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THE STUDY ON SLOPE DISASTER MANAGEMENT FOR FEDERAL ROADS IN MALAYSIA
FINAL REPORT
VOLUME II
MAIN REPORT
MARCH 2002
NIPPON KOEI CO. LTD.
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JAPAN INTERNATIONAL
COOPERATION AGENCY
(JICA)




THE PUBLIC WORKS
DEPARTMENT (JKR)
MALAYSIA

THE STUDY ON SLOPE DISASTER MANAGEMENT FOR FEDERAL ROADS IN MALAYSIA

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マレーシア国道路防災管理調査概要

1. 調査の概要

1. 国名	マレーシア国		
2. 調査名称	マレーシア国道路防災管理調査		
3. 受入機関	公共事業省 公共事業総局(JKR) 道路局		
4. 調査目的	・道路防災管理のガイドライン作成 ・道路斜面防災管理のための情報システム作成 ・技術移転と組織・人材開発の提案		
5. 対象地域	マレーシア半島、ならびに東マレーシアの6つの国道(総延長425km)		
6. 調査の内容	1年次 (フェーズ I)	データ収集(自然、経済、技術分野)	
		国道6路線での現地調査およびケース・スタディ路線の選定	
		防災ガイドラインの基本方針策定 情報管理システムの基本設計	
	2年次 (フェーズ II)	A	東西高速道路での現地調査(斜面点検・地質調査・モニタリング 斜面情報管理システム(SIMS)の開発 ・対策工概略設計)
			人材および組織のレビュー
			斜面管理計画の策定 斜面情報管理システム(SIMS)の適用確認
B		道路斜面管理システム(SIMS)の作成	
		道路防災ガイドラインの作成 組織および人材開発の提案	

2. 実施工程

年・月	2000					2001												
	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
フェーズ・報告書																		
現地調査																		
ケーススタディ(東西高速道路)																		
道路防災ガイドラインの作成																		
斜面情報管理システム(SIMS)開発																		
ファイナルレポートの作成																		

3. 調査の成果

1. ガイドラインの作成	ガイド I: 道路斜面維持防災管理ガイド ガイド II: 斜面点検ガイド ガイド III: 早期警戒および地質調査ガイド ガイド IV: 対策工選定および工費概算ガイド ガイド V: 斜面情報管理システム(SIMS)ガイド
2. 斜面情報管理システム(SIMS)の作成・適用性の確認	斜面危険度評価、経済分析、GIS機能を備えたシステムを作成した。作成した本システムを実際の道路斜面で試験運用し、適用性を確認した。
3. 技術移転・人材開発	道路防災、斜面点検、およびシステム管理を主題とした2回のワークショップ、3回のセミナー、3回の情報システム講習会、カウンターパート受入研修、斜面点検OJTを開催し、カウンターパート側への技術移転を行った。また、マレーシア国の道路防災管理の実施体制について提案を行った。

4. 導入計画(提言)

- 新システムの全国展開計画作成
- JKR本部維持管理部門への斜面防災、および情報管理専門家の導入
- 斜面防災関連担当者の教育訓練制度の新設
- 斜面点検などハード業務の外部委託化の推進

<以上>



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**THE STUDY
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MAIN REPORT**

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**NIPPON KOEI CO., LTD.
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VOLUME II: MAIN REPORT

