

Republic of Mauritius
Landslide Management Unit: LMU, Ministry of Public
Infrastructure and Land Transport: MPI

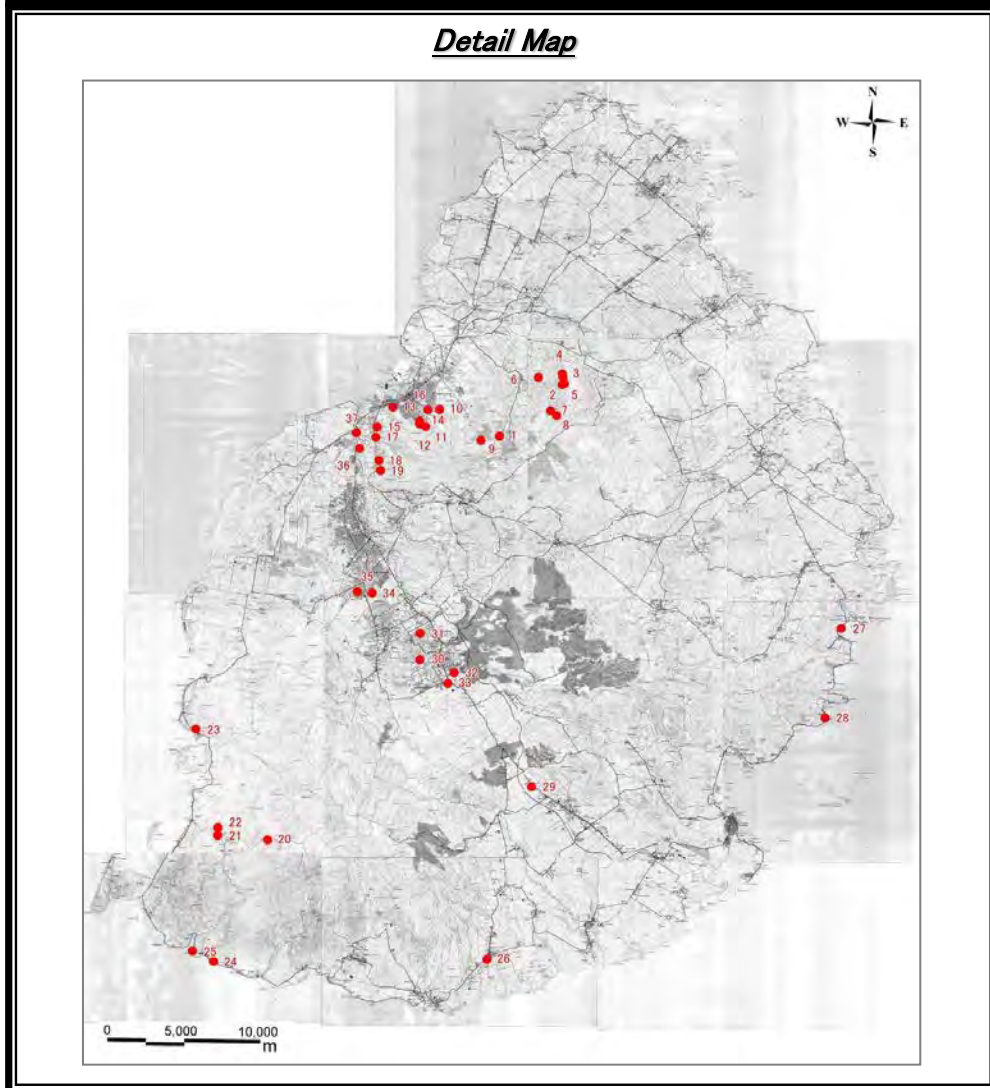
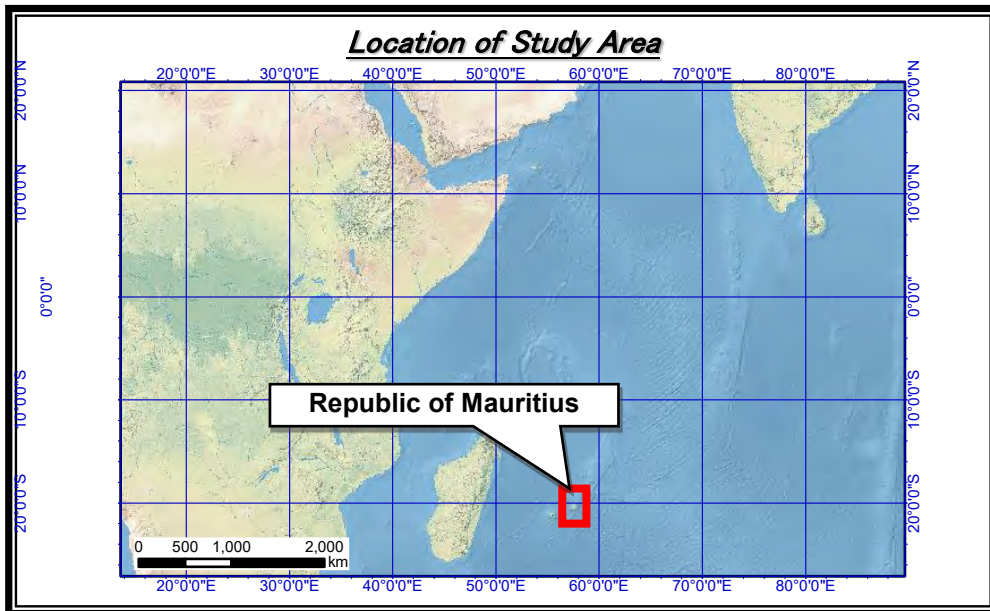
TECHNICAL COOPERATION PROJECT : LANDSLIDE ADVISER FOR MAURITIUS

FINAL REPORT

February 2018

**Japan International Cooperation Agency (JICA)
Kokusai Kogyo Co., Ltd.**

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MUR: Mauritius Rupee

As of 17 January 2018

[Landslide sites]



Landslide countermeasure constructed under the Previous JICA Project, Chitrakoot



Landslide countermeasure constructed under the Previous JICA Project, Chitrakoot



Measuring at the horizontal drainage constructed under the Previous Project, Chitrakoot



Automatic Weather Station (AWS) for early warning installed by the Mauritius Meteorological Services (MMS), Chitrakoot



Early warning system, Vallée Pitot



Early warning system, Vallée Pitot



Extensometer maintained by MPI/LMU, Vallée Pitot

【Slope failure sites】



The slope in which a retaining wall (1.5 m high) is to be applied, Batelage



The slope at middle of the road in which a crib wall is to be applied, Batelage



Site study of slope failure and rockfall, Hermitage



The investigation spot where two houses sit near the scarp, Camp Garreau, Flacq



Current condition of the site with slope failure and river erosion, Kewal Nagar Belle Rive



Cut slope failure, Pilot Bel Air



Construction of retaining wall at a place of possible slope failures, Batelage



Completed countermeasure work, Batelage

【Rock fall sites】



Rock fall, Maconde



Unstable rocks, Signal Mountain



Specification of unstable rocks, evaluation, and numbering, Signal Mountain



Marking the rocks, Signal Mountain



Consideration of measures (blue spray: stabilisation), Ruisseau Des Creoles



Unstable boulders on the steep slope, Coromandel

【Debris flow sites】



Countermeasure work for debris flow, Baie du Cap

Photos of the Project Activities (5) January 2016 – December 2017

【Meetings】



Kick-off workshop, Bagatelle, 10 February 2016



Minister's speech at the kick-off workshop, Bagatelle, 10 February 2016



Technical meeting on slope failures, rock falls and debris flows, Phoenix, 03 March 2016



Participants of Working session, Port Louis, 13 June 2016



Opening speech by the Minister in Working session, Port Louis, 13 June 2016



Technical meeting on slope failures, rock falls and debris flows, Phoenix, 14 July 2016

Photos of the Project Activities (6) January 2016 – December 2017



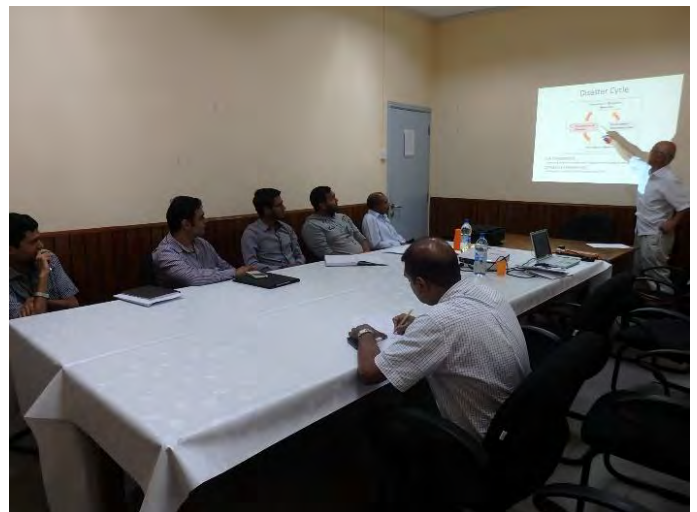
Technical meeting on rock falls, Phoenix, 20 July 2016



First Stakeholder meeting for implementation of the Work Section II, Chitrakoot, 17 August 2016



Second Stakeholder meeting for implementation of the Work Section II, Chitrakoot, 26 October 2016



Technical training for freshers, Phoenix, 22 May 2017



Technical training for freshers, Phoenix, 22 May 2017



Participants of seminar, Pointe Aux Piments, 01 March 2017

Photos of the Project Activities (7) January 2016 – December 2017



Presentation by the LMU engineer in the seminar, Pointe Aux Piments, 01 March 2017



Stakeholder meeting for phase 2 project of countermeasure works, Chitrakoot, 17 August 2016



Stakeholder meeting for phase 2 project of countermeasure works, Chitrakoot, 27 September 2016



Technical transfer workshop, Phoenix, 4 October 2017



Participants of the workshop, Balacrava, 6 December 2017



Handing over of the education materials in the workshop, Balacrava, 6 December 2017

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Abbreviations

Abbreviation	English
AWS	Automatic Weather Station
C/P	Counterpart
CES	Civil Engineering Section
CCPL	City Council of Port Louis
CES	Civil Engineering Section
CS	Cut Slope for Road
DD	Detail Design
DEM	Digital Elevation Model
Dep	Depression
DF	Debris Flow
DG	Director General
DPS	Deputy Permanent Secretary
DV	Development
EWS	Early Warning System
FL	Filling for Road
GEO	Geotechnical Engineering Office
GIS	Geographic Information System
GIS	Government Information Service
GSM	Global System for Mobile Communication
ICTA	Information and Communications Technologies Authority
JET	JICA Expert Team
JICA	Japan International Cooperation Agency
LMU	Landslide Management Unit
MFRS	Mauritius Fire and Rescue Services
MHL	Ministry of Housing and Lands
MMS	Mauritius Meteorological Services
MSSNSESD	Ministry of Social Security, National Solidarity, and Environment and Sustainable Development (former Ministry of Environment, Sustainable Development, Disaster and Beach Management (MOESDDBM))
MPI	Ministry of Public Infrastructure and Land Transport
MPI HO	MPI Head Office
NDRRMC	National Disaster Risk Reduction and Management Centre
OJT	On the Job Training
PPG	Planning Policy Guidance
PRB	Pay Research Bureau
PS	Permanent Secretary
RDA	Road Development Authority
RE	River Bank Erosion
RF	Rock fall
SF	Slope Failure
SMF	Special Mobile Force
SMS	Short Message Service

Chapter 1

Introduction

1 Introduction

1.1 General

Japan International Cooperation Agency (hereinafter JICA) has implemented the ‘project of landslide management in Mauritius’ (hereinafter the Previous Project) from May 2012 to July 2015 as a part of climate change adaptation and disaster mitigation programme for Small Island Developing States. This project of Landslide Adviser for Mauritius (hereinafter the Project) is planned to be implemented as a successor project of the Previous Project. Therefore, the Project has to be carried out identifying its role as being a part of the programmes against climate change. This Progress Report covers the activities and outcomes of the Project from January 2016 to March 2018.

1.2 Objectives and Outcomes of the Project

The outline of the Project is as shown in Table 1.2.1 below.

Table 1.2.1 Outline of the Project (Source: JET)

Items	Contents and details
Name of the Project	Landslide Adviser for Mauritius
The Project period	From January 2016 to March 2018 (approximately 26 months)
Overall goal	To mitigate slope disasters in Mauritius
Expected outcomes	<ol style="list-style-type: none"> 1. Technical transfer on landslide countermeasures’ management and maintenance implemented in the Previous Project by JICA from May 2012 to July 2015 is continuously carried out, firmly establishing these technologies. 2. The advanced technologies in implementing ‘surveys, analyses, designs, construction supervision, and management and maintenance’ of slope disaster countermeasures including slope failures, rock falls and debris flows are transferred.
Activities	<ol style="list-style-type: none"> 1. Technical support for implementation of the project evaluations and management and maintenance of landslide countermeasures 2. Technical support for implementation of the surveys, analyses, designs, construction supervision, management and maintenance, and project evaluations of slope failure, rockfall and debris flow countermeasures 3. Technical support for establishment of the remote monitoring system for slope disasters 4. Technical support for updating the early warning/evacuation system based on the results of the countermeasures against slope failures, rock falls and debris flows 5. Technical support for updating the land use regulation in the Planning Policy Guidance (PPG) based on the results of the countermeasures against slope failures, rock falls and debris flows 6. Technical support for development of the institution, system, and capacity of the Landslide Management Unit (LMU)
Counterpart organisation (C/P)	LMU, Ministry of Public Infrastructure and Land Transport (MPI)

1.3 Project work flow

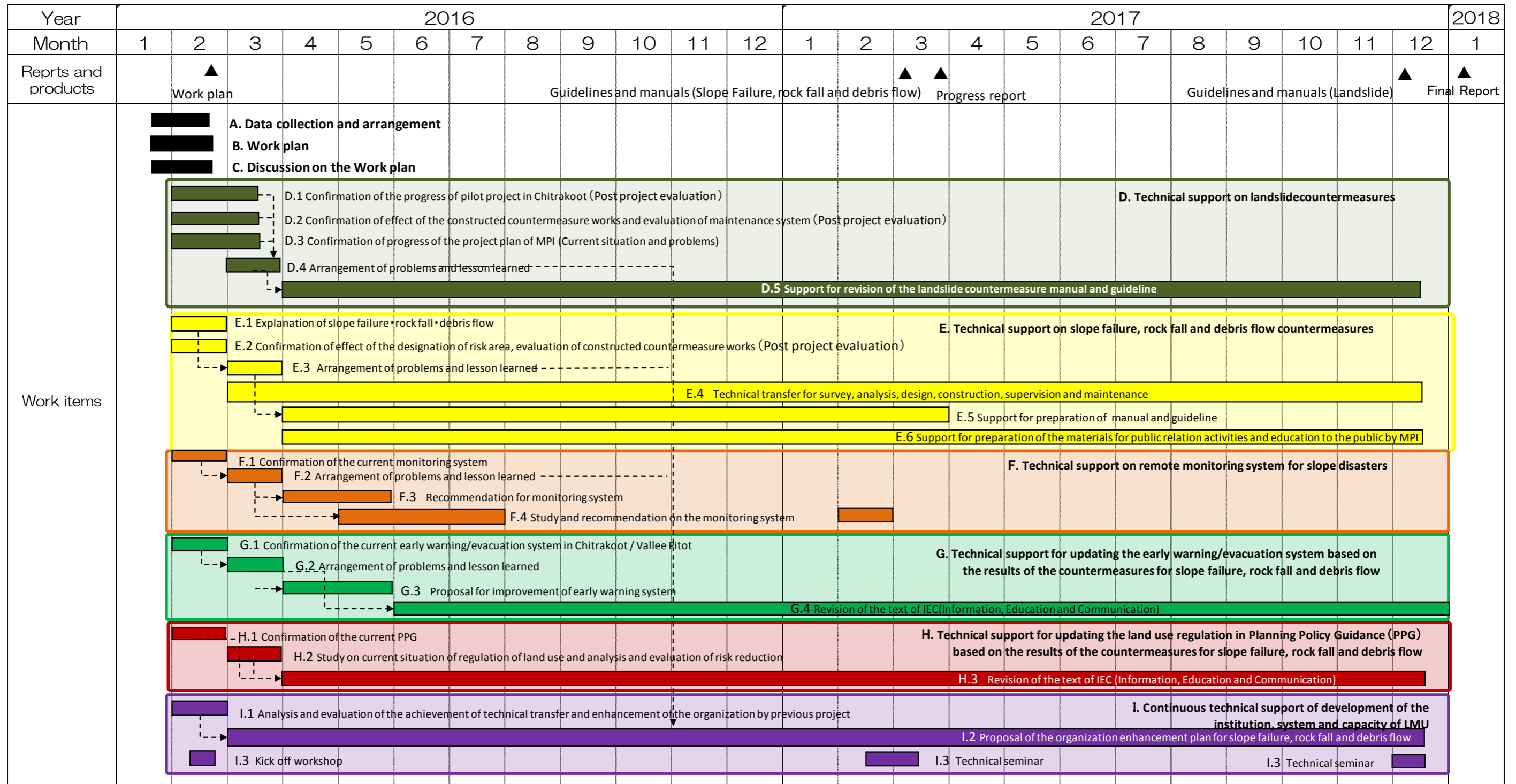


Figure 1.3.1 Project work flow (Source: JET)

Chapter 2

Project output

2 Project Output

2.1 Summary of Status by Output

The status of the Project outputs is summarised in the following table.

Table 2.1.1 Project outputs and its final status (Source: JET)

Output	Action	Final Status and Reference
Technical support on landslide countermeasures	Confirmation of the progress of pilot project in Chitrakoot	The work will be continued until end of January 2018.
	Confirmation of the effects of the constructed countermeasure works and evaluation of the maintenance system	Effects of phase 1 countermeasure under the Previous Project has been evaluated.
	Confirmation of the progress of the project plan of Ministry of Public Infrastructure and Land Transport (MPI) (current situation and problems)	Compiled in this report
	Identification of problems and lessons to be learned	Design work was properly prepared, and the site management work was conducted by Landslide Management Unit (LMU)
	Support for revision of the landslide countermeasure manual prepared by the Previous Project	Compiled in the Manual
Technical support on slope failures, rock falls, debris flow countermeasures	Explanation of slope failures, rock falls and debris flows	Completed through seminars and site survey
	Evaluation of the effects of the constructed countermeasure works, and designation of risk areas	Evaluation work was conducted together with C/P
	Problems identified and lessons to be learned on slope failures, rock falls and debris flow countermeasures	Compiled in the Manual
	Technical transfer in implementing surveys, analyses, designs, construction supervision, and management and maintenance for slope failures, rock falls and debris flows	Seminars and on-the-job training at sites are conducted
	Support for formulating the manual of slope failures, rock falls and debris flows	Compiled in the Manuals
	Support for preparing the materials for public relation and public awareness activities by MPI	Compiled in the 'Landslide Disaster Prevention Handbook'
Technical support for establishing a remote monitoring system for slope disasters	Confirmation of the current monitoring system	Checked and revised
	Problems identified and lessons to be learned	Compiled in this report
	Recommendations for monitoring system	Compiled in this report
	Study and recommendations on the monitoring system	Compiled in this report
Technical support for updating the early warning/evacuation system based on the results of the countermeasures for slope failures, rock falls and debris flows	Confirmation of the current early warning/evacuation system in Chitrakoot and Vallée Pitot	Confirmed. No specific issue raised
	Problems identified and lessons to be learned	Compiled in this report
	Proposal for the improvement of early warning system	Compiled in this report
	Revision of the awareness and sensitisation materials	Compiled in this report
Technical support for updating the	Confirmation of the current Planning Policy Guidance (PPG)	PPG 9 came into effect in March 2016

land use regulation in the PPG based on the results of the countermeasures for slope failures, rock falls and debris flows	Analyses and evaluations of the effects of risk reduction, and study on the status of the land use regulations	Compiled in this report
	Proposal for the revision of the PPG for slope failures, rock falls and debris flows	Revision was not made. However, the recommendations were made to MHL to refer to the Manuals for new development of the area.
Technical support for continuous development of the institution, system, and capacity of the LMU/MPI (confirmation of the proposal in the Previous Project and additional technical support for its implementation)	Analyses and evaluations of the achievements of technical transfer, and enhancement of the organisation by the Previous Project	New organisation (Geotechnical Engineering Office (GEO)) is considered for enhancement of the capacity. LMU is to support GEO's activities
	Proposal of the organisation enhancement plan for slope failures, rock falls and debris flows	Initial Plan for setting up GEO is formulated. Compiled in this report
	Workshop/Seminars and Working session	Major activities: Kick-off workshop (February 2016), Working Session (June 2016), Seminar (March 2017) and Workshop/Seminar (December 2017). Compiled in this report.

