REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS

FEASIBILITY STUDY ON THE RESTORATION OF RURAL ROADS

FINAL REPORT

VOLUME I

EXECUTIVE SUMMARY

JANUARY 1992

JAPAN INTERNATIONAL COOPERATION AGENCY

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DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS

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PREFACE

In response to a request from the Government of the Republic of the Philippines, the Government of Japan decided to conduct a study on the Feasibility Study on the Restoration of Rural Roads and entrusted the study to the Japan International Cooperation Agency(JICA).

JICA sent to the Philippines a study team headed by Mr. Kunihiko Sawano, Katahira & Engineers International, twice between October 1990 and November 1991.

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

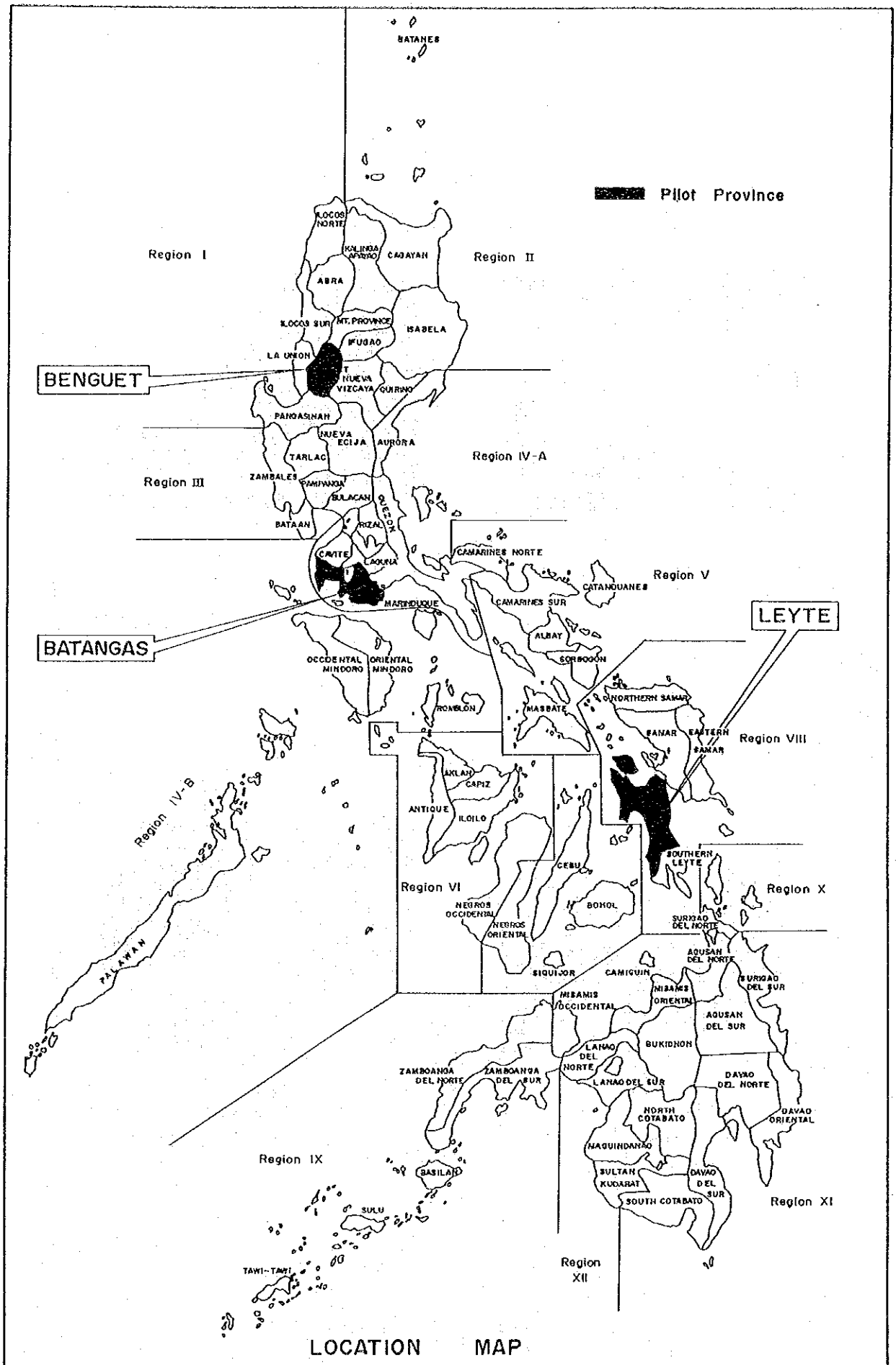
I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the the Republic of the Philippines for their close cooperation extended to the team.

January, 1992

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency



LOCATION MAP

1. Cut Slope Failure (C-F)
   Spot Bt - 43 (Benguet)

2. Embankment Slope Failure (E-F)
   Spot Bt - 20 (Benguet)

3. Rock Fall/Debris Fall (FALL)
   Spot Bs - 12 (Batangas)

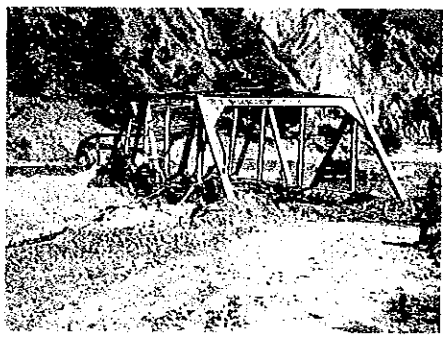
4. Landslide (L-SL)
   Spot L - 50 (Leyte)

TYPICAL DISASTER SPOTS (1)

5. Debris Flow (D - FL)
   Spot Bt - 39 (Benguet)

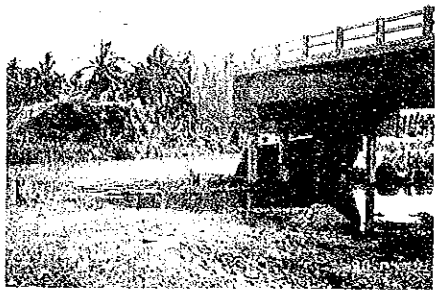
6. Scour/Washout of Roadbed (Rd - D)
   Spot Bs - 45 (Batangas)

7. Flooded/Muddy Road Surface (FM-Rd)
   Spot L - 23 (Leyte)

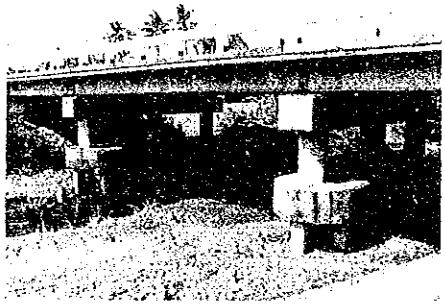


8. Permanent Bridge Washout (PBr-W)
   Spot Bt - 27 (Benguet)

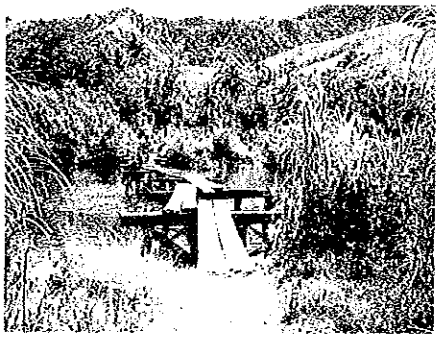
TYPICAL DISASTER SPOTS (2)



9. Permanent Bridge Approach Washout (PBr - A)
   Spot L - 76 (Leyte)



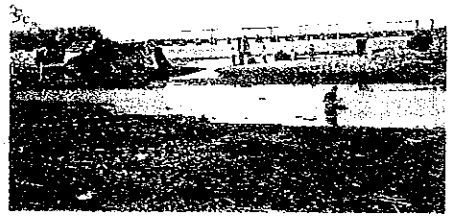
10. Permanent Bridge Other Damage (PBr - D)
    Spot Bs - 6 (Batangas)



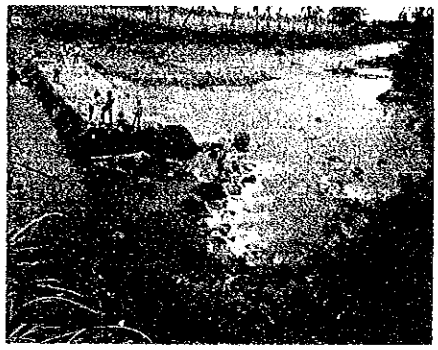
11. Temporary Bridge Washout (TBr - W)
    Spot L - 6 (Leyte)

12. Temporary Bridge Approach Washout (TBr - A)
    Spot L - 38 (Leyte)

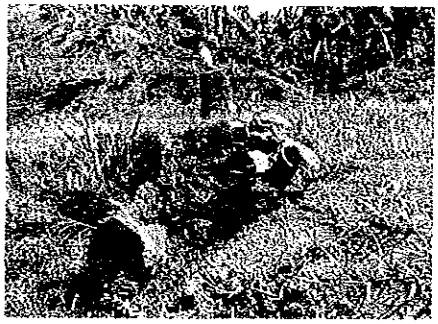
TYPICAL DISASTER SPOTS (3)



13. Temporary Bridge Other Damage (TBr - D)
Spot Bs - 50 (Batangas)



14. Spillway Damage (SPW-D)
Spot L - 90 (Leyte)



15. Culvert Damage (CLV - D)
Spot L - 81 (Leyte)

16. Seawall Damage (SW - D)
Spot Bs - 51 (Batangas)

TYPICAL DISASTER SPOTS (4)

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I INTRODUCTION

I INTRODUCTION

1. BACKGROUND OF THE STUDY

The development of the highway network in the Philippines is one of the major programs being implemented by the Government in support of the overall socio-economic development goals of the country. Road improvement and construction activities began in early 1970's and have been pursued continuously since then, a quantitative expansion of road system being realized. The qualitative improvement of roads is, however, still far from adequate. There is in fact an increase in road disasters such as slope failure, debris flow, landslide, and the like caused by typhoons and heavy rains, resulting in interruption of traffic.

In recognition of the problems attached to these road disasters, the Government of the Republic of the Philippines (hereinafter referred to as "GRP") has conducted the following two (2) studies with technical assistance provided by the Japan International Cooperation Agency (hereinafter referred to as "JICA"), which is the official agency responsible for the implementation of technical cooperation programs set up by the Government of Japan (hereinafter referred to as "GOJ"):

- The Feasibility Study of Philippine Road Disaster Prevention Project, June 1984; and
- The Feasibility Study of Philippine Road Disaster Prevention Project, Stage II, July 1985.

Based on the findings through the studies, disaster prevention projects along major trunk roads are now being implemented.

Moreover, road disasters have occured along rural roads more frequently, where the permanent and full-scale prevention measures are not taken. These disasters have obstructed the linkages from the rural areas resulting in hampering efficient distribution of agricultural and industrial commodities form surplus production areas to deficit areas, as well as efficient movement of people and services among growth centers and between these centers and hinterlands. Thus, restoration of rural roads damaged by disasters is an urgent issue in the highway sector to provide essential transportation facilities and improve agricultural productivities in rural areas.

With this view, GRP through the Department of Public Works and Highways (hereinafter referred to as "DPWH") sought a technical assistance from GOJ for the conduct of the Feasibility Study on the Restoration of Rural Roads (hereinafter referred to as "the Study").

In response to the request of GRP, GOJ decided to conduct the Study. JICA organized a study team to be engaged in the Study. The JICA Study Team, in close collaboration with the DPWH Counterpart Team, commenced work in September 1990 and completed its tasks in January, 1992.

2. OBJECTIVES OF THE STUDY

The objectives of the Study are:

1) To identify disaster spots along rural roads in the pilot provinces and recommend restoration measures;

2) To prepare a program for implementation of the recommended restoration measures;

3) To develop techniques of restoring rural roads damaged by disasters; and

4) To pursue technology transfer to the Philippine counterpart personnel in the course of the Study.

3. SCOPE OF THE STUDY

In order to achieve the objectives mentioned above, the Study was carried out in four (4) stages. The scope of work is as follows:

Stage I: Selection of Pilot Provinces and Identification of Disaster Spots in the Pilot Provinces

Three (3) provinces covering all types of disaster commonly found in the Philippines shall be selected as the pilot provinces.

Disaster spots along rural roads in the pilot provinces shall be identified and about 60 spots shall be selected for feasibility study.