GUIDELINE

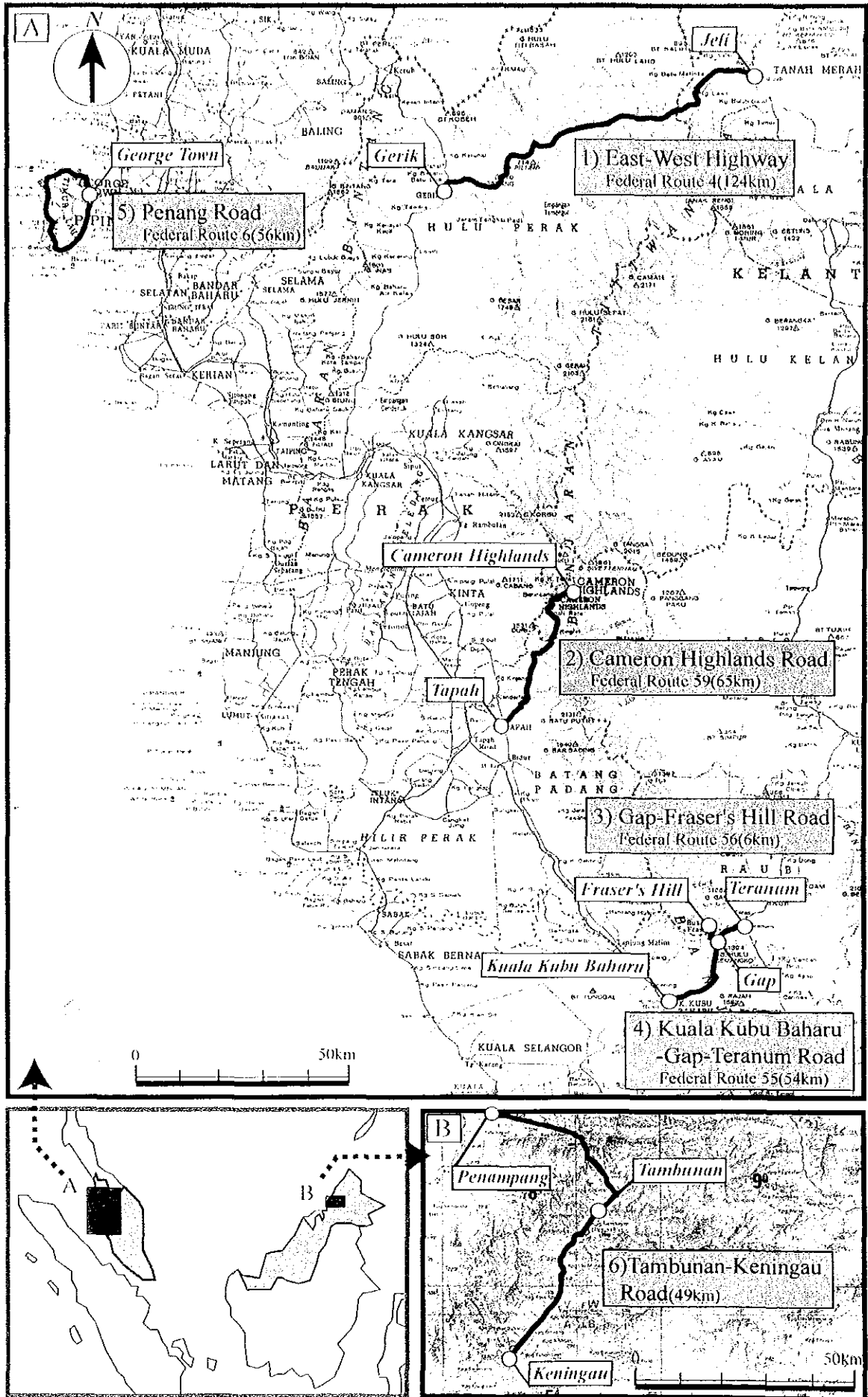
**GUIDE I: Guide to Slope Maintenance and Road
Disaster Management**