Chapter 3

Project activities

Project Activities

3.1 Technical support on landslide countermeasures

3.1.1 Progress of pilot project in Chitrakoot

In the Previous Project, the pilot project area of Chitrakoot was set as the object for countermeasure. Given that this site is a residential area located in private land, it was expected that the time for land acquisition was going to take a long time, consequently it was decided that the countermeasure works would be divided into two work sections, Work Section I and II. The construction of Section I is called ‘Phase 1’, and the construction of Section II is called ‘Phase 2’.

Phase 1 had been conducted during the previous project, 2014, and Phase 2 is conducted by the Ministry of Public Infrastructure and Land Transport (MPI) from 20 July and expected to be finished in the middle of February 2018. The locations of the two Work Sections are shown in the map below.

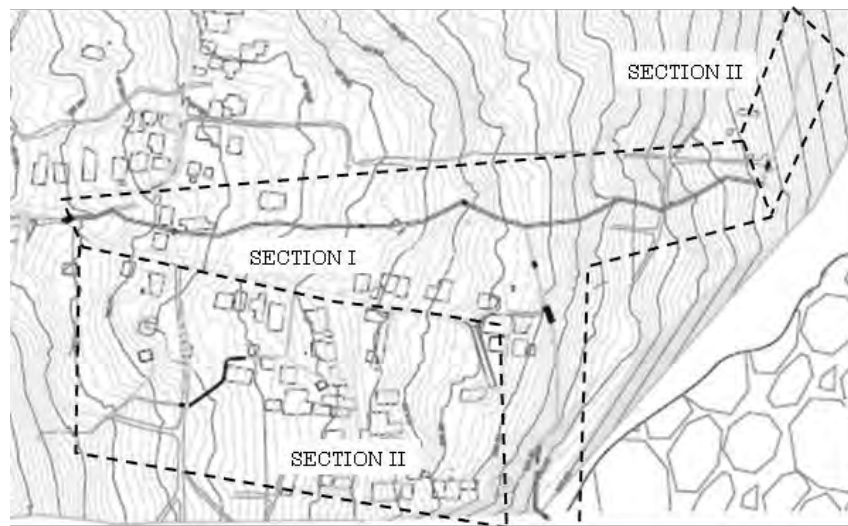


Figure 3.1.1 Work section of Block-A landslide in Chitrakoot (Source: The Project of Landslide Management in the Republic of Mauritius (Final Report), JICA, 2014)

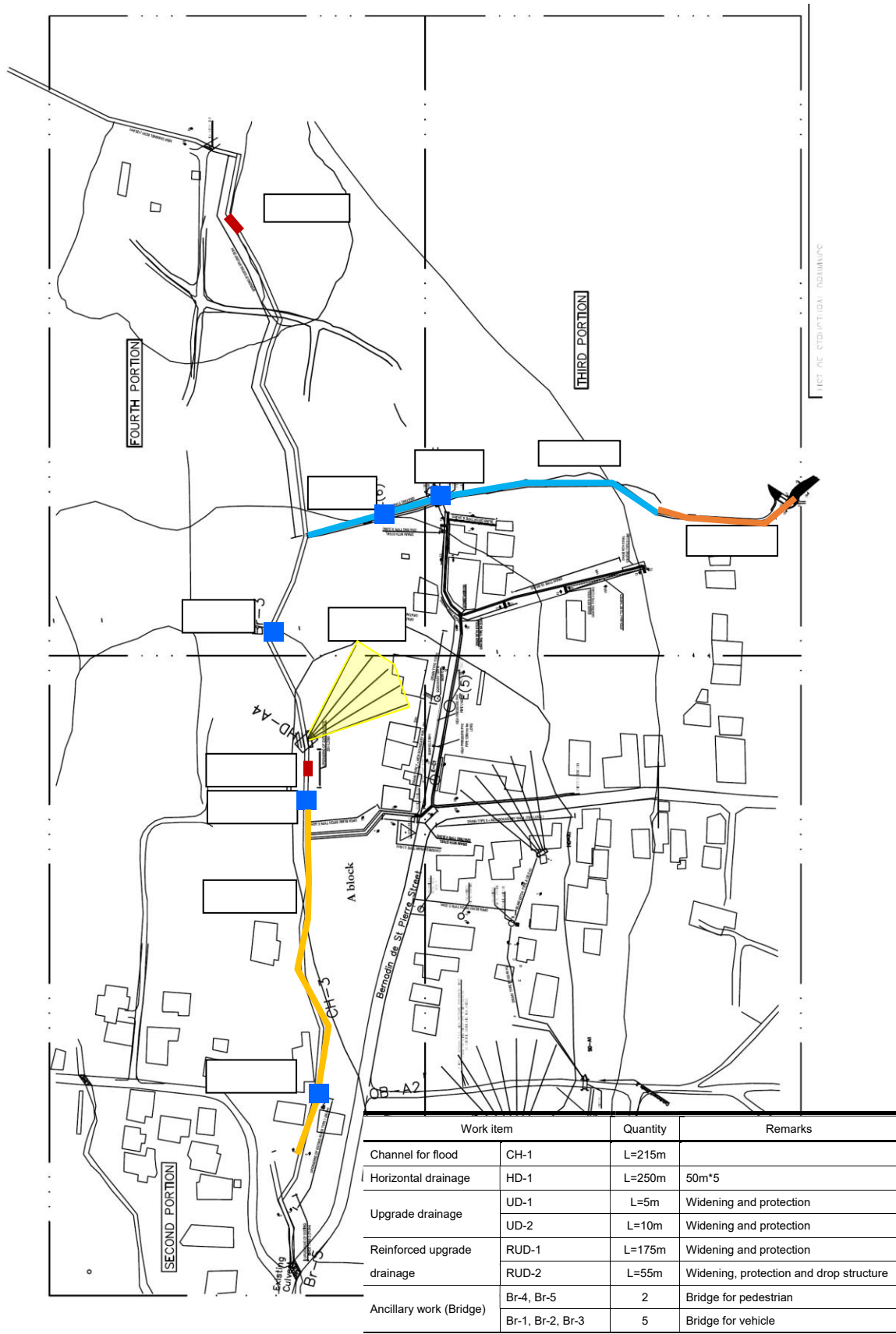


Figure 3.1.2 Location map of the countermeasure for Phase 1 in Chitrakoot (Source: JET)

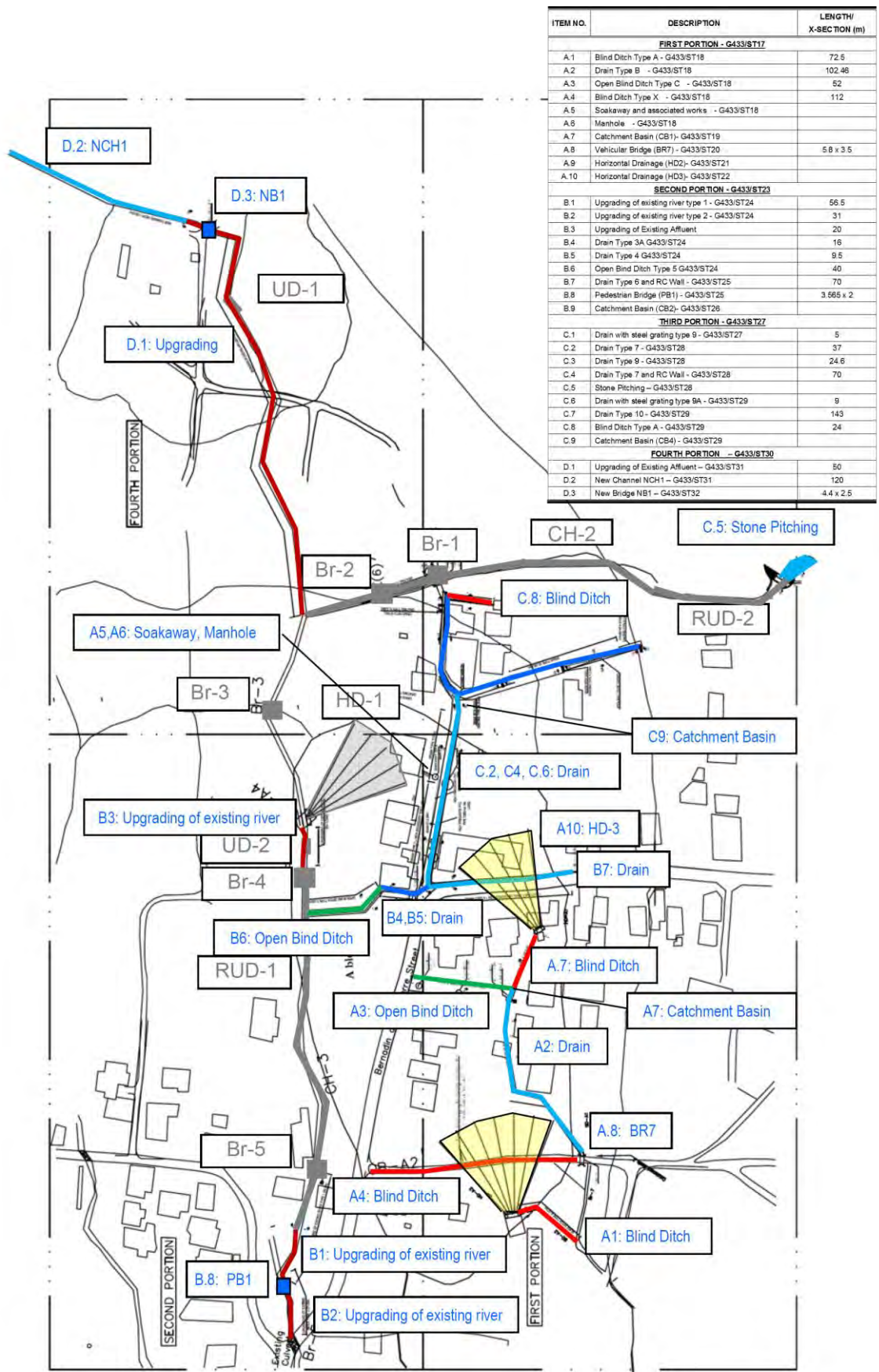


Figure 3.1.3 Location map of the countermeasure for Phase 2 in Chitrakoot (Source: JET)

- MPI/LMU and JICA Expert Team (JET) visited the site and confirmed the current situation of the landslide countermeasures for Phase 1 and Phase 2.

- Through the construction period, MPI, with assistance of JICA expert, supervised the construction of the landslide countermeasures. And some technical advice was given by JICA expert as part of this supervision.

The contents and output of the activity for progress of pilot project in Chitrakoot are shown in the table below.

Table 3.1.1 Contents and output of the activity, progress of pilot project in Chitrakoot (Source: JET)

Date	Item	Contents	Organisation (the number of participants)	MPI/LMU	Reference /Output
08 March 2017	Site survey for Phase 1 in Chitrakoot	<ul style="list-style-type: none"> MPI/LMU and JET have confirmed the current situation of the landslide countermeasures in Chitrakoot: Phase 1 	MPI (2)	<ul style="list-style-type: none"> Understanding of the present status Practical use of manual, Procedure Manual for Landslide On the Job Training (OJT) 	Appendix 3.1.1
17 August 2016	Stakeholder meeting for Phase 2 at Chitrakoot	<ul style="list-style-type: none"> Explaining the importance of the countermeasure works of Phase 2. Obtaining the consent of the inhabitants to construct the countermeasure works on their plots of land. 	MPI (3), National Disaster Risk Reduction and Management Centre (NDRRMC) (1), Ministry of Housing and Lands (MHL) (1), Other Authority (4), Local Authority (1), Inhabitant (25)	<ul style="list-style-type: none"> Understanding of sensitisation activity procedure Effective method of information dissemination 	Appendix 3.1.2
26 October 2016		<ul style="list-style-type: none"> Explaining the final planning of the project and its urgencies to the Inhabitants 	MPI (3), NDRRMC (1), MHL (1), Local Authority (1), Inhabitant (8)		
17 August 2017		<ul style="list-style-type: none"> Phase 2 of the countermeasure works (purpose, implementation period, details of the works) Q & A session 	MPI Head Office (HO) (2), LMU/MPI (7), related stakeholders (7), inhabitant (12)		
06 July 2017	1st Site meeting	<ul style="list-style-type: none"> Site meeting for countermeasure in Chitrakoot Assess overall progress of landslide countermeasure work on site and follow up on outstanding issues (was organized by MPI) 	MPI (10), MHL (2), NDRRMC (1), Local Authority (1), Contractor (4), Others (7)	<ul style="list-style-type: none"> Supervision of construction Practical use of manual, Procedure Manual for Landslide OJT 	Appendix 3.1.3
07 September 2017	2nd Site meeting		MPI (6), Contractor (2)		
28 September 2017	3rd Site meeting		MPI (6), Contractor (6)		
26 October 2017	4th Site meeting		MPI (4), Contractor (4)		
07 December 2017	5th Site meeting		MPI (6), Contractor (5)		
20 September 2017	Technical advice for supervision (1)	<ul style="list-style-type: none"> Through the construction period, some technical advice was given by JICA expert for supervision of the countermeasure construction. 	MPI (4), Other (3)	<ul style="list-style-type: none"> Supervision of construction Technical Transfer for supervision of the countermeasure construction OJT 	Appendix. 3.1.4
27 September 2017	Technical advice for supervision (2)		MPI (6), Other (11)		Appendix. 3.1.5
07 December 2017	Technical advice for supervision (3)		MPI (2)		Appendix. 3.1.6
15 December 2017	Site survey for Phase 2 in Chitrakoot	<ul style="list-style-type: none"> Confirmation of the current situation of the landslide countermeasures in Chitrakoot: Phase 2 	MPI (2)	<ul style="list-style-type: none"> Understanding of the present status Practical use of manual, Procedure Manual for Landslide OJT 	Appendix. 3.1.7

3.1.2 Effects of the constructed countermeasure works and evaluation of the maintenance system

- After completion of all countermeasures, groundwater level and landslide activity shall be monitored through at least one rainy season. And, the effects of the landslide countermeasure works should be evaluated by the stability analysis based on the result of the landslide monitoring.
- Regarding the evaluation method of the effect of landslide countermeasures using stability analysis, technical workshop for technology transfer was held by MPI and JICA; and a manual was prepared for this purpose.
- MPI has prepared a work plan for evaluating the countermeasure work in Chitrakoot using the manual.
- As one of the maintenance methods of the landslide countermeasures, the site inspection of the countermeasure in Chitrakoot was carried out on 6 March 2017 by MPI/LMU and JET.
- Generally, in Mauritius, landslide countermeasures are maintained by local authorities. Therefore, MPI and the JICA experts have prepared procedures for maintaining landslide countermeasures to be used by local authorities. MPI will be able to teach the maintenance procedures to the local authorities using this document.

The contents and output of the activity: effects of the constructed countermeasure works and evaluation of the maintenance system, are shown in the table below.

Table 3.1.2 Contents and output of the activity, effects of the constructed countermeasure works and evaluation of the maintenance system (Source: JET)

Date	Item	Contents	Organisation (the number of participants)	MPI/LMU	Reference /Output
06 March 2017	Site inspection for the maintenance of the countermeasure	The inspection of the drainage condition was carried out in Chitrakoot by MPI/LMU and JET.	MPI (2)	<ul style="list-style-type: none"> • Technical Transfer of the site inspection method for the landslide countermeasure maintenance • OJT 	Appendix 3.1.1 Appendix 3.1.8
17 October 2017	Maintenance manual	Procedure manual for the maintenance of landslide countermeasures was prepared.	MPI (5)	<ul style="list-style-type: none"> • Technical transfer of maintenance of landslide countermeasures • Preparation of procedure manual for maintenance of landslide countermeasures 	Appendix 3.1.9
17 October 2017	Technical meeting	Technical meeting for procedure of the maintenance of landslide countermeasures was held by MPI/LMU and JET.	MPI (5)	<ul style="list-style-type: none"> • Technical Transfer of procedure for the maintenance of landslide countermeasures 	Appendix. 3.1.10
15 December 2017	Technical workshop for the evaluation method of the effect of the landslide countermeasure'	The evaluation method of the effect of the landslide countermeasure using stability analysis was transferred to MPI by JICA experts, and a manual for that was prepared.	MPI (15)	<ul style="list-style-type: none"> • Technical Transfer: The evaluation method of the effect of the landslide countermeasure by the stability analysis • Practical use of procedure manual, Evaluation method for effects of the landslide countermeasure using Stability Analysis 	Appendix 3.1.11 Appendix 3.1.12
15 December 2017	Work plan for evaluation of the countermeasure	MPI has prepared a work plan for evaluations of the countermeasure work in Chitrakoot using the manual.	MPI (2)	<ul style="list-style-type: none"> • Technical Transfer: The evaluation method of the effect of the landslide countermeasure by the stability analysis • Practical use of procedure manual, Evaluation method for effects of the landslide countermeasure by using Stability Analysis 	Appendix 3.1.13

3.1.3 Usage of manual

MPI and JICA Expert Team have prepared two manuals, ‘Procedure Manual for Landslide’ and ‘Technical Guideline for Initial Survey’ in this project. These two manuals were made in the previous JICA project, and were revised in this project.

‘Procedure Manual for Landslide’ has been prepared to acquire basic knowledge of landslides and procedures of geological surveying, monitoring, stability analysis and design/maintenance of the countermeasures for landslides.

‘Technical Guideline for Initial Survey’ has been prepared for responding to a landslide after one has occurred. It includes guidance on initial site surveying, emergency response and planning for detailed landslide surveys.

- Using the above manuals, MPI carried out the detailed design (D/D) of the landslide countermeasures for Chitrakoot
- Using the manuals, MPI carried out the construction of the landslide countermeasures in Chitrakoot
- Using the manuals, a landslide investigation was carried out by MPI in Vallée Pitot
- The construction of landslide countermeasures was carried out using the manuals in Vallée Pitot
- Based on the manuals, MPI has prepared a procedure manual for the maintenance of landslide countermeasures

The contents and output of the activity: usage of manual, are shown in the table below.

