Chapter 5

Formulation of Capacity Development Plan for Road Disaster Preventive Management

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5.1 Background of Capacity Development Planning

In order to establish an efficient and transparent system for road management, SNC, the former nationwide road management organization, completed a program of institutional reforms from January 2000 to October 2006 with assistance of WB, IDB, and CAF.

Prior to the execution of the reform program, a series of discussions and consultations had been conducted by SNC. These discussions identified four major problem areas affecting road management: bribery and intervention by political parties, institutional vulnerability, lack of funds, and inadequate budget allocation.

SNC Act No.2064, which stipulated new institutional structure, and SNC Act No.26336, which stipulated organizational duties and responsibilities, were issued on April 3, 2000 and September 29, 2001, respectively. Many fruitful measures were achieved through the SNC reform program under these acts.

The ABC was subsequently founded on October 27, 2006 in accordance with ABC Act No.3507. By National Decree (Article-3 No.28946, November 25, 2006), the ABC is to provide effective, safe, and economical transportation services to people through maintenance and operation of the national highway network under the framework of ”National Development Policy, 2006.” It is evident that the ABC completely supersedes all assignments and roles of the SNC including subrogation of international contracts and agreements with overseas donors.

The importance of applying preventive measurements before occurrence of natural disasters has not yet been recognized in Bolivia. For instance, no concrete article concerning policy and plans for road disaster prevention management can be seen in the “Master Plan of Transportation in Bolivia” or the “Road Construction Strategy Plan”. In fact, ABC has carried out neither disaster preparedness measures nor disaster mitigation in a systemic manner. As a result, basic institutional knowledge and experience in this field have not yet been accumulated by ABC.

Since many roads, from national highways to local trails, pass through the Andes, landslides, slope failures, rock falls, and debris flows take place frequently and shut down land transportation for long periods at many places, especially during Bolivia’s rainy season. For example, the Jan 13, 2005 landslide at Sakurament Alto on National Highway No.3 caused a prolonged blockage and resulted in large damages to the social economy as well as loss of human life. The October 27, 2005 debris flow which washed out the Tiyumayu Bridge was another recent road disaster caused by intensive rainfall, and resulted in nine casualties and prolonged disruption to traffic (please see photo below).

Immediately after the Tiyumayu Bridge disaster

Typical slope failure at National highway No.4

As a result of these conditions, ABC strongly intends to create comprehensive road disaster preventive mechanisms for the purpose not only of saving human life and personal property, but also for maintaining social security and improving budget cost performance. ABC also has confidence that adequate road maintenance systems for national highways are already in place as a result of existing reforms, and that the next step is to establish a road disaster prevention management system.

Once the road disaster prevention system is established and in operation, existing road maintenance will improve as a result of both preventive and maintenance activities. Moreover, continuous execution of preventive management should make it possible to reduce the number of road natural disasters, with significant reduction in road maintenance expenditures. Bolivia is bounded by several nations, and is a hub country in terms of international land transportation in South America. For this reason, securing safe traffic on Bolivia's national highway network will lead to improved economic and social conditions in not only Bolivia, but also throughout the South America region

ABC counterparts in collaboration with JICA experts formulated a Capacity Development Plan (hereafter referred to as "the CD plan") for establishment of a road disaster preventive management system in accordance with the scope-of-work signed in March 2005 between SNC and JICA. ABC's president, Lic. Patricia Ballivian Estenssoro, issued "RESOLUCION PRESIDENCIAL No 30/2007" (please refer to the Annex) which formally approved the CD plan on February 22, 2007 and included:

1) Approval of the CD plan as "ABC's Road Disaster Preventive Management Plan"
2) Introduction of the CD plan into ABC's annual plan and action plan (POA)
3) Establishment of Road Disaster Preventive Management Unit in ABC

5.2 Problems in Executing Road Disaster Preventive Management by ABC

The present problems facing ABC have been clarified through PCM meetings, interviews, and analysis of collected data and references. The first PCM meeting was held using the PP method (Participatory Planning by JICA) at the ABC headquarters on November 29, 2005. Many significant opinions were given as shown in *Table 5.2.1*.

Table 5.2.1 Result of Problems Analysis on Road Disaster Preventive Management (1st PCM Result)

Contents of Works	SNC		
	Department	Activities	Problems
Risk inspection	SNC Regional Office	・Routine operation/ management works by contract	・No record of road disaster ・Few expert and engineer specialized in Disaster prevention
		・Management by consultant	・Insufficiency of technology in risk inspection ・No existence of Disaster Prevention Manuals
		・Maintenance by PROVIAL	・Limited works by hand
	Road Maintenance Dept.	・Administration on 0peration and management by contract	・Delay of emergency response (budget allocation, procedures) ・No existence of Disaster Prevention Manuals ・Few expert and engineer specialized in Disaster prevention(No disaster prevention team) ・No disaster monitoring system
Investigation/evaluation	Planning Technology Development Dept.	・Execution of basic investigation (Evaluation of risk section, mechanism, preventive measures) ・technical guidance ・Management of works by contract	・No system of collection of information and data management (rainfall, earthquake, disaster record, etc.) ・No sufficient accuracy in topographic and geological information ・No existence of Disaster Prevention Manuals ・No evaluation criteria in hazard ・Few opportunities of training of disaster prevention technology ・No item of risk assessment in the present study
	Social Environment Dept.	・Execution of environment screening ・Check and instruction of EIA ・Management worked by contract	・Lack of knowledge in disaster preventive management ・No relationship with Outside organization ・little information on disaster areas and conditions (topography, geology and soil, etc.) ・No idea of relationship of environmental deterioration and disaster prevention ・not stable execution of environment assessment at risk area
Design/cost estimate	Planning Technology Development Dept.	・Structural and Calculation in quantity ・Design preparation ・Calculation of unit price ・Management of works by contract	・Lack of specific knowledge on design and cost evaluation of disaster preventive measures ・Few opportunities of technical training and seminars ・No existence of guidelines and manuals in terms of design for disaster preventive measures ・Rare opportunities to follow up and evaluation of disaster preventive measures
Preparation of tender documents	Planning Technology Development Dept./ Road Maintenance Dept.	・Preparation of technical specification	・Lack of experience in disaster preventive measures ・Lack of experience in technical specification ・No standard document for disaster preventive measures
	Legal Dept.	・Preparation of contract document	・Waste of time to contract (necessary of many signatures) ・No transference local empowerment in tender to regional office
Tender	Contract Committee Administrative Dept.	・Publication, selection and approval of tender, etc.	・Waste of time to process ・delay of document preparation send signing
	Legal dept./ Financial and Administrative Dept.	・Execution of contract	
Supervision of disaster preventive works/value of construction/completion inspection	Road maintenance Dept./ Construction Dept./ Social Environmental Dept./ Regional Office	・Management of contractor ・Technical instruction to supervision company contracted ・response to emergency disaster ・Confirmation of work progress ・Execution of environment monitoring	・Lack of knowledge in disaster preventive works ・Delay of response to emergency of disaster budget allocation, approval of works to do ・Delay due to blockade of road ・Delay of construction due to climate conditions (during rainy season) ・Delay of payment for construction
management of payment	Financial and Administrative Dept.	・Payment of construction cost	・Inadequate cash flow of National Annual Budget ・Delay of payment of Local Contribution Budget ・No fund established for disaster preventive management
Finance securement	Planning Technology Development Dept./ Road Maintenance Dept./ Construction Dept./ Social Environment Dept.	・Preparation of annual prevention plan (POA) ・Allocation and management of National Annual Budget	・No proposal of disaster preventive investigation and measures in POA ・No budget for enhancement of strengthen disaster prevention organization ・Waste time of application and approval of budget ・Few opportunities to appeal importance of disaster prevention to government
	Financial and administrative Dept./ Administrative Dept./ Planning Technology Development Dept.	・Budget allocation and distribution ・Securing budget (Overseas fund, CNCV, TGN)	・No abundant securement of budget of disaster preventive projects (government, overseas donors) ・No prospect of other financial resources
Maintenance/management of disaster preventive measures after completion	Road Maintenance Dept./ Regional Office	・Maintenance of disaster preventive measures	・No periodical monitoring and evaluation systems for disaster preventive measures ・Insufficient facilities and tools for monitoring ・No establishment of evaluation manuals ・No database on past records concerning disaster preventive management
Warning/evacuation	Administrative Dept./ Planning Technology Development Dept./ Road Maintenance Dept./ Social Environment Dept.	・Monitoring/ warning/ evacuation	・No establishment of warning/evacuation systems during disaster ・No warning /evacuation manual ・insufficient information system to communicate with road users ・No mutual relationship with military, police, local entities concerned ・Insufficient warning boards installed at critical sections ・No establishment of communication system for early warning system
Road Disaster Preventive Technology Improvement	Administrative Dept./ Planning Technology Development Dept./ Road Maintenance Dept./ Social Environment Dept.	・Activities in technology	・Lack of technical information ・Lack of specified construction company in fields of disaster prevention ・Small chances of technical training and seminars ・Lack of opportunities of specific technical method (drainage, reinforcement)

5.3 Analysis of Problems and Items to be Solved

5.3.1 Analysis of Problems

Based on the results of the PCM meetings and interviews with SNC (headquarters, regional offices), other organizations (SEPCAM), overseas donors (WB, CAF, IDB, IIRSA), and the private sector (construction companies, supervisors, micro-enterprises), present problems relating to road disaster preventive management can be categorized as follows:

1) Insufficient public awareness with regard to the social role and activities of ABC
2) Lack of knowledge of road disaster preventive management
3) No establishment of a road disaster preventive management system
4) No planned execution of road disaster preventive measures
5) Inadequate emergency response to road disasters
6) No existence of early warning and evacuation system
7) Lack of experience with preparation of technical specifications and performance of tendering
8) Lack of simplified and prompt tendering procedures
9) Insufficient budget allocation for road disaster prevention

These nine items were analyzed from an individual, organization, and system/society view point as shown in *Table 5.3.1*. The major problem at the individual level is a lack of technical and institutional knowledge regarding road disaster preventive management. Organizationally, major problems include the lack of an executing department or unit, no manual and guideline to facilitate operations, insufficient management systems, and lack of an accessible information database. From a system/society perspective, insufficient awareness of ABC activities by the public and difficulties obtaining continuous funding or budget are also serious problems.

5.3.2 Result of Objectives Analysis and Items to be Solved

A second PCM meeting was held at the ABC headquarters on December 9, 2005 in order to conduct an objectives analysis on the problems identified during the first PCM meeting. The result of the objectives analysis, shown in *Table 5.3.2*, resulted in nine goals intended to fully establish a road disaster preventive management system. These goals were:

1) Enhancement of public awareness of ABC's road disaster preventive role and activities
2) Improvement of technology in road disaster preventive management
3) Establishment of a road disaster preventive management system
4) Execution of a planned road disaster preventive measurement works
5) Prompt response to emergency crisis in the case of road disaster
6) Establishment of early warning and evacuation systems
7) Simplified procedures for preparation of technical specifications and tendering
8) Simplification of administrative procedures
9) Obtainment of sufficient budget for road disaster prevention activities

Table 5.3.1 Problems in Promoting Road Disaster Preventive Management in ABC (Individual, Organization, System/Society in Level)

Overall Goal	problems	Cause of problems		
		Individual Level	**Organization Level**	**System/society Level**
		ABC staffs	**・Overall organization of ABC ・Each department relating to road disaster preventive management in ABC ・Regional offices of ABC**	**・All person and organization engaging in disaster preventive management ・Law, Act, regulation relating to road disaster prevention ・regal system, organization, culture and custom in ABC stimulated**
Continuous Road Disaster Preventive Management is executed in ABC	**1. Insufficient public awareness with regard to the social role and activities carried by ABCS**		・Lack of appealing importance of disaster prevention to the public	・Less recognition of benefit to prevent disasters inadvance for political dicision makers
	2. Lack of knowledge on road disaster preventive management	・Lack of technology in disaster prevention for person in charge ・Lack of communication among each department ・Insufficient opportunities of training and seminar in disaster prevention ・Poor opportunities to exchange information between other organizations	・No existence of department or unit for disaster preventive management ・No experts and engineers having disaster technology ・insufficient basic data and information in disaster prevention ・No assessment study on risk evaluation for possible disaster prone sections ・No preparation of design standard and manuals for disaster prevention investigation and preventive measures ・No database on past disaster with detailed information	・Few organizations disseminating information and educating disaster prevention technology and knowledge in Bolivia ・Lack of experiences in disaster prevention for engineers in construction companies and consultants
	3. No establishment of road disaster preventive management system	・Lack of knowledge on disaster preventive management system ・No existence of engineers having specific technology in disaster prevention	・No existence of department or unit executing disaster preventive management ・No establishment of ordinal system of disaster preventive management ・No establishment of recording system of disaster conditions ・No existence of manuals of disaster preventive management ・No establishment of database on disaster preventive management ・insufficient system of monitoring and communication during disasters ・No establishment of relationship with outside exterior organizations ・No establishment of follow-up and evaluation system of disaster preventive measures	・No national decree stipulating establishment of new executing department or unit in ABC ・Insufficient relationship among each organization relating to disaster preventive management
	4. No planned execution of road disaster preventive measures	・Lack of knowledge of disaster preventive measures	・No existence of mid-long term plan designating disaster preventive measures along national highways ・Rare opportunities to plan annual disaster preventive measures into POA ・No establishment of design criteria on disaster preventive measures ・Delay of completion of construction due to payment postponement ・insufficient experience of preparation of tender document and technical specification	・Insufficient budget for disaster preventive measures ・No existence of company specirized in disaster prevention technology in Bolivia
	5. Inadequate response to emergency of road disasters	・Lack of knowledge of disaster preventive management	・No existence of experts and engineers applying to emergency disaster response in ABC ・No smooth execution of emergent disaster preventive measures in ABC ・No preparation of manuals for emergency response during disaster ・No establishment of skill of preparation of specification of emergent preventive measures	・No reliable securement of budget for emergency response ・Insufficient collaborative relationship with SEPCOM ・No permission of nominated tender in emergency cases
	6. No existence of early warning and evacuation system	・Insufficient knowledge of warning and evacuation	・No establishment of warning and evacuation system ・No preparation of manuals on warning and evacuation ・Insufficient communication system on warning information to the public ・Poor development of communication network system for early warning of emergency disaster ・No establishment of alarming system of emergency conditions	・insufficient collaborative relationship with military, policw, local entities concerned ・No establishment of legal back-up system to declare emergency crisis
	7. No experience of preparation of technical specifications and performance of tendering	・Lack of preparation capability of technical specification	・No smooth performance of preparation of tender document and technical specification ・No preparation of standard documents in tendering ・No smooth execution of tender evaluation by contract committee	・No local empowerment in tender and contract to regional offices ・No selection of turn-key method for urgent works of preventive measures
	8. No simple procedure and prompt transaction in tender		・Waste of time in approval and procedures in tendering ・No clarification of responsibility at each position ・Long time process in issue of payment certiscate	・No local empowerment in tender and contract to regional offices ・No right to direct operation of overseas credit fund
	9. Insufficient budget for road disaster prevention		・Not planned obtainment Several of overseas assistant fund ・No strategy plan to obtain new financial fund	・Occasional delay of National Annual Budget ・Occasional cancellation of Local Contribution Budget ・No legal background of obtainment of budget for enhancement f disaster preventive organization

Table 5.3.2 (1) Result of Objectives Analysis (2nd PCM Meeting)
:Resolution of problems clarified in 1st PCM meeting

1. Public awareness of social role and activities carried by ABC are enhanced

1) Disaster prevention activities of ABC are widely disseminated to the public
2) Proper behavior and reaction in emergency disasters for local residents and road users are instructed to the public
3) Seminars on road disaster prevention with collaboration of societies and universities are hold to the public
4) Ordinary people participate in meeting to discuss and kake decision on disaster prevention matter
5) ABC disaster preventive activities by ABC are acknowledged through Web-site and monthly bulletin

2. Technology and Knowledge on road disaster preventive management are improved

1) Disaster preventive management department or unit is established
2) Experts and engineers specialized in disaster prevention are trained
3) Disaster preventive technology and knowledge are collected and accumulated
4) Data and information on disaster preventive management such as maps and geological data are compiled
5) Technology on inspection and evacuation in road disaster prevention are collected and stored
6) Database on risk points along national highway network is established
7) Attendance to seminars and training courses is easily available
8) Design standard and criteria on disaster preventive measures are established
9) Database on past disaster records along national highway is established
10) Cooperative relationship with other organizations are established

3. Road disaster preventive management system is established

1) Road preventive management system is well established
2) Recording system on disaster conditions is established
3) preventive management system is established (utilization of supervisor and micro-enterprise)
4) Manuals on road disaster preventive management is prepared
5) Database on disaster prevention information is established
6) Monitoring and communication system on road disasters is established
7) Cooperation system with exterior organizations is established
8) Follow-up and evaluation system on disaster preventive measures is established

4. Road disaster preventive measures are executed on schedule

1) Mid-long term master plan on disaster preventive measures along national highway is formulated
2) Annual preventive measures are planned on POA (large scale preventive measure not applied to maintenance works)
3) Management skill of disaster preventive measures is established (investigation, plan, design, upervision,etc.)
4) Design criteria of disaster preventive measures is prepared
5) No delay of payment for preventive works takes place
6) Smooth preparation of tender documents and specification is executed
7) Some companies having disaster preventive technology exist
8) Road disaster preventive fund is established and executed as planned
9) Legal condition for executing disaster preventive works is established

5. Emergency response to road disasters is rapidly executed

1) Budget for emergency disaster measures is secured
2) System of emergency response to disaster is established
3) Manuel on Emergency response is prepared
4) Cooperative relationship with SEPCOM is established
5) Technical working group for applying emergency measures is made up in ABC
6) Approved tender at emergency disaster is introduced
7) Preparation capability on technical specification on disaster emergency is established

Table 5.3.2 (2) Result of Objectives Analysis (2nd PCM Meeting)
:Resolution of problems clarified in 1st PCM meeting

6. Warning and evacuation system is established

1) warning and evacuation system is established
2) Manual on warning and evacuation is prepared
3) Warning information is provided to road users on time
4) Cooperative structure with military, police and local entities concerned is established
5) Communication network on early warning system is established
6) Legal back-up system on declaration of emergency crisis is established
7) Preparation skill of technical specification on emergency disaster preventive measures is established
8) Emergency warning communication system is established

7. Preparation of technical specifications and performance of tendering are conducted

1) Tender documents and technical specifications is smoothly prepared
2) Standard documents relating to tendering is prepared
3) Working in contract committee is smoothly conducted
4) Local empowerment of tendering and contract procedures is transfer to provincial offices
5) Turn-key method is partly adopted
6) Legal framework accelerating process is established

8. Administrative procedures are simplified

1) Procedures in tendering and approval are simplified (ISO, direct movelization of budget, etc.)
2) Local empowerment of tendering and contract procedures is transfer to provincial offices
3) Area and range of responsibility are clarified
4) Procedures for payment certificate is simplified

9. Budget for disaster prevention enterprise is secured

1) Payment from National Annual Budget is secured
2) Payment from Local Contribution Budget is secured
3) Budget for enforcement of organization is secured
4) Financing of Overseas Assistant Fund is progressed as scheduled
5) Strategy on securement for new financial resources is formulated

5.4 Formulation of the CD Plan

ABC's CD plan for road disaster preventive management was formulated mainly by ABC counterparts with the support of JICA capacity development experts. Three additional PCM meetings were held during the plan's formulation. The third and fifth PCM meetings were held with ABC counterparts. The fourth PCM meeting included every department director in ABC, and was intended to gain both a broad consensus and better understanding of the basic concepts, applied mythology, and contents of the CD plan.

PCM meeting participation by high level officers

Comments from Head of JICA's Bolivia Office

5.4.1 Definition, Framework and Main Actors of the CD Plan

Prior to the formulation of the CD plan, the names and statuses of stakeholders expected to be involved in CD planning were identified as shown in *Figure 5.4.1*. ABC is an administrating agency under the ministry of "Public Works and Vice Ministry of Transportation" and is expected to implement road disaster preventive management. Therefore, it is essential that ABC create and sustain strong partnerships with relevant organizations such as government agencies, overseas donors, SEPCAM, municipalities, private sector entities, users of national highways, and universities.