GUIDE II: Guide to Slope Inspection

**GUIDE III: Guide to Early Warning and Site
Investigation**

**GUIDE IV: Guide to Countermeasure Selection
and Cost Estimation**

**GUIDE V: Guide to Slope Information
Management System (SIMS)**



Location Map

**THE STUDY
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IN MALAYSIA**

**FINAL REPORT
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Abbreviations

$\text{--}^2, \text{m}^2$	square e.g. square meter(s)	GNP	Gross National Product
AE	Acoustic Emission	GPS	Global Positioning System
Bbl	barrel(s)	GRM	Generalized Reciprocal Method
B/C	Benefit Cost Ratio	gt	gross ton(s)
BEM	Board of Engineering Malaysia	GWh	gigawatt-hour(s)
BH	Borehole	H	Hazard Score
bn or 10⁹	Billion	ha	hectare(s)
C	Consequence	hp	horsepower
C & F	Cost and Freight	hr or h	hour(s)
CH	Chainage	hz	hertz
CIF	Cost, Insurance and Freight	IEM	Institute of Engineering Malaysia
CL	Collapse	in.	inch(es)
CT	Computed Tomography	kA	kilo-ampere
DB	Debris	kg	kilogram
Db	decibel	kl	kiloliter(s)
DF	Debris Flow	km	kilometer(s)
DID	Department of Irrigation and Drainage	kt	knot(s)
DPW	Digital Photogrammetric Workstation	kV	kilovolt
DTM	Digital Terrain Model	kVA	kilovolt-ampere
dw	deadweight	kVAr	reactive kilovolt-ampere
dwt	deadweight tons	kW	kilowatt(s)
EA Experts	Environmental Assessment Expert	kWh	kilowatt-hour(s)
EB	Embankment Failure	l	liter(s)
EIRR	Economic Internal Rate of Return	LS	Landslide
EW Highway	East-West Highway	Lt	long ton
FEM	Finite Element Method	m	meter(s)
FOB	Free on Board	m³/s or cu.m/sec	cubic meter(s) per second
g	gram(s)	M or 10⁶	million
GCPs	Ground Control Points	MAF	million acre-feet(=1,235 MCM)
GIS	Geographical Information System	MARRIS	The Malaysia Road Record Information System
GNI	Gross National Income	MCM	million cubic meter
		mgd	million gallons per day
		min	minute(s)

mg	milligram(s)	RQD	Rock Quality Designation
mm	millimeter(s)	RSO	Rectified Skew Orthomorphic
MMS	Malaysia Meteorological Service	S	Secondary
mt or t	metric ton(s) or tonne(s)	s	seconds
MVA	megavolt-ampere	SIMS	Slope Information Management System
MVA_r	reactive megavolt-ampere	SIRT	Simultaneous Reconstruction Technique
MW	megawatt(s)	SPT	Standard Penetration Test
MWh	megawatt-hour(s)	SPRS	Slope Priority Ranking System
nm	nautical mile(s)	t	ton(s) or tonne(s)
N/mm²	newton per square millimeter(=Pa)	TWIMs	Tropical Weathered in-situ Materials
No.	number(serial number)	UPPJ	Road Maintenance and Management Unit
no(s).	unit(s)	V	volt
NPV	Net Percent Value	VA	volt-ampere
OJT	On the Job Training	VHF radio modem	Very High Frequency radio modem
P	Primary	VW	Vibrating Wire
Pa	pascals	VWP	Vibrating Wire Piezometer
PAMS	Pavement Appraisal Management Suite	W	watt(s)
pf	power factor	Wh	watt-hour(s)
ppm	parts per million		
psi	pound per square inch		
R	Risk Rating		
RF	Rock Fall		
RIP	Resistivity Image Profiling		
RM	Rock Mass Failure		
rpm	revolutions		

Standard Conversions

acre	x	0.404	=ha
acre foot	x	1,235	=m ³
cusecs	x	0.02832	=m ³ /s
feet	x	0.3048	=m
in.	x	25.4	=mm
psi	x	0.070307	=kg/cm ²

CHAPTER 1 INTRODUCTION

1.1 Background of the Study

Over the last three decades Malaysia, has been experiencing tremendous development in the national infrastructure network which has contributed to the accelerated growth in the National Economy. The total length of road networks has more than doubled during this period and the funds allocated for road construction and upgrading have increased with each five-year development plan.

Along with the development of a nation-wide road network, more and more construction has been made for the road sections crossing mountainous area in Malaysian Peninsula as well as East Malaysia, in which slope failures are sometimes encountered. In such a background, the infamous Genting Bypass landslide occurred in June 1995, taking the lives of 21 persons. In addition to this tragedy, a number of disasters related to slope failure has happened throughout the country in recent years, which resulted in significant damages and casualties.