Table 3.1.3 Contents and output of the activity, usage of manual (Source: JET)

Date	Item	Contents	Organisation (the number of participants)	MPI/LMU	Reference /Output
05 May 2015	Landslide investigation by MPI in Vallée Pitot	Using a manual, a landslide investigation was carried out by MPI in Vallée Pitot.	MPI (3)	<ul style="list-style-type: none"> • Practical use of manual, Procedure Manual for Landslide • Landslide investigation 	Appendix 3.1.14
06 July 2017	D/D of the countermeasure for Chittrakoot	Using a manual, MPI has carried out the detailed design for Chittrakoot.	MPI (3)	<ul style="list-style-type: none"> • Practical use of manual, Procedure Manual for Landslide • OJT • D/D 	Appendix 3.1.15
06 July 2017	Construction of the landslide countermeasures in Chittrakoot	Using a manual, MPI has carried out the construction of the landslide countermeasures in Chittrakoot	MPI (3)	<ul style="list-style-type: none"> • Practical use of manual, Procedure Manual for Landslide • OJT • Construction of the landslide countermeasures 	Appendix 3.1.1 - 3.1.7
12 October 2017	Construction of landslide countermeasures in Valle Pitot.	The construction of landslide countermeasures was carried out using a manual in Valle Pitot.	MPI (3)	<ul style="list-style-type: none"> • Practical use of manual, Procedure Manual for Landslide • OJT • Construction of the landslide countermeasures 	Appendix 3.1.16
17 October 2017	Maintenance manual	Using a manual, MPI has prepared a procedure manual for the maintenance of landslide countermeasures.	MPI (5)	<ul style="list-style-type: none"> • Preparation of procedure manual for maintenance of landslide countermeasures • Understanding of the maintenance technique 	Appendix 3.1.9

3.1.4 Problems identified and lessons learnt

The countermeasure works in Chittrakoot were divided into two work sections, Phase 1 and Phase 2. Phase 1 had been conducted during the previous project in 2014, and Phase 2 was conducted by the MPI from 20 July to the end of January 2018. The contents of Phase 1 and Phase 2 are included in Section 3.1.1.

MPI and JET identified the problems and the lessons learnt based on the results of the projects, Phase 1 and Phase 2, for landslide countermeasures.

a. Capacity of landslide countermeasure construction and supervision

MPI already has knowledge and experience of construction and supervision for landslide countermeasure, surface drainage, blind ditch and horizontal drain, through a previous JICA project and this project, and can conduct a plan, D/D and construction of appropriate landslide countermeasures. However, MPI does not have experience of landslide prevention work such as anchor work, pile work and shaft work. It will be necessary to acquire knowledge and experience of the landslide prevention work as needed in the future.

b. Relocation of residents

In Mauritius, often one of the most effective countermeasures is to relocate the inhabitants of

the landslide hazard area. MPI is planning the relocation of inhabitants in three pilot sites, Chittrakoot, Vallée Pitot and Quatre Soeurs.

c. Organisation for managing and maintaining countermeasures

Generally, in Mauritius, the landslide countermeasures are maintained by local authorities. However, because the local authorities do not know the maintenance procedures, mostly, maintenance for landslide countermeasures is not carried out. Therefore, MPI and JICA should prepare the maintenance procedures of landslide countermeasures for local authorities.

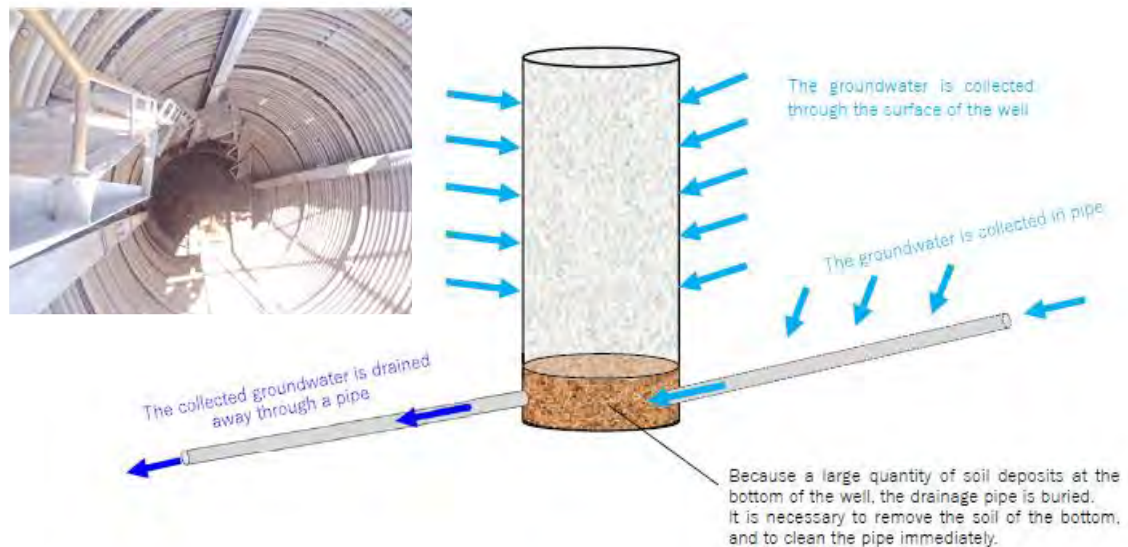


Figure 3.1.4 Existing drainage well in La Butte (Source: JET)

d. Hazard map of landslide disaster

The first step for mitigation of the slope disaster is to know the distribution of the slope angle in detail. If there is a high-resolution slope map as a hazard map in Mauritius, the land development in a steep slope area is easily controlled according to Planning Policy Guidance (PPG) 9. However, the grid data obtained in the previous project was too rough to be used for the PPG. If more high-resolution grid data is acquired in the future, the slope map as a hazard map should be prepared by MPI.

3.1.5 Recommendation

a. Capacity of landslide countermeasure construction and supervision

MPI already has knowledge about planning, D/D and construction of the landslide prevention work in manuals such as on anchor work, pile work and shaft work. However, MPI cannot carry out landslide prevention work by itself because MPI does not have construction experience. The experience of the landslide prevention work will be brought to Mauritius in 2018 by an MPI member currently studying in Japan through the ABE Initiative of JICA.

b. Organisation for managing and maintaining countermeasures

Generally, in Mauritius, landslide countermeasures are maintained by local authorities.

Therefore, MPI and the JICA experts have prepared the maintenance procedure of the landslide countermeasures for local authorities (refer to Appendix 3.1.9). MPI will be able to teach the procedures of maintenance to the local authorities using this document.

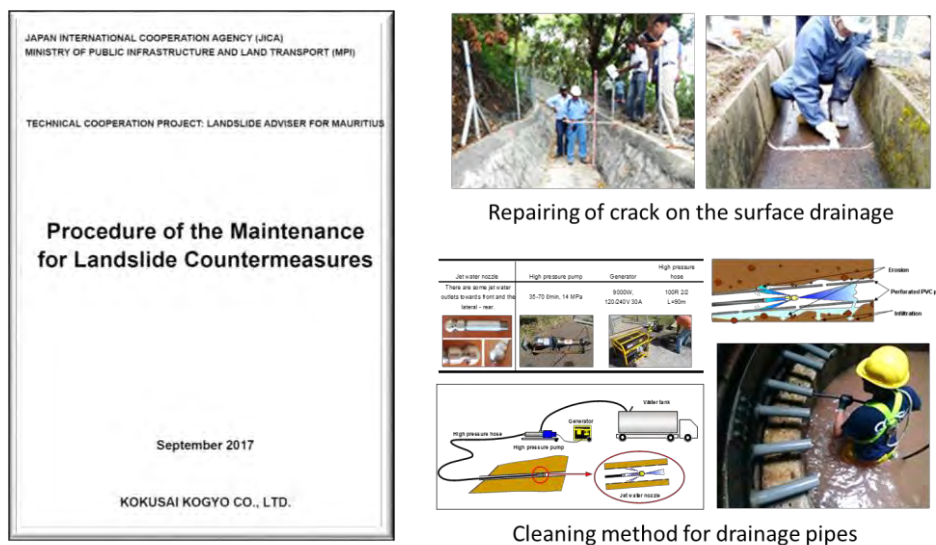


Figure 3.1.5 Procedure of the landslide countermeasure produced by MPI and JET (Source: JET)

c. Hazard map of landslide disaster.

JET held a technical transfer workshop to make a slope map using Geographic Information System (GIS) software (refer to Appendix 3.2.5). If higher-resolution Digital Elevation Model (DEM), < 2 m mesh, is acquired in future in Mauritius, the slope map as a hazard map can be prepared easily using the techniques taught in the workshop by MPI.

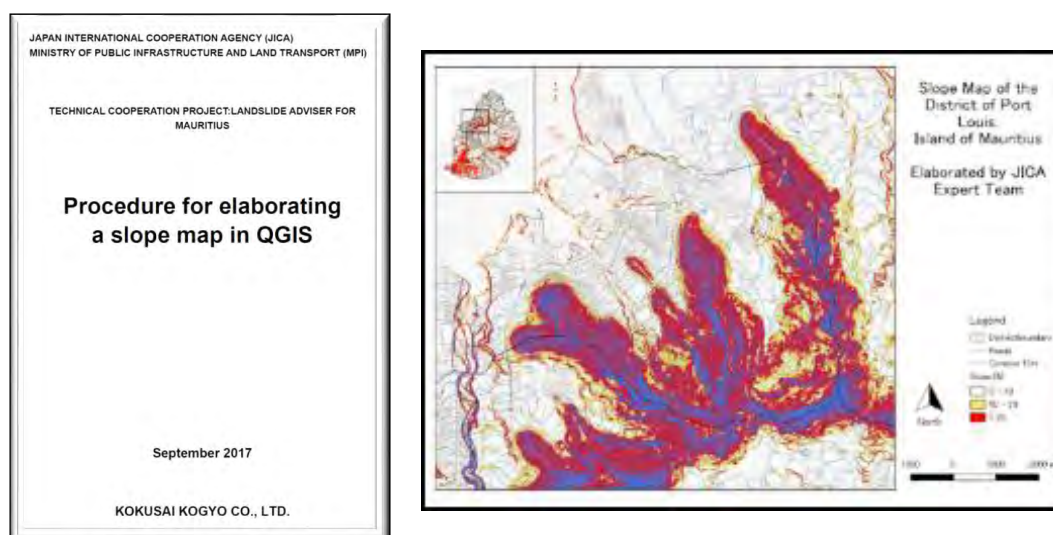


Figure 3.1.6 Procedures for creating slope maps; produced by MPI and JET (Source: JET)

3.2 Technical support on slope failures, rock falls and debris flow countermeasures

3.2.1 Explanation of slope failures, rock falls and debris flows

JET explained three types of slope disasters and their mechanisms (landforms, geology, inducing factors, movement of the soil and rocks, etc.) and the difference between the countermeasures.

Furthermore, JET explained not only structural countermeasures but also factors to take into account (short-period (intense) rainfall and long-period rainfall, groundwater conditions, earthquakes, strong winds) when planning the monitoring and early warning systems.

From March to July 2016, JET conducted field surveys to investigate the mechanisms of slope failures, rock falls, debris flows and their causes in Mauritius. JET also carried out technical transfer of recommendable measures. In addition, JET held two technical meetings and a workshop about slope disasters.

The contents and output of the activity: explanation of slope failures, rock falls and debris flows, are shown in the table below.

Table 3.2.1 Contents and output of the activity, explanation of slope failures, rock falls and debris flows (Source: JET)

Date	Item	Contents	Organisation (the number of participants)	MPI/LMU	Reference /Output
03 March 2016	Technical meeting (1)	<ul style="list-style-type: none"> • Agenda of Technical meetings for slope failures, rock falls and debris flows • Tendency of slope disasters • Cause of slope disasters • Selection of countermeasure works • Low cost countermeasure works • Explanation of crib walls 	MPI (5)	<ul style="list-style-type: none"> • Basic knowledge of slope failures, rock falls and debris flows • Practical use of manual, manual for survey and countermeasure of slope failure, rock fall and debris flow 	Appendix 3.2.1
14 July 2016	Technical meeting (2)	<ul style="list-style-type: none"> • Agenda of Technical meetings for rock falls • Explanation of rock falls (An example of Signal Mountain) • Structural Countermeasures • PPG • Rock fall countermeasure works 	MPI (5)	<ul style="list-style-type: none"> • Basic knowledge of slope failures • Practical use of manual, manual for survey and countermeasure of slope failure, rock fall and debris flow 	
20 July 2016	Technical meeting (3)	<ul style="list-style-type: none"> • Agenda of Technical meetings for rock falls • Methods of rock fall countermeasure works • Materials of countermeasure works • Basic design for Maconde and Signal Mountain 	MPI/LMU, Road Development Authority (RDA), NDRRMC, Contractor (27)	<ul style="list-style-type: none"> • Methods of rock fall countermeasure • Practical use of manual, manual for survey and countermeasure of slope failure, rock fall and debris flow 	

3.2.2 Designation of risk areas and effects of the constructed countermeasure works (evaluations)

a. Designation of risk areas

MPI and JET have visited 18 sites of slope failures, rock falls, and debris flows, and surveyed the current conditions of each slope during this project. As a result of the investigation of the 18 sites, slope investigation sheets and a slope inventory were made by MPI and JET. The slope inspection sheets of the 18 sites are attached as an Appendix at the end of the report.

11 sites designated with a risk rank of A or B are shown in the slope inventory by MPI and JET. The lists of the risk areas are as follows.

Table 3.2.2 List of the designated risk areas and proposed countermeasures (Source: JET)

Management No.	Address/Name	Slope Disaster Type		Risk Rank	Proposed countermeasures by JET and C/P
		Category 1	Category 2		
2016-001	A9 Road at Batelage	SF	CS	A	Crib wall & concrete spraying
2016-002	Valle Pitot	SF	FL	A	Retaining wall
2016-003	Ruisseau de Creoles	RF	DV	A	Rock removal & stabilisation
2016-004	Coromandel, land of Mr. H. Phutully	SF&RF	DV	B	Retaining wall
2016-006	Kewal Nagar Belle Rive at Shavala Road	SF	RE	A	River bank protection wall such as a gabion
2016-007	Application for Building and Land Use Permit at Moka	SF	DV	B	Reforming, re-cutting
2016-008	Signal Mountain	RF	CS	A	Rock removal, stabilization, rock fence and rock fall protection net
2016-009	Mount Ory	SF	DV	B	Reforming, re-cutting
2016-010	Maconde	RF	CS	A	Rock fall protection net
2016-017	Mrs Coolen House, Camp Garreau, Flacq	SF	RE	A	River bank protection wall such as a gabion
2016-018	Hermitage, Coromandel	SF&RF	DV	A	Retaining wall

<Legend>

SF	Slope failure
RF	Rock fall
DF	Debris flow
Dep	Depression
CS	Cut slope for Road
DV	Development
RE	River Bank Erosion
FL	Filling for Road

b. Slope map as a hazard map

The first step for mitigation of the slope disaster is to know the distribution of the slope angle in detail. If there is a high-resolution slope map in Mauritius, the land development in a steep slope area is easily controlled according to PPG 9, and the slope disaster will be mitigated.

Therefore, JET held a technical transfer workshop to make a slope map using the GIS software, QGIS. The existing DEM is the highest resolution data in Mauritius, 10 m mesh data, but it is insufficient for slope map as a hazard map. However, if higher resolution DEM, < 2 m mesh, is acquired in the future in Mauritius, the slope map can be updated easily using the techniques taught in the workshop by an MPI engineer.

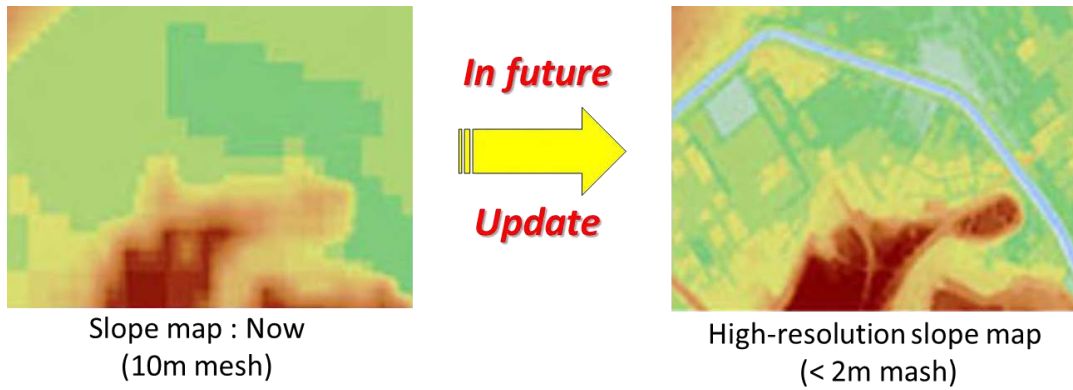


Figure 3.2.1 Difference in resolution in the slope map (Source: JET)

c. Effects of the constructed countermeasure works (evaluations)

Existing slope countermeasures were found only in two sites of the total 18, and it was judged that those countermeasures were insufficient by MPI and JET.

- Management No. 2016-010, Maconde
- Management No. 2016-018, Hermitage

The contents and output of the activity, designation of risk areas and effects of the constructed countermeasure works (evaluations) are shown in the table below.

Table 3.2.3 Contents and output of the activity, designation of risk areas and effects of the constructed countermeasure works (evaluations) (Source: JET)

Date	Item	Contents	Organisation (the number of participants)	MPI/LMU	Reference /Output
31 October 2016	Slope inventory	MPI and JET visited 18 sites of slope failures, rock falls, and debris flows, and a slope inventory was made by MPI and JET.	MPI (5)	<ul style="list-style-type: none"> • Practical use of manual, manual for survey and countermeasure of slope failure, rock fall and debris flow • OJT 	Appendix 3.2.2
31 October 2016	Slope investigation sheets	MPI and JET visited 18 sites of slope failures, rock falls, and debris flows, and slope investigation sheets were made by MPI and JET.	MPI (5)	<ul style="list-style-type: none"> • Practical use of manual, manual for survey and countermeasure of slope failure, rock fall and debris flow • OJT 	Appendix 3.2.3
31 October 2016	Effects of the constructed countermeasure works (evaluations)	Existing slope countermeasures were found in two sites of the total 18, and MPI and JET evaluated those countermeasures to be insufficient.	MPI (5)	<ul style="list-style-type: none"> • Practical use of manual, manual for survey and countermeasure of slope failure, rock fall and debris flow • OJT 	Appendix 3.2.4
11 October 2017	Technical workshop for making a slope map by GIS software	JET held a technical transfer workshop to make a slope map by GIS software, QGIS. If more high-resolution DEM, < 2 m mesh, is acquired in the future in Mauritius, the slope map as a hazard map can be updated easily using the technique of the workshop by MPI engineer.	MPI (15)	<ul style="list-style-type: none"> • Technical transfer: Procedure to make a slope map by QGIS • Practical use of procedure manual, procedure for elaborating a slope map in QGIS 	Appendix 3.2.5

3.2.3 Support for formulating the manual/guideline of slope failures, rockfalls, and debris flows

In accordance with the currently employed landslide countermeasure manual, JET is supporting the elaboration of two manuals called ‘Technical Guideline for Initial Survey’ and ‘Procedure Manual for Landslide’. The contents focused mainly on actual surveys and measures.

JET led the work to summarise the knowledge LMU and JET had gained through various instances, including the field surveys and the countermeasure work planning carried out in 2017.