The activities of ABC are regulated by ABC Act 3507, which came into effect on October 27, 2006. According to the Act, the main responsibility of ABC is to keep the national highway system (14,600km long as of December, 2005) secure and well maintained at all times. Taking into account the concepts discussed above, the CD plan is summarized in *Table 5.4.1* in terms of individual, organization, and system/society. Although ABC is the main actor for the CD plan, SEPCAM and private sector entities are also partial actors at the individual and organization level.

5.4.2 Selection of Projects

(1) Selected projects

Seven (7) projects shown in *Figure 5.4.2* were selected based on the results of the objectives analysis discussed above. Each proposed project can be executed independently, while at the same time there are relatively many relations among them. The super goal of the CD plan is designated as "Road Disaster are Reduced in Bolivia" while the overall goal is designated as "Continuous Road Disaster Preventive Management is executed by ABC".

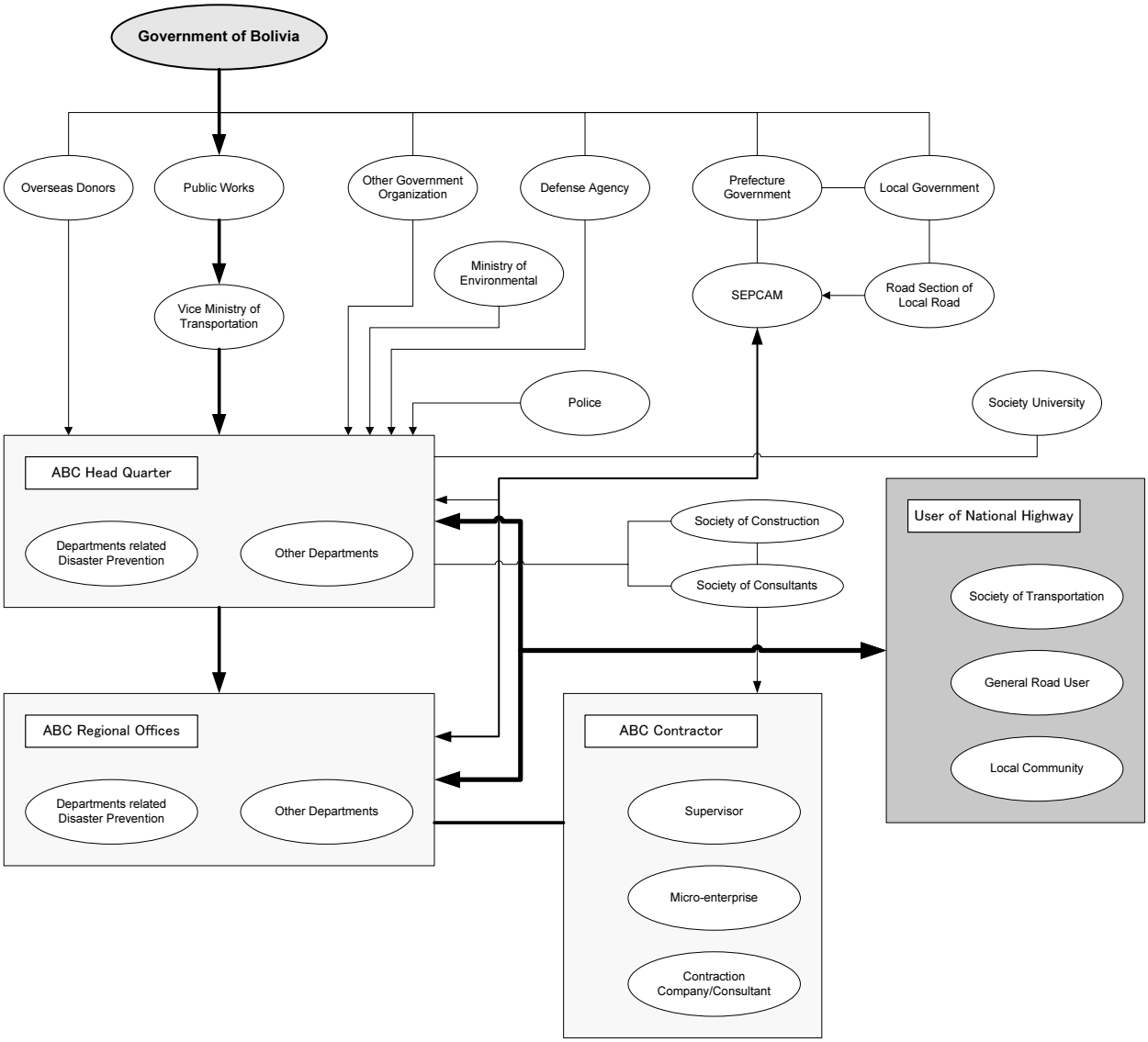

Figure 5.4.1 Relationship between ABC and Stakeholder Relating to Road Disaster Prevention

Table 5.4.1 Definition and Main Body of Capacity Development
for Road Disaster Prevention Management in ABC
(Overall Goal: Continuous road disaster preventive management is executed in ABC)

Definition of CD / Main actors of CD		<Individual>	<Organization>	<System society>
Public Sector	HQ of ABC	Senior officers ·can identify problems on road disaster prevention management concretely. ·can plan and conduct adequate road disaster preventive measures Technical personnel ·have specialized knowledge and technology on road disaster prevention ·can make technical judgment based on knowledge obtained ·can plan, execute and evaluate disaster preventive measures ·can prepare tendering documents property	Departments relating to disaster prevention ·Disaster prevention department (Unit) can execute disaster prevention enterprises as leading position ·Disaster prevention department (unit) has disaster prevention experts and engineers and execute disaster works ·SNC has each manual on disaster preventive management and use them constantly ·Mid-long term disaster preventive plan are formulated and executed as planned ·Equipment, materials and basic data necessary for disaster preventive works are settled and can be utilized anytime. ·Cooperative relationship is well established and emergency response is conducted smoothly Financial, and legal departments ·Establishment of disaster preventive management department (unit) is acknowledged regal ·System and staffs for execution of urgent disaster preventive measures are established ·Bourget of disaster prevention can be obtained constantly	Presidential office ·Legal framework to facilitate disaster preventive works is established Ministry of finance ·National Annual Budget, National Road Management Budget and local Contribution Budget are completely secured ·Budget and emergency disaster preventive fund are secured separately Preandino (CAF)
	ABC provincial offices			·the same as HQ of SNC
	SEPCOM	Persons in charge of road disaster prevention ·have basic knowledge on road disaster prevention	SEPCOM disaster prevention divisions ·Concrete problems on road disaster prevention can be recognized	Prefecture Governments
Private sectors	Contractors for ABC	Engineers of construction company ·similar to supervisors。	Construction Companies ·Importance of road disaster prevention can be recognized	Society of construction
		Supervisors (personnel contract) ·have basic knowledge on road disaster prevention ·can inspect road disaster slope condition, prepare disaster record sheet and manage them ·can instruct micro-enterprises technology in road disaster prevention		
		Micro-enterprises (Small scale employees) ·can do assistant works of road disaster preventive management	Association of Micro-enterprises	PROVAIL (WB, CAF)
	Transportation companies	Society representatives ·Chamber of transportation, Driver' union (CNCB, etc.)	Truck association, etc.	Administrative transportation organization
Nonprofit organization		Local residents ·Importance of road disaster preventive management is recognized Societies, Universities concerned ·Training and seminar on disaster prevention can be held periodically	Community	

: Main actors of CD

Overall Goal

Project Purpose

Outputs

Activities

Super goal: Road disasters in Bolivia are reduced

Overall goal : Continuous Road Disaster Preventive Management is executed in ABC

Project on Establishment of Road Disaster Preventive Management Department (unit)

Project on Road Disaster Preventive Technology Improvement

Project on Establishment of Road Disaster preventive management System

Project on improvement of emergency respose in disaster prevention

Project on road information enhancement and disclosure

Project on improvement of tender procedures in road disaster prevention

Project on formulation of strategy program of disaster prevention budget

Road disaster preventive department (unit) is established in ABC

Technology on road disaster preventive management is improved

Road disaster preventive management system is established

Disaster prevention capability in emergency is improved

ABC road disaster activities are acknowledged widely

Capability of tender procedures in disaster prevention is improved

Disaster prevention budget is obtained

Road disaster preventive mechanism is achieved in ABC

Disaster preventive management capability of ABC is enhanced

Effective measures for risk section are executed in advance

Warning/evacuation system is established

Prompt emergency response to disaster is conducted

ABC social contribution is appreciated publicly

Tender procedures are conducted promptly

Disaster prevention activities are continuously executed

Specify plinciple of SNC road disaster preventive management

Formulate road disaster preventive management program

Determine strategy of disaster preventive management

Adopt annual prevention plan to POA

Formulate strategy on dasaster prevention databese

Formulate strategy on emergency evacuation system

Determine overall framework of disaster response at emergency

Develop laws in immediate emergency response

Enhance public relations and activities with bulletin and web site

Enhance steakholder to understand importance of road disaster prevention

Prepare standard documents for tendering

Simplify tendering and approval process

Secure National Annual Burget (TGN)

Secure new financial resources

Restrict unplaned upgrade from prefecture road to national highway

Establish road disasterpreventive management department (unit)

Prepare road disaster preventive management manuales

Compile data and information on disaster preventive management

Transfer technology on disaster preventive management at practical level

Sellect preventive measures and formulate execution plan

Establish databese on disaster inspection result

Establish early warning system

Establish system of quick contract with private sectors

Designate procedure to declare of disaster emergency

Hold seminar on road disaster prevention with association and universities

Consider method for conract

Clarify responsibility coverage of personnel concerned

Secure National Road Maintenance urget (CNCV)

Establish new Road Disaster Prevention Fund

Formulate mid-long term plan on national road preventive management

Transfer basic tecnology of road disaster preventive management

Collect and accumulate expertise in disaster prevention

Prepare, save and update road inspection records

Follow-up strategy on relatived disaster prevention databese

Provide road user with disaster informstion on time

Establish cooperative structure with military, police and local entities concerned

Determine evacuation procedured

Propose and apply proper preventive measures

Strengten cooperative relationship with Sepcom

Accelerate transaction of contract committee

Analysis of local empowerment in tender and contract to ABC regional office

Secure Local Contribution Burget

Secure urgent budget for emergency of disaster prevention

Secure overseas assistant Fund as planed

Operate disaster prevention burget efficiently

Organize iimplementation system of road disaster preventive management

Train road disaster preventive management technology with seminar, etc.

Establish database on disaster data and information

Enhance present information communication system

Formulate starategy on ABC road disaster preventive management

Train and improve technology of inspection, evaluation in road dasaster prevention

Establish database on risk section s along national highway network

Establish relationship with other organization

Improve technology to select properly preventive countermeasures

Enhance capability to prepare technical specification

Enhance enforcement capability through OJT of pilot project, etc.

Figure 5.4.2 Overall Capacity Development Plan

(2) Outline of selected projects

Table 5.4.2 outlines project goals, evaluation results expected, main actors, contents of activities, and inputs. Brief descriptions of the proposed projects are as follows:

<Project-1: Establishment of Road Disaster Preventive Department / Unit >

This project is identified as the highest priority project among the seven projects proposed in the CD plan. The project goal is to establish an implementation body (a department or a unit) specializing in road disaster preventive management in ABC. The department or unit is expected to play an important role as a leader in execution and as one of the information centers for disaster preventive management in ABC. The initial members of the unit should include specialized experts consisting of a project manager, geological/geotechnical engineers, hydrologists, design/cost evaluation engineers, financial controllers, and judicial experts in the field.

<Project-2: Road Disaster Preventive Technology Improvement>

This project's goal is to improve technology for road disaster preventive management at ABC. The main activities of the project are technology transfer, provision of basic information, and establishment of a database system for road disaster preventive management. This project is expected to establish a foundation for road disaster management at ABC, and is a prerequisite for facilitating Projects 3 and 4 smoothly.

<Project-3: Establishment of Road Disaster Preventive Management System>

This project's goal is to establish a road disaster preventive management system at ABC. Once the system is established, critical national highway sections with high risk for natural road disasters can be readily identified, allowing proper countermeasures to be applied before occurrence of future disasters. Additionally, disaster records and road slope stability inspection information will be researched and compiled into a database prepared for the project.

<Project-4: Improvement of Emergency Response in Disaster Prevention>

This project's goal is to improve emergency response to road disasters, including the establishment of warning / evacuation systems and the prompt emergency response to natural disasters. High priority activities include the introduction of early warning system instrumentation and development of partnerships with military, police, and involved local entities. Other priorities include measures to quickly mobilize private sector entities for emergency response, strengthening relations with SEPCAM, development of legal declaration systems, and application of other proper urgent measures.

<Project-5: Road Information Enhancement and Discloser >

This project's goal is to enhance public awareness of ABC activities and social contributions, especially in road disaster preventive management. Tasks include wide dissemination of information to the public through a bulletin and website, holding seminars and training workshops in cooperation with other organizations and universities, communication with stakeholders, and similar activities.

Table 5.4.2 (1) Outline of Proposed Projects

	Project Name	Project Purpose	Outputs	Main Body of Activities	Activities	Inputs
1	Project on Establishment of Road Disaster Preventive Management department (unit)	Road disaster Preventive department (unit) is established in ABC	Road disaster preventive mechanism is achieved in ABC	·Road disaster prevention department (unit) and staff	·Specify principle of ABC road disaster preventive management ·Establish road Disaster preventive management department (unit) ·Formulate mid and long term plan on national road preventive management ·Organize implementation system of road disaster preventive management ·Formulate strategy on ABC road disaster preventive management ·Establish relationship with other organizations	·Transfer technology by experts and engineers ·Enhance capability with seminars and training ·Provide instrument and material
2	Project on Road Disaster Preventive Technology Improvement	Technology on road disaster preventive management is improved	Disaster preventive management capability of ABC is enhanced	·Road disaster prevention department (unit) and staff ·Other Departments and staff ·Regional offices and staff and supervisors	·Formulate road disaster preventive management program ·Prepare road disaster preventive management manuals ·Transfer basic technology of road disaster preventive management by experts ·Obtain road disaster preventive management technology with seminar, etc. ·Train and improve technology on inspection and assessment of hazardous section in disaster ·Improve technology to select properly preventive measures ·Improve technology to select properly preventive measures ·Enhance enforcement capability through OJT through pilot project, etc. ·Compile data and information on disaster preventive management ·Collect and accumulate expertise in disaster prevention ·Establish database on past disaster data and information ·Establish database on risk section along national highway network	·Transfer technology by experts and engineers ·Enhance capability with seminars and training ·Provide instrument and material ·Enhance enforcement capability through OJT through pilot project, etc.
3	Project on establishment of road disaster preventive management system	Road disaster preventive management system is established	Effective measures for risk sections are executed in advance	·Road disaster prevention department (unit) and staff ·Other Departments and staff ·Regional offices and staff, and supervisors and micro-enterprises	·Determine strategy of disaster preventive management ·Transfer technology on disaster preventive management at practical level ·Prepare, save and update road inspection records periodically ·Enhance present information communication system ·Include annual prevention plan in POA ·Select preventive measures and formulate execution plan ·Follow-up disaster prevention and upgrade evaluation system ·Formulate strategy on relative disaster prevention database ·Establish database on disaster inspection result	·Transfer technology by experts and engineers ·Enhance capability with seminars and training ·Prepare road disaster preventive management manuals ·Provide instrument and material ·Enhance enforcement capability through OJT through pilot project, etc.

Table 5.4.2 (2) Outline of Proposed Projects

	Project Name	Project Purpose	Outputs	Main Body of Activities	Activities	Inputs
4	Project on improvement of emergency response in disaster prevention	Disaster prevention capability in emergency is improved	·Warning/evacuation system is established ·Prompt emergency response to disaster is conducted	·Road disaster prevention department (unit) and staff ·Other Departments and staff ·Regional offices and staff, and supervisors and micro-enterprises ·SEPCOM	·Formulate strategy on emergency evacuation system ·Establish early warning system ·Provide road user with disaster information on time ·Establish cooperative relation with military, police and local entities concerned ·Determine evacuation procedures ·Determine overall framework of disaster response at emergency ·Establish system of emergency mobilization of private sectors ·Propose and apply proper preventive measures ·Strengthen corporative relation with SEPCOM ·Develop laws in immediate emergency response ·Designate procedure to declare of disaster emergency	·Transfer technology by experts and engineers ·Enhance capability with seminars and training ·Prepare road disaster preventive management manuals ·Provide instrument and material ·Enhance enforcement capability through OJT through pilot project, etc.
5	Project on road information enhancement and disclosure	ABC road disaster activities are acknowledged widely	·ABC social contribution is appreciated publicly	·Road disaster prevention department (unit) and staff ·Other Departments and staff	·Enhance public relations and activities with bulletin and Web site ·Hold seminar on road disaster prevention with associations and universities ·Hold seminar on road disaster prevention with associations and universities	·Transfer technology by experts and engineers ·Enhance capability with seminars and training
6	Project on improvement of tender procedures in road disaster prevention	Capability of tender procedures in disaster prevention is improved	·Tender procedures are conducted promptly	·Road disaster prevention department (unit) and staff ·Other Departments and staff	·Prepare standard documents for tendering ·Consider method for contract ·Accelerate transaction by contract committee ·Simplify tendering and approval process ·Clarify responsibility coverage of personnel concerned ·Analysis of local empowerment in tender and contract to ABC regional offices	·Introduction of ISO (WB) ·Execution of PRI(CAF,WB) ·Execution of administrative improvement project(ACDI) Some contents of the project have been already completed
7	Project on formulation of strategy program of disaster prevention budget	Disaster prevention budget is obtained constantly and assuredly	·Disaster prevention activities are continuously executed	·Executive administration Department ·Financial department ·Legal department ·Regional offices	·Secure National Annual Budget (TGN) ·Secure National Road Maintenance Budget (CNCV) ·Secure Local Contribution Budget ·Secure urgent budget for emergency of disaster prevention ·Secure Overseas Assistant Fund as planned ·Secure new financial resource ·Establish new Road Disaster Prevention Fund ·Operate disaster prevention budget efficiently ·Restrict unplanned upgrade from prefecture road to national highway	It is hard to complete the project without any cooperation of related organizations

<Project-6: Improvement of Tender Procedures in Road Disaster Prevention >

This project's goal is to improve tender procedures and upgrade transaction capability at ABC. Sources of tender delays include poor preparation of tender documents as well as bureaucratic delays during the signing process. At present, thanks to overseas technical assistance such as "The ISO9001 Achievement Project by WB" and "The Administrative Improvement Project by CIDA", some parts of documentation processes involved during tendering have gradually improved. Additionally, tender authority has been partially transferred from ABC headquarters to local offices.

<Project-7: formulation of Strategy Program of Disaster Prevention Budget >

This project's goal is to obtain sufficient funds/budget for road disaster preventive management, and along with Project 1 is one of the most important projects in the CD plan. The National Annual Budget (TGN), National Road Maintenance Budget (CN), Local Contribution Budget, and Overseas Assistance Fund, are considered as target sources of funding. Other new additional funding sources, for example the tentatively named "Road Disaster Preventive Fund", are also potential sources for funding. During promotion of this project, adequate judgment and timely action based on current political and social conditions are strongly required as funding matters are subject to political processes.

(3) Overall schedule of the CD plan

The seven (7) proposed projects are planned to be conducted within three (3) years from the commencement of the project as shown in *Figure 5.4.3*. Project 1 is to start at the beginning of the CD plan followed by projects 2 and 4 immediately after establishing the road preventive management department/unit in ABC. Project-3 is envisioned to start at the beginning of the second year of the CD plan. Projects 5, 6, and 7 may be started anytime after completion of Project-1 due to their independence.