This important topic in the management of federal road, "prevention of slope failure accident and installation of effective countermeasures", has been vigorously tackled by JKR in co-operation with local and alien institutions, resulting in such achievement as SPRS, MEHMES and SPRS. However, due to the technical difficulties combined with complicated natural conditions and to other limitations in finance and time, there still remains the necessity for further study to establish a more practical and reliable road slope management system.

The VISION 2020, the state strategy of striving towards becoming an industrialised nation by the year 2020, demands further development of the road network system nation-wide for the economical and social development of the country. A reliable road slope management system is necessary to meet this political requirement.

As far as road slope disaster and its management is concerned, Japan keeps lots of experiences in tackling with them through many years, as Japan is a mountainous country and road slopes are susceptible to causing failure due to various natural actions such as typhoon, concentrated rain, earthquake, snowfall and so. It was considered that Japan's technology and experiences in this field could be a good reference to further planning of road slope disaster management by Malaysian Government. In response to the Malaysian Government's request, the Japanese Government accepted with pleasure to work together with its counterpart in establishing a reliable and practical slope management plan appropriate to Malaysia's local conditions.

1.2 The Objectives of the Study

To improve the existing slope management systems such as SMS, SPRS etc., and to establish a reliable and practical system, this project has been initiated with the five objectives as below:

1. **Clarification and analysis of present situation of road slope and its management**, in connection with natural and socio-economic conditions.
2. **Development of database of road slope and Slope Information Management System of road (to be called as SIMS, in the abbreviation)**, which should be an efficient tool of road slope disaster management.
3. **Preparation of Guideline of road slope disaster management**, which consists of five volumes;
 - 1) Guide to road slope maintenance and disaster management
 - 2) Guide to Slope Inspection
 - 3) Guide to Early Warning System and Site Investigation
 - 4) Guide to Countermeasure Selection and Cost Estimation
 - 5) Guide to Slope Information Management System (SIMS)

4. **Preparation of Practical Implementation Plan**

Practical implementation plan shall be studied for proposed road slope disaster management system, including institutional and human resources development aspects.

5. **Technical transfer and mutual collaboration**

Through the execution of study, technical transfer and mutual collaboration between the JICA Study Team and JKR was emphasised. For this purpose, three (3) seminars and two (2) workshops have been held during the study period, together with daily co-operative work and discussion between both parties.

1.3 The Phasing

To attain the objectives as mentioned above, the study was carried out in accordance with the flow chart as shown in Figure 1.1.1. As shown in the figure, the work is divided into two phases, Phase-I and Phase-II, the latter can be divided again into Phase-II(A) and Phase-II(B).