‘Technical Guideline for Initial Survey’ and ‘Procedure Manual for Landslide’, which were made during the Previous Project, were brought in as a reference. Manuals concerning slope failure such as those created by JICA, the Japanese Ministry of Land, Infrastructure Transport and Tourism, or the Public Works Research Institute were not used, because the manuals created by JET were made having in mind the cases in Mauritius so that MPI and LMU will be able to use the manual easily.

The contents are as shown below. Each article describes slope failures, rock falls and debris flows respectively. Each countermeasure work is also explained in detail in the manuals of slope failures, rock falls and debris flows.

Table 3.2.4 Contents of the manual of slope failures, rock falls, and debris flows (Source: JET)

Chapter	Sub-Chapter	Contents
1 Introduction	1.1 What is landslide?	Definition of landslide, type of slope disasters in Mauritius. Location map and inventory
	1.2 Procedure manual of slope failures, rock falls and debris flows	Basic procedures and contents, proceedings of slope earthworks
	1.3 Explanation of technical terms	
2 Surveys	2.1 Introduction	Relationship between procedure of slope earthwork and soil investigation, survey method
	2.2 Survey on slope failures	Checkpoints of survey, cut slope and natural slope failures, survey on cut slope stability, survey on slope failures requiring extra precautions, surveys for planting
	2.3 Survey on rock falls	Checkpoints of survey, survey on rock fall requiring extra precautions
	2.4 Survey on debris flows	Checkpoints of survey, survey on occurrence of debris flows, survey on estimation of scale, character and inundation area of debris flows
	2.5 Survey on drainage systems	Checkpoints of survey, survey on drainage system for surface water, survey on drainage system for seepage water
	2.6 Survey on retaining wall and culvert	Checkpoints of survey, survey on retaining wall and culvert
3 Design	3.1 Introduction	Basic principles and important points for design
	3.2 Cut slopes	Standard cross-section of cut slopes. Cuts requiring extra precautions
	3.3 Slope protection	Selection of slope protection works, important points for introduction of slope protection works, planting, slope protection works with structures
	3.4 Countermeasures for rock	Selection of countermeasures for rock falls, important

	falls	points for application of countermeasures for rock falls
	3.5 Countermeasures for debris flows	Selection of countermeasures for debris flows, important points for countermeasures for debris flows
	3.6 Drainage	Road drainage, surface drainage, slope drainage, subsurface drainage, transverse drainage across road, drainage during construction work
	3.7 Retaining wall	Selection of structural and foundation types, determination of design conditions, earth pressure, stability analysis for retaining wall, design of various types of concrete retaining walls, design of foundations, design of drainage, design of reinforced soil wall
	3.8 Culvert	Selection of structural type, roads used for design of culvert, important points for design of various types of culvert, design of foundations
4 Execution	4.1 Introduction	
	4.2 Slope work	Cut slope work, embankment slope work, slope protection work
	4.3 Countermeasures for rock falls and debris flows	Countermeasures for rock falls, countermeasures for debris flows
	4.4 Construction of retaining wall and culvert, etc.	Construction of retaining wall, construction of culvert, execution of backfilling and approach cushion
5 Work Management and Inspection	5.1 Introduction	
	5.2 Execution management	Schedule control, quality and finished work control, environmental conservation measures
	5.3 Work inspection	Finished work inspection methods, quality inspection methods, acceptance judgment
6 Maintenance of Earth Structures	6.1 Introduction	Necessity for and components of maintenance, important points for maintenance, disaster restoration measures
	6.2 Maintenance of slopes	Inspection of slopes, maintenance and repair of slopes, countermeasures for post-completion abnormalities
	6.3 Maintenance of drainage facilities	Inspection of drainage facilities, maintenance and repair of drainage facilities
	6.4 Maintenance of retaining walls and culvert	Inspection of retaining walls and culvert, countermeasures for distortion of retaining walls and culvert

3.2.4 Usage of Manual

MPI and JICA Expert Team have prepared a manual titled ‘Manual for Survey and Countermeasure of Slope Failure, Rock Fall and Debris Flow’ in this Project. This manual mentions survey, inspection, D/D and maintenance of the countermeasures for slope failures, rock falls and debris flows.

Using a manual, JET transferred the techniques of countermeasures, structural and non-structural countermeasures, for slope failures, rock falls and debris flows, including the implementation of surveys, analyses, designs, construction supervision, management and maintenance to the LMU through OJT.

The main points are as follows:

- Construction works: technical transfer of construction, management and maintenance
- Planning countermeasure works: technical transfer of surveys, designs, constructions, management and maintenance

- Constructed works: technical transfer of management and maintenance

The following sections describe the technical transfer works carried out at each site.

Table 3.2.5 Summary of surveys and measures against slope failures, rockfalls, and debris flows, and technical transfer (Source: JET)

Name of the sites	Date and attendants (number of participants)	Items and results of survey	Items and results of countermeasures	Reference
1. Batelage (road cut slope failure)	<ul style="list-style-type: none"> 15, 17 and 23 February 2016: MPI (2) 7 July 2016: MPI (1) 7 October 2016: MPI (2), RDA 20 October 2016: MPI (1), NDRRMC, Savanne District Council, Police Office and RDA 26 September 2017: MPI (1), RDA 	<ul style="list-style-type: none"> Classification of the type of failure Main cause of slope failure was rain and wind during the cyclone in 2015 Water drainage from the houses influenced the slope stability 	<ul style="list-style-type: none"> Cut trees, shaping the slope, removal of unstable rocks On site crib wall, soil nailing, rock bolts, shotcrete, and retaining wall Improvement of sewage water 	Appendix 3.2.6
2. Signal Mountain (rock falls and debris flows)	<ul style="list-style-type: none"> 21,22 and 27 June 2016: MPI (2) 5 July 2016: MPI 12 July 2016: MPI (2) 19 July 2016: MPI (2), NDRRMC 1 and 5 August 2016: MPI (2) 24 and 26 October 2016: MPI (2) and Special Mobile Force (SMF) 	<ul style="list-style-type: none"> Rock fall, road settlement, and debris flow in the 3 km long road section Classification of rockfall type Mechanism analysis of rock fall Mechanism analysis of erosion and debris flow 	<ul style="list-style-type: none"> Preparation of rock fall countermeasure protocol Planning of rock fall survey Preparation of rock fall inventory Non-structural countermeasures, such as Information boards, sign poles, and traffic regulations Structural countermeasures-stabilisation, removal, protection measures by structures Training of rock fall survey and preparation of the inventory 	Appendix 3.2.6
3. Maconde (rock fall)	<ul style="list-style-type: none"> 21 July 2016: MPI 21 July 2016: MPI 26 July 2016: MPI 25 October, 4 and 7 November 2016: MPI (2) 26 September 2017: MPI (2) and RDA 	<ul style="list-style-type: none"> Steep scarp along the B9 road. Geology of the scarp is alternating beds of basalt lava and blocks Rock fall occurred frequently 	<ul style="list-style-type: none"> RDA changed the road alignment from the scarp side to the sea side and constructed a rock fall protection fence. RDA removed unstable rocks from the scarp NDRRMC discussed the rock fall countermeasure protocol Information boards and road signs were set on the road. Traffic regulation was discussed. LMU and JET discussed countermeasure works and estimated its cost. 	Appendix 3.2.6
4. Hermitage (slope failure and rock fall)	<ul style="list-style-type: none"> 21 October 2016: MPI (2) 	<ul style="list-style-type: none"> Artificially modified slope with risk of slope failure. Cause of the slope failure was improper development. LMU conducted survey of the slope 	<ul style="list-style-type: none"> LMU designed a retaining wall, a rock fall protection fence and drainage channels LMU and JET conducted site survey for countermeasure works 	Appendix 3.2.6
5. Mount Ory (M1)	<ul style="list-style-type: none"> 21, 22 and 27 June 2016: MPI (2) 	<ul style="list-style-type: none"> District Council of Moka requested LMU to conduct an emergency investigation Topographic survey by Laser equipment Slope gradient is in the critical line of 20 % 	<ul style="list-style-type: none"> LMU prepared a site report to District Council of Moka Detailed topographic survey is needed to define the border line of slope gradient 20 % 	Appendix 3.2.6
6. Mount Ory (Moka)	<ul style="list-style-type: none"> 29 March 2016: MPI (2) 	<ul style="list-style-type: none"> District Council of Moka requested LMU to carry out a survey of 'Application for the use of slope'. Topographic survey by Laser equipment Slope gradient is in the critical line of 20 % Back side slope is prone to rock falls. 	<ul style="list-style-type: none"> LMU prepared a site report to District Council of Moka Presumed gradient of this slope will be more than 20 % Detailed topographic survey is needed in order to define the border line of slope gradient 20 % 	Appendix 3.2.6
7. Ruisseau Créoles (rockfall)	<ul style="list-style-type: none"> 27 February 2016: MPI (2) 24 May 2016: MPI (1) 7 July 2016: MPI (1) and survey team 	<ul style="list-style-type: none"> There are several boulders in slopes on housing premises (behind the houses). Major type of rock fall is rolling. As the slope gradient is between 15 and 20 degrees, the reach of the rock fall will not be long. 	<ul style="list-style-type: none"> LMU and JET carried out site surveys, and discussed risks and countermeasures. Hazardous rocks were identified. 	Appendix 3.2.6
8. Camp Garreau, Flacq (river erosion and slope failure)	<ul style="list-style-type: none"> 9 August 2016: MPI (1) 	<ul style="list-style-type: none"> The failure was caused by sewage water, rain water, and river erosion. 	<ul style="list-style-type: none"> The cost of countermeasure works is likely to be expensive. MPI recommended those houses move from this area. 	Appendix 3.2.6
9. Kewal Nagar/ (1) Belle Rive (2) river erosion	<ul style="list-style-type: none"> 3 and 4 March 2016: MPI (1) 29 March 2016: MPI (1) 18 November 2016: MPI (1) 	<ul style="list-style-type: none"> The slope failure is produced due to river erosion and artificial modification. Man-made steps of several meters wide can be seen. The geology of the slope is highly weathered rock and clayey soil. 	<ul style="list-style-type: none"> Ministry of Social Security, National Solidarity, and Environment and Sustainable Development (MSSNSED) visited this site and commented on this problem. Some relation with river water erosion fluctuation to the slope is observed. LMU recommended Gabion protection against erosion. 	Appendix 3.2.6
10. Coromandel (slope failure)	<ul style="list-style-type: none"> 1 August 2016: MPI (1) 	<ul style="list-style-type: none"> There are a lot of unstable rocks on a steep slope. Rain water flowed down from the road located above of the slope, and caused instability. Land owner submitted application of development to build a house. 	<ul style="list-style-type: none"> Recommended not to do slope modification and excavation. Removal of unstable rocks. Construction of a retaining wall, and drainage channel works are recommended by LMU and JET. 	Appendix 3.2.6

11. Petit Bel Air (cut slope failure)	<ul style="list-style-type: none"> 29 February 2016: MPI (1) 3 March 2016 	<ul style="list-style-type: none"> The slope is near the mouth of Riviere des Creoles. The geology of the slope is highly weathered rock. Cut slope was done by the land owner in the lower part of the slope. 	<ul style="list-style-type: none"> LMU and JET advised residents living above the slope to cut unstable trees, to cover their land with stones and lawn, and to drain water properly. As the slope is inside a private plot, MPI cannot carry out countermeasure works. 	Appendix 3.2.6
12. Vallée Pitot (bank slope failure)	<ul style="list-style-type: none"> 16 February 2016: MPI (5) 26 February 2016: MPI (2) 	<ul style="list-style-type: none"> The target site is a mountain foot slope. This area is affected by development pressure due to the expansion of urban areas. Slope failure was caused by a flash flood flowing from the mountain slope and the water saturation of road fill materials. Damages were inundation, failure of a retaining wall and road collapse. 	<ul style="list-style-type: none"> Countermeasure for flash floods Improvement of the weak retaining wall. Improvement of the surface drainage system along the road. LMU and JET suggested water shed management on the slope area. 	Appendix 3.2.6
13. Long Mountain (river slope failure)	<ul style="list-style-type: none"> 8 July 2016: MPI (1) 15 July 2016 	<ul style="list-style-type: none"> The subject slope was created by river erosion. Damage in the slope was not caused by river water but surface water coming from the house yard. The foundation of the house was slightly washed out. 	<ul style="list-style-type: none"> Diversion of surface water from the house yard. An urgent countermeasure is the reinforcement of the foundation. 	Appendix 3.2.6
14. Signal Mountain, Maconde and Batelage	<ul style="list-style-type: none"> 26 October 2016: MPI (2) and SMF 7 November 2016: MPI (2) 7 July 2016: MPI (1) 	<ul style="list-style-type: none"> Signal Mountain: Support for creating the protocol for rockfalls Maconde: Support for drafting documents on measures against rockfalls Batelage: Support for drafting documents on measures against road cut slopes 	<ul style="list-style-type: none"> Signal Mountain: Making the 'Manual for Rock Fall Inventory at Signal Mountain Road' Maconde: D/D for road alignment, rock fall protection fence and rock net. Batelage: D/D for a crib wall, soil nailing, rock bolts, shotcrete, and retaining wall 	Appendix 3.2.7

3.2.5 Problems and lessons learnt

JET and the C/P selected the problems and arranged lessons to be learned so that MPI will be able to implement the countermeasures independently based on the results of the current implementation status of MPI's project plan for slope failures, rock falls and debris flows countermeasures.

a. Regulation of slope development by PPG

The Development on number of slopes has been given priority, therefore, inspections based on the PPG and on-site instructions at problematic areas are being postponed. Hence the reason, it is necessary to publicise the rules on slope development, because most of the disastrous slopes are located in these areas and many slope disasters happened due to such reckless development. Moreover, expansion of local houses has obviously become a potential danger. These geographical developments are likely to trigger other disasters in the future.

Cases in Moka Region and Mount Ory are typical examples. One of the target slopes is located along the M 1 motorway between Port Louis and Phoenix, where the colluvial deposit slope (talus) in the lower part of a steep slope was designed and developed without permission. The other slope is a little distance from the M 1 motorway, and its geological characteristics are similar with the previous site.

- Both of these sites have already been developed.
- The angle of land before the development is thought to be more than 20 degrees.
- The valley side of the slopes might cause landslides. The mountain sides of the slopes were so steep that they were likely to cause rock fall disasters.
- Development can make the slopes unstable.



Photo 3.2.1 Panoramic view of survey site (Source: JET)

Since the development at the slopes with gradients of more than 20 % is forbidden, a preliminary review system based on PPG needs to be established according to which District and Municipal Councils will give administrative approval or denial for development. After

the approval for development, LMU is expected to give the necessary slope countermeasures instructions to the contractors.

b. Preparation of detailed hazard map

Regulation of slope development is an important process to halt the increase of areas of risk. For that reason, it is urgently needed to make a slope classification map. The 20 m grid data obtained in the previous project was too rough to be used for the PPG. Though JET requested detailed digital data to MHL for Port Louis and Moka region, simpler data was obtained, so another request to MPI is necessary.

c. Establishment of the registered surveyor system

After primary approval for development has been given according to the slope classification map, survey of slope inclination on the planned site for development will be required.

d. Necessity of comprehensive basin management

Landslides or flash floods occurring at the foot of mountains are closely related to slope development and land use. Efforts for conservation of forests, tree planting and prevention of wild fire serve for the consolidation of surface soil, prevention of erosion and rockfalls, and control of surface runoff or floods. Furthermore, measures against landslides and road maintenance may include drainage of surface water, increase influx into the rivers and can cause floods downstream. Therefore, a comprehensive watershed management which takes the entire catchment area into account will be indispensable hereafter.

e. Increasing rock fall prone slopes

Rock falls have been an obvious risk at slopes along roads and steep slopes behind houses. In the natural state, unstable rocks are kept from falling by bushes and shrubs. However, some rocks on artificial slopes are not supported or sustained by such things, endangering roads and houses below. Unless adequate measures are taken, slope development will keep on increasing the risk of rock falls.

f. Few streams with risk of producing debris flows

When it comes to debris flows, there are a few torrent streams in Mauritius. Therefore, debris flows hardly occur. The debris flows are like floods in the sense that they contain less soil and sand than water. Preservation of forests in the basins is important as a measure in sites where there is risk of debris flow occurrence. Measures employing check dam are not cost efficient. Instead, small-scale river management along villages and bridges will often work.

g. Relocation of residents

It seems a very adequate decision both technically and economically to focus on relocating local residents as a measure against slope disasters. The existing plan that LMU made concerned three pilot sites in danger of landslide and involved transfer of residents. The impression of JET was that the most realistic and effective landslide countermeasures were in being carried out.

3.2.6 Recommendation

Furthermore, JET proposed countermeasures management and maintenance plans for slope failures, rock falls and debris flows.

a. Preparation of detailed hazard map

Regulation of slope development is an important process to halt the increase of areas of risk. For that reason, it is urgently needed to make a slope classification map. Referring to the precise landform data, the slope classification map will need to be made on a trial basis to regulate unauthorised development with the cooperation of MHL. Once the slope classification map is completed, its application method should be described in the PPG.

JET held a technical transfer workshop to make a slope map using GIS software (refer to Appendix 3.2.5). If higher-resolution DEM, < 2 m mesh, is acquired in future in Mauritius, the slope map as a hazard map can be prepared easily using the techniques taught in the workshop by MPI.

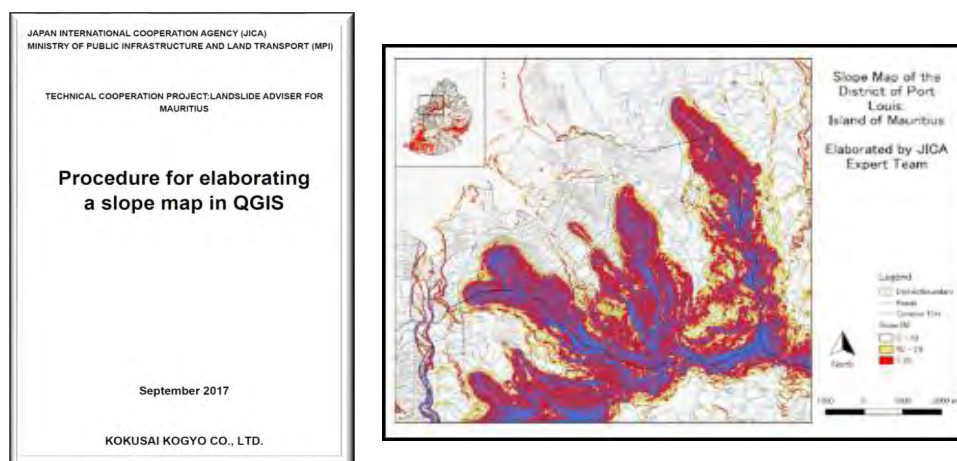


Figure 3.2.2 Procedures for creating slope maps; produced by MPI and JET

b. Establishment of the registered surveyor system

Although survey for housing plots may be conducted by a surveyor that belongs to the contractor, the final survey must be conducted by a reliable official surveyor. System for such authorised surveyors should be established.

c. Increasing rock fall prone slopes

Unless adequate measures are taken, slope development will keep on increasing the risk of rock falls. The presence of unstable rocks must be searched not only in the nearby slopes but also in a wider area behind the construction site before development works begin.

d. Relocation of residents

The impression of JET was that the most realistic and effective landslide countermeasures were in being carried out. In Mauritius, often one of the most effective countermeasures is to relocate the residents of the landslide hazard area.