5.4.3 Feasibility of Proposed Projects

ABC promotes and manages the road maintenance program as funded by national annual budget (CN). Maintenance works are usually outsourced to construction and consultant companies, micro-enterprises, and individual personnel such as supervisors. To implement the projects in the CD plan, ABC must develop a strong partnership with other concerned organizations including SEPCAM, transportation agencies, and academic societies as well as individuals. It is strongly recommended that all seven projects be executed at the same time in order to gain synergies and momentum for the CD plan.

5.4.4 Evaluation of Proposed Projects

The proposed projects can be evaluated using indexes such as relevance, social impact, expected negative influences, and ABC' views as summarized in *Table 5.4.3*. In any case, all projects (except Project-1) can be started as soon as possible after the road disaster preventive department/unit is established at ABC.

Regarding Projects 2, 3, and 4, advanced technology for enhancement of disaster prevention management can be obtained from overseas countries which have the latest information and technology in this field. As stated in the previous section, some portions of Project 6 are already ongoing, and good outcomes have been produced steadily. With regard to Project-7, both the time of execution and methods used should be judged more carefully as funding is a political decision.

	Project Name	Project Purpose	Activities	1st year												2nd year												3rd year											
				1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
1	Project on Establishment of Road Disaster Preventive Management department (unit)	Road disaster preventive department (unit) is established in SNC	･Specify plinciple of SNC road disaster preventive management ･Establish road Disaster preventive management department (unit) ･Formulate mid and long term plan on national road preventive management ･Organize implementation system of road disaster preventive management ･Formulate strategy on SNC road disaster preventive management ･Establish relationship with other organizations																																					
2	Project on Road Disaster Preventive Technology Improvement	Technology on road disaster preventive management is improved	･Formulate road disaster preventive management program ･Prepare road disaster preventive management manuals ･Transfer basic technology of road disaster preventive management by experts ･Obtain road disaster preventive management technology with seminar, etc. ･Train and improve technology on inspection and assessment of hazardous section in disaster ･Improve technology to select properly preventive measures ･Improve technology to select properly preventive measures ･Enhance enforcement capability through OJT through pilot project, etc. ･Compile data and information on disaster preventive management ･Collect and accumulate expertise in disaster prevention ･Establish database on past disaster data and information ･Establish database on risk section along national highway network																																					
3	Project on establishment of road disaster preventive management system	Road disaster preventive management system is established	･Determine strategy of disaster preventive management ･Transfer technology on disaster preventive management at practical level ･Prepare, save and update road inspection records periodically ･Enhance present information communication system ･Include annual prevention plan in POA ･Select preventive measures and formulate execution plan ･Follow-up disaster prevention and upgrade evaluation system ･Formulate strategy on relative disaster prevention database ･Establish database on disaster inspection result																																					

Figure 5.4.3 Overall schedule of Proposed Projects (1/2)

	Project Name	Project Purpose	Activities	1st year												2nd year												3rd year											
				1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
4	Project on improvement of emergency response in disaster prevention	Disaster prevention capability in emergency is improved	・Formulate strategy on emergency evacuation system ・Establish early warning system ・Provide road user with disaster information on time ・Establish cooperative relation with military, police and local entities concerned ・Determine evacuation procedures ・Determine overall framework of disaster response at emergency ・Establish system of emergency mobilization of private sectors ・Propose and apply proper preventive measures ・Strengthen corporative relation with SEPCOM ・Develop laws in immediate emergency response ・Designate procedure to declare of disaster emergency																																					
5	Project on road information enhancement and disclosure	SNC road disaster activities are acknowledged widely	・Enhance public relations and activities with bulletin and Web site ・Hold seminar on road disaster prevention with associations and universities ・Hold seminar on road disaster prevention with associations and universities																																				
6	Project on improvement of tender procedures in road disaster prevention	Capability of tender procedures in disaster prevention is improved	・Prepare standard documents for tendering ・Consider method for contract ・Accelerate transaction by contract committee ・Simplify tendering and approval process ・Clarify responsibility coverage of personnel concerned ・Analysis of local empowerment in tender and contract to SNC regional offices																																				
7	Project on formulation of strategy program of disaster prevention budget	Disaster prevention budget is obtained constantly and assuredly	・Secure National Annual Budget (TGN) ・Secure National Road Maintenance Budget (CNCV) ・Secure Local Contribution Budget ・Secure urgent budget for emergency of disaster prevention ・Secure Overseas Assistant Fund as planned ・Secure new financial resource ・Establish new Road Disaster Prevention Fund ・Operate disaster prevention budget efficiently ・Restrict unplanned upgrade from prefecture road to national highway																																				

Figure 5.4.3 Overall schedule of proposed projects (2/2)

Table 5.4.3 Evaluation of Proposed Projects

Name of project	Project on Establishment of Road Disaster Preventive Management Department (unit)	Project on Road Disaster Preventive Technology Improvement	Project on Establishment of Road Disaster preventive management System	Project on improvement of emergency response in disaster prevention	Project on road information enhancement and disclosure	Project on improvement of tender procedures in road disaster prevention	Project on formulation of strategy program of disaster prevention budget
Project purpose	Road disaster preventive department (unit) is established in ABC	Technology on road disaster preventive management is improved	Road disaster preventive management system is established	Disaster prevention capability in emergency is improved	ABC road disaster activities are acknowledged widely	Capability of tender procedures in disaster prevention is improved	Disaster prevention budget is continuously obtained
Outputs	Road disaster preventive mechanism is achieved in ABC	Disaster preventive management capability is enhanced	Effective measures for risk section are executed in advance	Warning/evacuation system is established Prompt emergency response to disaster is conducted	ABC social contribution is appreciated publicly	Tender procedures are conducted promptly	Disaster prevention activities are continuously executed
Relevance	Center for disaster preventive management is established	Lack of disaster preventive technology is improved	Accidents induced by natural disasters are reduced due to establishment of disaster preventive management	Social and economic loss is reduced due to emergency prompt response	Social liability is obtained due to increase of transparency of ABC	Management efficiency of tendering is improved due to smooth procedures	Funds are secured and disaster preventive management is executed without any trouble
Social impact	Great impact to ABC and SEPCOM	Small social impact due to technical transferring project	Greatly social impact due to reduction of road disasters	Greatly social and economic impact due to prompt emergency impact	Middle scale impact due to increase in awareness of road disaster preventive activities by ABC		
Possibility of achievement	High possibility because of fundamental agreement inside ABC	High possibility to achieve because of high-level staff in ABC	High possibility to achieve because of well functioned organization of ABC H.Q and provincial offices	Middle in possibility to achieve legal system, secure budget and cooperate with other agencies.	High possibility to achieve due to availability of web-site and monthly bulletin	Some parts of project have been proceeding with assistance of WB,CAF and Canadian government	It is uncertain to achieve because of possible influence from political issue
Independence possibilities	Possible to operate by ABC after completion of project. It is necessary to secure adequate budget.	Sustainability of disaster preventive technology is secured due to well information sharing	Sustainability of project is secured due to well cooperative relationship with ABCs and supervisors and micro-enterprises	Emergency budget is secured and relationship with SEPCOM is necessary	Sustainability is maintained with well function of disaster preventive department (unit)		
Expected negative influence	No negative influence	No negative influence	No negative influence	In the case of not being responsible, system is not functional	Effective of project is dependent on contents of article presented	No negative influence	There are some possibilities for ABC to be exploited for political purposes
ABC' view	Technical assistance from donor countries is requested	Technical assistance from donor countries is requested	Technical assistance from donor countries is requested	Technical assistance from donor countries is requested	ABC can carry out independently	At present, reformation program is under going backuped by WB, CAF and CIDA	Political judgment is necessary for decide when it starts
Comprehensive evaluation	Prompt execution is needed	After establishment of disaster prevention department, prompt execution is needed	After establishment of disaster prevention department, prompt execution is needed	After establishment of disaster prevention department, prompt execution is needed	After establishment of disaster prevention department, prompt execution is needed	Part of proposed project has been already conducting	It is important to start immediately but necessary to judge timing of execution

5.5 Scope of the CD Plan in the JICA Study

5.5.1 JICA Study in the CD Plan

The JICA study covers Projects 1, 2, and 3, but mainly focuses on activities under Project 2 as shown in *Figure 5.5.1*.

5.5.2 Content and Meteorology of the JICA Study

The framework of CD plan activities carried out in the JICA project is shown in *Figure 5.5.2* and *Table 5.5.1*. These activities target ABC's capability enhancement at the personnel, organizational, and social and institutional levels. As indicated in *Table 5.5.1*, capacity development at the personnel level consists of road disaster preventive management technology transfer through cooperative works with ABC counterparts. Development at the organization level consists of provision of intellectual property such as technical manuals, standards, and guidelines; and establishment of a database. *Table 5.5.2* presents the contents of CD activities and the implementation schedule of JICA experts in charge in the JICA project, and *Table 5.5.3* PDM_0 (Project Design Matrix)

5.5.3 Relationship between the Pilot Project and CD Plan

The pilot project, mainly intended to transfer preventive structural measures technology to ABC counterparts, was carried out after slope failure along National Highway 7 between Angostura and Samaipata in Santa Cruz Prefecture caused by heavy rain. The scope of the pilot project consisted of capacity development in the areas of geotechnical investigation, design of disaster preventive countermeasures, cost evaluation, supervision, justification of construction works, and similar areas. The relation between the pilot project and the CD plan is shown in *Figure 5.5.1*.

5.5.4 Relation between Manual Created in the Study and CD Plan

The manual prepared in the study is in accordance with "Formulation of manual preparation for road disaster preventive management" in the CD plan as shown in *Figure 5.5.1*. The Disaster Management Manual is currently under preparation in collaboration with JICA and ABC counterparts and is divided into five (5) guides as shown below:

1) Guide-1: Inspection and Plan
2) Guide-2: Disaster Prevention Measures
3) Guide-3: Ordinary Maintenance
4) Guide-4: Emergency Management
5) Guide-5: Restoration

It is recommended that the manual be revised in response to comments given to the study team and that it be officially authorized by the ABC president and Boarding Committee.

Super goal: Road disasters in Bolivia are reduced

Overall goal: Continuous Road Disaster Preventive Management is executed in ABC

Overall Goal

Project Purpose

- Project on Establishment of Road Disaster Preventive Management Department (unit)
- Project on Road Disaster Preventive Technology Improvement
- Project on Establishment of Road Disaster preventive management System
- Project on improvement of emergency respose in disaster prevention
- Project on road information enhancement and disclosure
- Project on improvement of tender procedures in road disaster prevention
- Project on formulation of strategy program of disaster prevention budget

- **Road disaster preventive department (unit) is established in ABC**
- **Technology on road disaster preventive management is improved**
- **Road disaster preventive management system is established**
- **Disaster prevention capability in emergency is improved**
- **ABC road disaster activities are acknowledged widely**
- **Capability of tender procedures in disaster prevention is improved**
- **Disaster prevention budget is obtained**

Outputs

- Road disaster preventive mechanism is achieved in ABC
- Disaster preventive management capability of ABC is enhanced
- Effective measures for risk section are executed in advance
- Warning/evacuation system is established
- Prompt emergency response to disaster is conducted
- ABC social contribution is appreciated publicly
- Tender procedures are conducted promptly
- **Disaster prevention activities are continuously executed**

Activities

- Specify plinciple of ABC road disaster preventive management
- Formulate road disaster preventive management program
- Determine strategy of disaster preventive management
- Adopt annual prevention plan to POA
- Formulate strategy on dasaster prevention databese
- Formulate strategy on emergency evacuation system
- Determine overall framework of disaster response at emergency
- Develop laws in immediate emergency response
- Enhance public relations and activities with bulletin and web site
- Enhance steakholder to understand importance of road disaster prevention
- Prepare standard documents for tendering
- Simplify tendering and approval process
- Secure National Annual Burget (TGN)
- Secure new financial resources
- Restrict unplaned upgrade from prefecture road to national highway
- Establish road disasterpreventive management department (unit)
- Prepare road disaster preventive management manuales
- Compile data and information on disaster preventive management
- Transfer technology on disaster preventive management at practical level
- Sellect preventive measures and formulate execution plan
- Establish databese on disaster inspection result
- Establish early warning system
- Establish system of quick contract with private sectors
- Designate procedure to declare of disaster emergency
- Hold seminar on road disaster prevention with association and universities
- Consider method for conract
- Clarify responsibility coverage of personnel concerned
- Secure National Road Maintenance urget (CNCV)
- Establish new Road Disaster Prevention Fund
- Formulate mid-long term plan on national road preventive management
- Transfer basic tecnology of road disaster preventive management
- Collect and accumulate expertise in disaster prevention
- Prepare, save and update road inspection records
- Follow-up strategy on relatived disaster prevention databese
- Provide road user with disaster informstion on time
- Propose and apply proper preventive measures
- Accelerate transaction of contract committee
- Analysis of local empowerment in tender and contract to SNC regional office
- Secure Local Contribution Burget
- Operate disaster prevention burget efficiently
- Organize iimplementation system of road disaster preventive management
- Train road disaster preventive management technology with seminar, etc.
- Establish database on disaster data and information
- Enhance present information communication system
- Establish cooperative structure with military, police and local entities concerned
- Strengten cooperative relationship with Sepcom
- Secure urgent budget for emergency of disaster prevention
- Formulate stararegy on ABC road disaster preventive management
- Train and improve technology of inspection, evaluation in road dasaster prevention
- Establish database on risk section s along national highway network
- Determine evacuation procedured
- Secure overseas assistant Fund as planed
- Establish relationship with other organization
- Improve technology to select properly preventive countermeasures
- Enhance capability to prepare technical specification
- Enhance enforcement capability through OJT of pilot project, etc.

LEGEND

- Activities will be executed in the development study
- Activities will be partialy executed through transfer tecnology in the development study
- Activities will be partialy executed through the pilot project in the development study

Figure 5.5.1
Relation between the CD activities and the CD plan

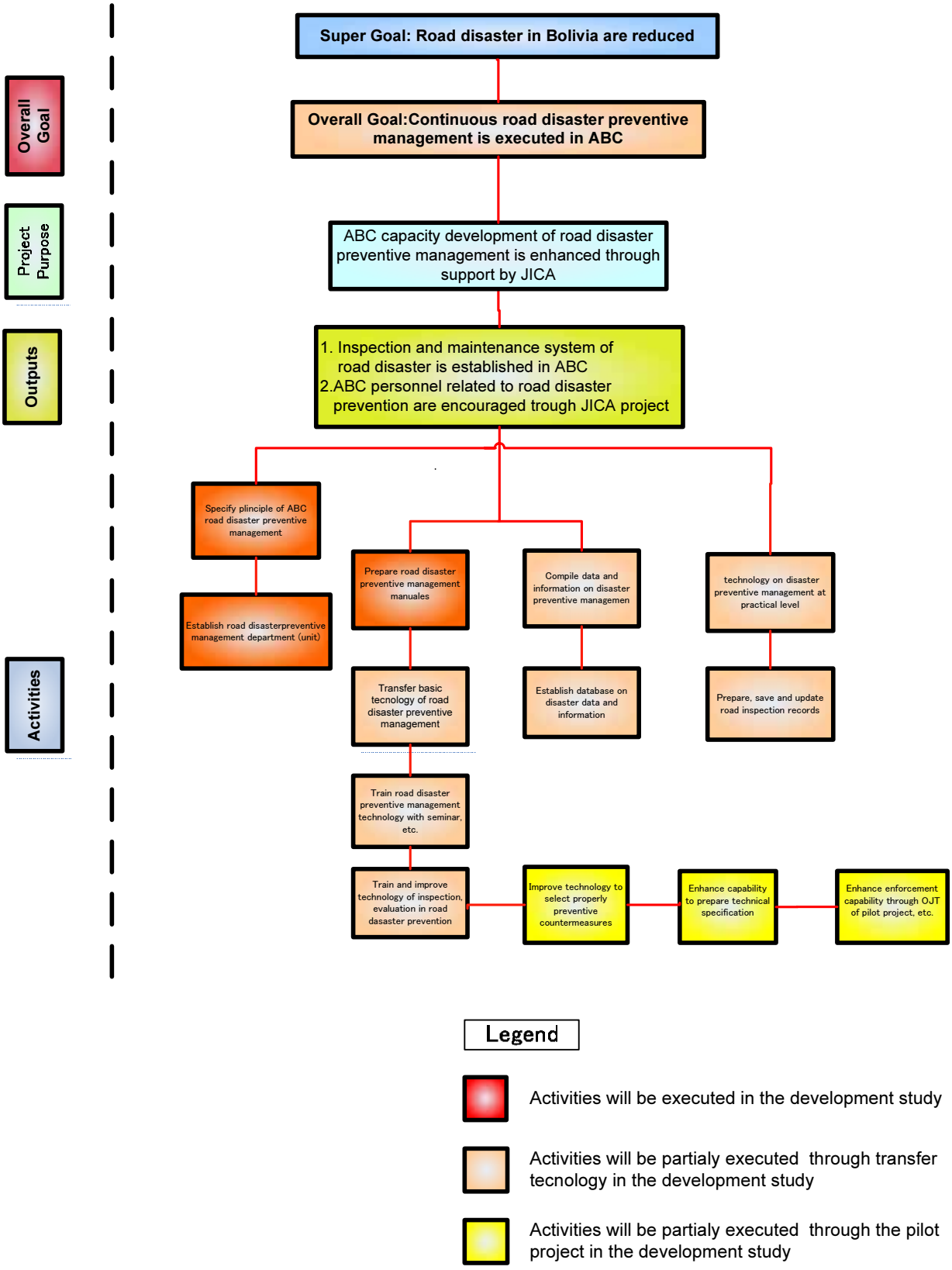

Figure 5.5.2 Framework of CD Activities

Table 5.5.1 Framework of Capacity Development (CD) Plan

CD objectives	Target of CD	Expected effectiveness by CD	Type of CD	Applied method to CD
Individual level	・Staff of each department in ABC ・Staff of each regional office in ABC ・Supervisors ・Micro enterprise ・SEPCOMs ・Private sectors (Contractors, Unions and associations)	・Technology transfer of road disaster preventive management ・Establishment of road disaster preventive management system ・Enhancement capability to plan, manage and inspect preventive measures ・Enhancement of capability to prepare technical specification for tendering ・Strength of technology in warning/evacuation ・Promotion of Information sharing and exchanging among ABC	・Technical knowledge and skill on road disaster preventive management ・Ability to judge in road disaster preventive management on technical basis ・Practical skill to plan, execute and evaluate road disaster preventive measures	・Transfer technology by experts ・Participation in training courses and seminars ・Preparation of road disaster registration records ・Preparation of manuals ・Execution of road disaster registration recording based on manual ・On the job training of planning, management and evaluation on disaster measures at pilot project
Organizational level	・Each department in ABC ・Each regional office in ABC ・SEPCOMs	・Encouragement of disseminating capability of disaster preventive management to outside of ABC ・Establishment of execution organization of disaster preventive management ・Establishment of training system for specialists in disaster preventive management ・Strength of risk evaluation system on critical section along national networks ・Enhancement of capability of warning and evacuation ・Establishment of information communication system ・Enhancement of ability to prepare, renew and store road disaster registration records ・Establishment system of emergency response ・Smooth mobilization of "Contract evaluation committee" ・Formulation of manuals, guidelines and design standard ・Building up databases on technical information ・Establishment of cooperative relationship with other agencies ・Formulation of middle-long term disaster preventive plan ・Improvement to prepare tendering document and specification ・Simplification of tendering documentation ・Formulation of obtainment of fund and budget	・Capacity to promote road disaster prevention in ABC ・Specialist with technology and skill in road disaster preventive management in ABC ・Capability to formulate disaster preventive plan and obtain fund/ budget ・Materials and data necessary for performance ・Information, intellectual property, technical know-how ・Facilitating skill in managing ,regulations and system in ABC ・Cooperative system with outside agencies	・Establishment disaster preventive management department/unit and enhancement of its management ・Transfer technology by experts ・Development of capacity with Participation in workshops and seminars ・Establishment of road disaster preventive management and technology support ・Provision of technical manuals, guidance and standards ・Support of establishment of database ・Technical specification, support of improvement of tendering
System/society level	・All agencies and persons related road disaster prevention ・People, local and industrial societies ・Low and regulation, policy, etc. ・Act, national policy ・Organization structure, authority	・Approval of CD plan by ABC president ・Establishment of disaster preventive unit ・Recognition of importance of disaster prevention ・Update and establishment of laws and regulations ・Securing of national budget of disaster prevention ・Effectively allocation and mobilization by Loan credit ・Establishment of definitely cooperative relationship with other agencies.	・ABC ACT, other regulations ・Road disaster related laws ・Tendering regulation, related laws ・Infrastructure, machine, etc. ・Donor's cooperative system ・Cooperation with other agencies	・Institutional reform in ABC ・Enactment and revision of laws relating disaster prevention ・Awareness of disaster information to the public with Web-site and newsletter. ・ABC's role and obligation at emergency crisis ・Holding Periodical donor's meeting ・Holding stakeholder meeting

Note: ・ Items in red can be identified as the CD activities in the JICA project, including transfer technology to ABC individuals and provision of technical know-how and skill concerning road disaster registration recording and manuals to ABC.
・ Quality control of documentation and transaction, WB proceeding at present, is main task by WB. JICA may support it indirectly.
・ Support for improvement of procurement system in tendering will be planned by WB in the project of BO-3630.