Stage II: Feasibility Study on Typical Disaster Restoration Measures

Feasibility Study shall be carried out for the disaster spots selected under Stage I, including traffic study, engineering surveys, preliminary design, cost estimate and project evaluation.

Stage III: Preparation of Implementation Program for the Selected Disaster Spots

Practical implementation program for restoration of the selected disaster spots shall be prepared based on the preliminary design conducted under Stage II.

Stage IV : Preparation of Rural Road Restoration Manual

Rural Road Restoration Manual shall be prepared based on the findings from the whole study. The manual shall cover procedure for identification of road disaster, design of restoration measure, and construction methods of restoration works.

4. REPORTS

The following reports were prepared during the Study:

Inception Report (October 1990)

Interim Report I (January 1991)

Progress Report (March 1991)

Interim Report II (September 1991)

Draft Final Report (October 1991)

The final report is organized with the following:

Volume I: Executive Summary

Volume II: Main Report

Volume III: Appendix

Volume IV: Drawings

Volume V: Rural Road Restoration Manual

The Study was undertaken jointly by the JICA Study Team and the DPWH Counterpart Team. Technical guidance in the conduct of the Study was provided through periodic review by the DPWH Steering Committee and the JICA Advisory Committee.

II FINDINGS AND RECOMMENDATIONS

II FINDINGS AND RECOMMENDATIONS

1. FINDINGS

1) Classification of Province

According to disaster potential and topography, provinces were classified as follows:

		Disaster Potential		
		L (Low)	M (Medium)	H (High)
Topo-graphy	M (Mountai-nous)			(CAR) Benguet (CAR) Ifugao (CAR) Abra (CAR) Mountain Province (2) Nueva Vizcaya (4) Aurora (5) Catanduanes (CAR) Kalinga-Apayao (2) Quirino
	MF (Mountai-nous and Flat)	(11) Davao del Sur (11) South Cotabato (11) Davao Oriental (11) Davao del Norte (12) Sultan Kudarat (10) Misamis Occidental (9) Zamboanga del Norte (12) Lanao del Sur	(6) Antique (10) Agusan del Norte (10) Misamis Oriental (7) Cebu (10) Bukidnon (7) Negros Oriental (4) Romblon (6) Aklan (10) Agusan del Sur	(3) Zambales (8) Southern Leyte (8) Samar (1) Ilocos Sur (1) Ilocos Norte (4) Rizal (5) Albay (4) Marinduque (4) Oriental Mindoro (2) Cagayan (2) Isabela (8) Northern Samar (8) Eastern Samar (4) Batangas
	F (Flat)	(12) Lanao del Norte (12) North Cotabato (9) Zamboanga del Sur (12) Maguindanao (9) Basilan (9) Tawi-Tawi (9) Sulu	(10) Surigao del Norte (4) Palawan (6) Negros Occidental (7) Bohol (6) Capiz (6) Iloilo (10) Camiguin (7) Siquijor (5) Masbate	(5) Camarines Norte (4) Occ. Mindoro (4) Quezon (5) Camarines Sur (8) Leyte (1) La Union (3) Bulacan (11) Surigao del Sur (4) Laguna (3) Bataan (3) Nueva Ecija (4) Cavite (3) Tarlac (5) Sorsogon (1) Pangasinan (2) Batanes (3) Pampanga

Three (3) provinces: Benguet, Batangas and Leyte were selected as pilot provinces.

2) Classification of Road Disaster

Road disasters were broadly classified into six (6) categories based on the portion of roadway damaged, then further classified into 16 categories by type of damage as follows:

Classification by Portion of Roadway Damaged	Classification by Type of Damage	Abbreviation
I. Slope Damage	1. Cut Slope Failure	C-F
	2. Embankment Slope Failure	E-F
	3. Rock Fall/Debris Fall	FALL
	4. Landslide	L-SL
II. Debris Flow	5. Debris Flow	D-FL
III. Road Damage	6. Scour/Washout of Roadbed	Rd-D
	7. Flooded/Muddy Road Surface	FM-Rd
IV. Bridge Damage	8. Permanent Bridge Washout	PBr-W
	9. Permanent Bridge Approach Washout	PBr-A
	10. Permanent Bridge Other Damage	PBr-D
	11. Temporary Bridge Washout	TBr-W
	12. Temporary Bridge Approach Washout	TBr-A
	13. Temporary Bridge Other Damage	TBr-D
	14. Spillway Damage	SPW-D
V. Culvert Damage	15. Culvert Damage	CLV-D
VI. Seawall Damage	16. Seawall Damage	SW-D

Other damages than listed above, for example, defects in bridge members like crack/spalling of beam/slab/substructure and deterioration of pavement and road accessories, are not covered by this Study.

3) Preliminary Design for the Selected Spots

Major restoration measures applied to the selected 62 disaster spots are as follows:

Type of Disaster	Urgent Measures	Permanent Measures
C-F (Cut Slope Failure)	U1-1: Removal of Deposit Material	P1-1: Recutting P4 : Slope Protection by Vegetation P6-2: Grouted Riprap
E-F (Embankment Slope Failure)	U1-4: Refilling/Embankment U3-1: Sheet Covering, or U3-2: Sand Bag Covering U4-3: Wooden Fence	P1-3: Refilling/Embankment P6-2: Grouted Riprap
FALL (Rock Fall/Debris Fall)	U1-1: Removal of Deposit Material U1-2: Removal of Unstable Material	P1-1: Recutting P6-2: Grouted Riprap, or P8-2: Catch Gabion Wall
L-SL (Landslide)	U1-1: Removal of Deposit Material	P3-2: Horizontal Drain Hole P16-2: Gabion Foot Protection
D-FL (Debris Flow)	U1-1: Removal of Deposit Material	P8-2: Catch Gabion Wall, or P15-1: Concrete Bridge
Rd-D (Scour/Washout of Roadbed)	U1-4: Refilling/Embankment U3-2: Sand Bag Covering	P6-2: Grouted Riprap
FM-Rd (Flooded/Muddy Road Surface)	U2-2: Temporary Side Ditch U7-1: Gravel Surfacing	P2 : Surface Drainage P19-1: Gravel Surfacing
PBr-W/TBr-W (Permanent/Temporary Bridge Washout)	U6-2: H-Pile Bent U6-3: Bailey Bridge	P15-1: Concrete Bridge, or None
PBr-A/TBr-A (Permanent/Temporary Bridge Approach Washout)	U6-3: Bailey Bridge	P6-2: Grouted Riprap P15-1: Concrete Bridge
PBr-D/TBr-D (Permanent/Temporary Bridge Other Damage)	None	P16-1: Concrete Foot Protection
SPW-D (Spillway Damage)	U1-5: Selected Material Fill U4-2: Gabion Wall	P6-6: Supported Type Concrete Wall P19-3: Concrete Pavement
CLV-D (Culvert Damage)	U1-4: Refilling/Embankment U3-1: Sheet Covering U3-2: Sand Bag Covering U4-1: Sand Bag Wall	P2 : Surface Drainage P6-2: Grouted Riprap
SW-D (Seawall Damage)	U4-3: Wooden Fence	U6-4: Gravity Type Stone Masonry, or U6-5: Gravity Type Concrete Wall

4) Project Evaluation

Technical Evaluation

The restoration measures proposed for the selected 62 disaster spots were examined on their technical feasibilities in terms of constructability, stability, durability, maintainability and environmental aspect.

From all technical points of view, the proposed restoration measures were judged to be feasible, with the following comments:

- Gabions, H-piles, bailey panels and seeds for vegetation may not always easily be procured. Proper steps for improving such situation are expected.
- Unconventional type of work such as gabion work and horizontal drain hole must be well understood on their construction requirements.
- Maintenance works especially for drainage system, vegetation and catch work need to be done in proper timing.

Economic Evaluation

The economic evaluation was made for permanent restoration measures against the condition where only urgent restoration measures are taken or do-nothing condition as the case may be, except for temporary bridge washout for which the following two cases were examined:

- Evaluation of bailey bridge construction against do-nothing condition; and
- Evaluation of concrete bridge construction against the condition of being restored by bailey bridge.

The former case is considered as restoration to the original condition, while the latter case as its upgrading.

The results of economic analysis show that implementation of the proposed restoration measures are all economically feasible, except that the feasibility of upgrading scheme of washed-out temporary bridge restoration depends on traffic demand.

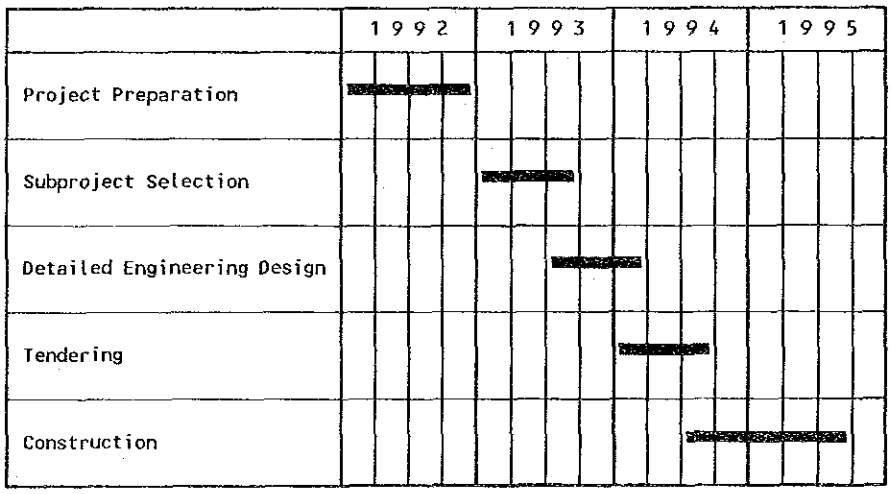
5) Implementation Program for Rural Road Restoration Project

The rural road restoration project is proposed as a foreign-assisted project with the object of restoring the damaged facilities that are left behind without having been covered by maintenance fund/calamity fund.

The project covers restoration of damaged facilities on national secondary roads, provincial roads and barangay roads in the 40 provinces which are ranked high disaster potential in the classification of province shown in 1) above. Road disasters in the following states are eligible to subproject:

- Damage left unrestored, keeping the road section closed to traffic;
- Progressive defect suspected to cause a serious damage in future even though presently no interference to traffic; and
- Damage for which only stopgap measure is taken, needing permanent measure for preventing its recurrence.

Implementation Schedule



Fund Requirement

Construction cost	510.6 million pesos
Cost for consulting services	66.4 million pesos
Total	577.0 million pesos

2. RECOMMENDATIONS

1) In line with the government policy on highway sector giving priority to the rehabilitation and restoration of existing facilities, the rural road restoration project is proposed as a foreign-assisted project.

   Since the project is composed of many small-scale subprojects, introduction of program type of loan is recommended.

2) Gabions, due to their advantages of being flexible, permeable, easily and quickly constructable, and economical, are widely applicable to restoration works as main material for retaining wall, foot protection, catch work, slope breasting, sabo dam, consolidation, spurdike, etc. However, the gabion supplying capacity in the Philippines is presently very low.

   Political measures to promote the spread of gabions are recommend to be taken. Establishment of gabion factories at seven (7) locations is proposed in this Study.

3) Many bridges and/or their approaches have been or will be damaged or destroyed causing traffic interruption.

   For these portions to be opened to traffic urgently, recommended is a stockpile of such bridges as are disintegrated into pieces, transported and assembled at site. Establishment of 13 depots possessed of 10 sets of 19-m span bridge and equipped with a complete set of equipment and tools necessary for construction of the bridge is proposed in this Study.

III SUMMARY

III SUMMARY

1. SELECTION OF PILOT PROVINCES

1.1 PHYSICAL AND SOCIO-ECONOMIC PROFILE OF THE COUNTRY

1) Topography

The Philippines is an archipelago composed of over 7,100 islands and islets with a total land area of approximately 300,000 square kilometers. The Philippines has a variety of topographical features from the low marsh a foot or so above high water at the head of Manila Bay to the high mountain masses, the highest peak being Mt. Apo in Mindanao with an elevation of approximately 2,953 m.

2) Geology

The geologic formation of the Philippines is composed of 30.6% Quaternary Deposit, 12.4% Neogene Deposit, 13.1% Palaeogene Deposit, 10.2% Pre-tertiary Deposit, 6.4% Intrusive Rock, and 27.3% Volcanic Rock.