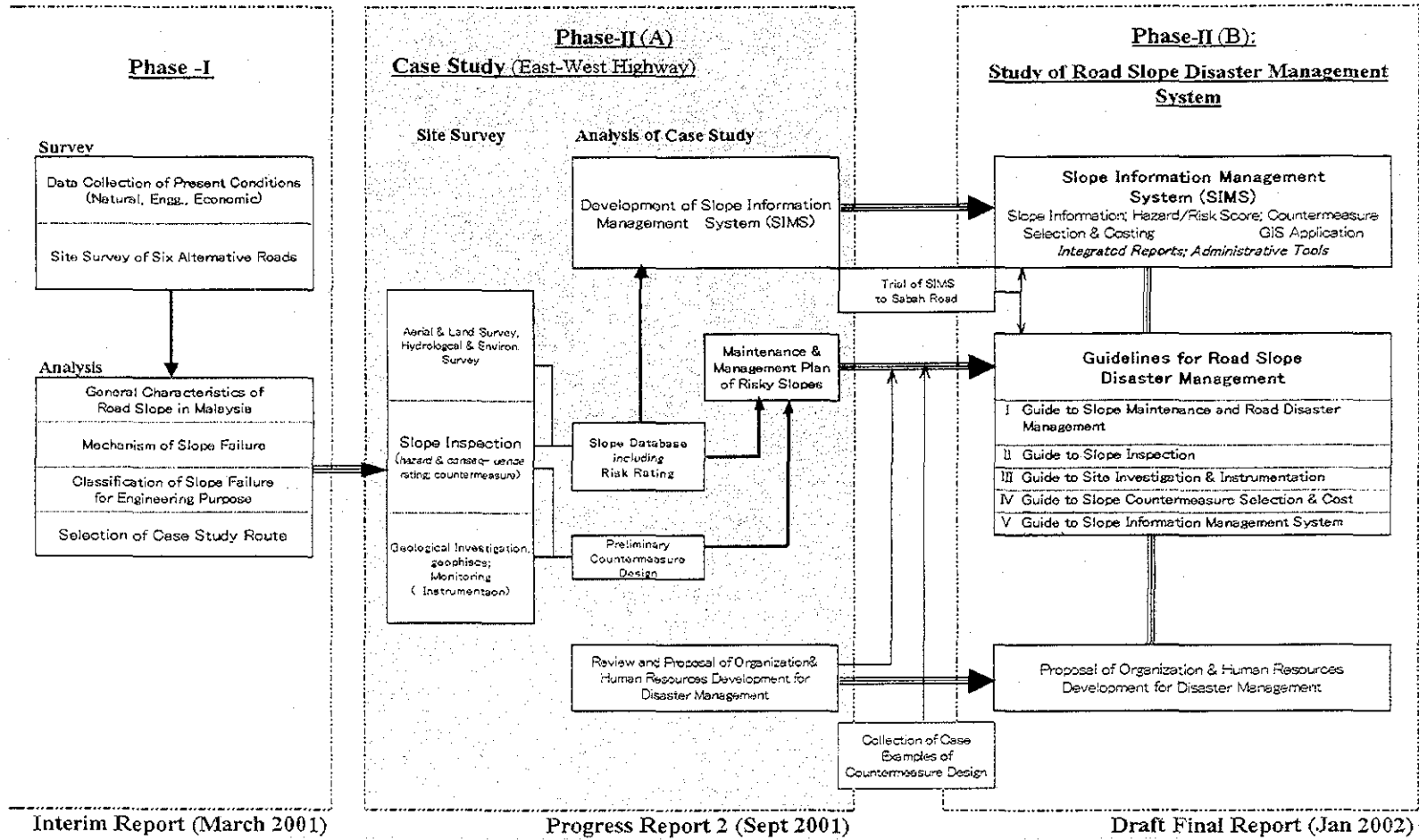


Figure 1.1.1 Flow of The Study

The scope of each Phase is summarized as below:

Phase-I: October 2000 – March 2001

- 1) To collect the information and grasp the present road slope condition of Malaysia in connection with :
 - Economical development
 - Network of federal roads
 - Organization and human resources for road management
 - Road slope condition and its maintenance
 - Natural conditions such as geography, geology, hydrology, environment, etc.
- 2) To analyze the mechanism and features of slope failures commonly observed along road slope in Malaysia and to establish:
 - Classification of typical slope failure along federal road
 - Mechanism of failure of each type, and
 - Relationship between slope failure and rainfall
- 3) To survey and compare the various features of six (6) assigned routes in Peninsula and Sabah State, and to select the most appropriate route for case study in Phase II, in respect to natural, engineering and management, socio-economic conditions.

<At the end of Phase-I, the federal route No.4, the East-West Highway, was selected as the case study route, while Penampun-Tambunan Road, Sabah was assigned as the route for trial checking of the new slope management system.>

Phase-II(A) (Case Study): April 2001 – September 2001

- 1) To carry out field study along the case study along the East-West Highway, which includes
 - Aerial photography and land survey
 - Slope inspection
 - Geological survey (Drilling and Geophysical Survey)
 - Instrumentation and monitoring
 - Hydrological and Environmental Survey
 - Preliminary Design of Countermeasure
- 2) To carry out engineering study on the case study route which includes
 - Risk rating of road slope
 - Consideration of priority risk ranking
 - Implementation plan of countermeasure and slope maintenance program

- 3) To develop a GIS based new slope information management system (SIMS) as a model target of system development, and
- 4) To study the present organization and human resources for slope management of the case study route, and to make a proposal for necessary improvement for implementation of the new slope management system.