Table 5.5.2 The Contents and Implementation Schedule of CD Activities in JICA Project

<Items of CD activities>	JICA expert in charge	Target persons of CD activities	2006								2007					
			May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June
<Support for CD activities by JICA experts>																
1)Specify principle of ABC road disaster preventive management	Capacity development 1, 2	・Counterparts(CD)														
2)Establish road disaster preventive management department (unit)																
3)Prepare road disaster preventive management manuals	Disaster prevention manual	・Counterparts manual)														
4)Transfer basic technology of road disaster preventive management	Road disaster prevention, Design, Natural condition, Geologist	・Persons in ABC headquarters														
5)Training road disaster preventive management technology with seminaries.	Road disaster prevention, Design, Manual, Geologist	・Persons in ABC headquarters ・Persons in ABC regional offices/ SEPCOM ・Contractors														
6)Train and improve technology of inspection, evaluation in road disaster prevention	Natural condition survey	・Persons in ABC headquarters ・Persons in ABC regional offices/contractors														
7)Compile data and information on disaster preventive management																
8)Establish database on disaster data and information																
①Instruct onsite road disaster registration recording (OJT)	Natural condition survey	・Persons in ABC headquarters ・Persons in ABC regional offices/contractors														
②Establish road disaster registration database	Database/GIS	・Counterparts(GIS) ・Persons in ABC regional offices														
③Formulate road disaster preventive management																
9)Transfer technology on disaster preventive management at practical level																
①Explain manuals to related agencies	Disaster prevention manual	・Persons in ABC headquarters ・Persons in ABC regional offices														
②Revise manual		・Counterparts manual) ・Persons in ABC regional offices														
③Transfer road disaster preventive management using manual (OJT)		・Persons in ABC regional offices/contractors ・Micro enterprises														
10)Prepare, save and update road inspection																
<Support for CD activities through pilot project>																
11)Improve technology to select properly preventive countermeasures																
①Geological investigation for selection of preventive measures	Natural condition survey	・Persons in ABC headquarters ・Persons in ABC regional offices/contractors														
②Methodology of disaster measures selection	Design, Natural condition survey															
12)Enhance capability to prepare technical specification																
①Topographic survey	Natural condition survey	・Persons in ABC regional offices ・Persons in ABC regional offices/contractors														
②design	design															
③pilot project	Construction plan/cost estimate/supervisor															
13)Enhance enforcement capability through OJT of pilot project, etc.																
①Support tender of topographic/geological survey	Natural condition survey	・Persons in ABCheadquarters ・Persons in ABC regional offices/contractors														
②Plan/execute/analysis geological investigation																
③Support tender of design of measures	Design															
④Design road disaster preventive measures																
⑤Plan of disaster construction management and estimate construction cost	Construction plan/cost estimate/supervisor															
⑥Support order of pilot work																
⑦Execute construction supervision of pilot works																
⑧Inspect completion of pilot work																

Table 5.5.3 PDM_0 of CD Activities in JICA Project

Project Name: Capacity Development (CD) activities for ABC road disaster preventive management Duration of project: October 19, 2005 to the middle of June, 2007 (21months) Ver.No:PDM_0

Main Body of Activities: Headquarters and regional office of ABC, and other related persons As of May 24, 2006

Narrative Summary	Objectively Verifiable indicators	Means of Verification	Important Assumption
Super Goal: Road disasters in Bolivia are reduced. **Overall Goal:** Continuous road disaster preventive management is executed in ABC	- Long term blockade caused by natural disasters is reduced along national highways in Bolivia. - Budget for road disaster preventive management is secured annually.	- Report on road disasters by maintenance department and/or regional offices in ABC - Financial report by financial department in ABC	- ABC's inner structural is not changed drastically.
Project purpose: ABC Capacity Development of road disaster preventive management is enhanced through support by JICA experts.	1. ABC's principle in road disaster preventive management is defined (ABC president's approval of the CD plan) 2. Transfer technology in road disaster preventive management is achieved effectively in ABC. 3. Knowledge and know-how related to road disaster preventive management is accumulated in ABC. 4. Road disaster preventive management is conducted based on the manual constantly in ABC.	1. Official document to prove ABC president's approval of the CD plan. (ABC president's signature) 2. CD evaluation report (JICA experts), interview records 3. Official document to prove ABC president approval of the manual (ABC president's signature) 4. Road disaster registration records, road disaster inspection sheets, road disaster database, rainfall observation records and interview records.	- Counterparts are secured continuously during the project.
Outputs: 1. Road inspection and maintenance system of road disaster is established in ABC. 2. ABC personnel having knowledge and skill in road disaster preventive management are encouraged through JICA project.	1. Road disaster preventive management unit is established and its executing system is fixed 2. Manuals and databases on road disaster preventive management are fully equipped. 3. Critical and highly risk points along national highways are revealed routinely by road disaster registration recording and inspection, and prompt response is improved 4. Transfer technology is achieved by training and seminar to ABC staff concerned.	1. Member list of road disaster preventive management department/unit, activity report. 2. Road disaster preventive manuals, road disaster database 3. Road disaster registration records, report of countermeasures to road disasters, evaluation checking list 4. Evaluation check list, questionnaire survey to seminar participants, interview records, construction record	- Cooperation from ABC headquarters and regional offices is secured continuously during the project. - Opportunity to obtain technology is secured.
Activities: 1. Specify principle of ABC road disaster preventive management (ABC president approval) 2. Establish road disaster preventive management department (unit) 3. Prepare road disaster preventive management manuals 4. Transfer basic technology of road disaster preventive management 5. Training road disaster preventive management technology with seminaries. 6. Train and improve technology of inspection, evaluation in road disaster prevention 7. Compile data and information on disaster preventive management 8. Establish database on disaster data and information 9. Transfer technology on disaster preventive management at practical level 10. Prepare, save and update road inspection 11. Improve technology to select properly preventive countermeasures 12. Enhance capability to prepare technical specification 13. Enhance enforcement capability through OJT of pilot project, etc.	**Inputs:** <Japan> Personnel [JICA Project team] Team Leader/Road Disaster Prevention 10.27 M/M Deputy Team Leader/Capacity Development 9.44 M/M Design for Road Disaster Prevention 5.27 M/M Disaster Prevention Manual 8.17 M/M Geologist for Collapse Mechanism 2.00 M/M Natural Condition Survey 4.10 M/M Construction Planning and Cost Estimation 10.77 M/M Environmental Assessment 2.30 M/M Capacity Development 7.17 M/M Database/GIS 1.00 M/M Total 60.49 M/M Holding of training and seminar 3 times Transfer technology through pilot project (slope failure at road shoulder and frame work for slope stability) 2 types of structure measures Provision of materials GIS software 1 set	<ABC in Bolivia> Personnel [ABC headquarters (Counterparts)] Chief coordinator 1 person Coordinator 1 person Planning and research department 3 persons Social environmental department 2 persons Construction department 2 persons Maintenance department 1 person Financial department 1 person Justice department 1 person Total 12 persons Provision of facilities 1 set	- Trained engineers continue to work for ABC **Preconditions:** - No political conflict takes place.

5.6 Recommendations for the CD Plan

(1) Sustainability

For promoting the proposed projects, the most important considerations are project ownership by ABC and the stable obtainment of execution funds and budget. Regarding project ownership, establishment of the road disaster preventive management department/unit in ABC described in Project-1 is the first priority of the CD plan. Consistent budget acquisition will require ABC's strong intention to achieve the projects, to increase awareness by the public, and to gain approval and assistance from the related government organizations involved.

(2) Schedule of implementation and framework of the CD plan

It is essential that the proposed projects in the CD plan be carried out simultaneously and extensively within three (3) years as planned. Among the proposed projects, Project-1 is the most important and should be completed as soon as possible. Since Project-2 and 3 are related in terms of project contents, it is possible to conduct them as one project.

(3) Monitoring and evaluation

Aiming at sustainability and effectiveness of the CD plan, project monitoring and evaluation should be conducted continuously throughout project implementation. The evaluation should be conducted based on the following evaluation index, as described in "PCM: Monitoring and Evaluation Based on the PCM Method: FASID, Japan:"

1) Relevance
2) Efficiency
3) Effectiveness
4) Impacts
5) Sustainability

(4) Establishment of the disaster prevention department /unit and selection of its members

Members of the department/unit are strongly recommended to have knowledge and experience with road disaster preventive management. Particularly, the present counterparts working with the JICA study team are considered to be suitable as members of the department/unit, because they have already obtained road disaster preventive management skills through technology transfer by JICA experts. At least seven (7) members are recommended to be assigned to the disaster prevention department/unit as follows:

- Project manager (project leader)
- Geologist / geotechnical engineer
- Hydro / Hydrologist
- Design / cost estimate expert
- Financial expert
- Judicial expert
- Secretary (excellent in English)

(5) Disaster preventive works under the pilot project

The pilot project did not cover all types of preventive structural measures considered for use in Bolivia due to JICA budget constraints. Several disaster preventive measures, for example measures against debris flow, rock mass collapse / rock fall, and large scale landslide, could not be selected in spite of ABC requests. Natural road disasters occur frequently in Bolivia as a result of the Andes Region's unique geological characteristics. It is believed that technical transfer through OJT (on-the-job-training) as in the pilot project will be more efficient and effective than classroom training.

(6) Cooperative implementation of the CD Plan with Donors

In Bolivia, the CD plan formulated during the JICA project is the first comprehensive plan for enhancement of road disaster preventive management. As a result of discussions regarding the CD plan with WB, IDB, and CAF, they expressed their desire to make cooperative contributions towards implementation of the CD plan. It is recommended that ABC develop a detailed action plan to accelerate the CD plan with support from other organization and donors.

Chapter 6

Site Survey and Creation of Road Disaster Registration System

Chapter 6 Site Survey and Creation of Road Disaster Registration System

6.1 General

The field survey along the selected national highways was carried out by ABC counterpart under the instruction of JICA expert in order to specify the critical sites from a viewpoint of geological perception. The risk points concerning sediment-related road disaster were finally identified at the past disaster sites on the basis of present disaster potential. The sections and period for the site survey were listed in *Table 6.1.1*.

Table 6.1.1 Sections and Period of Site Survey

Route No.	Section		Distance	Period of the Survey	
	From	To		From	To
Route 3	Cotapata	Yucumo	275km	Dec. 1, '05	Dec. 6, '05
Route 4	Colomi	Ivirgarzama	172km	Nov. 14, '05	Nov. 15, '05
Route 7	Epizana	El Torno	337km	Nov. 16, '05	Nov. 18, 05
Route 16	Charazani	Apolo	164km	Nov. 25, '05	Nov. 27, '05

As a result of the survey, 259 sites were identified as high risk sites and "diagnosis cards" were prepared at each site with descriptions of following items. Diagnosis card is shown in *Figure 6.1.1*.

- Route No.
- Approximate distance*
- Disaster type
- Geology (condition of bedrock, weathering)
- Type of existing countermeasure work
- Foreseen risks
- Sketch or photograph
- Date of survey
- Proposed countermeasure work

* Distance is identified based on the display of car odometer indicating the kilometer from a starting point.

It is essential that the diagnosis cards prepared in the site survey by compiled for future road disaster preventive management. Hazard level of each site in the diagnosis cards was determined by the following criteria.

- Hazard Level A: Slope is clearly unstable and preventive measures are urgently required.
- Hazard Level B: Slope is unstable. Additional investigation and judgment are required for application of preventive measures.
- Hazard Level C: Slope is rather unstable. Continuously monitoring is required.
- Hazard Level D: Slope is almost stable. No preventive measures are required.

DIAGNOSIS CARD FOR ROAD DISASTERS	Classification Number: 18 (16:40)	GPS Number: 290

Record of Inspection

Route Number. 3	121.5 Km	Date: 01/ 12 / 2005	Weather Conditions:
Latitude (S) 16 ° 02 ' 08,1 "	Longitude (O) 67 ° 37 ' 57,1 "		Checked by: Hayashi

Disaster type:	Rock fall	Main Reasons:	Block separation
Type of Structure:	Gravel road	Dimension (H/L):	10 mt / 10 mt
Geology · Geological Structure:	Steeply dipping sandstone.	Meteorological Characteristics:	> 3000 mm/year 20 ºC
Stability — Rocks:	Hard and massive.		
Stability — Weathering · Shearing:	Weak to none.		
Stability — Superficial · Underground Water:	Not observed.		
Existent Preventive Works:	None.		
Foreseen Risk (Influence over the road):	Covered with blocks.		
Remarks:	Downhill bedding plane. N30° W, 57° E.		
Proposed Works:	Free frame with rock anchor.		

Record of Photographs

Front Photograph

Sketch

Partial Photograph 1

Partial Photograph 2

Partial Photograph 3

Partial Photograph 4

Record of Disasters

Point (km)	Disaster Type	Date and Time of Ocurrence	Days with the road close	Risk Classification	Implemented Preventive Works

Figure 6.1.1 Diagnosis Card

6.2 Summary of the Results

The locations of the risk sites identified in the site survey are shown in *Figure 6.2.1 ~Figure 6.2.4* and results of the site survey were summarized in *Table 6.2.1 ~ Table 6.2.4*. The general conditions in risk of each selected national highways are at the time of the site survey as follows:

(1) Route 3

97 disaster sites were identified on Route 3, where 42 sites of rock fall and 28 sites of debris fall accounted for 44% and 30% respectively. In the mountainous area between 125km and 134km, where terrain of over-steep cliffs along the road and the river is mainly underlain by steeply dipping massive sandstone, rock falls are caused by block separation of loosened joint planes.

In the hilly area between 290km and 310km, rock falls are caused by differential weathering of gently dipping reddish brown sandstone and siltstone.

No disaster site at hazard level A exists in this section.

(2) Route 4

27 disaster sites were examined on Route 4. Distribution of these sites is restricted in the section between 70km and 144km; while 10 sites are evaluated hazard level A.

7 sites of large-scale debris flow are located in the lower parts of tributary streams. They are caused by slope failures of their catchment area. A large-scale landslide occurred at the point of 114.2km, which seems to be caused by unsuitable cutting with construction of the road.

(3) Route 7

53 disaster sites were checked on Route 7, where 17 sites of rock fall and 16 sites of debris fall are distributed. Furthermore, 6 sites of debris flow are observed in the district between 233km and 438km, which is called “Siberia”. A large-scale landslide occurred at the point of 270.9km.

6 sites are evaluated to be at hazard level A, in which 4 sites of debris flow are included on Route 7,

(4) Route 16

81 disaster sites were checked on Route 16, where 26 sites of rock fall and 24 sites of debris fall occupy 32% and 30% respectively. Existence of a large-scale landslide is supposed at the point of 265.3km, where very thick debris is deposited. At several points, fallen trees with slash-and-burn farming disturb traffics.

Only 2 sites of debris flow are evaluated hazard level A, on Route 16.

<Additional Information>
In Bolivia, a large number of sediment-related disasters occurred along the national highways No.4 and No.7 from December 2006 to April 2007, resulted from heavy rainfall by El Niño phenomenon. These disasters took place not only at the same places as the past disaster occurrence sites, but also many unexpected places having no records of disasters.