3.3 Technical support for establishing a remote monitoring system for slope disasters

3.3.1 Current monitoring system

In the Previous Project, landslide monitoring has been implemented at three sites, Chitrakoot, Vallée Pitot and Quatre Soeurs, and the MPI started monitoring the landslides at several sites additionally. Subsequently, JET and C/P have confirmed the current situation of landslide monitoring and the monitoring system.

Landslide monitoring is currently carried out by MPI in three sites, Chitrakoot, Vallée Pitot, and Quatre Soeurs. In addition, landslide monitoring with extensometers in La Butte and Vallée pitot was installed in 2015. The measurement items installed in each site and the condition of the monitoring equipment are shown in Appendix 3.3.1.

3.3.2 Problems and lessons learnt

The problems and lessons learnt for a remote monitoring system are as follows; MPI already has knowledge and experience of the landslide monitoring through a previous project, and can plan appropriate landslide monitoring. However, MPI does not have techniques needed for a remote monitoring system. MPI, with assistance of JET, should prepare a plan of the remote monitoring system in this project.

- In Mauritius, a cell-phone communication network is useful for data transmission for remote monitoring. A Global System for Mobile Communication (GSM) network is particularly convenient because it is the most widely used communications network globally. MPI should plan a remote monitoring system using GSM.
- Multiple landslides are the target of the remote monitoring. The remote monitoring system must be able to observe multiple landslides at the same time.
- The warning of the remote monitoring system should reach the various people and parties concerned such as NDRRMC, the police and MPI. Therefore, using mobile phone Short Message Service (SMS) is a realistic technique. Because those concerned can receive SMS warnings simultaneously, NDRRMC can respond to a landslide disaster without waiting for the judgment of MPI.

3.3.3 Recommendations for structure of monitoring system

Since MPI cannot go to all the sites when cyclones that activate landslides occur, the monitoring results cannot be confirmed in real time. MPI can confirm monitoring results at any time without being influenced by climatic conditions and traffic conditions if a remote monitoring system is introduced.

Therefore, JET and the C/P have been studying remote monitoring systems and recommended a structure of remote monitoring system that suit Mauritius. The assumptions for studying the landslide remote monitoring system are as follows:

- There are three sites to install/implement the remote monitoring system;

- Sites to be monitored are Chittrakoot, Vallée Pitot and La Butte; and
- The implementation flow of the remote monitoring system is shown in the figure below.

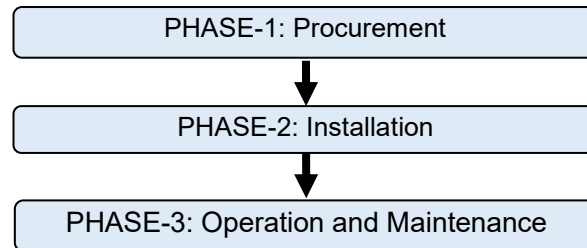


Figure 3.3.1 Implementation flow of the remote monitoring system (Source: JET)



Figure 3.3.2 Image of the remote monitoring system (Source: JET)

3.3.4 Study and recommendations on the remote monitoring system

According to ‘3.3.3 Recommendations for structure of monitoring system’, MPI and JET have proposed a remote monitoring system that is suitable for Mauritius. The proposed remote monitoring system is shown in Appendix 3.3.2.

3.4 Technical support for updating the early warning/evacuation system based on the results of the countermeasures for slope failures, rock falls and debris flows

3.4.1 Early warning/evacuation system in Chitrakoot / Vallée Pitot

In the Previous Project, landslide Early Warning System (EWS), consisting of extensometers and alert equipment, has been implemented at Chitrakoot and Vallée Pitot. Also, another EWS has been added in Vallée Pitot by MPI in 2015. Early warning/evacuation system in Chitrakoot / Vallée Pitot are shown in Appendix 3.4.1.

The equipment and the structure of the landslide EWS are shown below.

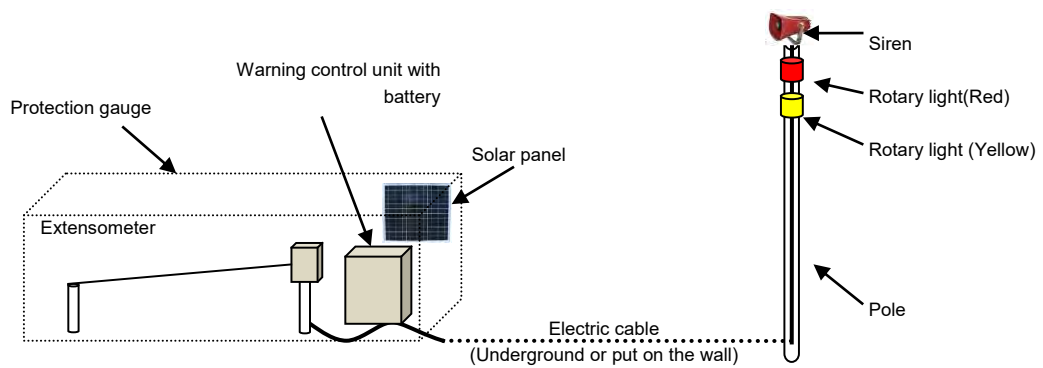


Figure 3.4.1 Conceptual diagram of EWS (Source: JET)

Table 3.4.1 Quantity of the parts for the EWS (Source: JET)

Location	Name	Quantity	Remarks
Chitrakoot	Siren	1	Previous Project by JICA, 2014
	Rotary light (red)	1	
	Rotary light (yellow)	1	
	Warning control box	1	
	Solar panel	1	
Vallée Pitot	Siren	1	Previous Project by JICA, 2014
	Rotary light (red)	1	
	Rotary light (yellow)	1	
	Warning control box	1	
	Solar panel	1	
Vallée Pitot	Siren	1	Other projects by MPI, 2015
	Rotary light (red)	1	
	Rotary light (yellow)	1	
	Warning control box	1	
	Solar panel	1	

3.4.2 Problems identified and lessons learnt

EWS has been installed recently in Mauritius. Current problems identified and lessons expected to be learned are as follows.

- Capacity of planning and designing EWS; MPI already has knowledge and experience of the EWS for landslide through a previous project, and can plan appropriate landslide EWS.
- Proficiency level for the operation of the monitoring equipment; after a previous JICA project, the additional EWS in Vallée Pitot was planned and installed by MPI in 2015. Three existing EWSs in Chitrakoot and Vallée Pitot are operated appropriately now by MPI.
- Operation system; the existing EWS can give a warning alert by a siren and a rotary light automatically on site. However, it cannot transmit measurement data and a warning to MPI. The existing EWS should be upgraded as a remote monitoring system in the future (refer to 3.2.3)
- Maintenance of the equipment; as maintenance of the apparatuses, the removal of weeds and exchange of the battery should be carried out regularly before a problem occurs. In addition, simple instruction manuals for EWS should be prepared.
- Knowledge, advanced technique, and experience in EWS for slope disasters (excluding landslides); the knowledge and the experience of the EWS for the landslide were brought to MPI through this project and a previous project. However, the preparations for EWS for slope failures, rock falls and debris flows are still insufficient. An automatic rainfall monitoring system and the slope map as the slope disaster hazard map are necessary for the EWS.

3.4.3 Proposal for the improvement of EWS

JET has studied the current system to provide proposals for making improvements in the early warning systems and evacuation procedures for slope failures, rock falls and debris flows.

a. Simple instruction manuals for EWS

As maintenance of the apparatuses, a simple setting manual for EWS has been prepared by MPI and JET (refer to Appendix 3.4.2).

b. An automatic rainfall monitoring system

An automatic rainfall monitoring system is necessary for the EWS. However, it is not easy to install an automatic rainfall monitoring system covering the whole island. Therefore, MPI suggested the use of Automatic Weather System (AWS) of Mauritius Metrological Service (MMS). In response to a request from MPI, MMS installed AWS in Chitrakoot in December 2016 (refer to Appendix 3.4.3). The JET proposes that AWS of MMS be expanded to cover the whole island. In addition, the use of a weather radar installed by another JICA project is expected in the future.

c. The slope map as the slope disaster hazard map

The slope map as the slope disaster hazard map is necessary for the EWS. Therefore JET held a technical transfer workshop to make a slope map using GIS software (refer to Appendix 3.2.5). If high-resolution DEM, < 2 m mesh, is acquired in the future in Mauritius, JET proposes that MPI makes a slope map as a hazard map using the techniques taught in the workshop.

3.5 Public awareness and sensitisation materials

3.5.1 Original sensitisation materials in the Previous Project

The 'landslide disaster prevention handbook (hereinafter 'landslide handbook')' was developed as a tool to disseminate landslide information to the local residents under the Previous Project. The JET found through the questionnaire survey and meetings that the level of understanding about landslide issues as well as early warning and evacuation systems was low among the local residents in the landslide prone areas. Consequently, JET decided to prepare the handbook which summarised the basic information of landslide, disaster preparedness and measures to cope with landslide.

The landslide handbook was published in both English and French. It was distributed to the local residents living in three landslide priority areas; Chitrakoot, Vallée Pitot and Quatre Soeurs. It was also distributed to the stakeholders during the technical seminar and steering committee.

3.5.2 Revision of the sensitisation materials

a. Process of updating the sensitisation materials

As the handbook developed under the Previous Project focused on landslide only, it must be updated with additional information including slope failure, rockfall and debris flow in this Project. Moreover, JET must consider the comments and suggestions on the previous handbook from the related stakeholders when they use it. Consequently, JET conducted questionnaire surveys to find out the quality of the handbook as well as to obtain their comments to improve it. While the first questionnaire survey was conducted in April 2016, the second one was in March 2017. The results of the questionnaire surveys are as attached (Appendix 3.5.1).

b. Revised items

According to the survey results, the feedback was relatively positive. The readers could improve their knowledge on landslides after reading the landslide handbook. However, at the same time, there are a number of comments and suggestions to further improve the contents. Also, JET and MPI carefully reviewed the handbook. The major comments and suggestions are as follows:

1. The handbook should be simplified with less literature and more illustrations/diagrams/cartoons
2. It should avoid technical terms
3. Information such as emergency shelters and emergency contact numbers should be added
4. Disaster preparedness including psychological preparedness should be added
5. Practical precautions of what to do during and after a slope disaster should be added
6. Creole version should be considered in order to sensitise a greater number of people

7. Countermeasure works in Chitrakoot needs more explicit information
8. Institutional framework should be included and the roles of each institution needs to be explained
9. Proof reading is necessary as there are grammatical and typological mistakes, especially in the French version

Based on the comments and suggestions, the material was updated and renamed the ‘slope disaster preparedness handbook (hereinafter ‘slope disaster handbook’)’. Also, in response to the requests from the stakeholders, the Creole version of the ‘slope disaster preparedness leaflet (hereinafter ‘slope disaster leaflet’)’ was developed.

The comments No. 1 to 6 mentioned above were taken into consideration for the slope disaster handbook/leaflet which is summarised in tables 3.4.1 and 3.4.2. For comment No. 7, as the slope disaster preparedness handbook covers more different types of slope disasters, the chapter specialised in landslide was deleted. Moreover, regarding the institutional framework in comment No. 8, it is not mentioned in the slope disaster handbook because the responsible unit in the MPI has not been clearly established yet. For comment No. 9, the Government Information Services (GIS), which is responsible for disseminating information on government policies, programmes and services, supported checking the language accuracy as a public relations officer had not yet been posted to the LMU. The overall updating works of the English/French handbook and developing works of Creole leaflet were done with the support of the GIS.

Table 3.5.1 Main features of sensitisation materials (Source: JET)

	<Previous Project>	<Current Project>	
	Landslide disaster prevention handbook	Slope disaster preparedness handbook	Slope disaster preparedness leaflet
Topic	Landslide	Landslide, slope failure, rock fall and debris flow	Landslide, slope failure, rock fall and debris flow
Language	English/French	English/French	Creole
Style	A5 brochure (24 pages)	A5 brochure (8 pages)	A4 tri-folded leaflet
Features for updated version		<ul style="list-style-type: none"> • Less pages • Less text • Less technical terms • More local photos • More illustration • More practical information 	<ul style="list-style-type: none"> • Most important messages extracted from English/French handbook

Table 3.4.2 specifically explains which contents have been deleted or added, by comparing the slope disaster preparedness handbook to the landslide disaster prevention handbook.

Table 3.5.2 Comparison of contents in the handbooks

<Previous Project> Landslide disaster prevention handbook	<Current Project> Slope disaster preparedness handbook	Reasons of addition/deletion and remarks for slope disaster handbook
(1). Aim of handbook	① Slope disasters and causes	<ul style="list-style-type: none"> • (1) Aim of handbook was deleted to reduce total number of pages • (2) What is landslide: In addition to landslide, definition, causes and signs of slope failure, rock fall and debris flow are added to ① Slope disasters and causes and ② signs of warning • (3). Landslide in Mauritius is shifted to ④ Slope disasters in Mauritius • (4) Why landslide occurs? added to ① slope disasters and causes • (5) features are combined with ④ slope disasters in Mauritius • (6) Development activities in a landslide area is deleted as policy should be considered by the Government, not by the public • (7) Ways of coping with landslide is deleted as slope disaster handbook covers wider topics, and it does not focus on only landslide • (8) Early warning and evacuation system is deleted as the system applies to landslide only • Contact numbers in (9) Emergency contacts are blank in landslide disaster prevention handbook, but were added to slope disaster preparedness handbook. Contact number of shelters are also added
(2). What is landslide?	② Signs of warning	
(3). Landslide in Mauritius	③ Features of slope disasters	
(4). Why landslide occurs?	④ Slope disasters in Mauritius	
(5). Features of a landslide area	⑤ Disaster preparedness	
(6). Development activities in a landslide area	⑥ Do's and Don'ts during slope disasters	
(7). Ways of coping with landslide	⑦ Emergency contacts and shelters	
(8). Early warning and evacuation system		
(9). Emergency contacts		

The final version of the handbook and leaflet is attached as Appendix 3.5.2. It was officially handed over from His Excellency Mr. Kato, Ambassador of Japan, to Honourable Bodha, Minister of MPI in the opening ceremony of the workshop/seminar on the 6th of December 2017.

3.5.3 Distribution of the handbook and leaflet

In the questionnaire surveys, there were some comments on distributing the materials such as:

- Sensitisation activity should target specific groups such as general public, students and senior citizens
- Community participation is essential to disseminate information
- Dissemination process should be carefully considered, for example, distributing to the schools would be effective as students sensitise their parents and relatives
- Public in the landslide prone areas should be sensitised first

After a series of discussions on the distribution plan with the GIS and Civil Engineering Section (CES) of the MPI, the principle of distribution plan was concluded as follows:

- Distributing to the related stakeholders as they have supported revising/developing the materials
- Distributing to the schools as school kids often influence their family, relatives and neighbours
- Distributing to the community facilities that a lot of people use
- Distributing to the 15 slope disaster prone areas as public in these areas are most vulnerable to the slope disasters

List of distributing organisations is attached as Appendix 3.5.3. The handbooks and leaflets were distributed according to the distribution plan except for the public. For the public in the 15 slope disaster prone areas, the MPI in collaboration with the related municipalities will organise a sensitisation session to explain slope disasters followed by distribution of the materials.

The slope disaster handbook and leaflet will be uploaded on the MPI website so that anyone can access the materials at any time. The uploading has been underway after the official launching on 6 December 2017.

3.6 Continuous support for organisation enhancement of the MPI/LMU

3.6.1 Analysis and evaluation of organisation enhancement conducted under the Previous Project

JET conducted interviews with the LMU engineers in April and December 2016 to find out the status of issues and targets identified under the Previous Project. The interview results are summarised in the table below.

Table 3.6.1 Progress of the capacity development plan from the Previous Project (Source: JET)

Issues	Targets	Progress of the capacity development plan
Insufficient knowledge and experience of the LMU	Enhancing technical knowledge and experience	<improvements> <ul style="list-style-type: none"> On site knowledge and experience: Basic technology was transferred under the previous project. Further technical transfer has been continuously conducted in this project. Academic knowledge: One of the LMU engineers has been selected as an ABE Initiative scholar and has studied in the MA of landslide programme in Niigata University since 2015. Knowledge enhancement through JICA training: Two LMU engineers participated in JICA's knowledge co-creation programme of 'Disaster management for landslide and sediment-related disasters' for two months from October to December 2016. Technical exchange with the other countries: The engineer studying in Japan participated in the international landslide conferences and presented his research outcomes as well as sharing technical knowledge and information with the other participants.
Insufficient staff in the LMU	Securing sufficient and appropriate staff	<improvements> <ul style="list-style-type: none"> Engineers: LMU engineers have been assigned on a full time basis instead of part time and the number of engineers has increased from six to 10 as of April 2016. <further improvements required> <ul style="list-style-type: none"> Public relations officer: MPI Head Office promised to post the officer to the LMU in March 2014. However, the officer has not been posted yet. An intern or part time officer will be recruited until the officer is officially posted. In-house consultant: Consulting works to the private firms have been discussed if necessary.
Weak coordination with the other stakeholders	Improving the LMU's management capacity for landslide sector	<further improvements required> <ul style="list-style-type: none"> Task sharing among the stakeholders: Although tasks and responsibilities of each stakeholder were defined and proposed in the previous project, LMU has taken most of the tasks and responsibilities due to limited understanding by the stakeholders.
Evacuation plan and emergency communication network are not fully developed	Prompt response in emergency situations	<improvements> <ul style="list-style-type: none"> Procedures in an emergency have been clearly defined in the National Disaster Scheme LMU's emergency operational system has been established <further improvements required> <ul style="list-style-type: none"> The institutional support for the LMU, particularly for the off-time work, has not been fully developed yet

3.6.2 Issues of the organisational structure

A certain level of progress for the organisational enhancement can be recognised as mentioned in 3.6.1. However, LMU engineers have pointed out the following issues since the beginning of the Previous Project.

➤ Lack of clear mandate of the LMU:

There has been no legal framework for the LMU to perform their activities on slope disasters. The LMU engineers are limited in carrying out their duties and taking responsibilities on slope disasters because there is no mandate.

➤ Inappropriate scheme of services for the LMU engineers:

The LMU engineers have been working voluntarily, particularly in emergency situations, which is beyond their scheme of services. For example, while the working hours of the engineers are defined as from 9 am to 4 pm under the scheme of services, the engineers must work at any time day or night if they are on call in emergency situations.

➤ Lack of qualification for the LMU engineers:

Technologies of slope disasters have been transferred from the JET to the LMU engineers through the workshops, seminars and on-the-job training. However, the LMU engineers are not acknowledged as slope disaster experts by the government nor do they have appropriate qualifications. In other words, although the LMU engineers can support the JET and the JET's activities of the Project, they are not entitled to make decisions on slope disaster measures.

LMU/CES has addressed these issues to the MPI Head Office and has urged improvement of the situations at every opportunity. The JET has also supported solving the issues as these issues negatively affect the organisational structure enhancement as well as sustainability of the project outcomes.

However, due to the absence of an operational and legal framework of LMU and slow response by the MPI Head Office, the LMU has decided that all staff who worked as counterparts on the project were to be redeployed to a new design unit in the CES in the MPI in January 2017. The memorandum submitted from the director of CES to the Senior Chief Executive of the MPI clearly mentions that no personnel is posted to the LMU until the unit is legally supported (Appendix 3.6.1).

JET faced issues of no counterparts to conduct technical transfer to as well as the threat of unsustainability in the Project unless the organisational issues above were resolved.