Phase-II(B): October 2001 – March 2001

- 1) To complete the slope information management system (SIMS) for general application to federal roads in Malaysia, including the trial application of slope inspection procedure on Penampang - Tambunan Road, Sabah.
- 2) To prepare the guidelines for road slope disaster management, which describe suggested principle and procedures for
 - Road slope maintenance and disaster management
 - Slope inspection
 - Geological investigation and instrumentation
 - Countermeasure selection and cost estimation and
 - Slope information management system (SIMS)
- 3) To study an improvement plan of organization and training program for implementation of the suggested slope management
- 4) To propose an total recommendation of implementation plan of the new system and future direction of slope management system.

1.4 The Study Area

Phase-I:

Reconnaissance survey was carried out on the six routes as shown below.

Several roads such as the 2nd East-West Highway (Simpang Pulai - Pos Selim-Kampong Raja), Tamparuli - Kanpong Telupid Road, Sabah, etc. were surveyed besides the above to grasp the general feature of road slope in Malaysia.

Table 1.4.1 List of Reconnaissance Survey during Phase-I Study

Alternative Route No.	Name of Road	Federal Route No.	Extension for survey
1	East-West Highway	Fed. Road 4	124 km
2	Cameron Highlands Road	Fed. Road 59	65 km
3	Gap-Fraser's Hill Road	Fed. Road 56	6 km
4	Kuala Kubu Baharu-Gap-Teranum Road	Fed. Road 55	54 km
5	Penang Road	Fed. Road 6	56 km
6	Penampang-Tambunan-Keningau Road	State Road	120 km
Total			425 km

Phase-II(A):

Case Study was carried out along the western part of the route No. 4, the East-West Highway, from the Chainage 25.0 to 82.30, in the Perak State.

Phase-II(B):

No field survey was carried out, while study was carried out so that its result should be applicable to whole the federal roads in Malaysia.

1.5 Period and Schedule of the Study

The period of this study is as follows:

Phase-I: October 2000 – March 2001-11-30

Phase-II:



Case Study: May 2001- September 2001-11-30

Management Plan: October 2001-March 2002

The actual schedule of performance of each study item is shown in Table 1.5.1.