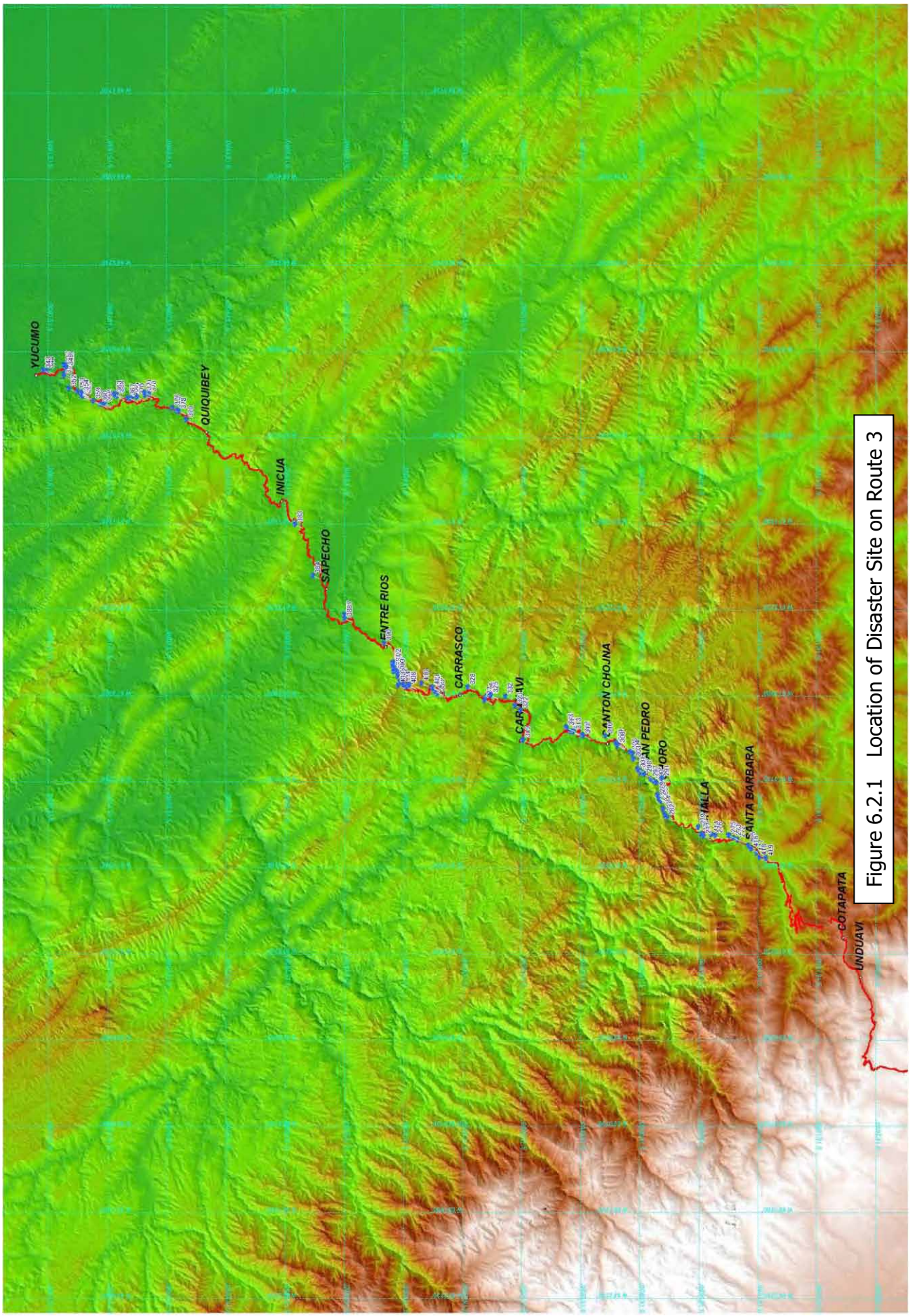

Figure 6.2.1 Location of Disaster Site on Route 3

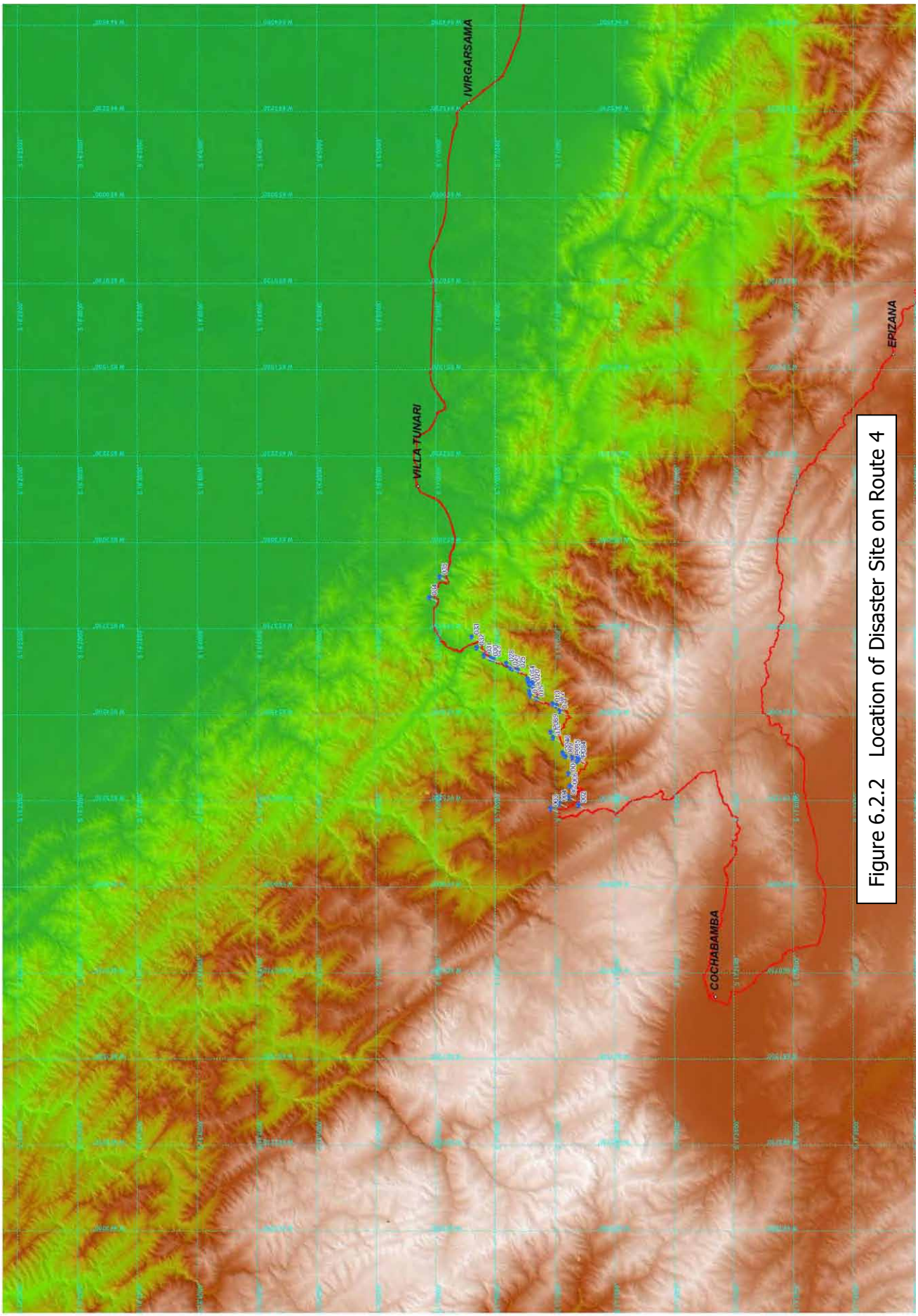

Figure 6.2.2 Location of Disaster Site on Route 4

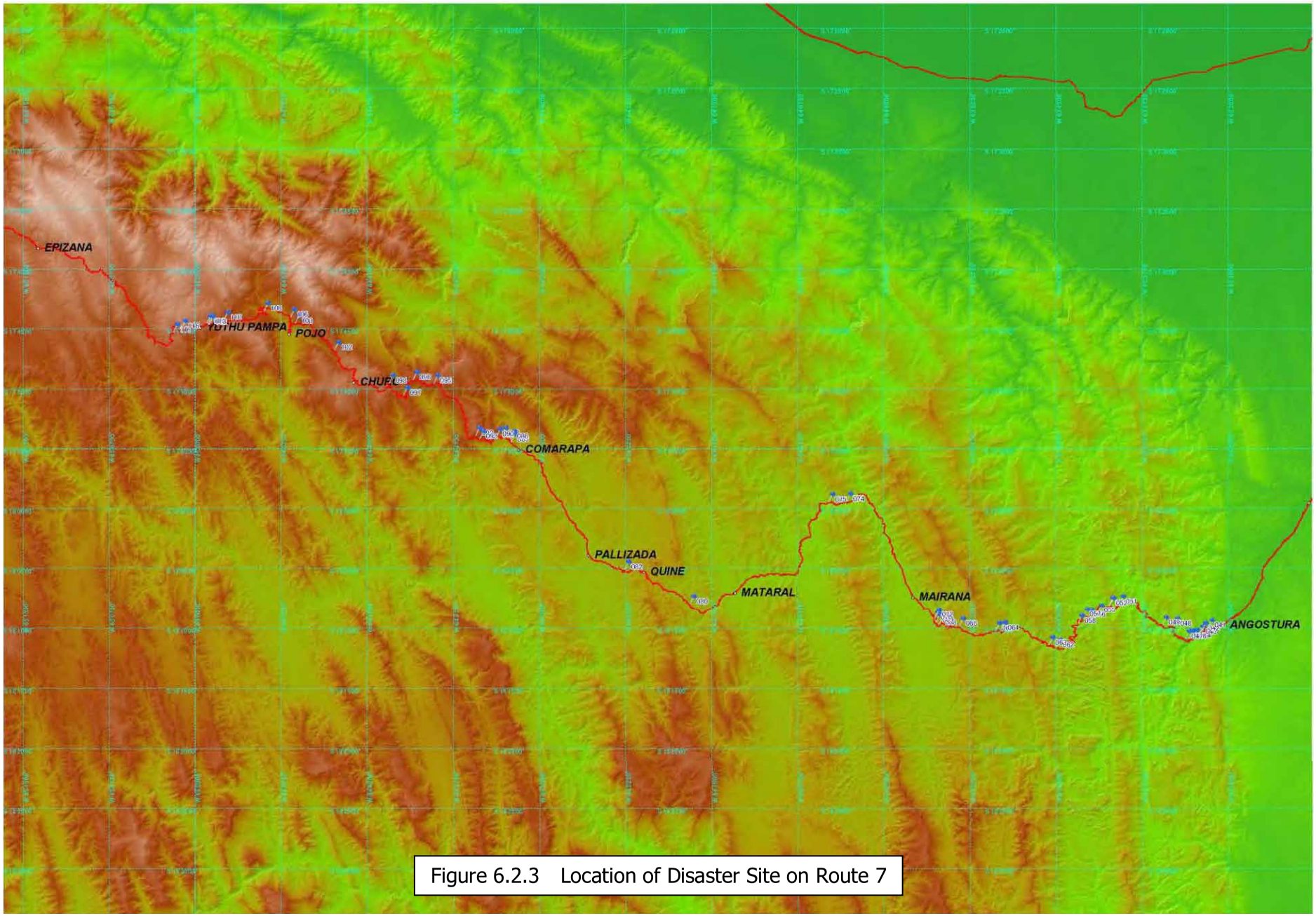

Figure 6.2.3 Location of Disaster Site on Route 7

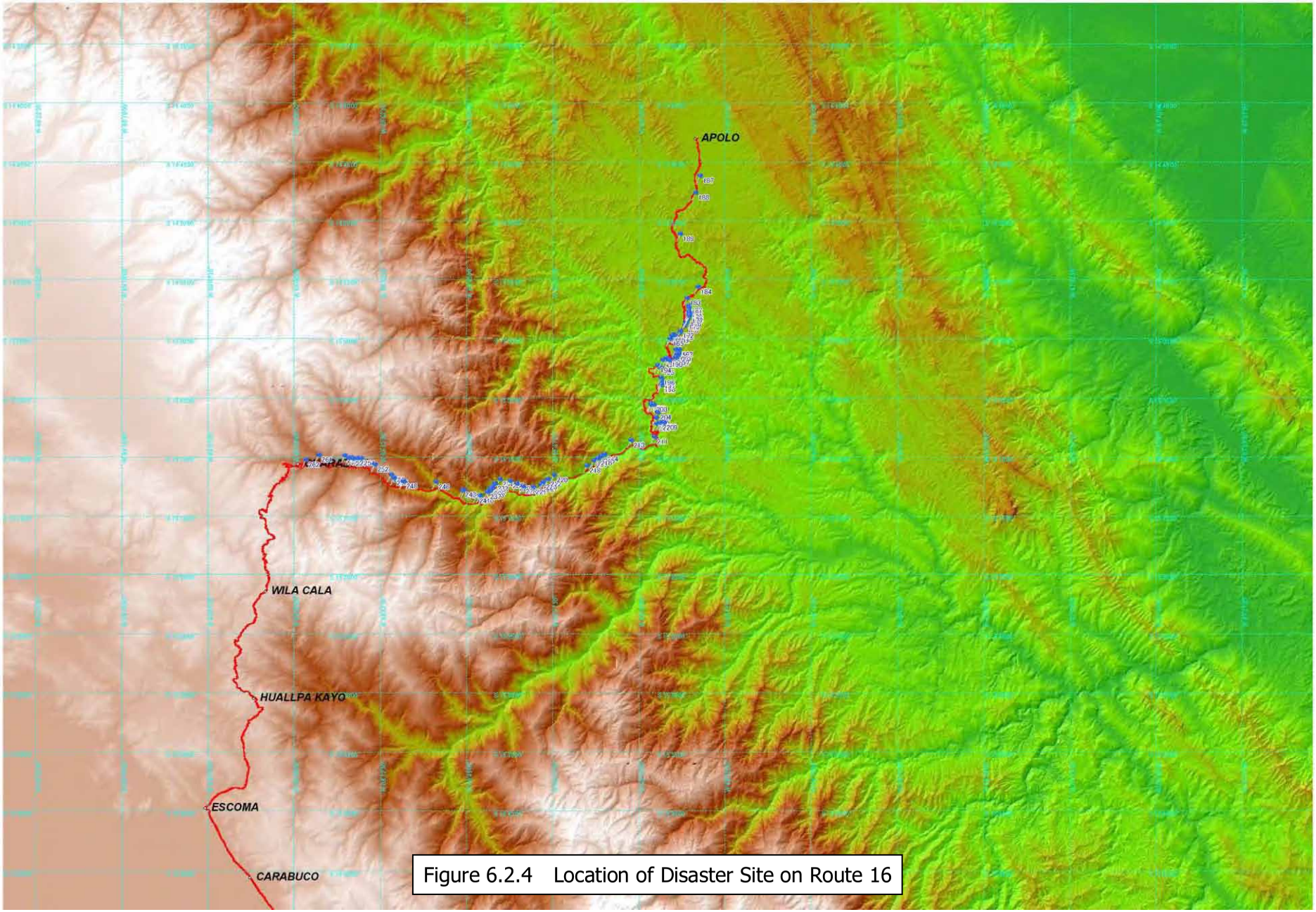

Figure 6.2.4 Location of Disaster Site on Route 16

List of Disaster Sites on Route 3 Tabla 6.2.1 Resultados del Estudio en la Ruta 3

No.	*Distance (km)*	*Main Disaster Type*	*Elementary Reason*	*Type of Structure*	*Geology • Geological Structure*	*Meteorological Characteristics*	*Foreseen Risk*	*Proposed Works*	*Hazard Level*
1	99.6	Debris fall	Steep slope	Gravel road	Talus deposits	> 3000 mm/year 20 ºC	Covered with debris.	Bench cut	C
2	100.3	Debris fall	Gully erosion	Gravel road	Talus deposits	> 3000 mm/year 20 ºC	Covered with debris.	Bench cut	C
3	101.7	Debris fall	Unsuitable cutting	Gravel road Bridge	Gently dipping shale. Talus deposits	> 3000 mm/year 20 ºC	Covered with debris.	Cutting	C
4	104.4	Debris fall	Unsuitable cutting	Gravel road Bridge	Gently dipping shale.	> 3000 mm/year 20 ºC	Covered with debris.	Retaining concrete wall	C
5	107.6	Debris fall	Gully erosion	Gravel road	Steeply dipping shale.	> 3000 mm/year 20 ºC	Covered with debris.	Concrete retaining wall	C
6	108.1	Debris fall	Gully erosion	Gravel road	Gently dipping shale	> 3000 mm/year 20 ºC	Covered with debris.	Concrete retaining wall	C
7	110.4	Unsuitable Construction	The construction of a bridge	Gravel road Bridge	Gently dipping sandstone	> 3000 mm/year 20 ºC	None.	None	D
8	113.9	Debris fall	Fracture zone	Quarry site	Gently dipping shale.	> 3000 mm/year 20 ºC	None	None	D

No.	*Distance (km)*	*Main Disaster Type*	*Elementary Reason*	*Type of Structure*	*Geology • Geological Structure*	*Meteorological Characteristics*	*Foreseen Risk*	*Proposed Works*	*Hazard Level*
9	114.7	Erosion of shoulder	Drained water	Underdrainage lined with stones	Embankment	> 3000 mm/year 20 ºC	Collapse of the shoulder.	None	D
10	118.5	Debris fall	Unsuitable drainage	Gravel road	Talus deposits	> 3000 mm/year 20 ºC	Covered with debris.	Removal of the debris	D
11	118.7	Debris fall	Superficial water	Gravel road	Steeply to gently folded sandstone.	> 3000 mm/year 20 ºC	Covered with debris.	None	D
12	118.8	Debris fall	Downhill bedding plane	Gravel road	Moderately dipping sandstone	> 3000 mm/year 20 ºC	Covered with debris	Concrete retaining wall	B
13	119.3	Debris fall	Steep slope	Gravel road	Talus deposits. Gently dipping shale.	> 3000 mm/year 20 ºC	Covered with debris.	Cutting	B
14	121.5	Rock fall	Block separation	Gravel road	Steeply dipping sandstone.	> 3000 mm/year 20 ºC	Covered with blocks.	Free frame	B
15	122.9	Debris fall	Steep cutting	Gravel road Bridge	Talus deposits and jointed massive sandstone.	> 3000 mm/year 20 ºC	Covered with debris	Check of the design of road and bridge	C
16	124.5	Erosion of shoulder	River erosion	Gravel road	Embankment	> 3000 mm/year 20 ºC	Collapse of the shoulder	Revetment with concrete retaining wall	C
17	125.2	Rock fall	Block separation	False tunnel	Steeply dipping jointed sandstone.	> 3000 mm/year 20 ºC	Damage to the road by fallen blocks.	Removal of the overhanging blocks	B

No.	*Distance (km)*	*Main Disaster Type*	*Elementary Reason*	*Type of Structure*	*Geology • Geological Structure*	*Meteorological Characteristics*	*Foreseen Risk*	*Proposed Works*	*Hazard Level*
18	126.5	Rock fall	Block separation	Gravel road	Steeply dipping jointed sandstone.	> 3000 mm/year 20 ºC	Damage to the road by fallen blocks.	Removal of the overhanging blocks	B
19	126.8	Erosion of shoulder	River erosion	Gravel road	Embankment	> 3000 mm/year 20 ºC	Collapse of the shoulder.	Banking	B
20	127.1	Debris fall	Fracture zone	Quarry site	Strongly folded shale.	> 3000 mm/year 20 ºC	Covered with debris.	Gabion wall	D
21	127.8	Rock fall	Block separation	Gravel road	Steeply dipping jointed sandstone.	> 3000 mm/year 20 ºC	Damage to the road by fallen blocks.	Removal of the overhanging blocks	B
22	127.9	Debris flow	Undercut slope	Gravel road Crossing of the creek	Talus deposits.	> 3000 mm/year 20 ºC	Covered with debris.	Revetment with gabion	C
23	129.7	Rock fall	Block separation	Gravel road	Vertically dipping jointed sandstone.	> 3000 mm/year 20 ºC	Damage to the road by fallen blocks.	Removal of loosen blocks	D
24	130.6	Rock fall	Block separation	Gravel road	Vertically dipping jointed sandstone.	> 3000 mm/year 20 ºC	Damage to the road by fallen blocks.	Removal of the overhanging blocks	B
25	131.1	Rock fall	Block separation	Gravel road	Vertically dipping jointed sandstone.	> 3000 mm/year 20 ºC	Damage to the road by fallen blocks.	Removal of the overhanging blocks	B
26	133.6	Rock fall	Block separation	Gravel road	Vertically dipping jointed sandstone.	> 3000 mm/year 20 ºC	Damage to the road by fallen blocks.	Tunnel	B

No.	*Distance (km)*	*Main Disaster Type*	*Elementary Reason*	*Type of Structure*	*Geology • Geological Structure*	*Meteorological Characteristics*	*Foreseen Risk*	*Proposed Works*	*Hazard Level*
27	136.8	Debris fall	Steep slope	Quarry site Gravel road	Talus deposits. Gently dipping shale.	> 3000 mm/year 20 ºC	Covered with debris.	Gabion wall	D
28	141	Debris fall	Steep slope	Quarry site Gravel road	Talus deposits.	> 3000 mm/year 20 ºC	Covered with debris.	Gabion wall	D
29	141.5	Debris fall	Steep slope	Gravel road	Gently dipping shale	> 3000 mm/year 20 ºC	Covered with debris.	Concrete retaining wall	C
30	143.7	Debris fall	Downhill bedding plane	Gravel road	Moderately dipping sandstone	> 3000 mm/year 20 ºC	Covered with debris.	Free frame	C
31	143.8	Debris fall	Steep slope	Gravel road	Moderately dipping sandstone	> 3000 mm/year 20 ºC	Covered with debris.	Rock-net	C
32	145.5	Disturbance by floodwater	Heavy rain	Gravel road Crossing of the creek	River deposits.	> 3000 mm/year 20 ºC	Obstruction of traffic by flood.	Culvert	C
33	146.8	Rock fall (wedge-form collapse)	Block separation	Gravel road	Gently dipping massive sandstone	> 3000 mm/year 20 ºC	Covered with fallen rocks.	Spraying	C
34	156.6	Rock fall	Block separation	Gravel road Underdrainage	Moderately dipping jointed sandstone.	> 3000 mm/year 20 ºC	Covered with fallen rocks. Collapse of the shoulder.	Bench cut	C
35	167.3	Rock fall	Block separation	Gravel road	Moderately dipping sandstone.	1000 - 2000 mm/year 23 ºC	Covered with fallen rocks.	Rock-net	D