3) Meteorology

The climate of the Philippines is tropical and maritime, characterized by relatively high temperature, high humidity and abundant rainfall.

Temperature	:	The mean monthly temperature ranges from 25.7C in January to 27.8C in May.
Relative Humidity	:	The mean monthly relative humidity ranges from 78.6% in April to 83.3% in November.
Prevailing Wind	:	The northeast monsoon prevails from October to January. The southwest monsoon from June to September, and the trade winds in the rest of the year.
Rainfall	:	The average annual rainfall is 2,405 mm, ranging from 955 mm in South Cotabato to 5,237 mm in Batanes.

4) Natural Calamities

Volcanoes	:	The Philippine has 220 volcanoes, 22 of which are considered active having erupted during the last 600 years.
Earthquake	:	The Philippines, being situated within the Pan- Pacific Seismic Belt Zone, have experienced 41 destructive earthquakes since 1599.
Tropical Cyclones	:	An average of 22 tropical cyclones form annually in the north-west Pacific Ocean, about 19 of which enter the Philippine Area of Responsibility and about 9 cross the country.

5) Road Network

As of 1987, the public road network system in the Philippines consists of:

National Roads	26,100 km	(16.5%)
Provincial Roads	28,900 km	(18.3%)
City Roads	4,000 km	(2.5%)
Municipal Roads	12,900 km	(8.2%)
Barangay Roads	85,900 km	(54.4%)
T o t a l	157,800 km	(100.0%)

6) Road Disaster

Typhoon damages for 10 years from 1980 to 1989 are as follows:

- Number of typhoons affected — 6 times a year
- Estimated cost of damage

All infrastructure	P1,025 M per annum (1989 price)
Roads/bridges only	P 463 M per annum (1989 price)

1.2 CLASSIFICATION OF PROVINCE

1) Factors used in the Analysis

To classify provinces in view of road disaster, various factors were analyzed and indicators representing respective factors were established as follows:

Factor		Indicator/Base Data	Classification
Road Disaster	Intensity and Frequency of Road Disaster	Damage Rate = D/L D = total amount of road damage by typhoon for 10 years (1980-1989) in 1,000 pesos L = total length of road in Km	
	Type of Road Disaster	Damage amount by disaster category classified into: - Road damage - Bridge damage - Slope damage	A: mostly road damage B: road damage and bridge damage C: remarkably slope damage D: all categories
Physical Factors	Topography	Average slope in %	F: average slope 0 - 21% MF: average slope 21 - 34% M: average slope 34 -
	Geology	Land area by geological category classified into: - Quaternary deposit (Q) - Tertiary deposit (T) - Igneous rock (I)	Q: predominantly Q T: predominantly T I: predominantly I QT: predominantly Q and T QI: predominantly Q and I TI: predominantly T and I
	Meteorology	Meteorological Effect Index (MEI) = Nt + Rm/900 Nt = average number of typhoons per year Rm = maximum monthly rainfall in mm	L: MEI 0 - 0.8 M: MEI 0.8 - 1.6 H: MEI 1.6 -

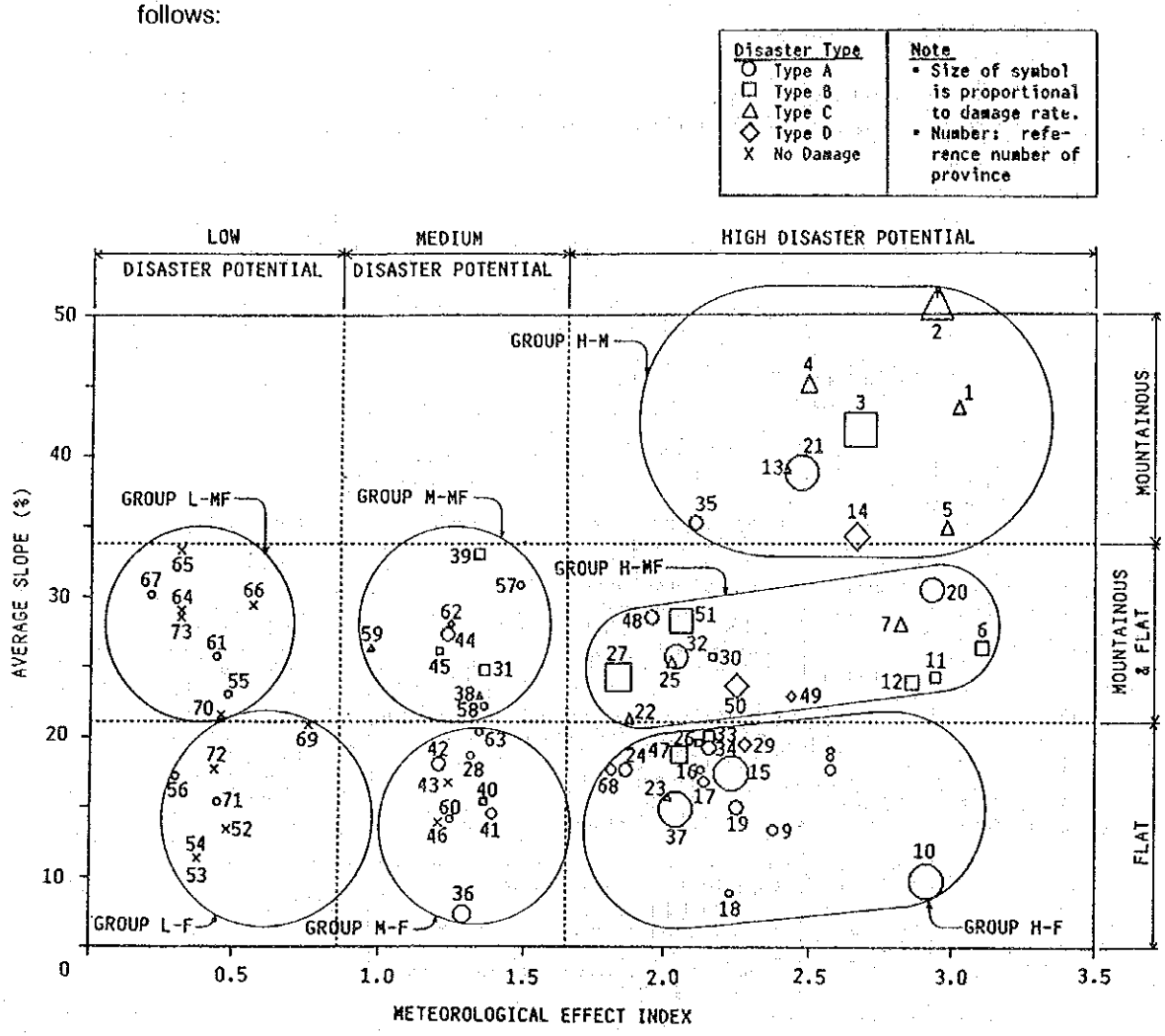
2) Correlation between Factors

- There is no connection between disaster intensity/frequency and disaster type.
- There is no connection between any two physical factors, except that a slight correlation is found between topography and geology.
- Among physical factors, meteorology is the most closely correlated with disaster intensity/frequency, and topography with disaster type.

Accordingly, disaster potential may be assessed mainly based on meteorological factor, while disaster type is mainly related to topography.

3) Classification of Province

According to two factors: meteorology and topography, provinces were classified as follows:



		4 Ifugao 13 Nueva Vizcaya 21 Aurora 35 Catanduanes	2 Benguet 1 Abra 3 Mt. Province 5 Kalinga-Apayao 14 Quirino
65 Davao del Sur 67 South Cotabato 66 Davao Oriental 64 Davao del Norte 73 Sultan Kudarat 61 Misamis Occidental 55 Zamboanga del Nor. 70 Lanao del Sur	39 Antique 57 Agusan del Norte 62 Misamis Oriental 44 Cebu 59 Bukidnon 45 Negros Oriental 31 Romblon 38 Aklan 58 Agusan del Sur	48 Southern Leyte 51 Samar 30 Rizal 32 Albay 25 Marinduque 27 Oriental Mindoro 22 Batangas	20 Zambales 7 Ilocos Sur 6 Ilocos Norte 11 Cagayan 12 Isabela 50 Northern Samar 49 Eastern Samar
69 Lanao del Norte 72 North Cotabato 56 Zamboanga del Sur 71 Maguindanao 52 Basilan 54 Tawi-Tawi 53 Sulu	63 Surigao del Nor. 28 Palawan 42 Negros Occi'l 43 Bohol 40 Capiz 41 Iloilo 60 Camiguin 46 Siquijor 36 Masbate	26 Occidental Mindoro 47 Leyte 16 Bulacan 68 Surigao del Sur 24 Laguna 17 Nueva Ecija 23 Cavite 37 Sorsogon	33 Camarines Norte 29 Quezon 34 Camarines Sur 8 La Union 15 Bataan 19 Tarlac 9 Pangasinan 10 Batanes 18 Pampanga

1.3 SELECTION OF PILOT PROVINCES

1) Selection Criteria

- Select provinces with high disaster potential.
- Cover a variety of topography.
- Distribute widely over the country.
- Include both economically developed and undeveloped provinces.
- Include a province along the Pan-Philippine Highway.
- Select provinces with no or less problem on peace and order.

2) Selection of Pilot Provinces

The following three (3) provinces were selected as pilot provinces.

Province	Benguet	Batangas	Leyte
Region	CAR	IV	VIII
Province Classification	Group H-M	Group H-MF	Group H-F
Disaster Potential	High	High	High
Topography	Mountainous	Mountainous and Flat combined	Flat
Economic Development	Higher than country average	Higher than country average	Lower than country average
Whether located along the Pan-Philippine Highway or not	No	No	Yes

1.4 PROFILE OF PILOT PROVINCES

			Benguet	Batangas	Leyte	Philippines
Physical	Topography		Mountainous	Mountainous and flat combined	Flat	Mountainous and flat combined
	Geology		Predominantly tertiary deposit and igneous rock	Predominantly quaternary deposit and igneous rock	Predominantly quaternary deposit and tertiary deposit	Various
	Meteorology	Annual rainfall	3,563 mm	1,790 mm	2,216 mm	2,405 mm
		Max. Monthly Rainfall	848 mm	324 mm	317 mm	299 mm
		Average No. of Typhoon p.a.	2.0	1.5	1.7	9.0
Demographic	Land Area (km2)		2,655	3,165	6,189	300,000
	Population, 1990 (1,000)		486	1,477	1,487	60,685
	Population density, 1990 (/km2)		183	467	240	202
Economic	Per capita income, 1985	(P)	9,216	5,431	3,456	5,593
	No. of workers by sector, 1980					
	Agriculture	(%)	43	45	68	51
	Industry	(%)	25	22	8	15
	Service	(%)	32	33	23	32
	5 Major Crops		Palay Cabbage Camote White Potato Mustard	Corn Palay Sugarcane Coconut Coffee	Corn Palay Coconut Abaca Camote	Palay Corn Coconut Vegetables Fruits
Social	Incidence of poverty, 1985	(%)	36	52	68	59
	Unemployment rate, 1988	(%)	2.7	11.4	5.5	8.3
	Underemployment rate, 1988	(%)	3.3	19.8	17.3	11.6
Road Network, 1987	Road Length (Km)					
	National Road		467	508	959	26,082
	Provincial Road		321	637	521	28,928
	City Road		142	37	61	3,984
	Municipal Road		36	237	351	12,875
	Barangay Road		791	2,235	1,913	85,941
	T o t a l		1,757	3,654	3,805	157,810
	Pavement Ratio	(%)				
	National Road		49	83	37	46
	Provincial Road		13	40	7	11
	City Road		100	90	56	67
	Municipal Road		3	54	32	26
	Barangay Road		5	7	0	1
	T o t a l		26	27	14	14
	Road Density, L/√PA 1)					
	National Road		0.436	0.243	0.315	0.199
	Other Roads		1.206	1.510	0.935	1.004
	T o t a l		1.642	1.753	1.250	1.203

1) L = length (km), P = population (1,000), A = area (km^2)

2. ROAD DISASTER IN PILOT PROVINCES

2.1 CLASSIFICATION OF ROAD DISASTER

Road disasters were broadly classified into six (6) categories based on the portion of roadway damaged, then further classified into 16 categories by type of damage as follows:

Classification by Portion of Roadway Damaged	Classification by Type of Damage	Abbreviation
I. Slope Damage	1. Cut Slope Failure	C-F
	2. Embankment Slope Failure	E-F
	3. Rock Fall/Debris Fall	FALL
	4. Landslide	L-SL
II. Debris Flow	5. Debris Flow	D-FL
III. Road Damage	6. Scour/Washout of Roadbed	Rd-D
	7. Flooded/Muddy Road Surface	FM-Rd
IV. Bridge Damage	8. Permanent Bridge Washout	PBr-W
	9. Permanent Bridge Approach Washout	PBr-A
	10. Permanent Bridge Other Damage	PBr-D
	11. Temporary Bridge Washout	TBr-W
	12. Temporary Bridge Approach Washout	TBr-A
	13. Temporary Bridge Other Damage	TBr-D
	14. Spillway Damage	SPW-D
V. Culvert Damage	15. Culvert Damage	CLV-D
VI. Seawall Damage	16. Seawall Damage	SW-D

Other damages than listed above, for example, defects in bridge members like crack/spalling of beam/slab/substructure and deterioration of pavement and road accessories, are not covered by this Study.