Table 1.5.1 Project Schedule

Year	2000						2001											
	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
Phase of the Study	Phase-I Reconnaissance of Present Conditions						Phase-II The Case Study (E-W Highway)						Study of Management System					
Study in Malaysia	[Bar chart]						[Bar chart]						[Bar chart]					
Study in Japan	[Bar chart]						[Bar chart]						[Bar chart]					
Reporting	Inception Report						Progress Report (1)						Interim Report					
Seminar & Workshop	Seminar (1)						Seminar (2) & Workshop (1)						Workshop (2)					
Steering Committee	[Bar chart]						[Bar chart]						[Bar chart]					
[1] Preparation of Inception Report	[Bar chart]						[Bar chart]						[Bar chart]					
[2] Data Collection and Analysis	[Bar chart]						[Bar chart]						[Bar chart]					
[3] Reconnaissance of Six Federal Roads	[Bar chart]						[Bar chart]						[Bar chart]					
[4] Classification/mechanism of Failure	[Bar chart]						[Bar chart]						[Bar chart]					
[6] Review of Existing Slope Management	[Bar chart]						[Bar chart]						[Bar chart]					
[6] Basic Design of Information System	[Bar chart]						[Bar chart]						[Bar chart]					
[7] Selection of the Case Study Route	[Bar chart]						[Bar chart]						[Bar chart]					
[8] Planning of the Case Study program	[Bar chart]						[Bar chart]						[Bar chart]					
[9] Aerial Survey for the Case Study	[Bar chart]						[Bar chart]						[Bar chart]					
[Case Study - Field Work]	[Bar chart]						[Bar chart]						[Bar chart]					
[10] Slope Inspection	[Bar chart]						[Bar chart]						[Bar chart]					
[11] Geological Investigation	[Bar chart]						[Bar chart]						[Bar chart]					
a. Drilling	[Bar chart]						[Bar chart]						[Bar chart]					
b. Geographical Survey (Seismic & Electrical Survey)	[Bar chart]						[Bar chart]						[Bar chart]					
[12] Instrumentation and Monitoring	[Bar chart]						[Bar chart]						[Bar chart]					
[13] Land Survey and Mapping	[Bar chart]						[Bar chart]						[Bar chart]					
Land Topographical Survey	[Bar chart]						[Bar chart]						[Bar chart]					
Digital Orthophoto mapping/ Topographical Mapping	[Bar chart]						[Bar chart]						[Bar chart]					
[14] Hydrological and Environm. Survey	[Bar chart]						[Bar chart]						[Bar chart]					
[Case Study - Office Work]	[Bar chart]						[Bar chart]						[Bar chart]					
[15] Slope DataBase (using SDMS)	[Bar chart]						[Bar chart]						[Bar chart]					
[16] Risk Rating Analysis (using SDMS)	[Bar chart]						[Bar chart]						[Bar chart]					
[17] Preliminary Countermeasure Design	[Bar chart]						[Bar chart]						[Bar chart]					
[18] Study of Organization/ Human Resources (Case Study)	[Bar chart]						[Bar chart]						[Bar chart]					
[10] Study of Slope Maintenance/ Management (Case Study)	[Bar chart]						[Bar chart]						[Bar chart]					
[20] Slope Information System (SIMS) Development	[Bar chart]						[Bar chart]						[Bar chart]					
1) System Design and Program Plan	[Bar chart]						[Bar chart]						[Bar chart]					
2) System Programming	[Bar chart]						[Bar chart]						[Bar chart]					
3) Economic Analysis	[Bar chart]						[Bar chart]						[Bar chart]					
4) Data Input	[Bar chart]						[Bar chart]						[Bar chart]					
5) System Verification and Version-up	[Bar chart]						[Bar chart]						[Bar chart]					
[21] Proposal of Guideline to Road Disaster Management	[Bar chart]						[Bar chart]						[Bar chart]					
Guide to Road Slope Maintenance and Disaster Management	[Bar chart]						[Bar chart]						[Bar chart]					
Guide to Slope Inspection	[Bar chart]						[Bar chart]						[Bar chart]					
Guide to Monitoring and Site Investigation for road slope	[Bar chart]						[Bar chart]						[Bar chart]					
Guide to Slope Countermeasure Selection and Cost Estimation	[Bar chart]						[Bar chart]						[Bar chart]					
Guide to User's reference of SIMS	[Bar chart]						[Bar chart]						[Bar chart]					
[22] Trial Application of Slope Information System (to Sabah Road)	[Bar chart]						[Bar chart]						[Bar chart]					
[23] Collection of Examples of Countermeasure Design (Japan/ Malaysia)	[Bar chart]						[Bar chart]						[Bar chart]					
[24] Proposal of Organization and Human Resources for Disaster Management	[Bar chart]						[Bar chart]						[Bar chart]					
[25] General Recommendation for Road Disaster Management	[Bar chart]						[Bar chart]						[Bar chart]					
[26] Project Video Film	[Bar chart]						[Bar chart]						[Bar chart]					

Remarks:
 Work done by JICA Team Engineer
 Work supported by Local Contractor

1.6 Reporting

This draft final report consists of two (2) volumes as below:

Main Report Volume

- Executive Summary
- Main Report :
 - Chapter 1 to Chapter 8
 - Appendices

Guideline Volume

Guidelines for Road Slope Disaster Management

- Guide I: Guide to Road Slope Maintenance and Disaster Management
- Guide II: Guide to Slope Inspection
- Guide III: Guide to Early Warning System and Site Investigation
- Guide IV: Guide to Countermeasure Selection and Cost Estimation
- Guide V: Guide to Slope Information Management System (SIMS)