No.	*Distance (km)*	*Main Disaster Type*	*Elementary Reason*	*Type of Structure*	*Geology • Geological Structure*	*Meteorological Characteristics*	*Foreseen Risk*	*Proposed Works*	*Hazard Level*
36	168.6	Rock fall	Steep slope	Gravel road	Steeply dipping sandstone.	1000 - 2000 mm/year 23 ºC	Covered with rocks.	Rock-net	C
37	174.8	Debris fall	Gully erosion	Gravel road	Talus deposits.	1000 - 2000 mm/year 23 ºC	Covered with debris.	Cutting	C
38	174.9	Small scale landslide	Fracture zone	Gravel road	Talus deposits	1000 - 2000 mm/year 23 ºC	Covered with debris.	Concrete retaining wall	C
39	175.7	Debris fall	Underground water	Gravel road	Talus deposits	1000 - 2000 mm/year 23 ºC	Covered with debris.	Drainage system	B
40	181.7	Rock fall	Steep slope	Gravel road	Gently dipping platy sandstone	1000 - 2000 mm/year 23 ºC	Damage of the road by fallen rocks.	Removal of loosen blocks	C
41	185.3	Debris fall	Steep slope	Gravel road	Steeply dipping mudstone and slate	1000 - 2000 mm/year 23 ºC	Covered with debris.	Bench cut	B
42	186.3	Debris flow	Slaking	Gravel road Gutter	Steeply dipping mudstone and slate	1000 - 2000 mm/year 23 ºC	Covered with debris.	Concrete retaining wall	C
43	186.5	Debris flow	Slaking	Gravel road	Steeply dipping mudstone and slate	1000 - 2000 mm/year 23 ºC	Covered. With debris.	Retaining wall	C
44	188.4	Debris fall	Fracture zone	Gravel road	Steeply dipping sandstone.	1000 - 2000 mm/year 23 ºC	Covered with debris.	According to the investigation	C

No.	*Distance (km)*	*Main Disaster Type*	*Elementary Reason*	*Type of Structure*	*Geology • Geological Structure*	*Meteorological Characteristics*	*Foreseen Risk*	*Proposed Works*	*Hazard Level*
45	189.8	Debris flow	Steep slope	Gravel road	Steeply dipping mudstone.	1000 - 2000 mm/year 23 ºC	Covered with debris.	Rock-net	C
46	193.4	Rock fall	Block separation	Gravel road	Steeply dipping mudstone and slate	1000 - 2000 mm/year 23 ºC	Covered with rocks.	Underdrainage	B
47	193.7	Debris flow	Fracture zone	Gravel road	Debris	1000 - 2000 mm/year 23 ºC	Covered with debris.	Groundsill	B
48	193.7	Rock fall	Fracture zone	Gravel road	Steeply dipping shale.	1000 - 2000 mm/year 23 ºC	Covered with rocks.	Spraying	B
49	194.2	Rock fall	Steep slope	Gravel road	Folded siltstone	1000 - 2000 mm/year 23 ºC	Covered with debris.	Spraying	C
50	194.2	Rock fall	Block separation	Gravel road	Steeply dipping jointed sandstone.	1000 - 2000 mm/year 23 ºC	Damage to the road by fallen rocks.	Spraying	B
51	195	Rock fall	Steep slope	Gravel road	Moderately folding jointed siltstone.	1000 - 2000 mm/year 23 ºC	Covered with rocks.	Spraying	D
52	196.2	Debris fall	Steep slope	Quarry site	Moderately folding jointed siltstone.	1000 - 2000 mm/year 23 ºC	None.	None	D
53	197.7	Debris fall	Steep slope	Gravel road Quarry site	Moderately folding jointed siltstone.	1000 - 2000 mm/year 23 ºC	Covered with debris	Spraying	C

No.	*Distance (km)*	*Main Disaster Type*	*Elementary Reason*	*Type of Structure*	*Geology • Geological Structure*	*Meteorological Characteristics*	*Foreseen Risk*	*Proposed Works*	*Hazard Level*
54	199.3	Debris fall	Steep slope	Gravel road Quarry site	Moderately folding jointed siltstone.	1000 - 2000 mm/year 23 ºC	Covered with debris	Concrete retaining wall	B
55	200.8	Debris fall	Downhill bedding plane	Gravel road Quarry site	Moderately dipping jointed siltstone.	1000 - 2000 mm/year 23 ºC	Covered with debris	Gabion wall	D
56	201.2	Rock fall	Block separation	Gravel road	Steeply dipping jointed sandstone.	1000 - 2000 mm/year 23 ºC	Damage to the road by fallen rocks.	Spraying	B
57	201.9	Large scale debris fall	Fracture zone	Gravel road	Steeply dipping shale.	1000 - 2000 mm/year 23 ºC	Collapse of the road.	According to the investigation	B
58	202.6	Rock fall	Steep slope	Gravel road	Steeply dipping sandstone.	1000 - 2000 mm/year 23 ºC	Damage to the road by fallen rocks.	Cutting	C
59	202.8	Rock fall	Slope failure of the catchment area	Gravel road	Gently dipping sandstone.	1000 - 2000 mm/year 23 ºC	Damage to the road by fallen rocks.	Screen for fallen stones	B
60	203.8	Debris fall	Fracture zone	Quarry site	Moderately dipping siltston	1000 - 2000 mm/year 23 ºC	Covered with debris.	Cutting	C
61	203.9	Rock fall	Fracture zone	Gravel road	Reddish brown jointed sandstone.	1000 - 2000 mm/year 23 ºC	Damage to the road by fallen rocks.	According to the investigation	C
62	204.1	Rock fall	Downhill bedding plane	Gravel road	Moderately dipping sandstone.	1000 - 2000 mm/year 23 ºC	Covered with debris.	Bench cut	C

No.	*Distance (km)*	*Main Disaster Type*	*Elementary Reason*	*Type of Structure*	*Geology • Geological Structure*	*Meteorological Characteristics*	*Foreseen Risk*	*Proposed Works*	*Hazard Level*
63	208.7	Landslide	Underground water	Gravel road	Debris and lateritic soil	1000 - 2000 mm/year 23 ºC	Deformation of the road	According to the investigation	C
64	218.1	Rock fall	Differential erosion	Gravel road	Gently dipping red siltstone and sandstone	1000 - 2000 mm/year 23 ºC	Damage to the road by fallen rocks.	None	D
65	218.5	Rock fall	Differential erosion	Gravel road	Gently dipping red siltstone and sandstone	1000 - 2000 mm/year 24 ºC	Damage to the road by fallen rocks.	Free frame	D
66	218.8	Hole of the road	Not clear	Bridge	Banking material	1000 - 2000 mm/year 23 ºC	Enlargement of the hole.	Back filling	C
67	226.1	Deformation of the bridge girder	Weak foundation of the pier	Bridge	River deposits	1000 - 2000 mm/year 24 ºC	Slide of the girder	Check of the foundation of the pier	B
68	286.8	Landslide	Not clear	Asphalt pavement Gutter	Debris	1000 - 2000 mm/year 24 ºC	Deformation of the road	Repair of the pavement	C
69	287	Landslide	Underground water	Asphalt pavement	Debris	1000 - 2000 mm/year 24 ºC	Deformation of the road	According to the investigation	C
70	288	Debris fall	Fracture zone	Gravel road	Debris	1000 - 2000 mm/year 24 ºC	Covered with debris.	Leaning concrete wall for the base	C
71	293.9	Rock fall	Block separation	Gravel road	Gently dipping reddish brown sandstone	1000 - 2000 mm/year 24 ºC	Damage to the road by fallen blocks.	None	D

No.	*Distance (km)*	*Main Disaster Type*	*Elementary Reason*	*Type of Structure*	*Geology • Geological Structure*	*Meteorological Characteristics*	*Foreseen Risk*	*Proposed Works*	*Hazard Level*
72	294.6	Rock fall	Block separation	Gravel road	Gently dipping reddish brown sandstone	1000 - 2000 mm/year 24 ºC	Damage to the road by fallen blocks.	Observation	C
73	295.1	Rock fall	Steep slope	Gravel road	Gently dipping reddish brown siltstone and sandstone	1000 - 2000 mm/year 24 ºC	Damage to the road by fallen blocks.	Cutting	D
74	296.9	Rock fall	Downhill bedding plane	Gravel road	Gently dipping platy sandstone	1000 - 2000 mm/year 24 ºC	Damage to the road by fallen blocks.	Concrete retaining wall	C
75	297.7	Sinking of the road	Insufficient compactior	Gravel road	Embankment	1000 - 2000 mm/year 24 ºC	Deformation of the road	Repair of the pavement	C
76	298.4	Landslide	Downhill bedding plane	Gravel road	Gently dipping reddish brown sandstone and debris	1000 - 2000 mm/year 24 ºC	Deformation of the road	Drainage system	C
77	299	Rock fall	Block separation	Gravel road	Gently dipping Reddish brown sandstone and siltstone	1000 - 2000 mm/year 24 ºC	Damage to the road by fallen blocks.	Free frame	C
78	301.1	Rock fall	Block separation	Gravel road	Steeply dipping jointed reddish brown sandstone.	1000 - 2000 mm/year 24 ºC	Damage to the road by fallen blocks.	Bench cut	B
79	301.6	Rock fall	Steep slope	Gravel road	Gently dipping reddish brown siltstone. Inter-calated with thin sandstone	1000 - 2000 mm/year 24 ºC	Covered with debris.	Rock-net	C
80	301.9	Landslide	Underground water	Gravel road Gutter	Debris	1000 - 2000 mm/year 24 ºC	Deformation of the road	Removal of the slid block	C

No.	*Distance (km)*	*Main Disaster Type*	*Elementary Reason*	*Type of Structure*	*Geology • Geological Structure*	*Meteorological Characteristics*	*Foreseen Risk*	*Proposed Works*	*Hazard Level*
81	304	Rock fall	Differential erosion	Gravel road	Gently dipping Reddish brown siltstone and sandstone	1000 - 2000 mm/year 24 ºC	Damage to the road by fallen rocks.	Drainage system	C
82	304.3	Rock fall	Differential erosion	Gravel road	Gently dipping Reddish brown siltstone and sandstone	1000 - 2000 mm/year 24 ºC	Damage to the road by fallen rocks.	Drainage system	C
83	304.9	Rock fall	Differential erosion	Gravel road	Gently dipping Reddish brown siltstone and sandstone	1000 - 2000 mm/year 24 ºC	Damage to the road by fallen rocks.	Removal of the overhanging blocks	B
84	306.3	Rock fall	Differential erosion	Gravel road	Gently dipping Reddish brown siltstone and sandstone	1000 - 2000 mm/year 24 ºC	Damage to the road by fallen rocks.	Spraying	C
85	308.9	Rock fall	Block separation	Gravel road Gutter	Gently dipping jointed sandstone and siltstone	1000 - 2000 mm/year 24 ºC	Damage to the road by fallen blocks.	Shift the alignment of the road (Relocation)	C
86	309.4	Rock fall	Block separation	Gravel road Gutter	Gently dipping jointed sandstone and siltstone	1000 - 2000 mm/year 24 ºC	Damage to the road by fallen blocks.	Shift the alignment of the road (Relocation)	C
87	309.6	Landslide	Existence of underground water	Gabion wall	Debris	1000 - 2000 mm/year 24 ºC	Deformation of the road.	According to the investigation	C
88	309.8	Rock fall	Differential weathering	Gravel road	Gently dipping Reddish brown siltstone and sandstone	1000 - 2000 mm/year 24 ºC	None.	None	D
89	310.7	None	None	Gravel road	Reddish brown siltstone and sandstone	1000 - 2000 mm/year 24 ºC	None	None	D

No.	*Distance (km)*	*Main Disaster Type*	*Elementary Reason*	*Type of Structure*	*Geology • Geological Structure*	*Meteorological Characteristics*	*Foreseen Risk*	*Proposed Works*	*Hazard Level*
90	312.3	Rock fall	Differential erosion	Gravel road	Gently dipping red siltstone and sandstone	1000 - 2000 mm/year 24 ºC	Damage to the road by fallen rocks.	Free frame	D
91	314.7	Washout of soil	Thin vegetation	Gravel road	Reddish brown lateritic soil	1000 - 2000 mm/year 24 ºC	Covered with soil	None	D
92	315	Washout of soil	Thin vegetation	Asphalt pavement	Reddish brown lateritic soil	1000 - 2000 mm/year 24 ºC	None.	None	D
93	316	Washout of soil	Thin vegetation	Asphalt pavement	Reddish brown lateritic soil	1000 - 2000 mm/year 24 ºC	Covered with soil?	None	C
94	316.3	Deformation of the asphalt pavement	Downhill bedding plane	Asphalt pavement	Gently dipping sandstone.	1000 - 2000 mm/year 24 ºC	Deformation of the road.	According to the investigation	C
95	321.4	Rock fall	Gully erosion	Asphalt pavement Gutter	White altered rock (tuff?)	1000 - 2000 mm/year 24 ºC	Covered with rocks and debris	None	D
96	322	Rock fall	Gully erosion	Quarry site	White altered rock (tuff?)	1000 - 2000 mm/year 24 ºC	Covered with rocks and debris	None	C
97	329.8	Rock fall	Block separation	Gravel road Gutter	Reddish brown siltstone and sandstone	1000 - 2000 mm/year 24 ºC	Covered with fallen rocks.	Rock-net	C

List of Disaster Sites on Route 4 Tabla 6.2.2 Resultados del Estudio en la Ruta 4

No.	*Distance (km)*	*Main Disaster Type*	*Elementary Reason*	*Type of Structure*	*Geology • Geological Structure*	*Meteorological Characteristics*	*Foreseen Risk*	*Proposed Works*	*Hazard Level*
1	70	Sinking of the road	Insufficient compaction	Asphalt pavement	Gently dipping Sandstone	> 3000 mm/year 7 ºC	Cracks of the pavement	Compaction of the embankment	C
2	72.4	Sinking of the road	Insufficient compaction	Asphalt pavement	Gently dipping Sandstone	> 3000 mm/year 7 ºC	Cracks of the pavement	Compaction of the embankment	C
3	74	Sinking of the road	Insufficient compaction	Asphalt pavement	Gently dipping Sandstone	> 3000 mm/year 7 ºC	Cracks of the pavement	Compaction of the embankment	C
4	77.3	Sinking of the road	Insufficient compaction	Asphalt pavement	Gently dipping Sandstone	> 3000 mm/year 7 ºC	Cracks of the pavement	Compaction of the embankment	C
5	80.5	Rock slide	Downhill bedding plane	Tunnel	Jointed sandstone	> 3000 mm/year 7 ºC	None	None	D
6	84.3	Landslide	Fracture zone	Gravel road Cut slope	Debris	> 3000 mm/year 7 ºC	None	None	D
7	91.4	Rock slide	Downhill bedding plane	Asphalt pavement Gutter	Jointed sandstone	> 3000 mm/year 7 ºC	Damage to the pavement and the gutter.	Free frame	B
8	100.3	Deformation of stone wall	Fracture zone	Stone wall Ggravel road Gutter	Debris	> 3000 mm/year 7 ºC	Deformation of the road	According to the investigation	C

No.	*Distance (km)*	*Main Disaster Type*	*Elementary Reason*	*Type of Structure*	*Geology • Geological Structure*	*Meteorological Characteristics*	*Foreseen Risk*	*Proposed Works*	*Hazard Level*
9	100.8	Debris fall	Downhill bedding plane	Asphalt pavement Gutter	Moderately dipping sandstone and siltstone.	> 3000 mm/year 7 ºC	Damage to the structures.	Cutting	B
10	103.8	Erosion of shoulder	River erosion	Stone pavement Concrete pavement	Embankment	> 3000 mm/year 24 ºC	Sinking of the road	Underdrainage	C
11	105	Debris flow	Fracture zone	Asphalt pavement	Existence of fault zone is supposed	> 3000 mm/year 24 ºC	Covered with debris.	Sabo-dam	A
12	108.7	Debris fall	Fracture zone	Asphalt pavement	Sheared slate	> 3000 mm/year 24 ºC	Covered with debris.	Concrete retaining wall	A
13	109.2	Debris flow	Fracture zone	Asphalt pavement Underdrainage	Sheared slate	> 3000 mm/year 24 ºC	Covered with debris. Erosion of shoulder.	Sabo-dam	A
14	109.5	Debris flow	Fracture zone	Asphalt pavement	Sheared slate	> 3000 mm/year 24 ºC	Covered with debris.	Sabo-dam	B
15	110.1	Debris fall	Fracture zone	Gravel road	Sheared slate	> 3000 mm/year 24 ºC	Covered with debris.	Concrete retaining wall	A
16	110.5	Debris flow	Fracture zone	Gravel road Underdrainage	Sheared slate	> 3000 mm/year 24 ºC	Covered with debris. Erosion of shoulder.	Sabo-dam	B
17	111.1	Erosion of shoulder	Running water	Concrete pavement (under construction).	Debris	> 3000 mm/year 7 ºC	Erosion of shoulder	Underdrainage	B

No.	*Distance (km)*	*Main Disaster Type*	*Elementary Reason*	*Type of Structure*	*Geology • Geological Structure*	*Meteorological Characteristics*	*Foreseen Risk*	*Proposed Works*	*Hazard Level*
18	114.2	Landslide	Unsuitable cutting	Gravel road	Debris	> 3000 mm/year 7 ºC	Covered with debris.	According to the investigation	A
19	114.6	Debris flow	Slope failure of the catchment area.	Bridge	Debris and river deposits	> 3000 mm/year 24 ºC	Destruction of the bridge.	Sabo-dam	B
20	115.5	Erosion of shoulder	River erosion	Gravel road	Debris and banking material.	> 3000 mm/year 24 ºC	More erosion	Concrete retaining wall for revetment	A
21	117.6	Debris fall	Seepage of water	Asphalt pavement	Debris	> 3000 mm/year 24 ºC	Covered with debris. Erosion of shoulder.	Concrete retaining wall	B
22	118.2	Damage of the bridge	Flood water	Bridge	River deposits.	> 3000 mm/year 24 ºC	Destruction of the bridge.	Sabo-dam	B
23	119.2	Debris flow	Dammed up by slope failure	Bridge gravel road	Debris and river deposits	> 3000 mm/year 24 ºC	Destruction of the bridge.	Sabo-dam	A
24	121.4	Erosion of shoulder	Unsuitable drainage	Concrete pavement	Banking material.	> 3000 mm/year 24 ºC	Damage on the platform	Reform of drainage	A
25	123.5	Erosion of shoulder	River erosion	Concrete pavement	River deposits	> 3000 mm/year 24 ºC	Damage on the platform	Revetment with gabion	A
26	137.5	Landslide	Underground water	Stone pavement	Debris	> 3000 mm/year 24 ºC	Deformation of the road	According to the investigation	C

No.	*Distance (km)*	*Main Disaster Type*	*Elementary Reason*	*Type of Structure*	*Geology • Geological Structure*	*Meteorological Characteristics*	*Foreseen Risk*	*Proposed Works*	*Hazard Level*
27	142.2	Debris flow	Thick river deposits in the catchment area	Asphalt pavement Underdrainage	River deposits.	> 3000 mm/year 24 ºC	Covered with debris. Destruction of the drainage system.	Sabo-dam	A

List of Disaster Sites on Route 7 Tabla 6.2.3 Resultados del Estudio en la Ruta 7

No.	*Distance (km)*	*Main Disaster Type*	*Elementary Reason*	*Type of Structure*	*Geology • Geological Structure*	*Meteorological Characteristics*	*Foreseen Risk*	*Proposed Works*	*Hazard Level*
1	166.6	Rock fall	Fracture zone	Gravel road	Gently dipping siltstone and sandstone.	1000 – 2000 mm/year 10 ºC	Damage to the road by fallen rocks.	Cutting	B
2	167	Erosion of shoulder	Erosion by drained water	Gravel road	Debris and embankment	1000 – 2000 mm/year 10 ºC	Failure of shoulder.	Shoot	B
3	171.9	Debris fall	Earthquake May 1998	Gravel road	Steeply dipping sandstone.	1000 – 2000 mm/year 10 ºC	Covered with debris	Cutting	B
4	172.1	Debris fall	Earthquake May 1998	Gravel road	Steeply dipping sandstone.	1000 – 2000 mm/year 10 ºC	Covered with debris	Cutting	B
5	172.3	Rock fall	Earthquake May 1998	Gravel road	Steeply dipping sandstone.	1000 – 2000 mm/year 10 ºC	Covered with debris	Cutting	B
6	175.5	Rock fall	Steep cutting	Gravel road	Gently dipping sandstone.	1000 – 2000 mm/year 10 ºC	Damage to the road by fallen blocks.	None	D
7	185.4	Erosion of shoulder	Erosion by drained water	Gravel road	Debris and embankment	1000 – 2000 mm/year 10 ºC	Failure of shoulder.	Shoot	B
8	185.4	Rock fall	Block separation	Gravel road	Gently dipping jointed sandstone	1000 – 2000 mm/year 10 ºC	Damage of the road by fallen block.	Cutting	B