2.2 IDENTIFICATION OF DISASTER SPOTS

Disaster spots were identified by field inspection in the following manner:

- Prior to visiting site, information on road disaster prone sections and latest road disasters was obtained from District/City Engineering Offices and Provincial Engineer's Office.

- In addition to those road sections, as many national secondary roads and provincial roads as possible were inspected by the field inspection team within the scheduled survey period.

- As for barangay roads, only road disaster spots suggested by local officials were visited by the team.

Eight (8) kinds of field inspection sheets were prepared depending on the type of disaster, and information on the spots obtained from the field inspection was recorded on the sheets.

A total of 226 disaster spots were identified; 70 spots in Benguet, 66 spots in Batangas and 90 spots in Leyte. Number of spots by type of disaster is shown in Table 2.3-1.

2.3 SELECTION OF DISASTER SPOTS FOR FEASIBILITY STUDY

1) Preliminary Assessment of Disaster Spots

The identified disaster spots were assessed in terms of importance of road, magnitude of damage, and impact on socio- economic activities.

- Importance of Road

Importance of road was assessed in accordance with administrative road classification, namely:

National Road;

Provincial Road; and

Barangay Road.

- Magnitude of Damage

Magnitude of damage was assessed on the following basis:

Class A: Full carriageway is damaged or covered by mass of soils/rocks/debris, making the road section impassable;

Class B: One lane of carriageway is damaged or covered by mass of soils/rocks/debris, allowing one lane to open to traffic; and

Class C: Damage or fallen mass of soils/rocks/debris extends only within shoulder.

- Impact on Socio-economic Activities

  Impact on socio-economic activities was assessed based on the duration of traffic function affected, as follows:

Very High :	The road section is closed for more than seven (7) days and no detour road is available;
High :	The road section is closed for seven (7) days or less, or the road section is closed for more than seven (7) days but a detour road is available;
Medium :	Although the road section is damaged, one lane can be secured for traffic; and
Low :	Two-lane operation can be maintained, though vehicle operating speed may be reduced.

2) Selection Criteria

- At least one (1) spot shall be selected from every type of disaster.
- Spots shall be selected so as to cover different classes of road, different magnitudes of damage and different impacts on socio-economic activities.
- When there are several candidate spots in a certain category, only one (1) spot which is considered typical shall basically be selected.
- Even when there is only one (1) spot in a certain category but it is not judged typical, it may be omitted.

3) Selected Disaster Spots for Feasibility Study

In accordance with selection criteria, a total of 62 spots were selected; 21 spots in Benguet, 18 spots in Batangas and 23 spots in Leyte.

Selected spots by type of disaster are shown in Table 2.3-1. As shown in the table, all types of disaster were covered except "Permanent Bridge Washout". Under the said classification, only one (1) spot was identified in Benguet. The bridge was damaged by the July 1990 earthquake and then washed out by succeeding typhoons. This case was not considered typical. Therefore, the spot was not selected.

Figures 2.3-1, 2.3-2 and 2.3-3 show the selected spots in Benguet, Batangas and Leyte, respectively.

TABLE 2.3-1 NUMBER OF SELECTED SPOTS

Type of Damage		Number of Spots Identified				Number of Selected Spots for F/S			
		Benguet	Batangas	Leyte	Total	Benguet	Batangas	Leyte	Total
I. Slope Damage	1. Cut Slope Failure	34	3	30	67	5	1	6	12
	2. Embankment Slope Failure	11	11	15	37	5	2	2	9
	3. Rock Fall/Debris Fall	3	5	16	24	1	2	2	5
	4. Landslide	1	0	4	5	1	0	2	3
II. Debris Flow	5. Debris Flow	7	0	-	7	4	0	1	5
III. Road Damage	6. Scour/Washout of Roadbed	1	3	0	4	1	1	0	2
	7. Flooded/Muddy Road Surface	0	14	2	16	0	2	2	4
IV. Bridge Damage	8. Permanent Bridge Washout	1	0	0	1	0	0	0	0
	9. Permanent Bridge Approach Washout	1	1	1	3	2	1	1	4
	10. Permanent Bridge Other Damage	2	11	0	13	0	2	0	2
	11. Temporary Bridge Washout	0	0	13	13	0	0	2	2
	12. Temporary Bridge Approach Washout	0	1	3	4	0	1	1	2
	13. Temporary Bridge Other Damage	0	1	1	2	0	1	0	1
	14. Spillway Damage	1	6	4	11	0	1	2	3
V. Culvert Damage	15. Culvert Damage	8	8	1	17	2	2	2	6
VI. Seawall Damage	16. Seawall Damage	0	2	0	2	0	2	0	2
T O T A L		70	66	90	226	21	18	23	62