3.6.3 Proposal of the setting up of the organisation

In order to solve the issues mentioned above, the JET organised a series of meetings and working sessions to discuss the organisational issues and solutions with the Minister, Permanent Secretary (PS), Deputy Permanent Secretary (DPS) and the other related officers in the MPI Head Office (HO). Table 3.5.2 is a summary of discussions on the organisational structure with the MPI HO.

Table 3.6.2 Discussions and achievements (Source: JET)

Date	Participants	Discussion points	Achievements
20/12/2016	DPS	<ul style="list-style-type: none"> Mandate of the LMU Recruitment of geotechnical engineers and geologists 	<ul style="list-style-type: none"> Increased MPI HO's understanding of current situation and issues of LMU
10/02/2017	DPS	<ul style="list-style-type: none"> Sustainability of LMU and project achievements Proper setting up of LMU or new organisation 	<ul style="list-style-type: none"> Increased HO's understanding of issues in which there are no engineers for LMU
14/02/2017	PS, Director of CES, Assistant PS, Office management assistant	<ul style="list-style-type: none"> Information sharing with MPI HO about status of LMU Discussion on setting up of Geotechnical Engineering Office and legislation 	<ul style="list-style-type: none"> Raised awareness on JET's problems in which there are no C/Ps for technical transfer Increased understanding of LMU's status
27/02/2017	PS, DPS, Assistant PS, Office management assistant	<ul style="list-style-type: none"> Information sharing about LMU's mandate prepared by MPI HO and organisational reform 	<ul style="list-style-type: none"> Clarified new organisational structure
09/03/2017	Minister, Senior advisor, PS, 2 DPSs, Director of CES	<ul style="list-style-type: none"> Information sharing with Minister about LMU's issues and problem solving procedure MPI's plan to establish GEO 	<ul style="list-style-type: none"> Clarified human resources and establishment procedure of new institution Expedited the set-up of new organisation with the support of the Minister
10/03/2017	DPS, assistant	<ul style="list-style-type: none"> Explanation of past projects, LMU's status and issues, and solution 	<ul style="list-style-type: none"> Increased understanding of the Projects and organisational issues
10/03/2017	Senior advisor	<ul style="list-style-type: none"> Discussion of legislation process and organisational structure of GEO Discussion of LMU's cooperation until GEO will be established 	<ul style="list-style-type: none"> Identified organisational structure of GEO
16/03/2017	DPS	<ul style="list-style-type: none"> Discussion of MPI's plan about GEO's organisational structure, budget and human resources 	<ul style="list-style-type: none"> Identified organisational structure of GEO
22/08/2017	Director and Deputy director of CES	<ul style="list-style-type: none"> Information sharing about status of LMU and GEO establishment 	<ul style="list-style-type: none"> Increased understanding of LMU's situation and establishing GEO
28/08/2017	Lead engineer of CES	<ul style="list-style-type: none"> Information sharing about current works on slope disaster management 	<ul style="list-style-type: none"> Identified works by engineers in CES
30/08/2017	DPS, Director of CES	<ul style="list-style-type: none"> Information sharing about status of establishing GEO 	<ul style="list-style-type: none"> Increased understanding of status of GEO
07/12/2017	2 DPSs, Director of CES and 4 MPI officers	<ul style="list-style-type: none"> Information sharing about recruitment procedure Finalisation of bidding documents for recruiting GEO director 	<ul style="list-style-type: none"> Identified necessary human resources for new organisation and recruitment procedure

Discussions hardly reached any conclusions at the beginning. The MPI and the JET had a series of meetings to identify the issues and consider solutions to make the organisation fully operational and enhance its organisational capacity. The minister of the MPI and the MPI management members have reached a conclusion to establish the Geotechnical Engineering Office (GEO) with the following details.

- Purpose of setting up the GEO

- To conduct slope disaster management by accredited professionals in geotechnical engineering and geology without the support of the JET after the Project
 - To solve the constraints of qualification (one of the current issues is that the MPI engineers who support slope disaster management have a civil engineering background, whereas the experts with landslide background will be recruited for the GEO.)
 - To widen responsibilities of slope disaster management
- Organisational structure
- GEO has two main sections. While the landslide section is responsible for landslide only, the geotechnical unit is responsible for the other slope disasters.

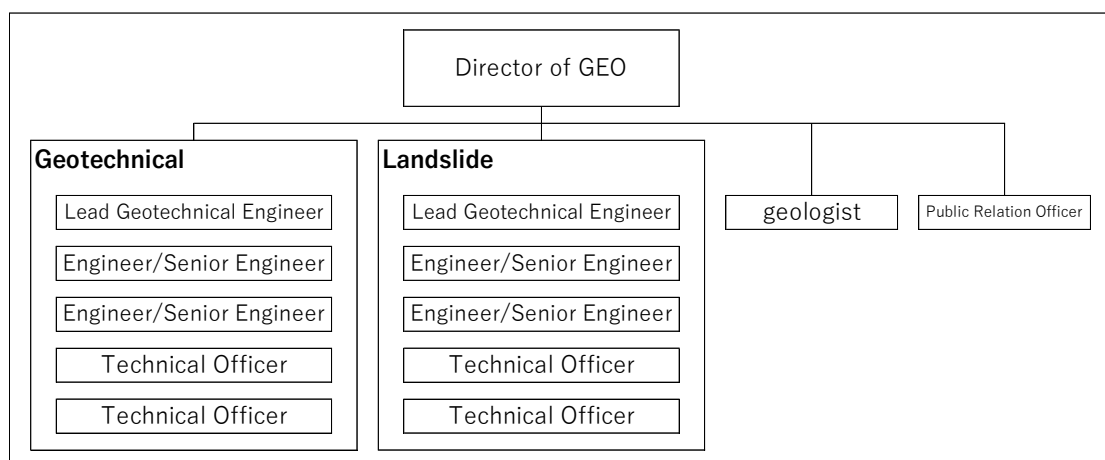


Figure 3.6.1 Proposed organisational structure (Source: JET)

- As the engineers currently working with the JET have strengthened technical capacity for slope disasters, the MPI allows them to transfer to the new organisation if they wish. These engineers support the qualified geotechnical engineering experts and geologist by utilising their technical knowledge obtained from the JICA Projects.
 - GEO will be established at the same level of the CES in the MPI.
- Tasks and responsibilities of the GEO
- Management of landslide, slope failure, rock fall, debris flow, soil erosion.
 - Carrying out geotechnical surveys and investigations, soil tests, zoning studies and slope disaster hazard mapping.
- Current recruitment status
- The MPI has initiated recruiting one geotechnical engineer and one geologist on a contract basis until the GEO is officially set up.
 - As schemes of service, as well as all the conditions, including remuneration for Geotechnical engineer and geologist are finalised, recruitment is initiated through the Pay Research Bureau (PRB). The MPI is concerned that the conditions might not be

attractive to suitable candidates. In that case, the MPI will negotiate with the PRB to review the conditions.

- At the same time, the Expert Skills Scheme of the Ministry of Finance and Economic Development is considered to hire a director and lead engineers. The expert Skills Scheme offers better conditions than that of PRB. The MPI expects that the candidates with extensive knowledge and experience will apply.
- The budget for the public relations officer has been earmarked. As soon as the geotechnical engineer and geologist are recruited, the position of the public relations officer will also be advertised and the recruitment process will be started.

3.6.4 Technical workshop, working session and seminar

a. Kick-off workshop

a.1 Overview

The two-day workshop on ‘Sendai disaster risk reduction framework and promotion of mainstreaming disaster risk reduction and reinforcement of quick response capacity’ was organised on 10 and 11 February 2016. The main purpose of the workshop was to discuss the Project details with MPI and all the related stakeholders.

47 participants from 21 stakeholders participated in the first day of the workshop (attendance list is attached as Appendix 3.6.2). Followed by the opening remarks, lectures by Dr. Hitoshi Baba, Special adviser from JICA Tokyo, explained the Sendai Framework for Disaster Risk Reduction 2015-2030 (Sendai Framework) and recommendations for the new Project as well as disaster response capacity enhancement. In addition, several presentations by the officers from Madagascar and Mauritius were given to share the disaster risk reduction activities in these countries.

The field excursion was scheduled on 11 February to share the outcomes of the Previous Project.

a.2 Outcome

On 10 February, followed by the opening remarks of the Honourable (Hon.) Mr. Bodha, Minister of MPI, Dr. Baba gave a lecture on the Sendai Framework and promotion of mainstreaming disaster risk reduction. However, a cyclone level 3 alert was declared for the whole island of Mauritius and an evacuation advisory was issued to all the participants of the seminar. The Seminar was terminated at 11 am. The field excursion was also cancelled.

Dr. Baba explained the outline of the Sendai Framework, seven targets and four priorities for action to prevent new and existing disaster risks to: (i) Understand disaster risk; (ii) Strengthen disaster risk governance to manage disaster risk; (iii) Invest in disaster reduction for resilience and; (iv) Enhance disaster preparedness for effective response, and ‘Build Back Better’ in recovery, rehabilitation and reconstruction.



Photo 3.6.1 Kick-off workshop (Source: JET)

b. Working session

b.1 Overview

The working session was organised on 13 June 2016 with the following aims:

- To introduce the activities of the Project;
- To reaffirm the mandate of the LMU among the related Ministries and Authorities;
- To identify the current situation and issues of the LMU;
- To reclarify the tasks of each stakeholder and understand the importance of cooperation among them; and

55 participants including minister of the MPI attended the session. Attendance list and programme are attached as Appendix 3.6.2.

b.2 Outcomes

- Hon. Mr. Bodha, Minister of MPI, emphasised the importance of slope disaster management in future in his opening speech. He also mentioned the activities conducted by the JET, LMU, and related stakeholders. According to his speech, small works such as the private house renovation plan should be managed by the local authorities, not by JET.
- Followings were discussed in order to establish a proper LMU:
 - LMU's mandate should be defined;
 - Appropriate resources such as personnel for the LMU are essential; and
 - Tasks and responsibilities of all the related stakeholders should be defined.
- The MPI Head Office submitted a letter to the Local Authorities about the shared responsibilities of slope disasters among the related stakeholders on the next day of the working session.
- The roles and tasks of the LMU were discussed in the session. This discussion was

highly important in order to define the mandate of the LMU in future.

- The roles of the JET in the Project was reemphasised as follows:
 - To develop a manual for slope disasters including slope failure, rockfall and debris flow;
 - To conduct technical transfer of slope disasters;
 - To define the responsibility of LMU and other stakeholders for slope disasters; and
 - To develop a mandate of the LMU as well as organising seminars and workshops in order to increase understanding of the responsibility of each stakeholder.



Photo 3.6.2 Working session (Source: JET)

c. Seminar

c.1 Overview

A seminar on slope disasters was held on 1 March 2017 in order to 1) provide technical transfer on slope failure, rock fall and debris flow; 2) share the efforts on slope disaster management by the related Ministries and Authorities; and 3) share the current situations and lessons learnt from the several project sites. 40 participants from 31 ministries and authorities attended the seminar (attendance list is as Appendix 3.6.2).

Followed by the opening speech by Mr. Jewon, Director of CES for the MPI and Mr. Ichikawa, Chief Adviser of the JET, an engineer from CES, JET and an officer from the NDRRMC conducted presentations. The discussion session was held in the afternoon in order to discuss the issues of slope disasters in each stakeholder.

The MPI Head Office was supposed to present the future organisational structure of landslide management, however the presentation was cancelled due to the absence of PS and DPS of the MPI. The seminar was concluded with the speech by Hon. Mr. Bodha, Minister of MPI (The programme is as Appendix 3.6.2).

c.2 Outcomes

- The Hon. Mr. Bodha, Minister of the MPI, emphasised the followings:
 - GEO will be established in the MPI. It is a full-fledged unit and address all the issues

relating to geotechnical survey, soil test and slope disaster management. It interfaces to all the related stakeholders. The unit consists of the existing engineers from the LMU and new employees. The MPI is currently setting up this unit and it is a transition period now. The LMU continues to follow up the countermeasure works in the slope disaster areas identified under the JICA project, however, a coordinating team is required for the new sites; and

- The slope disaster scheme which all the public in Mauritius is essential. In terms of cyclone, everyone understands the cyclone scheme and knows what to do in each stage of emergency. Mauritius needs a similar scheme for slope disasters.
- The MPI's organisational issues such as lack of mandate were shared and discussed with the related stakeholders. The stakeholders proposed several solutions to solve these issues.



Photo 3.6.3 Seminar (Source: JET)

d. Workshop/Seminar

d.1 Overview

A workshop/seminar on slope disasters was held on 6 December 2017 in order to 1) handover the manuals, guidelines and sensitisation materials to the MPI, 2) share the achievements and efforts on slope disaster management by the MPI and related stakeholders and 3) explain MPI's organisational plan for slope disaster management. Approximately 100 participants including the Minister of the MPI, Chief Representative of JICA Madagascar, Ambassador of Japan and other high delegates attended the opening ceremony. For the presentation session, 67 participants from 37 ministries and authorities attended (attendance list is as shown in Appendix 3.6.2).

The opening ceremony of the workshop/seminar commenced with a speech by Mr. Parbhunath, Director of CES for the MPI and Mr. Ichikawa, Chief Adviser of the JET. This was followed by the speech by Mr. Murakami, Chief Representative of JICA Madagascar as well as Hon. Bodha, Minister of the MPI. After this the opening ceremony was concluded by handing over of materials developed under the Project. There were nine presentations and Q&A session in the workshop/seminar. The programme is as shown in Appendix 3.6.2.

d.2 Outcomes

As a last occasion to meet all the related stakeholders in the Project, the workshop/seminar

provided a great opportunity to share the achievements, efforts and challenges to be tackled in the future. The outcomes observed from the presentations are summarised as follows:

- CES engineers fully understood the problems and conditions of the sites, and learnt what to do based on the technical transfer by the JET. They also emphasised the importance of cooperation among the related stakeholders, which is essential for the slope disaster management.
- Deputy Permanent Secretary of the MPI shared clear organisational structure of the GEO. The current set-up status was also mentioned.
- The related stakeholders shared what they have done for the slope disaster management of both hard countermeasures and soft countermeasures including community sensitisation activities. They also identified the issues and challenges, and considered future action plans.
- Manuals, guideline and sensitisation materials were explained. These materials will help the MPI and the other stakeholders to work in slope disaster management in the future without the support of the JET.

The workshop/seminar was covered by the media. The Minister of the MPI as well as a CES engineer were interviewed. The details are attached in Appendix 3.6.3.



Photo 3.6.4 Workshop/Seminar (Source: JET)

Chapter 4

Summary of technical transfer

4 Summary of technical transfer

4.1 General

One of the objectives of this Project is to upgrade the capacity of counterparts (C/P) to cope with the slope disasters such as rock falls, slope failures and debris flows. As the C/P have already grasped the basic concept of the landslide management during the Previous Project (including survey, monitoring analysis and countermeasure design and the site works at Chitrakoot), training under this Project involves small scale lectures, site investigations and reporting. At the same time, manuals of respective slope disasters are prepared for supporting sustainable knowledge and knowhow dissemination.

During the training under this Project, the C/P engineers did not seem motivated regarding the activities due to their views of the Ministry of Public Infrastructure and Land Transport (MPI) and lack of authority to make decisions with regard to the National Disaster Scheme published by National Disaster Risk Reduction and Management Centre (NDRRMC).

Although this is an internal issue of MPI, the Landslide Management Unit (LMU) members pointed out the following main issues:

- LMU members are employed under certain conditions (such as working hours of 9.00 to 16.00) which are the same as the other engineers. However, the LMU is forced to follow up on landslide issues whenever a disaster occurs without any consideration made for overtime hours, being on standby 24 hours a day;
- LMU members do not have any certificates nor registration in geotechnical engineering and thus they are not entitled to make decisions at the disaster site. These conditions are extremely difficult for them as making decisions at disaster sites is part of the responsibility of the engineers; and
- LMU members have no knowledge of slope disasters. Therefore, they cannot be obligated to support making the manual with the JICA Expert team (JET).

Unless these issues are resolved, the atmosphere and attitudes of C/P will not be as cooperative as has been the case in other disaster risk management projects conducted by JICA in various other countries. Therefore, JET decided to divide the issue into three parts: 1) Investigation of problematic slope disaster sites which is requested by the various stakeholders with C/P members; 2) After the inspection of the site, the report has been made to reflect the technical issues into the manual; 3) Support preparation of procurement protocol for the Chitrakoot Phase 2 countermeasure work; and 4) Visit MPI Head Office to ask for update on conditions to make performance on the project TOR easier for the C/P.

As mentioned in Chapter 3.5, since August 2017, the MPI and the JET had a series of meetings to identify issues and consider solutions to make the organization fully operational and enhance its capacity. The minister of the MPI and the MPI management members have reached a conclusion to establish the Geotechnical Engineering Office (GEO). Since then, the LMU and MPI have become fully involved and are cooperative on the ongoing issues. In this section, 1), 2) and 3) are described. Administrative issue 4) is summarised in Section 5.

4.2 Slope disaster site visits and reporting

Respective sites were visited and the type of the slope disaster was determined with the counterpart and reported. Major sites visited between January 2016 and December 2017 are summarised as follows:

Table 4.2.1 Site list by type of slope disasters (Source: JET)

Slope Disaster Type	Name of the sites (*)	Causes and Notes	Times Visited
Slope failure	1 Batelage	<ul style="list-style-type: none"> Main causes of slope failure were rain and wind by cyclone in 2015 Water from the houses influenced the slope stability 	6
	10 Coromandel	<ul style="list-style-type: none"> Rain water flowed down from the upper road, and it causes instability of the slope. 	1
	11 Pitit Bel Air	<ul style="list-style-type: none"> Part of the base of the slope was excavated by the land owner below the slope. 	2
	12 Vallée Pitot	<ul style="list-style-type: none"> Slope failure was caused by flash flood from the mountain slope and saturation of water in the filled material. 	2
	13 Long Mountain	<ul style="list-style-type: none"> Erosion of the slope was not caused by river water but from surface water from the house yard. 	2
Rock fall and debris flow	2 Signal Mountain	<ul style="list-style-type: none"> Rock fall, road settlement and debris flow in the 3km long road section 	10
Slope failure and rock fall	4 Hermitage	<ul style="list-style-type: none"> Artificially modified slope with the risk of slope failure. Cause of the slope failure was improper development. 	1
Rock fall	3 Maconde	<ul style="list-style-type: none"> Steep scarp along the B9 road. Rock fall occurred frequently 	6
	7 Ruisseau Créoles	<ul style="list-style-type: none"> There are several boulders on the housing premises and in the slope behind. 	3
River erosion and slope failure	8 Camp Garreau, Flacq	<ul style="list-style-type: none"> The failure was caused by sewage water, rain water and river erosion. 	1
	9 Kewal Nagar/Belle Rive	<ul style="list-style-type: none"> The slope was created by river erosion and artificially modified slope 	4
Landslide (no investigation)	5 Mount Ory	<ul style="list-style-type: none"> District Council of Moka requested LMU to conduct an emergency investigation 	3
	6 Mount Ory (Moka)	<ul style="list-style-type: none"> District Council Moka requested LMU to carry out the survey of 'Application for the use of slope'. 	1

* Name of the sites refers to Table 3.2.8.

Total sites visited together with LMU, JET and other stakeholders were 13. JET and LMU jointly investigated the sites as part of on-the-job training. The reports were compiled mainly by JET with the support of LMU. Still, the main actor shall be JET as the C/P clearly demonstrated their incompetence regarding technical background to make decisions. However, the routine was the same as the normal technical transfer in other similar types of JICA technical assistance.