No.	*Distance (km)*	*Main Disaster Type*	*Elementary Reason*	*Type of Structure*	*Geology • Geological Structure*	*Meteorological Characteristics*	*Foreseen Risk*	*Proposed Works*	*Hazard Level*
9	193	Debris fall	Gully erosion	Gravel road	Talus deposits	1000 – 2000 mm/year 10 ℃	Covered with debris	Cutting	C
10	197.6	Rock fall	Overhanged slope	Quarry site	Gently dipping sandstone.	1000 – 2000 mm/year 10 ℃	None.	None	D
11	224.4	Erosion of shoulder	Erosion by drained water	Gravel road	Debris and embankment	2000 – 3000 mm/year 10 ℃	Failure of shoulder.	Underdrainage	B
12	228.3	Debris fall	Differential weathering	Gravel road	Steeply dipping siliceous siltstone.	2000 – 3000 mm/year 10 ℃	Covered with debris	Free frame	C
13	232.8	Debris flow	Slope failure of the catchment area	Gravel road	Debris	2000 – 3000 mm/year 10 ℃	Covered with debris	Sabo-dam	A
14	237	Debris fall	Steep slope	Quarry site	Steep dipping sandstone and siltstone.	500 – 1000 mm/year 15 ℃	Covered with debris	None	D
15	254.3	Muddy place	Running water	Gravel road	Debris and embankment	500 – 1000 mm/year 15 ℃	Sticky road surface.	Gutter	D
16	255	Rock fall	Block separation	Gravel road	Vertically dipping jointed sandstone	500 – 1000 mm/year 15 ℃	Damage to road by fallen blocks.	Cutting	B
17	258.9	Debris flow	Gully erosion	Gravel road	Debris	500 – 1000 mm/year 15 ℃	Covered with debris	Cutting	B

No.	*Distance (km)*	*Main Disaster Type*	*Elementary Reason*	*Type of Structure*	*Geology • Geological Structure*	*Meteorological Characteristics*	*Foreseen Risk*	*Proposed Works*	*Hazard Level*
18	259	Debris fall	Gully erosion	Gravel road	Talus deposits	500 – 1000 mm/year 15 ºC	Covered with debris	Cutting.	D
19	270	Landslide	Underground water	Gravel road	Phyllitic siltstone and debris	500 – 1000 mm/year 15 ºC	Covered with debris	According to the observation	B
20	270.9	Landslide	Underground water	Gravel road	Debris	500 – 1000 mm/year 15 ºC	Deformation of the road.	According to the investigation	A
21	294.3	Rock fall	Steep cutting	Asphalt pavement	Talus deposits	500 – 1000 mm/year 15 ºC	Covered with debris and damage of the pavement by fallen rocks	Rounding of the top	D
22	308.8	Rock fall	Steep cutting	Asphalt pavement	Talus deposits	500 – 1000 mm/year 15 ºC	Covered with debris and damage of the pavement by fallen rocks	Cutting	D
23	327.2	Debris fall	Thin vegetation	Quarry site	Finely bedded siliceous sandstone (or tuff)	1000 – 2000 mm/year 24ºC	Covered with debris	None	D
24	344.2	Rock fall	Earthquake May 1998	Quarry site	Moderately dipping sandstone and siltstone.	1000 – 2000 mm/year 24ºC	None.	None	D
25	347.3	Debris fall	Weathering of the red bed	Asphalt pavement	Steeply dipping red beds	1000 – 2000 mm/year 24ºC	Covered with debris	Cleanup of the road	D
26	347.3	Debris flow	Fracture zone	Asphalt pavement	Steeply dipping sandstone and siltstone.	1000 – 2000 mm/year 24ºC	Covered with debris	Sabo-dam	A

No.	*Distance (km)*	*Main Disaster Type*	*Elementary Reason*	*Type of Structure*	*Geology • Geological Structure*	*Meteorological Characteristics*	*Foreseen Risk*	*Proposed Works*	*Hazard Level*
27	347.9	Landslide	Unsuitable cutting	Asphalt pavement	Debris	1000 – 2000 mm/year 24ºC	Deformation of the road.	According to the observation	C
28	348.2	Debris fall	Differential erosion	Asphalt pavement	Moderately dipping sandstone and siltstone	1000 – 2000 mm/year 24ºC	Covered with debris	Concrete retaining wall	D
29	348.8	Rock fall	Weathering of the red bed	Asphalt pavement	Reddish brown siltstone and sandstone	1000 – 2000 mm/year 24ºC	Rock fall and covered with granular debris.	Cutting	B
30	349.4	Debris fall	Differential erosion	Asphalt pavement	Gently dipping sandstone and siltstone	1000 – 2000 mm/year 24ºC	Covered with debris	Concrete retaining wall	B
31	350.2	Debris fall	Differential erosion	Asphalt pavement	Gently dipping sandstone and siltstone	1000 – 2000 mm/year 24ºC	Covered with debris	Cutting	B
32	352.5	Branching gullies	Gully erosion	Asphalt pavement	Debris	1000 – 2000 mm/year 24ºC	Erosion of shoulder	Surface drainage	D
33	354.7	Debris fall	Differential erosion	Asphalt pavement	Horizontally dipping sandstone and siltstone	1000 – 2000 mm/year 24ºC	Covered with debris	Cutting	D
34	361.3	Debris fall	Gully erosion	Asphalt pavement	Debris	1000 – 2000 mm/year 24ºC	Covered with debris and damage of the pavement by fallen rocks	Cutting	C
35	362.2	Rock fall	Block separation	Asphalt pavement	Steeply dipping jointed sandstone.	1000 – 2000 mm/year 24ºC	Damage of the pavement by fallen rocks.	Free frame	C

No.	*Distance (km)*	*Main Disaster Type*	*Elementary Reason*	*Type of Structure*	*Geology • Geological Structure*	*Meteorological Characteristics*	*Foreseen Risk*	*Proposed Works*	*Hazard Level*
36	372.4	Debris fall	Steep slope	Asphalt pavement	Debris	1000 – 2000 mm/year 24ºC	Covered with debris	Concrete Retaining wall	C
37	373.9	Rock fall	Steep slope	Asphalt pavement Houses	Medium to fine grained Sandstone	1000 – 2000 mm/year 24ºC	Rocks can fall over on a house	Free frame	A
38	412.4	Rock fall	Weathering of the red bed	Asphalt pavement	Reddish brown siltstone and sandstone	1000 – 2000 mm/yea 24ºC	Rock fall and covered with granular debris.	Cutting	B
39	414.7	Rock fall	Weathering of the red bed	Asphalt pavement	Reddish brown siltstone and sandstone	1000 – 2000 mm/year 24ºC	Rock fall	Cutting	C
40	415.7	Debris fall	Weathering of the red bed	Asphalt pavement	Reddish brown siltstone.	1000 – 2000 mm/year 24ºC	Covered with the granular debris.	Cutting	C
41	418.3	Construction of a drainage	None	Drainage	Banking material.	1000 – 2000 mm/year 24ºC	None.	Compaction of the embankment	D
42	418.7	Unsuitable Construction	None	Drainage	Banking material	1000 – 2000 mm/year 24ºC	None.	Compaction of the embankment	D
43	421.3	Debris fall	Fracture zone	Quarry site	Steeply dipping sandstone and siltstone.	1000 – 2000 mm/year 24ºC	None.	None	D
44	421.6	Debris flow	Slope failure of the catchment area	Asphalt pavement	Gently dipping sandstone.	1000 – 2000 mm/year 24ºC	Covered with debris.	Sabo-dam	A

No.	*Distance (km)*	*Main Disaster Type*	*Elementary Reason*	*Type of Structure*	*Geology • Geological Structure*	*Meteorological Characteristics*	*Foreseen Risk*	*Proposed Works*	*Hazard Level*
45	424.1	Landslide	Fracture zone	Earthy road	Steeply dipping phyllitic siltstone.	1000 – 2000 mm/year 24ºC	Deformation of the road.	According to the observation	C
46	429.8	Rock fall	River erosion	Gravel road	Gently dipping jointed sandstone	1000 – 2000 mm/year 24ºC	Damage to the road and gabion wall by fallen blocks.	Concrete retaining wall	B
47	435.3	Sinking of the road	Fracture zone	Earthy road	Debris	1000 – 2000 mm/year 24ºC	Deformation of the road.	Diversion of the road.	B
48	436.5	Debris flow	Slope failure of the catchment area	Retaining wall. Asphalt pavement	River deposits and debris.	1000 – 2000 mm/year 24ºC	Covered with debris.	Sabo-dam	C
49	437.2	Rock fall	Steep slope	Asphalt pavement	Gently dipping sandstone.	1000 – 2000 mm/year 24ºC	Fallen rocks over the road	Rock-shed	B
50	437.6	Debris flow	Slope failure of the catchment area	Asphalt pavement Underdrainage	River deposits	1000 – 2000 mm/year 24ºC	Road will be covered with debris	Sabo-dam	A
51	439.1	Rock fall	Gully erosion	Asphalt pavement	Talus deposits.	1000 – 2000 mm/year 24ºC	Damage to the pavement.	Concrete retaining wall	B
52	440	Landslide	Fracture zone	Asphalt pavement	Steeply dipping phyllitic shale.	1000 – 2000 mm/year 24ºC	Deformation of the road.	According to the investigation	C
53	441.6	Small sinking of the pavement	Insufficient compactior	Asphalt pavement	Banking material	1000 – 2000 mm/year 24ºC	Cracks of the pavement	Compaction of the back-filling	C

List of Disaster Sites on Route 16 Tabla 6.2.4 Resultados del Estudio en la Ruta 16

No.	*Distance (km)*	*Main Disaster Type*	*Elementary Reason*	*Type of Structure*	*Geology • Geological Structure*	*Meteorological Characteristics*	*Foreseen Risk*	*Proposed Works*	*Hazard Level*
1	193.8	Debris flow	Thick river deposits of catchment area.	Gravel road River crossing	River deposits.	500 - 1000 mm/year 8 ºC	Covered by debris. Obstruction of traffic by flood.	Culvert.	C
2	196.8	Debris flow	Slope failure of the catchment area.	Gravel road River crossing	Debris, river deposits	500 - 1000 mm/year 8 ºC	Obstruction ob traffic by flood. Covered by debris	Sabo-dam	A
3	203.2	Rock fall	Block separation	Gravel road	Steeply dipping jointed sandstone.	500 - 1000 mm/year 8 ºC	Damage of the road by fallen blocks	Removal of the overhanging blocks	B
4	203.5	Rock fall	Toppling	Gravel road	Steeply dipping jointed sandstone.	500 - 1000 mm/year 8 ºC	Damage of the road by fallen blocks	Removal of the overhanging blocks	B
5	203.9	Rock fall	Toppling	Gravel road	Steeply dipping jointed sandstone.	500 - 1000 mm/year 8 ºC	Damage of the road by fallen blocks	Removal of the overhanging blocks	B
6	204.7	Rock fall	Loosening of cracks	Gravel road	Steeply dipping jointed sandstone.	500 - 1000 mm/year 8 ºC	Damage of the road by fallen blocks	Rock-shed	B
7	207.8	Rock fall	Block separation	Gravel road	Moderately dipping jointed sandstone.	500 - 1000 mm/year 8 ºC	Damage of the road by fallen blocks. Erosion of shoulder	Bench cut	C
8	211	Rock fall	Block separation	Gravel road	Jointed granodiorite	500 - 1000 mm/year 8 ºC	Damage of the road by fallen blocks	Shift the alignment of the road (Relocation)	B

No.	*Distance (km)*	*Main Disaster Type*	*Elementary Reason*	*Type of Structure*	*Geology • Geological Structure*	*Meteorological Characteristics*	*Foreseen Risk*	*Proposed Works*	*Hazard Level*
9	213.6	Debris fall	Steep slope.	Gravel road	Talus deposits include huge boulders.	500 - 1000 mm/year 8 ºC	Covered with debris and boulders.	Removal of the overhanging blocks	C
10	219.3	Rock fall	Downhill bedding plane	Gravel road	Moderately dipping jointed sandstone.	500 - 1000 mm/year 8 ºC	Damage of the road by fallen blocks	Removal of loosen blocks	B
11	224.1	Debris fall	Superficial water	Gravel road	Debris composed of fragments of shale	500 - 1000 mm/year 8 ºC	Covered with debris	Bench cut	C
12	224.4	Erosion of shoulder	Steep slope	Bridge Gravel road.	Steeply dipping sheared slate. Debris.	1000 - 2000 mm/year 13 ºC	Covered with debris Erosion by river water.	Revetment with concrete retaining wall	B
13	226.5	Rock fall	Block separation	Gravel road	Vertically dipping jointed sandstone.	500 - 1000 mm/year 8 ºC	Damage of the road by fallen blocks	Shift the alignment of the road (Relocation)	B
14	227.1	Debris fall	Fracture zone	Gravel road	Steeply dipping sheared shale.	> 3000 mm/year 24 ºC	Covered with debris	Bench cut	C
15	227.9	Debris fall	Fracture zone	Gravel road	Debris	500 - 1000 mm/year 8 ºC	Covered with debris	Concrete retaining wall	B
16	229	Rock fall	Block separation	Gravel road	Moderately dipping jointed sandstone.	500 - 1000 mm/year 8 ºC	Damage of the road by fallen blocks	Removal of loosen blocks	B
17	229.4	Rock fall	Block separation	Gravel road	Steeply dipping jointed sandstone.	500 - 1000 mm/year 8 ºC	Damage of the road by fallen blocks	Removal of the overhanging blocks	B

No.	*Distance (km)*	*Main Disaster Type*	*Elementary Reason*	*Type of Structure*	*Geology • Geological Structure*	*Meteorological Characteristics*	*Foreseen Risk*	*Proposed Works*	*Hazard Level*
18	229.5	Debris fall	Steep slope	Gravel road	Talus deposit	500 - 1000 mm/year 8 ºC	Covered with debris	Gabion wall	B
19	229.9	Rock fall	Block separation	Gravel road	Vertically dipping jointed sandstone.	500 - 1000 mm/year 8 ºC	Damage of the road by fallen blocks. Erosion of shoulder by river water	Cutting	B
20	230.5	Rock fall	Block separation	Gravel road	Steeply dipping jointed sandstone.	500 - 1000 mm/year 8 ºC	Damage of the road by fallen blocks	Concrete retaining wall	B
21	233.5	Debris fall	Steep slope	Gravel road	Talus deposits.	500 - 1000 mm/year 8 ºC	Damage of the road by fallen blocks. Covered by debris. Erosion of shoulder	Gabion wall	C
22	235	Debris fall	Steep slope	Gravel road	Talus deposits or debris.	500 - 1000 mm/year 8 ºC	Damage of the road by fallen blocks. Covered by debris	According to the investigation	C
23	236	Flood waters	Heavy rain	Gravel road River crossing.	Reddish-brown Lateritic soil, river deposits.	1000 - 2000 mm/year 13 ºC	Obstruction of traffic by flood	Construction of a bridge	C
24	237.6	Flood waters	Heavy rain	Gravel road River crossing.	River deposits.	1000 - 2000 mm/year 13 ºC	Obstruction of traffic by flood	Construction of a bridge	C
25	239.4	Rock fall	Block separation	Gravel road	Vertically dipping silicified sandstone.	1000 - 2000 mm/year 13 ºC	Damage of the road by fallen blocks	Removal of the overhanging blocks	B
26	240.6	Erosion of road surface	Heavy rain.	Gravel road	Old fan deposits.	1000 - 2000 mm/year 13 ºC	Erosion of road surface and shoulder by running water	Culvert	D

No.	*Distance (km)*	*Main Disaster Type*	*Elementary Reason*	*Type of Structure*	*Geology • Geological Structure*	*Meteorological Characteristics*	*Foreseen Risk*	*Proposed Works*	*Hazard Level*
27	241.9	Rock fall	Block separation	Gravel road	Vertically dipping silicified shale.	1000 - 2000 mm/year 13 ºC	Damage of the road by fallen blocks	Removal of the overhanging blocks	B
28	246.1	Flood waters	Heavy rain	Gravel road River crossing.	River deposits.	1000 - 2000 mm/year 13 ºC	Obstruction of traffic by flood	Culvert	C
29	247.4	Flood waters	Heavy rain	Gravel road River crossing.	River deposits.	1000 - 2000 mm/year 13 ºC	Obstruction of traffic by flood	Culvert	C
30	248.3	Erosion of shoulder	Underdrainage filled by rocks and debris.	Gravel road	Embankment	1000 - 2000 mm/year 13 ºC	Overflow of river water is eroding the shoulder	Culvert	C
31	248.3	Rock fall	Block separation	Gravel road	Gently dipping jointed sandstone	1000 - 2000 mm/year 13 ºC	Huge blocks damage the road	Rock bolt	B
32	249	Flood waters	Heavy rain	Gravel road River crossing.	River deposits.	1000 - 2000 mm/year 13 ºC	Obstruction of traffic by flood	Culvert	C
33	249.8	Flood waters	Heavy rain	Gravel road River crossing.	River deposits.	1000 - 2000 mm/year 13 ºC	Obstruction of traffic by flood	Culvert	C
34	258.6	Debris flow	Slope failure of the catchment area	Gravel road	Moderately dipping sheared sandstone.	1000 - 2000 mm/year 13 ºC	Covered with debris Erosion of shoulder.	Construction of a bridge.	A
35	259.2	Hole of the road	?	Gravel road	Embankment	1000 - 2000 mm/year 13 ºC	The hole will be bigger and will destroy the road	Filling	C

No.	*Distance (km)*	*Main Disaster Type*	*Elementary Reason*	*Type of Structure*	*Geology • Geological Structure*	*Meteorological Characteristics*	*Foreseen Risk*	*Proposed Works*	*Hazard Level*
36	263	Rock fall	Block separation	Gravel road Bridge	Horizontally dipping jointed sandstone.	1000 - 2000 mm/year 13 ºC	Damage on the road and the bridge by fallen blocks	Removal of the overhanging blocks	C
37	265.3	Landslide	River erosion	Gravel road	Thick deposits of debris.	1000 - 2000 mm/year 13 ºC	Deformation of the road	According to the investigation	C
38	265.5	Flood waters	Heavy rain	Gravel road River crossing.	River deposits.	1000 - 2000 mm/year 13 ºC	Obstruction of traffic by flood	Culvert	C
39	266.2	Debris fall	Fracture zone.	Gravel road	Moderately dipping slate. Steep joint.	1000 - 2000 mm/year 13 ºC	Covered with debris	Spraying	B
40	266.9	Erosion of shoulder	Drained water	Gravel road	Embankment	1000 - 2000 mm/year 13 ºC	Erosion of shoulder and road surface	Gutter	C
41	268.2	Debris fall	Fracture zone.	Gravel road	Steeply dipping altered slate	1000 - 2000 mm/year 13 ºC	Covered with debris	Cutting	B
42	269.3	Disturbance by fallen trees	Slash-and-burn farming	Gravel road	Debris and soil	1000 - 2000 mm/year 13 ºC	Disturbance by fallen trees	Cleanup of the fallen trees	C
43	271.1	Debris fall	Superficial water.	Gravel road	Debris	1000 - 2000 mm/year 13 ºC	Erosion of the slope	Concrete retaining wall	D
44	272.1	Debris fall	Fracture zone.	Gravel road	Steeply dipping slate.	1000 - 2000 mm/year 13 ºC	Covered with debris	Spraying	B