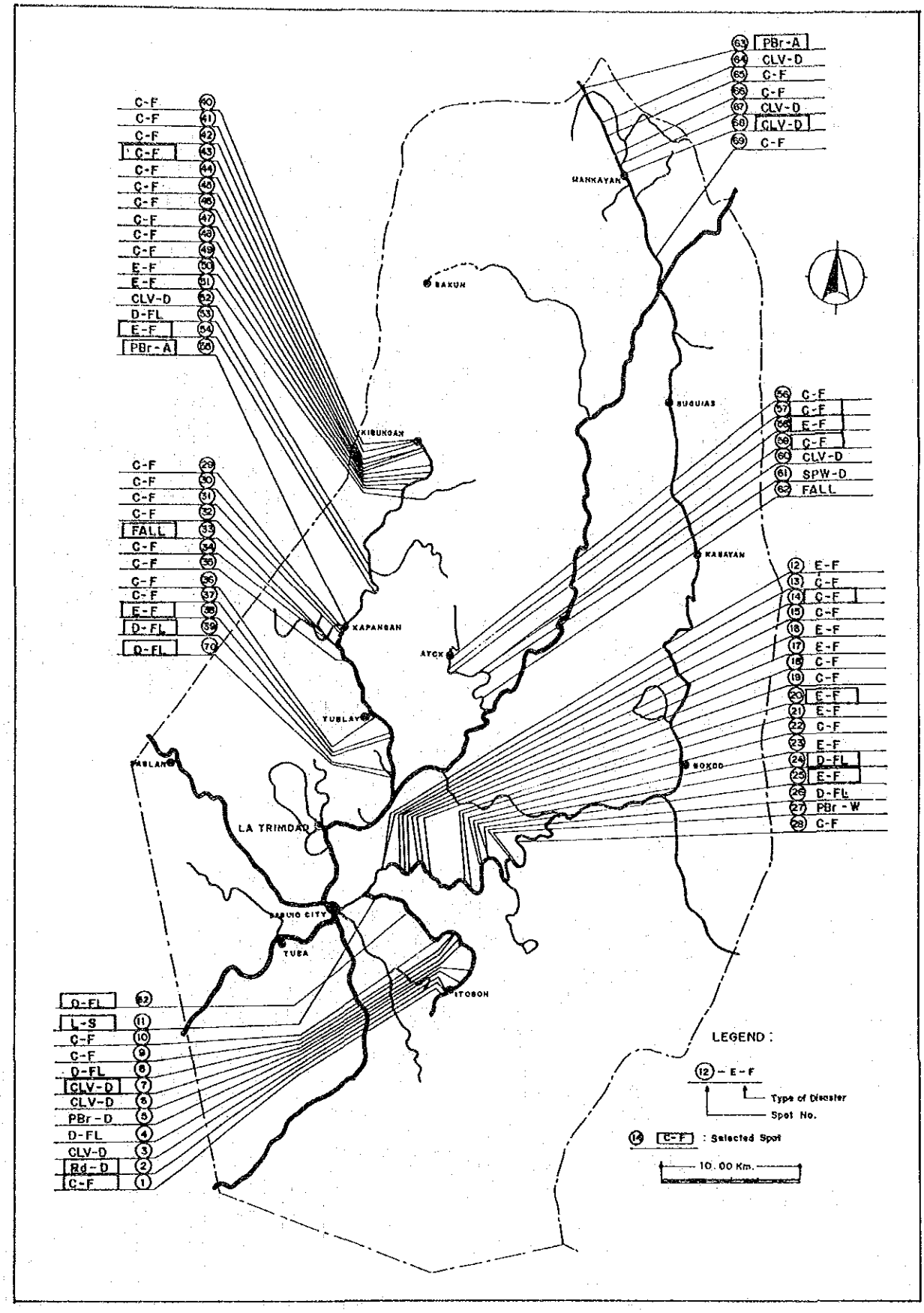


FIGURE 2.3-1 SELECTED SPOT IN BENGUET

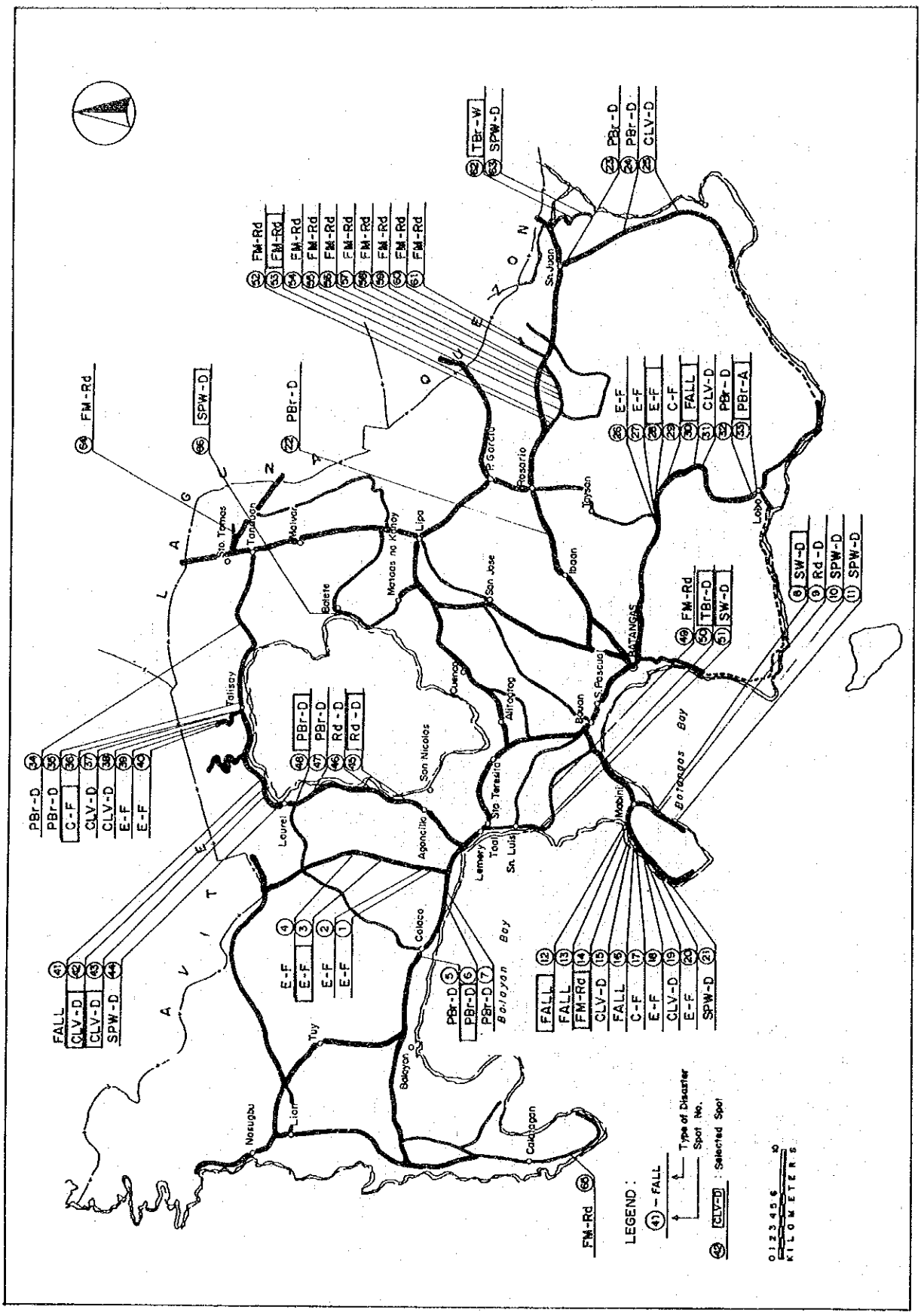


FIGURE 2.3-2 SELECTED SPOT IN BATANGAS

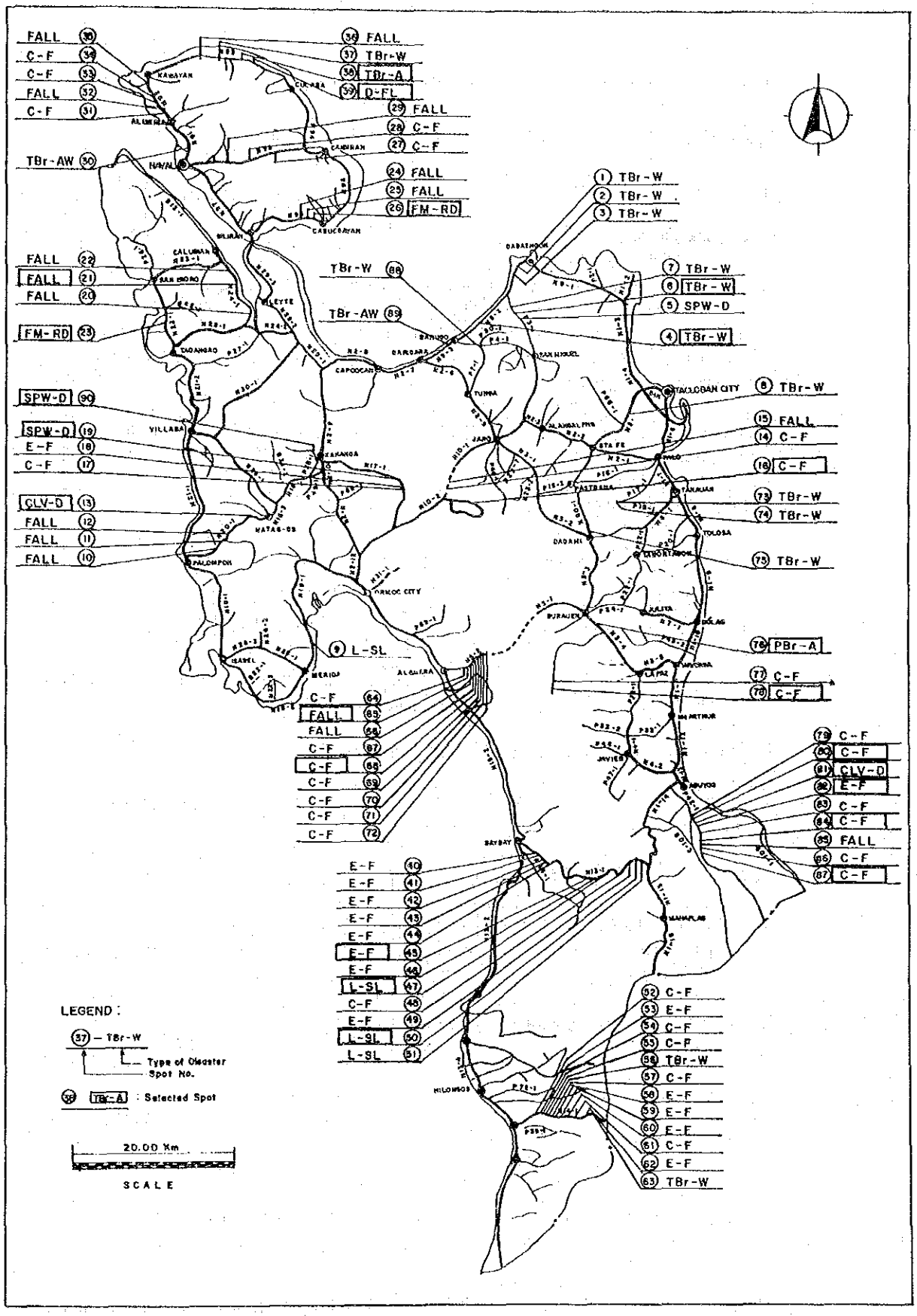


FIGURE 2.3-3 SELECTED SPOT IN LEYTE

3. FEASIBILITY STUDY FOR SELECTED DISASTER SPOTS

3.1 TRAFFIC FORECAST

1) Approach

Road Classification

Rural Roads were functionally classified into the following two categories:

- Major Roads: Inter-provincial or major intra-provincial roads linking municipal towns to the provincial capital or municipal towns each other, which form a skeleton road network of the province.
- Minor Roads: Feeder roads linking barangay centers to major roads or farm areas to barangay centers.

Traffic Forecast for Major Roads

Present traffic was obtained from traffic survey data.

Future traffic was forecasted assuming a traffic growth rate which was determined considering the following factors:

- Population growth: This was estimated basically according to the NEDA Population Projection and adjusting it based on the later census data.
- Others factors such as income growth, production growth, etc:

The effect of these factors on traffic growth was estimated from statistical analysis using the RRNDP[1)] data.

Traffic Forecast for Minor Roads

Present traffic was estimated based on population within the road influence area (RIA), applying the relation between traffic demand and population within RIA which was derived from statistical analysis using the RRNDP[1)] data.

Future traffic was forecasted in the same way as in major roads.

Note:

1) Pilot Study for the Rural Road Network Development Project, 1989 and Feasibility Study on the Rural Road Network Development Project, 1990

2) Traffic on Relevant Roads

1992 traffic on the roads where the selected spots are situated is as follows:

Province	Road	Classification	Disaster Spots	1) 1992 AADT
Benguet	Baguio-Itogon Road	Major	Bt-1,Bt-2,Bt-7,Bt-11,Bt-62	1,042
	Baguio-Bokod Road	Minor	Bt-14,Bt-20,Bt-24,Bt-25	180
	Kapangan-Acop Road	Minor	Bt-33,Bt-38,Bt-39,Bt-70	127
	Kibungan-Kapangan Road	Minor	Bt-43,Bt-54,Bt-55	97
	Atok Provincial Road	Minor	Bt-57,Bt-58,Bt-59	145
	Abatan-Mankayan Road	Major	Bt-63,Bt-68	588
Batangas	Matingain-Tabla Road	Major	Bs-3	508
	Calaca-Sinisian Road	Major	Bs-6	4,128
	Mabini-Saguid Road	Major	Bs-8	988
	Mabini-Solo Road	Major	Bs-12,Bs-14	169
	Batangas-Lobo Road	Major	Bs-28,Bs-30,Bs-33	1,333
	Talisay-Canlubang Road	Major	Bs-36	122
	Laurel-Talisay Road	Major	Bs-42,Bs-43	398
	Tubig-Agoncillo Road	Minor	Bs-45	413
	Bugaan-Tubig Road	Minor	Bs-48	103
	San Luis-Bato Road	Major	Bs-50,Bs-51	428
	Bayabayin Road	Minor	Bs-53	48
	Pinagbayanan Road	Minor	Bs-62	109
	Lipa-Balete Road	Minor	Bs-66	101
Leyte	Barugo-Bagacay Road	Minor	L-4	79
	Babatogon-Sta.Cruz Rd.	Minor	L-6	35
	Palompon-Matagob Road	Major	L-13	204
	Ormoc-Lake Danao Road	Minor	L-16	55
	Kananga-Milagros Road	Minor	L-19	102
	Calubian Road	Major	L-21	164
	San Isidro-Tabango Rd.	Major	L-23	141
	Cabugcayan Road	Major	L-26	229
	Calaba-Kawayan Road	Major	L-38,L-39	132
	Baybay-Liberacio Road	Major	L-45,L-47,L-50	409
	Albuera-Burauen Road	Minor	L-65,L-68	31
	Burauen-Lapaz Road	Major	L-76	107
	Mahagnao Road	Minor	L-78	68
	Abuyog-Nebga Road	Minor	L-80,L-81,L-82,L-84,L-87	99
	Sto. Domingo Road	Minor	L-90	54

1) Annual average daily traffic excluding tricycle and motorcycle.

3.2 ENGINEERING SURVEY

1) Outline of the Engineering Survey

The Engineering Survey contained the following:

- Topographic Survey;
- Geotechnical Survey; and
- Disaster Survey.

Number of spots covered by each survey was as follows:

Province	F/S Spots	Topographic Survey	Geotechnical Survey	Disaster Survey
Benguet	21	9	2	21
Batangas	18	11	2	18
Leyte	23	11	2	23
T o t a l	62	31	6	62

2) Topographic Survey

The topographic survey was conducted at 31 spots by the off-set survey method, including centerline survey, cross-section survey and topographic mapping. For the rest 31 spots, rough plans and cross-sections were prepared by observing the topography and measuring the major length/height/gradient.

3) Geotechnical Survey

The geotechnical survey was conducted at 6 spots to get data for slope stability analysis and to confirm the embedment depth of foundation, including standard penetration test, soil sampling and laboratory tests.

4) Disaster Survey

The disaster survey was conducted for all selected spots, containing the following works:

- Assessment of present condition of the damaged portion and its surrounding area;
- Assessment of potential causes of disaster; and
- Collection of other relevant information.

3.3 CAUSES OF ROAD DISASTER AND CURRENT RESTORATION MEASURES

1) Causes of Road Disaster

Cut Slope Failure (C-F)

The main causes of cut slope failure are erosion of slope surface of soil by surface water; weathering and structural weakness in rocks susceptible to partial falls; scour of slope toe by rain pour; improper configuration of slope in height and gradient subject to rotational slide; and presence of structural weak planes subject to translational slide.

Embankment Slope Failure (E-F)

Erosion of slope surface by surface water; saturation of embankment; scour of slope toe by rain pour, sea water or river flow; and instable configuration of slope are the main causes of embankment slope failure.

Rock Fall/Debris Fall (FALL)

Open cracks developed in hard rock and alternations of different rock layers are the main causes of rock fall, and unsupported pebbles, cobbles and boulders cause debris fall.

Landslide (L-SL)

Landslide is caused by loss of balance between shearing strength and movement force, and often induced by rise of groundwater level due to heavy rain.

Debris Flow (D-FL)

Deposits on stream bed brought from upstream or made by erosion of stream bed or bank are carried downstream by the force of flow generated by supply of a large quantity of water.

Scour/Washout of Roadbed (Rd-D)

Scour by river stream or sea or lake wave action where a road fronts water and erosive action of overflowed water where a road surface is lower than flood level are the main causes of washout of roadbed.

Flooded/Muddy Road Surface (FM-Rd)

Poor drainage of road surface due to elevation of road being lower than abutting area, insufficient capacity of side ditch, deformation of shoulder, etc. cause the road to be flooded or muddy.

Permanent/Temporary Bridge Washout (PBr-W, TBr-W)

Insufficient waterway opening may cause washout of the bridge due to drag force of flow acting on the submerged or partially submerged superstructure or impact imparted by floating debris. In some cases, bridge washout is induced by collapse of substructure due to scour or debris force.

Permanent/Temporary Bridge Approach Washout (PBr-A, TBr-A)

The main causes of erosion of bridge approach are change in alignment of river channel due to meandering of stream and encroachment of the approach on stream.

Permanent/Temporary Bridge Other Damage (PBr-D, TBr-D)

Natural scour or sedimentation due to flood, general scour at contracted section and local scour at obstruction in the flow are the causes of bridge related damages such as exposure of foundation, tilting of pier, decrease in freeboard, etc.

Spillway Damage (SPW-D)

Spillway damages are caused by erosion/scour by hydraulic force, impact force imparted by debris, debris clogging in pipe culvert, etc.