4.3 Manuals

After the investigation, reporting and counterpart design are compiled. Each area was put into the investigation site record sheet with a serial number. Then the traditional phenomenon of the slope disaster was selected as the reference of the manual of slope failures, rock falls and debris flows developed under this Project. Some of the samples are figured out for use in the manual. As described in chapter 3, outline of the manual is shown in the following table:

Table 4.3.1 Contents of the manual of slope failures, rock falls and debris flows (Source: JET)

Chapter	Sub-Chapter
1 Introduction	1.1 What is landslide?
	1.2 Procedure manual of slope failures, rock falls and debris flows
	1.3 Explanation of technical terms
2 Surveys	2.1 Introduction
	2.2 Survey on slope failures
	2.3 Survey on rock falls
	2.4 Survey on debris flows
	2.5 Survey on drainage systems
	2.6 Survey on retaining wall and culvert
3 Design	3.1 Introduction
	3.2 Cut slopes
	3.3 Slope protection
	3.4 Countermeasures for rock falls
	3.5 Countermeasures for debris flows
	3.6 Drainage
	3.7 Retaining wall
	3.8 Culvert
4 Execution	4.1 Introduction
	4.2 Slope work
	4.3 Countermeasures for rock falls and debris flows
	4.4 Construction of retaining wall and culvert, etc.
5 Work Management and Inspection	5.1 Introduction
	5.2 Execution management
	5.3 Work inspection
6 Maintenance of Earth Structures	6.1 Introduction
	6.2 Maintenance of slopes
	6.3 Maintenance of drainage facilities
	6.4 Maintenance of retaining walls and culvert

The draft manual was developed by the end of March 2017, and the manual will be applied for the slope disaster sites during the Project period. The final version of the manual was published in December 2017.

Table 4.3.2 Contents of the revised landslide countermeasure manual (Source: JET)

0. Preface
0.1 Definition of landslides
0.2 Classification and mechanisms of landslides
0.3 Outline of landslides in Mauritius
1. Introduction
2. Survey and analysis
2.1 Landslide survey
2.2 Landslide monitoring
2.3 Landslide analysis
2.4 Basic factors and triggers (inducing factors) of landslides
2.5 Stability analysis
3. Landslide warning system
3.1 Introduction of landslide warning system
3.2 Landslide monitoring and warning
3.3 Emergency communication and evacuation
3.4 Landslide warning without instruments
4. Relocation support and compensation
4.1 Confirmation of the legal systems and schemes
4.2 Confirmation of the development restriction/land-use control
4.3 Basic concept of the hazard zone for development restriction
4.4 Confirmation of the proposed landslide prone areas and landslide hazard zones
4.5 Identification of the target areas for relocation and compensation
4.6 Implementation of the relocation
4.7 Implementation of the compensation
5. Information, Education, Communication (IEC)
5.1 Importance of IEC for landslide management
5.2 The main actors of the IEC activities for landslide management in Mauritius
5.3 Types of the IEC activities
6. Design for structural countermeasures
6.1 Principal of design for landslide countermeasures
6.2 Design of structural countermeasure works for landslide
7. Maintenance after installation of countermeasure works
7.1 Execution plan
7.2 Execution
7.3 Work management
7.4 Maintenance after installation of landslide countermeasure
7.5 Maintenance of existing structural countermeasure facilities
8. Initial survey and emergency response
8.1 General
8.2 Literature survey
8.3 Initial survey at site
8.4 Emergency response
8.5 Detailed survey plan

Table 4.3.3 Contents of the revised landslide countermeasure guideline (Source: JET)

0. Preface
0.1 Definition of landslides
0.2 Classification and mechanisms of landslides
0.3 Outline of landslides in Mauritius
1. Introduction
2. Literature survey
2.1 Data collection and its utilization
2.2 Confirmation of the legal systems/schemes and development restriction/land-use control
3. Initial survey at site
3.1 Setting of target landslide areas
3.2 Site survey and analysis
4. Emergency response
4.1 Structural countermeasure works
4.2 Evacuation and relocation support
4.3 Landslide warning systems
5. Detail survey plan
5.1 Outline of detail survey
5.2 Outline of countermeasure policy
5.3 Confirmation of development restriction/land-use control and legal systems/schemes

4.4 Countermeasure (Chitrakoot Phase 2 Site Works)

The Chitrakoot phase 2 site works were scheduled to commence in August 2016. Technical specifications were proposed at the time and the budget for 2016 (July 2016 - June 2017) was approved. However, due to the delay of the works such as bidding procedures, commencement of work was postponed to avoid the rainy season from December to April. The tendering was conducted in early February, and followed by the review of the documents along with the financial proposal. Although the final proposal was more than the ceiling price, the contractor and MPI reached a compromise.

The dry season is expected to begin in May; therefore, the commencement of the work was set for May 2017. Actual site work started in June 2017 after a land acquisition program by Ministry of Housing and Lands (MHL). As of December 2017, the work progress achieved 70% completion of the whole project. Supporting work of JET for MPI's administration and management were smoothly implemented for all kinds of countermeasure works to be conducted at the site.

Chapter 5

Issues identified

5 Issues identified

5.1 General

Major objectives of the Project operation can be classified into the two categories below (more specific issues, targets and current developments are tabulated in Table 3.5.1):

- Strengthening capacity of Landslide Management Unit (LMU) for disaster management of slope disasters
- Enhancing the ability to promote self-sustaining development

The first issue is much more about the LMU's legal frame work to create stress free working conditions for counterpart (C/P) engineers and motivate them to protect their country from slope disasters. Therefore, actions were taken by the Ministry of Public Infrastructure and Land Transport (MPI) Head Office to support LMU by taking the legal frame work (mandate) of LMU into consideration. The basic institutional frame work was suggested during the Previous Project as such that the recommendation of institutional arrangement and mandate of LMU. Therefore, JICA Expert Team (JET) repeatedly pushed MPI Head Office to promote proper assignment of registered engineers (geotechnical engineers) and preparation of the mandate of LMU since the beginning of the Project.

Second issue is about securing the sustainability of the slope disaster responsible body. This relates the basic background of LMU which leads the measures against the national policy. Therefore, the establishment of proper functional unit is the key issue of the Project.

These issues are matters of policy and of MPI administration, and are internal matters of MPI. Even the LMU made letters to improve the situations to the Senior Chief Executive (the top policy maker of public administration) who has not made any decisions yet. Unfortunately, due to the frequent change of the position of Permanent Secretary (PS) of MPI, these issues are not turn over properly to the successors.

However, in March 2017, Mr. Bundhooa, Deputy Permanent Secretary (DPS), was appointed as a 'C/P member' of the Project. Since then, JET visited his office to explain everything that had occurred during the past year regarding the Project.

Mr. Bundhooa promised JET to investigate the issues of this Project as well as to present JET with a draft paper of the 'mandate' and 'assignment of responsible engineers'. In addition to the DPS being appointed, Mr Parbhunath, successor of Mr Jewon, was also appointed as director of Civil Engineering Section (CES). The importance of the issues in regard to the slope disaster were well recognised by the MPI at this stage

Under the Minister's leadership, with strong support by the newly appointed successors of MPI Head Office and CES, the mood of LMU has changed into one of cooperation to tackle the slope disaster issues. The needs of formulating an organisation to manage slope disaster (such as Geotechnical Engineering Office (GEO)) were well acknowledged and became one of the priority issues for MPI.

5.2 Solution of the Issues

5.2.1 Strengthening capacity of LMU for disaster management on slope disasters

Since January 2016, JET concentrated on supporting the establishment of a mandate and the assignment of responsible engineers. Until March 2017, JET held several meetings, joint discussions and seminars with all levels of MPI members including LMU, PS and DPS and the Honourable (Hon.) Minister of MPI.

On 14 February 2017, first meeting was held with Mr. Ragen, the newly appointed PS. There the explanation of the Project was made again with current issues to be solved. At the time the PS clearly stated the 'Civil Engineering Section and MPI Head Office will jointly prepare a cabinet paper (mandate) in 15 days to improve the situation of the LMU'. However, since then no response has been received or progress made on this issue.

Therefore, a meeting was urgently held with all policy makers on 9 March 2017. Together with the meeting with the Senior Advisor to the Minister held on 10 March 2017, the following decisions were made:

- C/P of JET is MPI (for most of the administrative issues) and LMU (for the technical aspects)
- A new office, GEO, will be established and some/all LMU members will be assigned to the office. The recruitment of geotechnical engineers is vital and is currently proceeding.
- Inside MPI, the same legal framework applies to all members. Therefore, there is no need to prepare a paper called a 'mandate' to be submitted to the cabinet.

JET was very anxious about the 'mandate' which has been followed up since 2015. Because of the lack of geotechnical background, no one knows how to formulate a proper plan for the setup of the new organisation; JET supported their activity to make Terms of Reference (TOR) of the new organisation (mandate), engineers' qualification and utilization of LMU members.

At the Seminar held in March 2017, the Minister made the following remarks;

- GEO will be established in the MPI. It is a full-fledged unit and will address all the issues relating to geotechnical surveys, soil tests and slope disaster management. It interfaces with all the related stakeholders. The unit consists of the existing engineers from the LMU and new employees. The MPI is currently setting up this unit and it is in a transition period now. The LMU continues to follow up the countermeasure works in the slope disaster areas identified under the JICA project; however, a coordinating team is required for the new sites; and
- A slope disaster scheme for all the public in Mauritius is essential. In terms of cyclones, everyone understands the cyclone scheme and knows what to do in each stage of emergency. Mauritius needs a similar scheme for slope disasters.

The institutional arrangement of GEO, with the utilization of LMU (and its know-how gained in the technical transfer), was raised as one of the priority issues in MPI.

On December 2017 the Workshop/Seminar was held (see Chapter 3.5.4). As a last occasion to meet all the related stakeholders in the Project, the workshop/seminar provided a great opportunity to share the achievements, efforts and challenges to be tackled in future. The outcomes observed from the presentations are summarised as follows:

- CES engineers fully understood the problems and conditions of the sites, and learnt what to do based on the technical transfer by the JET.
- Emphasised the importance of cooperation among the related stakeholders which is essential for the slope disaster management.
- Deputy Permanent Secretary of the MPI shared clear organisational structure of the GEO.
- The related stakeholders shared what they have done for the slope disaster management of both hard countermeasures and soft countermeasures including community sensitisation activities. They also identified the issues and challenges, and considered future action plans.

Manuals, guideline and sensitisation materials were explained. These materials will help the MPI and the other stakeholders to work for the slope disaster management in the future without the support of the JET.

5.2.2 Enhance the ability to promote self-sustaining development

The slope disaster management body will be under the transitional phase during the Project activity. Referring to the recent discussion, GEO will be the responsible body of MPI for the disaster management and will be functional within two years.

MPI is currently seeking geotechnical engineers to help establish and be assigned to the GEO. As some/all LMU members will be posted in this unit, hopefully the sustainability will be secured.

However, given the uncertainty of the time schedule for setting up the GEO, the JET decided to act with the LMU and continue the technical transfer and manual description.

JET supported all activities which relate to the strengthening of slope disaster management to enhance their capability, which will be the back bone of the GEO.

5.2.3 Other Progress

- Early warning system: The proposed system and plans to set it up are described in this report in Chapter 3.4.
- Planning Policy Guidance (PPG): Amended PPG 9 has been in effect since March 2016. It is planned to utilise the established Manuals in relation with the land management.
- Slope Disaster Preparedness Handbook and Leaflet: Public awareness and sensitisation materials covering four types of slope disasters were developed .

Chapter 6

Future directions

6 Future directions

The actions of JICA Expert Team (JET) on institutional strengthening of Landslide Management Unit (LMU) for the past year were made since these actions were recommended in the Previous Project. Still, there are number of uncertainties in the technical transfer and institutional strengthening of LMU, Ministry of Public Infrastructure and Land Transport (MPI).

Some of the important outcomes of the recent activities are as follows:

- Major policy makers and administrative staff jointly held a meeting and Hon. Minister gave clear direction to all, which was to set up the Geotechnical Engineering Office (GEO). LMU will also extend their knowledge into their activities. Most importantly, all the top MPI members shared information.
- Mr Bundhooa, Deputy Permanent Secretary (DPS), was appointed as a ‘Counterpart of JET’; therefore, JET has a clear road map to make consultations about all administrative issues regarding MPI.
- Mr Parbhunath, Director of Civil Engineer Section, was appointed as the top management decision maker of LMU. He is prepared to provide full support for the establishment of GEO utilising LMU know-how and use/dissemination of the Manual
- Convenient sensitisation material ‘Slope disaster preparedness handbook (English/French)’ and ‘Slope disaster preparedness leaflet (Creole)’ was established by JET and GIS. A public relations officer will be recruited as soon as the GEO is established, and will be involved in the activities of sensitisation of both Public/Private organisations and local communities.
- MPI acknowledges the importance of slope disaster issues.
- MPI started to set up an organisation to tackle the issues on their own.
- MPI is highly motivated to cope with the issues for future activities against slope disasters.

Appendix 3.1.1

*Confirmation of the current
situation of the landslide
countermeasures in Chitrakoot:
Phase 1*

Confirmation of the current situation of the landslide countermeasures in Chitrakoot: Phase 1

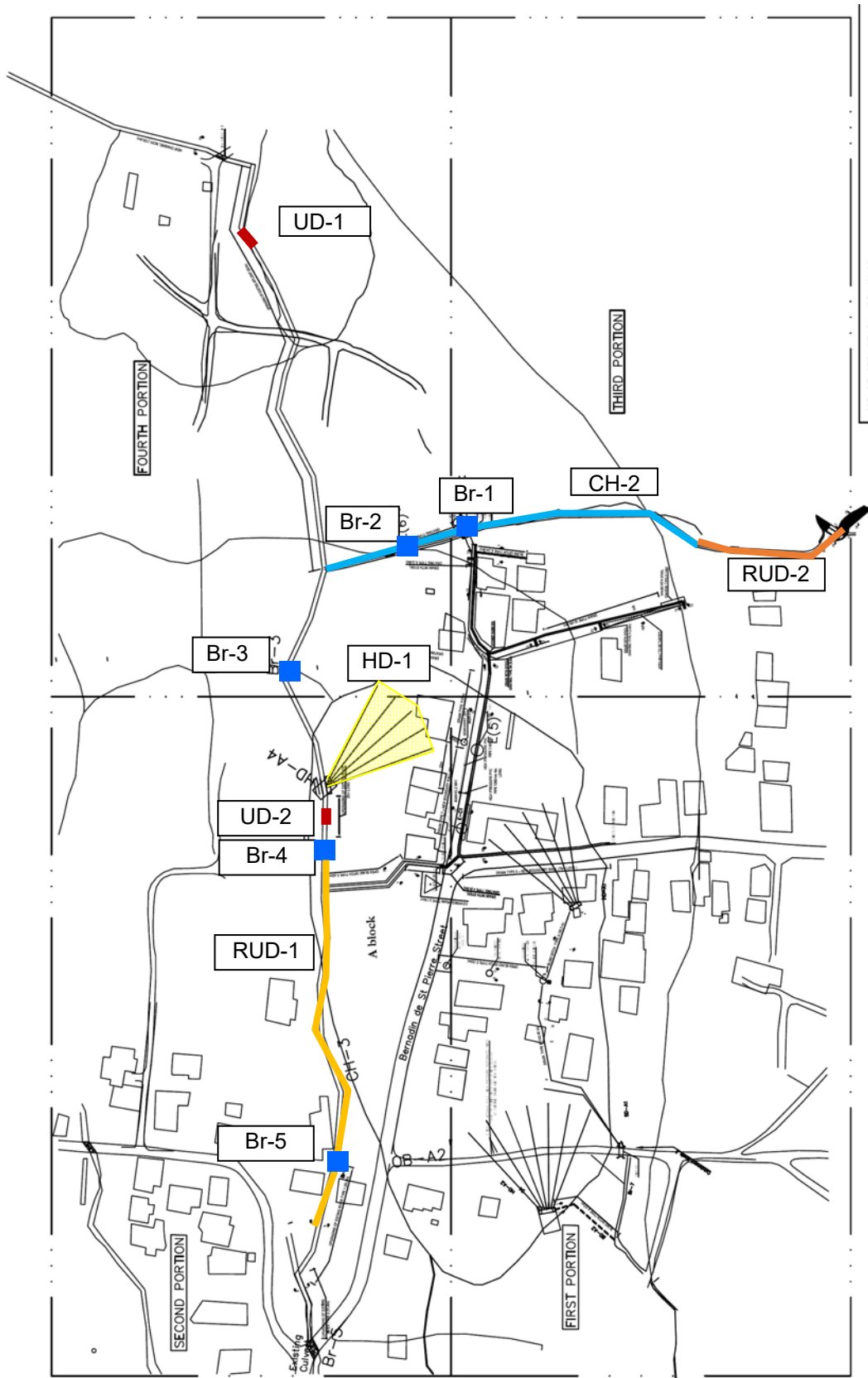


Figure 1 Location map of the countermeasure for Phase 1 in Chitrakoot (Source: JET)

As for Phase 1, the landslide countermeasure works (channel for flood, horizontal drainage, up-grade drainage, reinforced up-grade drainage) had been constructed in the pilot site of Chitrakoot during the Previous Project in 2014. The work items and the quantity of the landslide countermeasures for Phase 1 are shown below.

Table 1 Countermeasure works in Chitrakoot, Phase 1 (Source: JET)

Work item		Quantity	Remarks
Channel for flood	CH-1	L=215m	
Horizontal drainage	HD-1	L=250m	50m*5
Upgrade drainage	UD-1	L=5m	Widening and protection
	UD-2	L=10m	Widening and protection
Reinforced upgrade drainage	RUD-1	L=175m	Widening and protection
	RUD-2	L=55m	Widening, protection and drop structure
Ancillary work (Bridge)	Br-4, Br-5	2	Bridge for pedestrian
	Br-1, Br-2, Br-3	5	Bridge for vehicle

The counterpart (C/P), MPI/LMU and JICA Expert Team (JET) visited the site and confirmed the current situation of the landslide countermeasures for Phase 1 in 8th March 2016.

The current situation and problems of countermeasure works are shown in the table and photographs below.

Table 2 Current situation and problems of countermeasure works, Phase1, 8th March 2016
 (Source: JET)

Work item		Current situation	Problems
Channel for flood	CH-1	It does not have damage nor loss, and functions normally	The obstacles which are collected at the bottom of the canals such as soil or leaves must be removed regularly to keep good condition. The inspection of the structure is required regularly. When damage is discovered, it should be repaired promptly.
Horizontal Drainage	HD-1	A groundwater is drained away from two drillings, and the trace that groundwater is being drained away is confirmed at all of the horizontal drainages (five drillings). It is estimated that there was a considerable amount of drained water during the heavy rain from the observation of these horizontal drainages.	The washing work of the drainage hole should be carried out regularly to keep good condition.
Upgrade drainage	UD-1, UD-2	It does not have damage nor loss, and functions normally.	The obstacles which are collected at the bottom of the canals such as soil or the leaves must be removed regularly to keep good condition. The inspection of the structure is required regularly. When damage is discovered, it should be repaired promptly.
Reinforced upgrade drainage	RUD-1, RUD-2		
Ancillary work (Bridge)	Br-1, Br-2, Br-3, Br-4, Br-5		



Photo 1 View of landslide Countermeasure, channel for flood, CH-1, 08th March 2016
(Source: JET)



Photo 3 View of landslide countermeasure, horizontal drainage, HD-1, 08th March 2016
(Source: JET)



Photo 4 View of landslide countermeasure, upgrade drainage, UD-2, 08th March 2016
(Source: JET)



RUD-1



RUD-2

Photo 5 View of landslide countermeasure, upgrade drainage, RUD-1 and 2, 08th March 2016
(Source: JET)



Br-4



Br-5

Photo 6 View of landslide countermeasure, bridge (Source: JET)

Appendix 3.1.2

*Stakeholder meeting for
the implementation of Phase 2*

Stakeholder meeting for the implementation of Phase 2 at Chitrakoot

Stakeholder Meeting for the implementation of the Countermeasure works, Phase 2, had been held two times.