No.	*Distance (km)*	*Main Disaster Type*	*Elementary Reason*	*Type of Structure*	*Geology • Geological Structure*	*Meteorological Characteristics*	*Foreseen Risk*	*Proposed Works*	*Hazard Level*
45	277.3	Debris fall	Fracture zone.	Gravel road	Steeply dipping slate.	1000 - 2000 mm/year 13 ºC	Covered with debris	Spraying	B
46	277.9	Debris fall	Block separation	Gravel road	Moderately dipping jointed altered siltstone.	1000 - 2000 mm/year 13 ºC	Covered with debris and blocks	Spraying	B
47	278.6	Debris fall	Fracture zone	Gravel road	Steeply dipping shale & fine grain sandstone.	1000 - 2000 mm/year 13 ºC	Covered with debris Damage of the road by fallen blocks.	Cutting	B
48	281.8	Rock fall	Alteration zone	Gravel road	Steeply dipping altered shale.	1000 - 2000 mm/year 13 ºC	Covered with debris and rocks.	Cutting	B
49	282.9	Rock fall	Fault	Gravel road	Strongly folded sandstone.	1000 - 2000 mm/year 13 ºC	Covered with rocks and debris.	Concrete retaining wall	B
50	286.2	Debris fall	Fracture zone.	Quarry site	Strongly folded sandstone.	1000 - 2000 mm/year 13 ºC	Covered with debris	Cleanup of the road	D
51	287	Disturbance by fallen trees	Slash-and-burn farming	Gravel road	Debris and soil	1000 - 2000 mm/year 13 ºC	Disturbance by fallen trees	Cleanup of the road	C
52	287.7	Debris fall	Steep slope	Gravel road	Steeply dipping siltstone or slate.	1000 - 2000 mm/year 13 ºC	Covered with debris	Cutting	D
53	288.2	Rock fall	Steep slope	Gravel road	Steeply dipping siltstone or slate.	1000 - 2000 mm/year 13 ºC	Covered with fallen rocks.	Spraying	C

No.	*Distance (km)*	*Main Disaster Type*	*Elementary Reason*	*Type of Structure*	*Geology • Geological Structure*	*Meteorological Characteristics*	*Foreseen Risk*	*Proposed Works*	*Hazard Level*
54	288.2	Rock fall	Toppling	Gravel road	Steeply dipping shale	1000 - 2000 mm/year 13 ºC	Covered with rocks	Bench cut	B
55	288.5	Debris fall	Fracture zone	Gravel road Ggutter without concrete structure	Steeply dipping shale	1000 - 2000 mm/year 13 ºC	Covered with debris	Cleanup of the gutter.	B
56	289.1	Debris fall	Fracture zone	Gravel road Ggutter without concrete structure	Steeply dipping shale	1000 - 2000 mm/year 13 ºC	Covered with debris	Bench cut	B
57	289.2	Rock fall	Steep slope	Gravel road	Vertically dipping jointed sandstone.	1000 - 2000 mm/year 13 ºC	Damage to the road by fallen rocks	Spraying	B
58	289.5	Rock fall	Steep slope	Gravel road	Vertically dipping jointed sandstone.	1000 - 2000 mm/year 13 ºC	Damage to the road by fallen rocks	Spraying	B
59	290.1	Disturbance by floodwater	Heavy rain	Crossing of the creek	River deposits.	1000 - 2000 mm/year 13 ºC	Erosion of shoulder	Culvert	C
60	290.6	Debris fall	Fracture zone	Quarry site	Strongly folded shale.	1000 - 2000 mm/year 13 ºC	Covered with debris	Cleanup of the road	D
61	291.2	Disturbance by fallen trees	Slash-and-burn farming	Gravel road	Debris and soil	1000 - 2000 mm/year 13 ºC	Disturbance by fallen trees	Cleanup of the road	C
62	294.1	Debris fall	Fracture zone	Quarry site	Strongly folded shale.	1000 - 2000 mm/year 13 ºC	Covered with debris	Cleanup of the road	D

No.	*Distance (km)*	*Main Disaster Type*	*Elementary Reason*	*Type of Structure*	*Geology • Geological Structure*	*Meteorological Characteristics*	*Foreseen Risk*	*Proposed Works*	*Hazard Level*
63	294.8	Disturbance by fallen trees	Slash-and-burn farming	Gravel road	Debris and soil	1000 - 2000 mm/year 13 ºC	Disturbance by fallen trees	Cleanup of the fallen trees	C
64	295	Debris fall	Steep slope	Gravel road Gutter without concrete structure	Talus deposits.	1000 - 2000 mm/year 13 ºC	Disturbance of drained water	Cutting	C
65	297.9	Rock fall	Alteration zone	Gravel road (hair-pin curve)	Steeply dipping altered shale.	1000 - 2000 mm/year 13 ºC	Covered with rocks and blocks.	Spraying	B
66	298.4	Rock fall	Alteration zone	Gravel road	Steeply dipping altered shale.	1000 - 2000 mm/year 13 ºC	Covered with rocks and blocks.	Spraying	D
67	298.7	Muddy place	Inferior q uality of banking material	Earthy road	Embankment (white soil)	1000 - 2000 mm/year 13 ºC	Sticky road surface	Change the surface material to gravel	B
68	301.4	Debris fall	Fracture zone	Quarry site	Steeply dipping phyllitic shale.	1000 - 2000 mm/year 13 ºC	Covered with debris	Removal of loosen materials	C
69	301.8	Choke of drainage	Steep slope	Gravel road Gutter without concrete structure	Steeply dipping phyllitic shale.	1000 - 2000 mm/year 13 ºC	Erosion of shoulder by running water	Cutting	C
70	302.1	Landslide	Alteration zone	Gravel road	Steeply dipping altered siltstone.	1000 - 2000 mm/year 13 ºC	Deformation of the road	Removal of the slid block	B
71	303	Debris fall	Superficial water	Gravel road Gutter without concrete structure	Steeply dipping altered siltstone.	1000 - 2000 mm/year 13 ºC	The quantity of debris will increase	Free frame	B

No.	*Distance (km)*	*Main Disaster Type*	*Elementary Reason*	*Type of Structure*	*Geology • Geological Structure*	*Meteorological Characteristics*	*Foreseen Risk*	*Proposed Works*	*Hazard Level*
72	303.8	Muddy place	Inferior q uality of banking material	Earthy road	Embankment (white soil)	1000 - 2000 mm/year 13 ºC	Sticky road surface	Change the surface material to gravel	B
73	304.1	Rock fall	Steep slope	Gravel road Gutter without concrete structure	Talus deposits.	1000 - 2000 mm/year 13 ºC	Erosion of shoulder	Cutting	C
74	304.4	Landslide	Downhill bedding plane	Earthy road.	Moderately dipping altered siltstone.	1000 - 2000 mm/year 13 ºC	Deformation of the road	According to the investigation	B
75	304.6	Erosion of shoulder	Drained water	Underdrainage.	Embankment	1000 - 2000 mm/year 13 ºC	Covered with fallen blocks Hume pipe.	Shoot	C
76	304.6	Rock fall	Block separation	Earthy road.	Moderately dipping jointed altered siltstone.	1000 - 2000 mm/year 13 ºC	Covered with fallen blocks.	Gabion wall	C
77	305.7	Landslide	Alteration zone	Gravel road Gutter without concrete structure	Gently dipping altered siltstone	1000 - 2000 mm/year 13 ºC	Deformation of the road	According to the investigation	C
78	307	Debris fall	Downhill bedding plane and fault.	Gravel road	Moderately dipping jointed altered siltstone.	1000 - 2000 mm/year 13 ºC	Covered with debris and blocks	Gabion wall	B
79	310.7	Muddy place	Inferior q uality of banking material	Earthy road	Embankment (reddish soil)	1000 - 2000 mm/year 13 ºC	Sticky road surface	Change the surface material to gravel	B
80	334.7	Flood waters	Heavy rain	Earthy road River crossing.	Reddish-brown Lateritic soil, river deposits.	1000 - 2000 mm/year 13 ºC	Obstruction of traffic by flood	Construction of a bridge.	C

No.	*Distance (km)*	*Main Disaster Type*	*Elementary Reason*	*Type of Structure*	*Geology • Geological Structure*	*Meteorological Characteristics*	*Foreseen Risk*	*Proposed Works*	*Hazard Level*
81	337.8	Flood waters	Heavy rain	Earthy road River crossing.	Reddish-brown Lateritic soil, river deposits.	1000 - 2000 mm/year 13 ºC	Obstruction of traffic by flood	Construction of a bridge.	C

6.3 Improvement of Road Disaster Registration (Trial Result)

6.3.1 Outline of Road Disaster Registration System

(1) Objective

The objective of the road disaster registration system is to record and register basic data on road disasters occurs at the national highways managed by ABC. After this system will have been achieved well functionally, ABC's capability to implement the maintenance activities of national highways will be enhanced systematically and ABC information net work on road disaster improved efficiently.

(2) Outline of System

In the case of natural road disasters taking place at national highways, each ABC's regional office shall prepare road disaster records and send them to UPD in the ABC headquarters as soon as possible. UPD must administrate the system and store the accumulated registration records. UPD in charge of running the system should accept to disclose the records when required.

(3) Contents of Road Disaster Registration System

Appointment of administrator
At each ABC's regional office and UPD, one and more than one person shall be selected as administrators. Renewal of data processing and system improvement of the system shall be made routinely under the responsibility of appointed administrators.

Establishment of disaster registration system
UPD shall be responsible for establishing and operating the system in connection with the present ABC information network and distribute it to each regional office. The system should be set up in their computers by each regional administrator and internet system is recommendable as a main method to communicate information between regional offices and UPD.

Emergency response in road disaster
In emergency case of road disasters, persons appointed as administrators or supervisors by ABC shall go to disaster sites and record the current disaster conditions immediately after events.

Input of disaster registration records
Either administrators or supervisors in charge shall input road disaster registration records into computers in designated manner after approval of administrators.

Transmittance of registration records to UPD
Disaster information input in the system at each regional office shall be sent to UPD at the end of every month. As for major disasters bringing big damages to residences, administrators can request regional officers to send the records to them as soon as possible.

Renewal of disaster registration system
On the basis of proposal concerning defective points to be improved in the system, UPD shall modify the system more efficiently and send its revised version to each regional office.

Formulation of guideline on disaster registration system
Guideline describing basic concept and procedure of the system should be prepared by UPD.

6.3.2 Trial of Road Disaster Registration Recording (Trial Result)

(1) General Concept of Disaster Registration Recording

Site briefing to ABC staff
Site briefings on road disaster registration recording were carried out two times, on June 27, 2006 and January 30, 2007, at the No.11 section of ABC National highway. The persons targeted for the briefing were ABC counterparts and supervisors of La Paz regional office.

Site briefing on road disaster registration recording

Trial section
The trial section of road disaster registration recording was designated between Unuavi and Chaco from view points of disaster features: frequency and magnitude.

Preparation of road disaster registration record
Trial of the road disaster registration was commenced in November 2006 and ended in late April 2007. During the trial, 11 disasters were reported and all of them were recorded on the disaster inspection sheets, as shown in *Figure 6.3.1*, in consideration of opinions from ABC's staff. The distance indicating locations of the disaster sites was identified based on the distance displayed on a vehicle's distance meter.

Preparation of guide on road disaster inspection sheet

The guide on road disaster inspection sheet, attached to Appendix, has been prepared based on the lesson learned from the trial. The guide is for ABC's engineers and supervisors to register the disaster conditions on the sheet using some decisive criteria.

SLOPE INSPECTION SHEET (MAIN) *ABC / JICA*

Route Number : 025 Section : 0 0 0		Inspected by : *Ing. Luis Vargas*	
Chainage : 8+250 *km* - 8+300 *km*		Date Inspected : 2007/2/15	
Coordinate : lati. Long.		Checked by Ing. Gabriel Collao	
Side of Road : ☐ *Right* ☒ *Left*		Date Checked : 2007/2/21	

Condition of Disaster

SOCIAL	Time of Occurrence : date(dd/mm/yy) (7 / 02 / 2007) time (17 :30)
	Reported Time : date(dd/mm/yy) (15 / 02 / 2007) time (10:30)
	Reported by : *Driver / Residents / ME / Supervisor / Police / Other ( ) / Unidentified*
	Vehicles involved : number (5), type (bus) , Condition (
	Personal Injully : number (0), condition ( )
DISASTER TYPE	Typical Section : 01 / 02 / 03 / 04
	Type of Disaster : *Type 1 / Type 2 / Type 3 / Type 4 / Type 5 / Type 6 / other*
	Material from Slope : Hard rock / Soft Rock / Weathered Rock / Sediment / Colluviums / other
	Repetitiousness at the location : Repetitive Disasters / New Disaster
	Recurrence of disaster : yes (still in danger) / possible / no (stable now)
	Dimensions of Disaster : 2000 m3
WEARTHTE	Weather when disaster occur : *Rain / Heavy Rain / Cloudy / Fine / unclear*
	State of weather in 48 hours before disa: *Rain / Heavy Rain / Cloudy / Fine / unclear*
	Meteorological Condition *Wet / Dry*
CAUSE	Cause of Disaster : *rain, earthquake, human activity, eroded by river, other ( ), uncle*

Condition of Road

ROAD SURFACE	Type of Pavement	*Asphalt / Concrete / Empedrado / Ripio / Tierra / other*
EXISTING DRAINAGE	Drains:	*Roadside Drains / Cascade Drain / Cross Drains / other*
	Conditions:	*good / needs desiliting / needs repair / not present*
EXISTING PREVENTION MEASURES &	Measures	*Gabions / Concrete Wall / Rock Bolts / Soil Nail / Netting / Dam / other*
	Quantity	
SLOPE	Type of Slope	*Natural / Cut / Cut + Natural / Stream / Embankment*
	Cover on Slope	*Bare / Grass / Shrubs / Trees / Shotcrete / other*

Proposal

Proposed Prevention Measures	Construction Period of Temporary Diversion : (1 dia			
item	quantity	unit	unit rate Bs	amount
Limpieza de via obstruida	2000	m3	13.76	27,520.00
	Total Cost (Bs.)			27,520.00
Comment				

ACTUAL ACTIVITIES

Figure 6.3.1 (1) Format of Road Disaster Registration Record

SLOPE INSPECTION SHEET (PHOTOGRAPH) *ABC / JICA*			
Route No. 25	Chainage: 8+250 km - km	Side of Road *Right* (*/ Left*)	Date: 2007/2/7

Photograph

Figure 6.3.1 (2) Format of Road Disaster Registration Record

6.4 Recommendation on Maintenance of Road Disaster Registration System

(1) ABC staff understands the importance of road disaster registration and many significant opinions on maintenance of the system were expressed through a series of discussions during the trial. It is clarified that supervisors are capable to check the road disaster inspection survey without any troubles judging from their trial performances.

(2) It is necessary that the system be introduced to all ABC regional offices for practical use under the responsibility of UPD.

(3) It is recommendable that the road disaster registration data stored on the GIS system be utilized for making decision of ABC policy and enhancement of awareness to stakeholder concerned.

<Guide of Disaster Inspection Sheet>

1. Location of Disaster

The location of the disaster site must be recorded in accordance with the following points when a engineer or supervisor of the regional office gets to the place.

- Route number: write the number of the National highway.
- Section: write the number of the section based on the existing numeration
- Station identification: write the starting and terminal points of the section, it's available to use a car odometer.
- Coordinates: measure and register the longitude and latitude of the disaster site using a GPS.
- Road side: mark correspondent side with an X.
- Person Inspected: write the name of the technique or supervisor who inspected the disaster.
- Inspection date: write the date on which the inspection was made by the technique or supervisor.
- Person checked: write the name of the person of the regional office who checked the inspection sheet.
- Date checked: write the date on which the engineer of the regional office who checked the inspection sheet.

2. Record of the Disaster Condition

The disaster condition must be recorded based on the following steps:

- Social condition
- Disasters type
- Weather
- Cause / reason

2.1 Social Condition

The social condition should be written based on the following items:

- Date/time of disaster occurrence: write the date and hour
- Date/time of reporting: write the date and hour
- Person reported: mark an X in the corresponding box, if it corresponds "Others", it is necessary to specify the condition of the person who reported in the corresponding box.
- Involved vehicles: record the number of affected vehicles and the type of vehicle based on the list in Annex 1 (Record of Traffic Accidents ACC-01). Damages should be written, for example; the conditions of the vehicles that are involved.
- Involved persons: record the number of affected persons in the box and register the number and condition of dead and injured persons.

2.2 Type of Disaster

The Type of Disaster must be registered under the following items:

- Typical Section: register the typical section in accordance with four cases of platforms.
- Type of Disaster: mark an X in the box which corresponds to an event in the table with the sketch of Types of Disaster.
    - Collapse (DR)
    - Rock fall (CR)
    - Rock Mass Failure (FR)
    - Landslide (DL)

    - Debris flow (FE)
    - Embankment failure (FB)
    - Others.
- Repetitive disaster at the same location: mark an X in the box.
- Dimension of the Disaster: It is necessary to quantify the disaster, write the estimative volume

2.3 Weather

The weather must be registered in accordance with the following points:

- Weather when the disaster happens: mark an X in the box corresponds to item among Rain, Strong Rain, Cloudy, Clear, etc.
- Conditions of the weather before 48 hours of the disaster occurrence: mark an X in the box corresponds to item among Rain, Strong Rain, Cloudy, Clear and not clearly.
- Meteorological Condition: mark an X in the box corresponds between humid or dry, taking into account the characteristics of the zone.

2.4 Cause

The cause of the disaster must be marked X in the box corresponding to item of Rain, Earthquake, Human Activity, Erosion for Rivers, Others and not clear. If it corresponds to the box of “Others”, specify cause of the disaster.

3. Condition of Road

The condition of the road must be registered in accordance with the following points:

- Road surface
- Existing drainage system
- Existing Prevention Measures
- Slope condition

3.1 Road Surface

The road surface must be registered in the following items:

- Type of Pavement: It is necessary to write the type of pavement that corresponds to item among Asphalt, Concrete, Stone pavement, Gravel, Earth and others.

3.2 Existing Drainage system

The existing drainage system must be recorded in accordance with the following items.

- Drainages: mark an X in the box in the case of corresponding to existing of drainage. If it corresponds to the box “Others”, the drainage will be specified clearly.
- Conditions: mark an X in the box corresponds. In case that corresponds to the box “Others“ it is necessary to describe clearly the conditions of the existing drainage

3.3 Existing Prevention Measures

The existing prevention measures must be registered in accordance with the following points:

- Measurements: the existing measurements must be marked with an X: seven existing cases of Gabions, Concrete Wall, Rock Bolts, Rock Nails, Netting, Dam and Others. If the case corresponds to others, the existing measurements must be described.
- Quantity: number and scale of the existing measurements must be described.

3.4 Slope

All the information observed on the existing slope must be registered based on the following points:

- Type of Slope: mark an X in he box corresponding to one of the existing cases in the form, that are: Natural, Cut, Cut + Natural, Gully and Filling.

- Coverage of the Slope: mark an X in the box corresponding to one of the cases with coverage, observed. If the case is “Others“, it is necessary to describe clearly the existing coverage.
- Material of the slope: mark an X in the box corresponding to the type of material observed in the slope, that are: Hard rock, Soft Rock, Weathering Rock, Sediment, Colluviums and Others. If it was a combination of these cases, both would be marked. In case of Others it is necessary to describe clearly the existing material

4. Proposals

The proposals must be recorded in accordance with the following points:

- Proposed preventive measures
- Temporary deviation period
- Comments

4.1 Proposed Prevention Measures

The proposed prevention measures must be registered in the following things:

- Item: write the activities or acts to be applied, to which proposed by supervisor.
- Cost estimate: write the estimate of applied measures in investment.
- Quantity of measures: Type of measures, number and quantities of measures with their volume or weight.
- Unit price: write the unit price of applied measures.
- Cost: write all cost spent in investigation, designing and construction, etc.

4.2 Temporary Deviation Period

In this pointt the supervisor will record the period of temporary deviation foresee by himself to realize these works.

4.3 Comments

In this point the supervisor will write all the comments and remarks related to the disaster that will not be recorded in the form.

5. Actual Activities

The proposals must be recorded in the following points:

- Period of perturbation of the traffic: write the period of closing the traffic and the expected date of reopening the traffic.
- Preventive Measures: write the preventive measures that have being executed during the date of inspection.