Culvert Damage (CLV-D)

Improper location of culvert, insufficient capacity of culvert, debris clogging, insufficient outlet protection, etc. cause the culvert related damages like erosion of slope.

Seawall Damage (SW-D)

Seawall damages are caused by insufficient strength of seawall against seawave and backwash actions.

2) Current Restoration Measures

Common restoration measures currently being taken are removal of fallen soils/rocks/debris at the occurrence of cut slope failure/rock fall/debris fall/debris flow and stone masonry or grouted riprap for embankment slope protection. Damaged portions are often left unrestored, especially for bridge related disasters.

3.4 TYPE OF RESTORATION MEASURES

Restoration measures are broadly classified into urgent restoration measures and permanent restoration measures.

1) Urgent Restoration Measures

The purposes of urgent restoration are generally as follows:

- To secure urgently and temporarily at least one lane traffic by removing obstacles or by refilling eroded portion;
- To remove materials suspected to endanger traffic like unstable rocks on a slope; and
- To check the progress of damage until permanent measures are taken.

The requirements for urgent restoration measures are as follows:

- To be able to be implemented immediately after occurrence of disaster and completed in a short period;
- To require no special equipment, material and expertise; and
- To be low-cost.

Urgent restoration measures selected in view of the above and included in the Rural Road Restoration Manual (Volume V) are as follows:

U1: Earth Work

- U1-1: Removal of Deposit Materials
- U1-2: Removal of Unstable Materials
- U1-3: Removal of Head
- U1-4: Refilling/Embankment
- U1-5: Selected Material Fill

U2: Surface Drainage

- U2-1: Temporary Slope Ditch
- U2-2: Temporary Side Ditch
- U2-3: Sand Bag Setting

U3: Slope Protection

- U3-1: Sheet Covering
- U3-2: Sand Bag Covering

U4: Retaining Work

- U4-1: Sand Bag Wall
- U4-2: Gabion Wall
- U4-3: Wooden Fence

U5: Foot Protection

- U5-1: Gabion Foot Protection

U6: Bridges

- U6-1: Wooden Pile Bent
- U6-2: H-Pile Bent
- U6-3: Bailey Bridge

U7: Pavement Work

- U7-1: Gravel Surfacing

2) Permanent Restoration Measures

Permanent restoration measures are usually taken after urgent measures for the following purposes:

- To restore the road completely to its original condition or upgrade it when necessary; and
- To prevent the recurrence of disaster.

Major considerations taken in selecting permanent restoration measures are as follows:

- To be technically and practically applicable in the Philippines using available equipment, materials and expertise;
- To introduce new or uncommon techniques in the Philippine as far as practically acceptable; and
- To be harmonized with natural environment.

Permanent restoration measures selected in view of the above and included in the Rural Road Restoration Manual (Volume V) are as follows:

P1: Earthwork

- P1-1: Recutting
- P1-2: Removal of Head
- P1-3: Refilling/Embankment
- P1-4: Counterweight Fill
- P1-5: Selected Material Fill

P2: Surface Drainage

- P2-1: Slope Ditch
- P2-2: Side Ditch
- P2-3: Water Channel
- P2-4: Culvert
- P2-5: Catch Basin

P3: Subsurface Drainage

- P3-1: Subsurface Drainer
- P3-2: Horizontal Drain Hole
- P3-3: Deep Well
- P3-4: Drain Tunnel

P4: Slope Protection by Vegetation

- P4-1: Hand Seeding
- P4-2: Hand Seeding With Mat
- P4-3: Sodding
- P4-4: Strip Sodding
- P4-5: Seed Spraying
- P4-6: Pick Hole Seeding
- P4-7: Seed Packet
- P4-8: Wattling

P5: Slope Protection by Structure

- P5-1: Mortar Spraying
- P5-2: Concrete Spraying
- P5-3: Stone Pitching
- P5-4: Concrete Pitching
- P5-5: Gabion Pitching
- P5-6: Concrete Block Crib
- P5-7: Cast-in-place Concrete Crib
- P5-8: Sprayed Concrete Crib

P6: Retaining Wall

- P6- 1: Riprap
- P6- 2: Grouted Riprap
- P6- 3: Concrete Block Wall
- P6- 4: Gravity Type Stone Masonry Wall
- P6- 5: Gravity Type Concrete Wall
- P6- 6: Supported Type Concrete Wall
- P6- 7: Cantilever Type Concrete Wall
- P6- 8: Buttressed Type Concrete Wall
- P6- 9: Gabion Wall
- P6-10: Sheet Pile Wall

P7: Anchoring

- P7-1: Rock Bolt
- P7-2: PC-Anchor

P8: Catch Work

- P8-1: Catch Fill and Ditch
- P8-2: Catch Gabion Wall
- P8-3: Catch Concrete Wall
- P8-4: Catch Fence
- P8-5: Catch Wire Net

P9: Supporting Work

- P9-1: Concrete Supporting

P10: Rock Shed

- P10-1: Concrete Rock Shed

P11: Prevention Pile

- P11-1: Steel Prevention Pile

P12: Slope Breasting

- P12-1: Stone Breasting
- P12-2: Gabion Breasting

P13: Sabo Dam

- P13-1: Concrete Sabo Dam
- P13-2: Gabion Sabo Dam
- P13-3: Steel Sabo Dam

P14: Consolidation

- P14-1: Concrete Consolidation
- P14-2: Gabion Consolidation

P15: Bridge

- P15-1: Concrete Bridge
- P15-2: Steel Bridge

P16: Foot Protection Including Apron

- P16-1: Concrete Foot Protection
- P16-2: Gabion Foot Protection
- P16-3: Grouted Riprap Apron

P17: Spurdike

- P17-1: Stone Spurdike
- P17-2: Gabion Spurdike

P18: Spillway

- P18-1: Concrete Spillway

P19: Pavement Work

- P19-1: Gravel Surfacing
- P19-2: Bituminous Pavement
- P19-3: Concrete Pavement

P20: Reinforced Earth

- P20-1: Reinforced Earth Wall
- P20-2: Inserting of Reinforcing Bar

3.5 SELECTION OF RESTORATION MEASURES

1) Selection of Urgent Restoration Measures

Since main purposes of urgent restoration are 1) to reopen the road to traffic, 2) to remove materials endangering traffic, and 3) to check the progress of damage, urgent restoration measures should be selected depending on necessity of answering respective purpose. Applicable measures corresponding to the purposes are shown for each type of disaster as follows:

APPLICATION OF URGENT RESTORATION MEASURES

Type of Disaster	Purposes		
	To Open Road to Traffic	To Remove Dangerous Material to Traffic	To Prevent Disaster Expansion
1. Cut Slope Failure (C-F)	U1-1 Removal of Deposit Materials	U1-2 Removal of Unstable Materials	U2 Surface Drainage U3 Slope Protection U4 Retaining Work
2. Embankment Slope Failure (E-F)	U1-4 Refilling/Embankment U4 Retaining Work	-	U2 Surface Drainage U3 Slope Protection
3. Rock Fall/ Debris Fall (FALL)	U1-1 Removal of Deposit Materials	U1-2 Removal of Unstable Materials	U2 Surface Drainage U3 Slope Protection U4 Retaining Work
4. Landslide (L-SL)	U1-1 Removal of Deposit Materials	U1-3 Removal of Head	U2 Surface Drainage U4 Retaining Work
5. Debris Flow (D-FL)	U1-1 Removal of Deposit Materials	-	-
6. Scour/Washout of Roadbed (Rd-D)	U1-4 Refilling/Embankment U4 Retaining Work	-	U2 Surface Drainage
7. Flooded/Muddy Road Surface (FM-Rd)	U1-4 Refilling/Embankment U4 Retaining Work	-	U2 Surface Drainage
8. Permanent Bridge Washout (PBr-W)	U6 Bridge	-	-
9. Permanent Br. Approach Wash-out (PBr-A)	U1-4 Refilling/Embankment U4 Retaining Work	-	U5 Foot Protection
10. Permanent Br. Other Damage (PBr-D)	-	-	U5 Foot Protection
11. Temporary Bridge Washout (TBr-W)	U6 Bridge	-	-
12. Temporary Br. Approach Washout (TBr-A)	U1-4 Refilling/Embankment U4 Retaining Work	-	U5 Foot Protection
13. Temporary Br. Other Damage (TBr-D)	-	-	U5 Foot Protection
14. Spillway Damage (SPW-D)	U1-5 Selected Material Fill U4 Retaining Work		U5 Foot Protection
15. Culvert Damage (CLV-D)	U1-4 Refilling/Embankment U4 Retaining Work		U3 Slope Protection
16. Seawall Damage (SW-D)	U1-4 Refilling/Embankment U4 Retaining Work		U2 Surface Drainage

2) Selection of Permanent Restoration Measures

Factors to be considered in Selection of Permanent Restoration Measures

- Restoration Level

  Permanent restoration measures can be classified into two levels: standard measures which are commonly applied to rural roads with good stability and durability, such as stone masonry and gabion wall; and high class measures which are more stable and durable, such as reinforced concrete structures. Standard measures can be widely applied except in case that there is no proper standard measure, for example, large-scale debris flow and bridge washout. High class measures are applicable to the road with enough traffic demand to justify the economic feasibility. Roughly speaking, the borderline traffic is 100 vehicles per day except for application of permanent bridge instead of bailey bridge as a measure for bridge washout, wherein the borderline traffic is 400 vehicles per day.

- Work Conditions

  Such measures as require special equipment/expertise or materials with difficulty in procurement are not recommended for restoration of rural roads, except for gabions which are presently not so widely used that they may not easily be procured. However, their wide use is recommended because of their aptitude for restoration work.

- Application of New Techniques

  New techniques in the sense of being rarely used in the Philippines are recommended to be positively introduced as far as they are effective, economical and constructable with available equipment and materials.

- Environmental Impact

  Restoration measures well harmonizing with natural environment such as slope protection by vegetation are recommended to be positively introduced. On the other hand, measures or construction methods having negative effect on environment such as pushing down of soil and debris directly to valley side of road should be avoided.

Procedure for Selection of Permanent Restoration Measures

For each type of disaster, procedure for selection of appropriate measures is prepared in the form of flow chart as exemplified in Figure 3.5-1 as for cut slope failure.

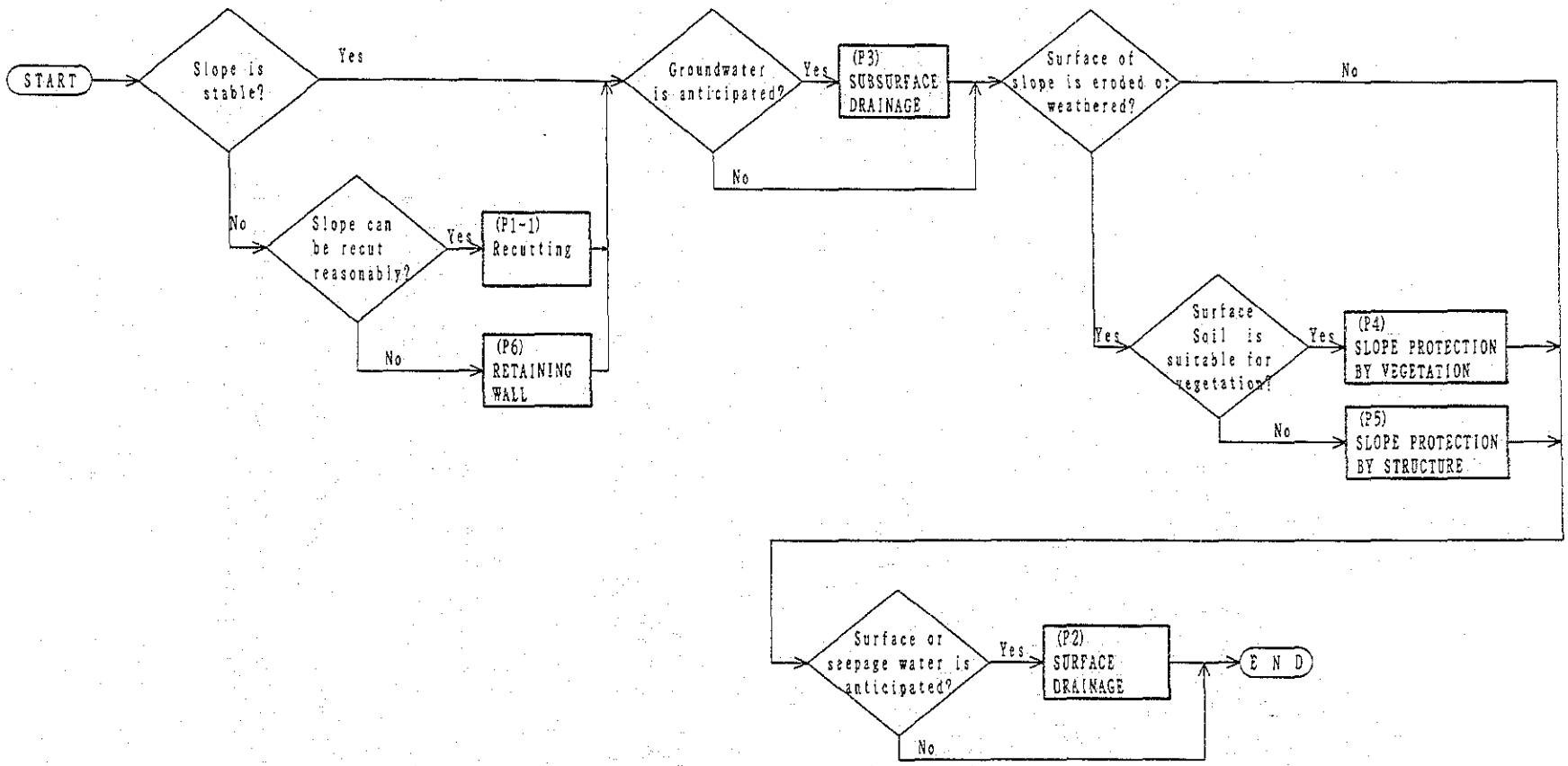


FIGURE 3.5-1 FLOW CHART FOR SELECTION OF RESTORATION MEASURES FOR CUT SLOPE FAILURE (C-F)

3.6 PRELIMINARY DESIGN FOR THE SELECTED SPOTS

1) Procedure

Preliminary design for the selected spots was carried out in the following procedures:

Engineering Survey

Site conditions were surveyed and causes of disaster were assessed by the engineering survey as mentioned in Chapter 3.2.

Selection of Restoration Measures

Restoration measures, both urgent measures and permanent measures, were selected out of various measures presented in Chapter 3.4, in accordance with the selection criteria shown in Chapter 3.5.

Preliminary Design of the Selected Restoration Measures

Restoration measures were designed in accordance with the Rural Road Restoration Manual (Volume V).

Cost Estimate

The construction costs were estimated.

2) Selected Restoration Measures

Selected restoration measures are summarized in Table 3.6-1. Often selected measures by type of disaster are shown in Table 3.6-2.

TABLE 3.6-1 RESTORATION MEASURES APPLIED TO EACH SPOT

		TYPE OF DISASTER	C - F												E - F									FALL					L-SL			D-FL					Rd-D		FM-Rd				PBr-W/ TBr-W			PBr-A/ TBr-A					PBr-D/ TBr-D			SPW-D			CLV - D						SW-D	
	TYPE OF RESTORATION MEASURE	SPOT NUMBER	Bt-1	Bt-14	Bt-43	Bt-57	Bt-59	Bs-36	L-16	L-68	L-78	L-80	L-84	L-87	Bt-20	Bt-25	Bt-38	Bt-54	Bt-58	Bs-3	Bs-28	L-45	L-82	Bt-33	Bs-12	Bs-30	L-21	L-65	Bt-11	L-47	L-50	Bt-24	Bt-39	Bt-62	Bt-70	L-39	Bt-2	Bs-45	Bs-14	Bs-53	L-23	L-26	Bs-62	L-4	L-6	Bt-55	Bt-63	Bs-33	L-38	L-76	Bt-6	Bs-48	Bs-50	Bs-66	L-19	L-90	Bt-7	Bt-68	Bs-42	Bs-43	L-13	L-81	Bs-8	Bs-51
URGENT	U1-1	Removal of Deposit Materials	O	O	O	O	O	O	O	O	O	O	O	O										O	O	O	O	O		O	O	O	O	O	O	O																					O							
	U1-2	Removal of Unstable Materials	O			O				O														O	O	O	O	O						O																														
	U1-4	Refilling /Embankment													O			O		O	O	O																O						O	O				O				O					O		O	O			O
	U1-5	Selected Material Fill																																																				O	O	O								
	U2-2	Temporary Side Ditch																				O	O							O											O																							
	U3-1	Sheet Covering		O												O	O		O																																						O	O			O	O		
	U3-2	Sand Bag Covering													O					O	O	O														O		O											O									O		O	O			
	U4-1	Sand Bag Wall																																								O				O												O	O			O	O	O
	U4-2	Gabion Wall																																																		O	O	O	O								
	U4-3	Wooden Fence													O			O			O	O																																							O		O	O
	U5-1	Gabion Foot Protection																																																O													
	U6-2	H - Pile Bent																																								O	O	O			O																
	U6-3	Bailey Bridge																																								O	O	O		O	O		O														
	U7-1	Gravel Surfacing																										O										O		O			O	O																			
PERMANENT	P1-1	Recutting	O	O	O	O		O		O			O	O										O		O	O	O		O		O				O																											
	P1-3	Refilling / Embankment												O		O	O	O		O	O	O								O					O		O			O		O	O			O							O										O		
	P1-4	Counterweight Fill																											O																																			
	P2-1	Slope Ditch																											O											O																					O			
	P2-2	Side Ditch	O	O	O	O	O	O		O			O	O		O	O					O		O			O	O		O	O	O							O		O	O																						
	P2-3	Water Channel																																					O																							
	P2-4	Culvert																			O																			O	O												O		O		O	O		O			
	P2-5	Catch Basin																										O										O	O	O																	O			O	O		
	P3-2	Horizontal Drain Hole																										O	O	O																																	
	P4-2	Hand Seeding with Mat		O									O	O			O					O																																								O		
	P4-6	Pick Hole Seeding			O					O		O												O						O																																		
	P4-8	Wattling	O			O	O	O			O															O																																						
	P5-3	Stone Pitching		O																																																												
	P6-2	Grouted Riprap	O	O	O	O	O			O			O		O	O	O		O	O	O			O			O	O					O	O				O				O	O			O	O		O	O							O	O	O	O	O	O		
	P6-4	Gravity Type Stone Masonry						O																																																						O	
	P6-5	Gravity Type Concrete Wall																																																													O
	P6-6	Supported Type Concrete Wall												O																								O															O	O	O								
	P6-9	Gabion Wall	O															O			O								O								O		O									O						O				O							
	P6-10	Sheet Pile Wall																																																O												
	P8-2	Catch Gabion Wall							O		O														O	O						O	O	O																														
	P14-2	Gabion Consolidation																																															O													
	P15-1	Concrete Bridge																																O	O							O			O	O	O		O														
	P16-1	Concrete Foot Protection													O																																			O	O											
	P16-2	Gabion Foot Protection																O			O								O	O												O						O			O				O								
	P16-3	Grouted Riprap Apron													O				O	O	O												O	O				O	O																		O	O	O	O	O	O		
	P17-2	Gabion Spurdike																																												O																
	P18-1	Concrete Spillway																													O						O			O															O							
	P19-1	Gravel Surfacing																						O										O	O	O			O			O																					
	P19-2	Bituminous Pavement																										O																																				
	P19-3	Concrete Pavement																																																		O	O	O								

TABLE 3.6-2 RESTORATION MEASURES MAINLY APPLIED

Type of Disaster	Urgent Measures	Permanent Measures
C-F (Cut Slope Failure)	U1-1: Removal of Deposit Material	P1-1: Recutting P4 : Slope Protection by Vegetation P6-2: Grouted Riprap
E-F (Embankment Slope Failure)	U1-4: Refilling/Embankment U3-1: Sheet Covering, or U3-2: Sand Bag Covering U4-3: Wooden Fence	P1-3: Refilling/Embankment P6-2: Grouted Riprap
FALL (Rock Fall/Debris Fall)	U1-1: Removal of Deposit Material U1-2: Removal of Unstable Material	P1-1: Recutting P6-2: Grouted Riprap, or P8-2: Catch Gabion Wall
L-SL (Landslide)	U1-1: Removal of Deposit Material	P3-2: Horizontal Drain Hole P16-2: Gabion Foot Protection
D-FL (Debris Flow)	U1-1: Removal of Deposit Material	P8-2: Catch Gabion Wall, or P15-1: Concrete Bridge
Rd-D (Scour/Washout of Roadbed)	U1-4: Refilling/Embankment U3-2: Sand Bag Covering	P6-2: Grouted Riprap
FM-Rd (Flooded/Muddy Road Surface)	U2-2: Temporary Side Ditch U7-1: Gravel Surfacing	P2 : Surface Drainage P19-1: Gravel Surfacing
PBr-W/TBr-W (Permanent/Temporary Bridge Washout)	U6-2: H-Pile Bent U6-3: Bailey Bridge	P15-1: Concrete Bridge, or None
PBr-A/TBr-A (Permanent/Temporary Bridge Approach Washout)	U6-3: Bailey Bridge	P6-2: Grouted Riprap P15-1: Concrete Bridge
PBr-D/TBr-D (Permanent/Temporary Bridge Other Damage)	N o n e	P16-1: Concrete Foot Protection
SPW-D (Spillway Damage)	U1-5: Selected Material Fill U4-2: Gabion Wall	P6-6: Supported Type Concrete Wall P19-3: Concrete Pavement
CLV-D (Culvert Damage)	U1-4: Refilling/Embankment U3-1: Sheet Covering U3-2: Sand Bag Covering U4-1: Sand Bag Wall	P2 : Surface Drainage P6-2: Grouted Riprap
SW-D (Seawall Damage)	U4-3: Wooden Fence	U6-4: Gravity Type Stone Masonry, or U6-5: Gravity Type Concrete Wall

3.7 PROJECT EVALUATION

1) Technical Evaluation

The restoration measures proposed in Chapter 3.6 were examined on their technical feasibilities in terms of constructability, stability, durability, maintainability and environmental aspect.

From all technical points of view, the proposed restoration measures were judged to be feasible, with the following comments:

- Gabions, H-piles, bailey panels and seeds for vegetation may not always easily be procured. Proper steps for improving such situation are expected.
- Unconventional type of work such as gabion work and horizontal drain hole must be well understood on their construction requirements.
- Maintenance works especially for drainage system, vegetation and catch work need to be done in proper timing.

2) Economic Evaluation

Subject of Evaluation

In the cost-benefit analysis, benefit is generally defined as extra costs which will be needed if a project is not implemented (without case) and will be saved if a project is implemented (with case). The conditions in the without and with cases are assumed according to the kind of work subjected to the evaluation.

Restoration works are broadly divided into urgent measures and permanent measures. The necessity and viability of urgent measures are beyond question because if not, the road would stop its function. The viability of permanent measures were, therefore, examined in this Study by quantifying the cost and benefit accruing from implementation of permanent measures against the condition where only urgent measures are taken, except for the spots where no urgent measures are proposed and the spots where only urgent measures are proposed. In such exceptional cases, the cost-benefit analysis was made against do- nothing condition.

Disaster Occurence Pattern and Definition of Without and With Cases

The conditions in the without and with cases are assumed depending on type, magnitude and frequency of disaster and timing of taking measures, which are classified into five (5) patterns. Assumed timing of taking measures and definitions of without and with cases are presented in Figure 3.7-1.

Quantified Cost

Cost for permanent restoration measures or urgent restoration measures whichever is the subject of evaluation was counted as cost in the cost-benefit analysis.

Quantified Benefit

Benefits are divided into traffic benefit and maintenance benefit.

- Traffic Benefit: The difference in traffic costs between the without and with cases.
- Maintenance Benefit: Costs for repeated urgent measures in disaster occurrence pattern-1 or 3, restoration costs of collapsed road facilities in disaster occurrence pattern-5, and maintenance costs of bailey bridge, which are needed in the without case and savable in the with case

Economic Evaluation

The economic evaluation was made for permanent measures against the condition where only urgent measures are taken or do-nothing condition as the case may be, except for temporary bridge washout at spots Bs-62, L-4 and L-6. For these spots, the following two cases were examined:

- Evaluation of bailey bridge construction against do-nothing condition; and
- Evaluation of concrete bridge construction against the condition of being restored by bailey bridge.

The former case is considered as restoration to the original condition, while the latter case as its upgrading.

The results of economic analysis show that implementation of the proposed restoration measures are all economically feasible, except that the upgrading schemes in spots L-4 and L-6 are unfeasible.

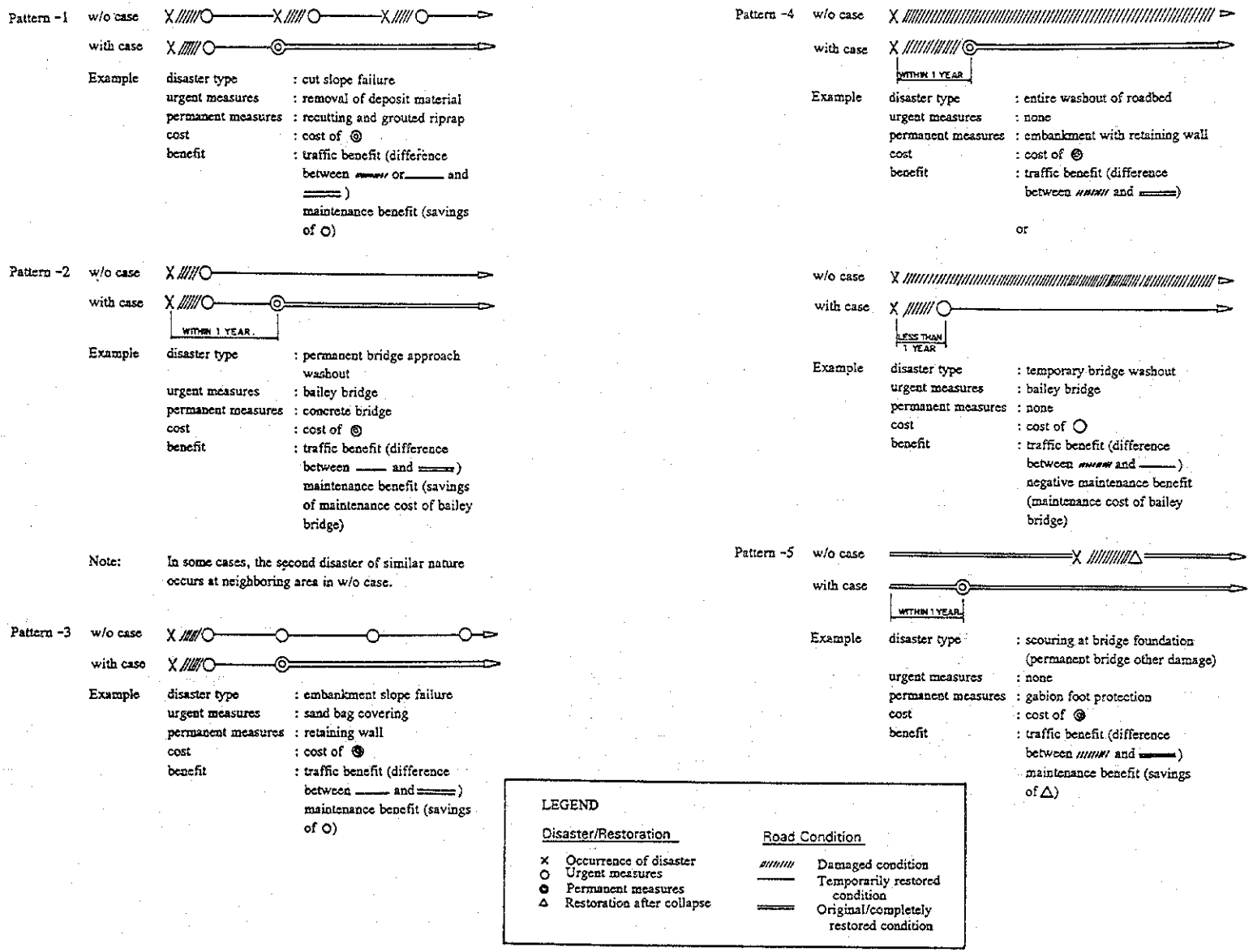


FIGURE 3.7-1 DISASTER OCCURRENCE PATTERN AND ASSUMED TIMING OF TAKING MEASURES

4. PROJECT IMPLEMENTATION

4.1 DISASTER MANAGEMENT SYSTEM

Under direction and control of the National Disaster Coordinating Council (NDCC), all emergency operations are exercised by the all concerned Departments, local government units, as well as non- government organizations and private sectors.

The Department of Public Works and Highways (DPWH) organizes the Disaster Coordinating Body at the Central Office as well as field offices from Regional down to District/City levels. Standard organization of the Disaster Coordinating Body is shown in Figure 4.1-1.

Major tasks of DPWH in the overall context of disaster operation are as follows:

- Restores destroyed public works such as flood control, waterworks, roads, bridges, and other vertical and horizontal facilities/structures;
- Provides heavy and light equipment for rescue and recovery operations;
- Makes available existing communications facilities for disaster operations;
- Assists in providing transportation facilities to transport relief supplies, personnel and disaster victims;
- Provides warning to the public on impending releases of water from dams under its control; and
- Organizes reaction teams in the department proper as well as in all bureaus and offices under it.

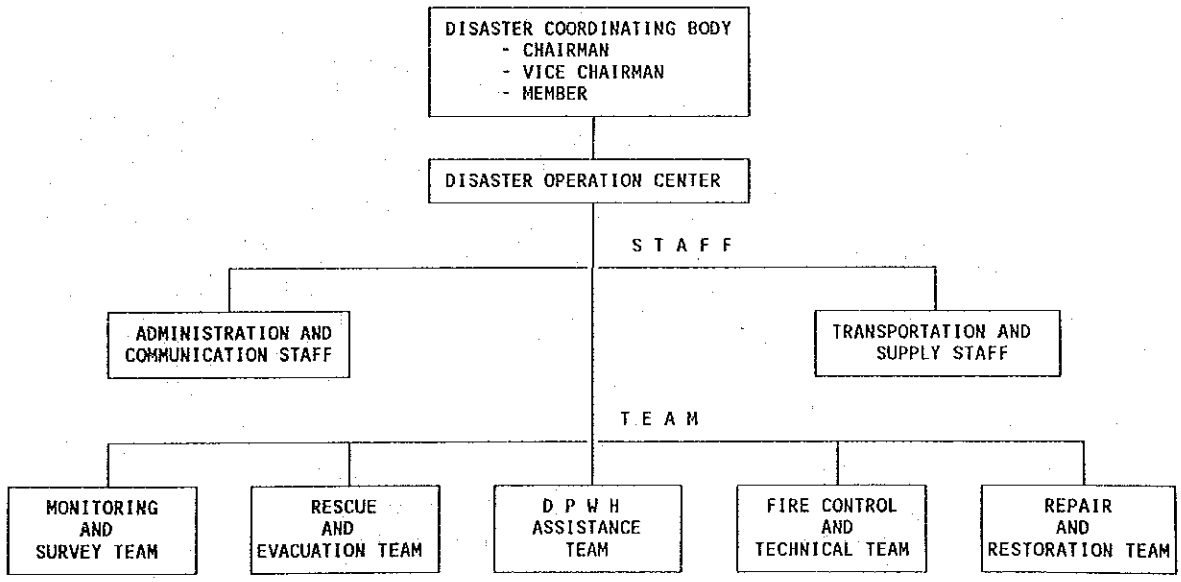


FIGURE 4.1-1 STANDARD DPWH DISASTER COORDINATING BODY

4.2 IMPLEMENTATION PROGRAM FOR RURAL ROAD RESTORATION PROJECT

1) Outline of the Project

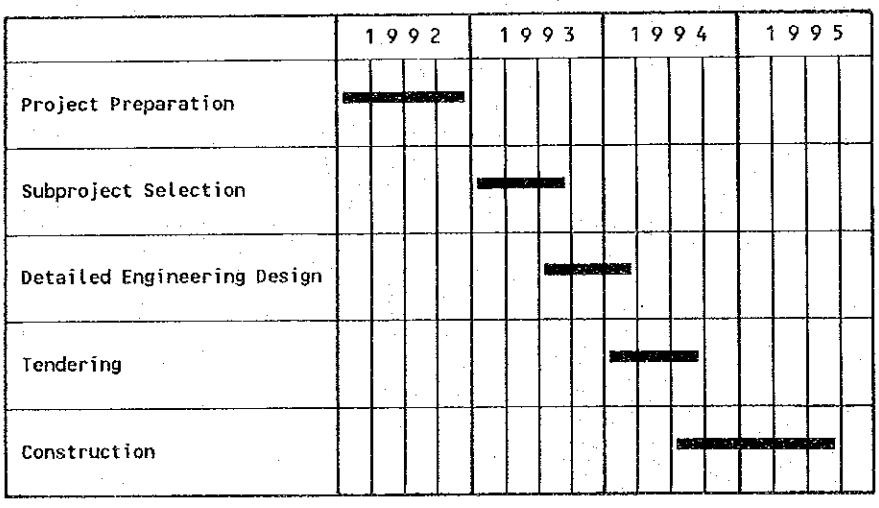
The rural road restoration project is proposed as a foreign- assisted project with the object of restoring the damaged facilities that are left behind without having been covered by maintenance fund/calamity fund.

Since the project is composed of many small-sized subprojects, introduction of program type of loan is recommended. The program type of loan is a form of financing of a group of subprojects in the same nature. The selection, formulation and appraisal of subprojects are generally the responsibility of the executing agency.

The project covers restoration of damaged facilities on national secondary roads, provincial roads and barangay roads in the 40 provinces which are ranked high disaster potential in the classification of province shown in Chapter 1.2. Road disasters in the following states are eligible to subproject:

- Damage left unrestored, keeping the road section closed to traffic;
- Progressive defect suspected to cause a serious damage in future even though presently no interference to traffic; and
- Damage for which only stopgap measure is taken, needing permanent measure for preventing its recurrence.

2) Implementation Schedule



3) Fund Requirement

Construction cost	510.6 million pesos
Cost for consulting services	66.4 million pesos
Total	577.0 million pesos

4.3 RECOMMENDATIONS FOR FACILITATING RESTORATION WORKS

Difficulty in procurement of pertinent materials is one of the problems hindering quick and proper execution of restoration works. To get out of such situation and facilitate restoration works, two projects are proposed:

- Establishment of gabion factories; and
- Stockpile of portable bridges for emergency use.

1) Establishment of gabion factories

Gabions, due to their advantages of being flexible, permeable, easily and quickly constructable, and economical, are widely applicable to restoration works as main material for retaining wall, foot protection, catch work, slope breasting, sabo dam, consolidation, spurdike, etc.

However, the gabion supplying capacity in the Philippines is presently very low. As an initial step to promote the spread of use of gabions and the development of gabion industry, it is proposed that gabion factories are established by the government and operated and maintained under the Regional Offices of DPWH.

Seven (7) factories equipped with one gabion manufacturing machine are proposed to be allocated, one each in CAR; Region I and III; II; IV; V and VIII; VI, VII and IX; and X, XI and XII.

The estimated cost amounts to 16 million pesos per factory and totals to 112 million pesos for all seven (7) factories.

2) Stockpile of Portable Bridges for Emergency Use

Washed-out bridges/approaches were observed at 23 spots in the three (3) pilot provinces as of November 1990. It is estimated that hundreds of bridges are in the same situation in the whole country. These spots are in urgent need of being opened to traffic by constructing a temporary bridge. For this purpose, such bridges as are disintegrated into pieces, transported and assembled at site like bailey bridge are suitable but there is no stockpile of bailey bridge for emergency use. The project for procurement and stockpile of portable bridges for emergency use is proposed to cope with the above situation.

The principles of the project are as follows:

- The bridge components shall be used only for emergency and temporary replacement of bridges damaged by natural calamities.
- Temporary bridges constructed with the bridge components shall be removed immediately after the completion of permanent bridges, since the components are designed only for temporary use, not for permanent use.

- The bridge components shall be properly stored in the designated places (depots) and maintained to be always ready for emergency use.

- The working crew shall be well trained to be skilled in emergency construction of temporary bridges with the bridge components using tools and equipment kept in the depots.

Disposition plan is proposed as follows:

- 10 sets of 19-m span bridge (1 depot) each for CAR and Region I; II; III; IV-A; IV-B; V; VI; VII; IX and XII; X; and XI; and

- 20 sets of 19-m span bridge (2 depots) for Region VIII.

The estimated project cost amounts to 57 million pesos per depot and totals to 741 million pesos for all 13 depots.