Table 1 1st Stakeholder meeting for Phase 2, 17th August 2016 (Source: JET)


Date	17 August 2016																																																																																																								
Venue	Chitrakoot Government Primary School																																																																																																								
Stakeholder	Stakeholder (Governmental)																																																																																																								
	<table border="1"> <thead> <tr> <th>Stakeholder</th> <th>Name</th> <th>Designation</th> </tr> </thead> <tbody> <tr> <td>Ministry of Housing and Lands</td> <td>Mr. R. Venkataswami</td> <td>Land Surveyor</td> </tr> <tr> <td>City Council of Port Louis</td> <td>Mr. R. Deenoo</td> <td>Chief Inspector of Works</td> </tr> <tr> <td>NDRRMC</td> <td>Mr. Mungrah</td> <td>Chief Inspector</td> </tr> <tr> <td>Forestry Service</td> <td>Mr. G. Pato</td> <td>Principal Forest Conservator Enforcement Officer</td> </tr> <tr> <td>Police</td> <td>Responsible Officer in the Locality</td> <td></td> </tr> <tr> <td>Ministry of Education</td> <td>Responsible Engineer</td> <td></td> </tr> <tr> <td>MPI&LT</td> <td>Responsible Public Relation Officer</td> <td></td> </tr> </tbody> </table>	Stakeholder	Name	Designation	Ministry of Housing and Lands	Mr. R. Venkataswami	Land Surveyor	City Council of Port Louis	Mr. R. Deenoo	Chief Inspector of Works	NDRRMC	Mr. Mungrah	Chief Inspector	Forestry Service	Mr. G. Pato	Principal Forest Conservator Enforcement Officer	Police	Responsible Officer in the Locality		Ministry of Education	Responsible Engineer		MPI<	Responsible Public Relation Officer																																																																																	
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Objectives	<p>The objectives of the meeting are as follows:</p> <ul style="list-style-type: none"> • Explaining the importance of the countermeasure works of Phase II. • Disseminating information on the work program of the project. • Explaining the land acquisition. • Obtaining the consent of the inhabitants to construct the countermeasure works in their plots of land. • During this process a letter of consent prepared by the MPI and necessary arrangement should be made for the inhabitants to sign on as a proof of permission during the meeting. 																																																																																																								
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Table 2 2nd Stakeholder meeting for the implementation of the Phase 2, 26th October 2016
 (Source: JET)



Date	26 October 2016
Venue	City Council of Port Louis (CCPL)
Stakeholder	<ul style="list-style-type: none"> • Representatives of the CCPL • Representative of the National Disaster Risk Reduction and Management Centre (NDRRMC) • Representative of the Ministry of Housing and Lands (MHL) • Representatives of the MPI • JET • Inhabitants of the affected area of Chittrakoot
Objectives	<ul style="list-style-type: none"> • Explaining the final planning of the project and its urgencies to the Inhabitants • Informing them on their roles and contributions of interest for the project • Clarifying on any issues concerning them about disaster occurrence • Refreshing them on the protocol of the early warning system existing in the region for evacuation
Explanation/ discussion	<ul style="list-style-type: none"> • The MPI explained the final planning of the project to the Inhabitants. • Due to the nature of the countermeasure works, the project is planned to commence at the start of the dry season i.e. early May 2017. • The inhabitants were informed on the urgency of completing the second phase of the project, otherwise countermeasure works of phase 1 will not mitigate disasters on their own. • It was also pointed out that after the implementation of the second phase of the project, the area concerned will need to be evaluated on the effectiveness of the countermeasures in order to consider other countermeasure works if necessary i.e. piling may be recommended if the factor of safety has not been reached. • The inhabitants were also informed on the difficulties face by the Contractor and the responsible Authorities in the implementation of the phase 1 project due to the non-cooperation of certain Inhabitants in the process of land acquisition. In order to avoid such problem, it is recommended that a letter of consent be signed with the Inhabitants who will be involved in the land acquisition Procedures. • During the meeting, all the inhabitants present agreed to sign the letter of consent and requested for a site visit so that the portion of lands to be acquired by the Government could be indicated to them. • It was decided that the MHL will take the lead to organise the site visit and the related Ministries will prepare the remaining letters of consent and necessary signature during the visit with the Inhabitant. • The Representative of the NDRRMC explained to the Inhabitants on the protocol for evacuation based on the established early warning system.
Photo	

Table 3 3rd Stakeholder meeting for the implementation of the Phase 2, 17th July 2017
 (Source: JET)

Date	17 July 2017																																																																										
Venue	Chittrakoot Government Primary School																																																																										
Stakeholder	<p>Ministry of Public Infrastructure and Land Transport (Public Infrastructure Division)</p> <table border="1"> <thead> <tr> <th>NAME</th> <th>DESIGNATION</th> </tr> </thead> <tbody> <tr> <td>Mr. S.P. Anadachee</td> <td>Engineer/Senior Engineer (Chairperson)</td> </tr> <tr> <td>Mr. V. Ramlohol</td> <td>Assistant Permanent Secretary</td> </tr> <tr> <td>Mr. M. K. Mosaheb</td> <td>Engineer/Senior Engineer</td> </tr> <tr> <td>Mr M. Gobin</td> <td>Engineer/Senior Engineer</td> </tr> <tr> <td>Mrs R. Nohur</td> <td>Trainee Engineer</td> </tr> <tr> <td>Mr S. Gooda</td> <td>Technical Officer</td> </tr> <tr> <td>Mr V. Ramchurn</td> <td>Technical Officer</td> </tr> <tr> <td>Miss R. Mahadev</td> <td>Technical Officer</td> </tr> <tr> <td>Mrs F Jumon</td> <td>Office Management Assistant</td> </tr> </tbody> </table> <p>JICA Expert Team</p> <table border="1"> <thead> <tr> <th>NAME</th> <th>DESIGNATION</th> </tr> </thead> <tbody> <tr> <td>Mrs. H. Yoshida</td> <td>Communication Officer ✓</td> </tr> <tr> <td>Mr K. Bhuckory</td> <td>JICA Assistant</td> </tr> </tbody> </table> <p>Sotravic Lee</p> <table border="1"> <thead> <tr> <th>NAME</th> <th>DESIGNATION</th> </tr> </thead> <tbody> <tr> <td>Mr. Mario Lafleur</td> <td>Project Manager</td> </tr> <tr> <td>Mr A. Mootia</td> <td>Representative</td> </tr> <tr> <td>Mr S. Rose</td> <td>Representative</td> </tr> </tbody> </table> <p>Ministry of Housing and Lands</p> <table border="1"> <thead> <tr> <th>NAME</th> <th>DESIGNATION</th> </tr> </thead> <tbody> <tr> <td>Mr R. Venkata-Swami</td> <td>Land Surveyor</td> </tr> </tbody> </table> <p>National Disaster Risk Reduction Management Centre</p> <table border="1"> <thead> <tr> <th>NAME</th> <th>DESIGNATION</th> </tr> </thead> <tbody> <tr> <td>Mr. V. Heerah</td> <td>Police Constable</td> </tr> </tbody> </table> <p>City Council of Port Louis (Highway Section)</p> <table border="1"> <thead> <tr> <th>NAME</th> <th>DESIGNATION</th> </tr> </thead> <tbody> <tr> <td>Mr. A. Mohanut</td> <td>Trainee Engineer</td> </tr> </tbody> </table> <p>Forestry Service</p> <table border="1"> <thead> <tr> <th>NAME</th> <th>DESIGNATION</th> </tr> </thead> <tbody> <tr> <td>Mr. Y.K. Allykhan</td> <td>SFCEO</td> </tr> </tbody> </table> <p>Inhabitants</p> <table border="1"> <tbody> <tr><td>1.</td><td>Mr B. Luchoomun</td></tr> <tr><td>2.</td><td>Mrs P. Rambaccus</td></tr> <tr><td>3.</td><td>Mrs A.B. Luchoomun</td></tr> <tr><td>4.</td><td>Mr R. Hookoom</td></tr> <tr><td>5.</td><td>Mrs D. Hookoom</td></tr> <tr><td>6.</td><td>Mrs S.D. Persand</td></tr> <tr><td>7.</td><td>Mrs G. Seegoolam</td></tr> <tr><td>8.</td><td>Mrs M. Deeljore</td></tr> <tr><td>9.</td><td>Mr D. Luchoomun</td></tr> <tr><td>10.</td><td>M. Bhikaree</td></tr> <tr><td>11.</td><td>L. Ramdin</td></tr> <tr><td>12.</td><td>S. Colleechum</td></tr> </tbody> </table>	NAME	DESIGNATION	Mr. S.P. Anadachee	Engineer/Senior Engineer (Chairperson)	Mr. V. Ramlohol	Assistant Permanent Secretary	Mr. M. K. Mosaheb	Engineer/Senior Engineer	Mr M. Gobin	Engineer/Senior Engineer	Mrs R. Nohur	Trainee Engineer	Mr S. Gooda	Technical Officer	Mr V. Ramchurn	Technical Officer	Miss R. Mahadev	Technical Officer	Mrs F Jumon	Office Management Assistant	NAME	DESIGNATION	Mrs. H. Yoshida	Communication Officer ✓	Mr K. Bhuckory	JICA Assistant	NAME	DESIGNATION	Mr. Mario Lafleur	Project Manager	Mr A. Mootia	Representative	Mr S. Rose	Representative	NAME	DESIGNATION	Mr R. Venkata-Swami	Land Surveyor	NAME	DESIGNATION	Mr. V. Heerah	Police Constable	NAME	DESIGNATION	Mr. A. Mohanut	Trainee Engineer	NAME	DESIGNATION	Mr. Y.K. Allykhan	SFCEO	1.	Mr B. Luchoomun	2.	Mrs P. Rambaccus	3.	Mrs A.B. Luchoomun	4.	Mr R. Hookoom	5.	Mrs D. Hookoom	6.	Mrs S.D. Persand	7.	Mrs G. Seegoolam	8.	Mrs M. Deeljore	9.	Mr D. Luchoomun	10.	M. Bhikaree	11.	L. Ramdin	12.	S. Colleechum
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Objectives	Countermeasure work in Chirakoot, Phase 2																																																																										

<p>Explanation/ discussion</p>	<p>Matters arising</p> <p>He then made a presentation of the project with the help of Mr M.K Mosaheb, Engineer/Senior Engineer.</p> <p>He explained that the main purpose of the countermeasure works was to prevent water from ground infiltration and ensure prompt evacuation of same simultaneously.</p> <p>He also explained that the project would comprise two horizontal drainage systems, open blind ditches (French drains), catchment basins, boundary walls, bridges, tarring of one water bound road, upgrading of existing rivers, soakaway/french drains and associated works, drains with steel grating and RC covers, stone pitching and associated works. Moreover, 5 perforations would be carried out passing beneath the compound of the school to evacuate underground water in that area. He further added that vehicular bridges for four plots of land upstream would be considered in this project.</p> <p>Mr Anadachee pointed out that the project had already started on 20 July 2017. The duration of the contract would be 150 days and the completion date had been set as <u>16 December 2017</u>.</p> <p>He also informed the inhabitants of the importance of the proposed drains at different areas which would be covered and the open ones would be fenced as a security measure. He also drew the attention of the affected inhabitants that all measures would be taken to minimize disruption of their daily activities and that their close collaboration would be required for the smooth implementation of the project.</p> <p>He also reassured the affected inhabitants that measures had been taken into account during the design of the project to alleviate the constraints caused to the inhabitants due to the difficult access uphill. He stated that any other constraints, as pointed out by them during the implementation of the project would be considered and necessary action would be taken where necessary.</p> <p>Besides, Mr Anadachee pointed out that to ensure the success of the infrastructure, a proper maintenance of the drains must be undertaken. Hence, he requested the City Council of Port Louis to shoulder this responsibility effectively.</p> <p>Pending the finalisation of the acquisition for land, the inhabitants had been requested to give their permission to the Ministry for the execution of the project through the signature of a Consent Form which would be circulated among the land owners affected by the project.</p> <p>Concerning the works, pegging of the alignment of the drains was in progress.</p> <p>During the meeting complaints were received as follows:-</p> <ul style="list-style-type: none"> (i) Non payment for acquisition of land in 2014 for the Phase I project; (ii) City Council of Port Louis was still claiming some inhabitants for payment of Residence; (iii) A common boundary wall of Chittrakoot G.S which was in an alarming state; (iv) there was little progress in the relocation of the inhabitants of Chittrakoot; (v) Some authorities namely the National Disaster Risk Reduction Management Centre, Ministry of Housing and Lands and City Council of Port Louis requested to organise a prompt meeting with all related authorities in order to look into the matter pointed out by the inhabitants;and (vi) Damaged buildings were left at the mercy of inhabitants. As this represents a danger, especially for children, the representative of NDRRMC stated that he would take up the matter to the responsible authority so that appropriate measures be taken on security grounds.
<p>Photo</p>	

Appendix 3.1.3

*Site meeting organized by MPI
No.1 – No.5*

MINISTRY OF PUBLIC INFRASTRUCTURE & LAND TRANSPORT

Civil Engineering Section

[Notes of Meeting #1]

Contract	LANDSLIDE MANAGEMENT COUNTERMEASURE WORKS AT CHITRAKOOT PHASE II	Meeting No. 01
Venue	Chitrakoot	
Date	6 July 2017	
Time	10 00 hrs	
Subject	Handing Over of Site	

Present

SR No.	Name	Designation	Organisation	Contact No.
1.	D. Chinasley (Chairman)	Lead Engineer	Ministry of Public Infrastructure & Land Transport (MPI)	601 1600
2.	S. P. Anadachee	Engineer/Senior Engineer	MPI	601 1600
3.	M. K. Mosaheb	Engineer/Senior Engineer	MPI	601 1600
4.	M. Gobin	Engineer/Senior Engineer	MPI	601 1600
5.	R. M. Nohur	Trainee Engineer	MPI	601 1600
6.	Z. Joomun	Trainee Engineer	MPI	601 1600
7.	K. Mohabuth	Trainee Engineer	MPI	5970 9016
8.	Y. R. Deenoo	Trainee Engineer	MPI	5777 5573
9.	V. Ramchurn	Technical Officer	MPI	601 1600
10.	R. Mahadeo	Technical Officer	MPI	5753 0491
11.	M. La Fleur	Site Agent	Sotravic Ltée	5947 3908
12.	J. François KO	Site Agent	Sotravic Ltée	5252 8212
13.	M. Rajcoomarsing	Senior Quantity Surveyor	Sotravic Ltée	5252 8206
14.	A. Bacorissen	Engineer	Sotravic Ltée	5942 7337
15.	S. Ramrechia	Inspector of Works	City Council of Port – Louis (CCPL)	405 6600
16.	G. Nayajen	Senior Inspector of Works	CCPL	5752 0783
17.	D. Ellayah	Inspector	National Disaster Risk Reduction Management Centre (NDRRMC)	207 3700
18.	Y. Sairally	Engineer/Senior Engineer	Ministry of Education and Human Resources, Tertiary Education and Scientific Research (MoE)	601 5244
19.	A. Gunnuck	Trainee Engineer	MoE	-
20.	V. A. Beemud	Technical Officer	MoE	5259 2586
21.	S. Goolamhossen	Technical Officer	MoE	5292 3484
22.	R. Ramdohur	Surveyor	Ministry of Housing and Lands (MHL)	401 6808
23.	R. Venkataswami	Surveyor	MHL	401 6808
24.	R. Rampertaub	Forest Conservation Enforcement Officer	Forestry Service (FS)	245 0219
25.	Y. K. Allykhan	Senior Forest Conservation Enforcement Officer	FS	245 0219

Absent

1. JICA Expert
2. Central Water Authority
3. Central Electricity Board

Circulation

All present & absent

Senior Chief Executive, MPI & LT
 Director (CE) – Mr. T. Parbhunath
 Deputy Director – Mr. R. Ramdhan

Project File (MPIP/A/482/C/PhII)

MINISTRY OF PUBLIC INFRASTRUCTURE & LAND TRANSPORT

Civil Engineering Section

[Notes of Meeting #1]

Item No.	Description	Action By
1.0	CONTRACTUAL MATTERS	
	Contract Price → MUR 39,951,188.60 inclusive of VAT and contingency sum of Rs 2,000,000	
	Start Date → 20 July 2017	
	Intended Completion Date → 16 December 2017	
	Contract Period → 150 Days	
	Amount of Liquidated Damages → 0.1 % of contract price per day	
	Expiry date of Insurance cover → 30/11/2017 (Maintenance Period: 01/12/17 to 30/11/18)	
2.0	SUBJECT OF MEETING	
2.1	The Lead Engineer, Mr. D. Chinasamy, of the (MPI) welcomed members present for the meeting which had as objective to hand over the site to the Contractor to proceed with the Works.	
3.0	PROJECT CONTACT PERSONS	
3.1	The Project Manager on the project shall be the Director of the MPI (Civil Engineering Section), represented on site by the Engineer/Senior Engineers Mr. S.P. Anadachee Mr. M.K. Mosaheb, Mr. M. Gobin, and assisted by the JICA Expert. Contact details are: - phone: 601 1600; fax: 686-4506. The Contractor shall be Sotravic Ltée, represented on site by Mr. Mario La Fleur (Site Agent). The Contractor's mobile number is 5947 3908 and fax number is 405 7801.	
4.0	LINE OF COMMUNICATION	
4.1	Correspondences should be addressed to the Director (CE) Attn: - Mr. M.K. Mosaheb and copied to MPI Head Office. The Contractor was requested to keep a site instruction book (triplicate) on site for instructions and approvals by the MPI's supervising officers on this project. The Contractor was informed not to take any instructions for the works from any one else than the Engineer/Senior Engineer or his representative(s).	Contractor
5.0	PROGRAMME OF WORKS	
5.1	The Contractor informed the MPI that a detailed Programme of Works had been submitted on Wednesday 05 th July 2017.	Contractor
6.0	APPLICATION FOR PAYMENT	
6.1	The Contractor had been requested to submit his application for payment (in one original and two copies) to the MPI, Technical Office, Phoenix.	Contractor
7.0	APPROVAL AND PROGRESS OF THE WORKS	
7.1	The Contractor had been instructed to request for approval of the works at each stage of significant progress. He was informed that no payment would be made for works which had not been approved.	Contractor

MINISTRY OF PUBLIC INFRASTRUCTURE & LAND TRANSPORT

Civil Engineering Section

[Notes of Meeting #1]

Item No.	Description	Action By
7.2	The Contractor had been instructed to give notice for approval at least 48 hours prior to inspection.	Contractor
8.0	MATERIALS TO BE USED, COMPLIANCE CERTIFICATES AND SAMPLE	
8.1	The Contractor was informed that all materials to be used for the Works had to be in line with the Contract Documents and also to obtain prior approval of the Engineer/Senior Engineer.	Contractor
8.2	The Contractor was requested to submit Compliance Certificates for all materials to be used under the project to the Engineer/Senior Engineer as soon as possible for approval.	Contractor
9.0	DUE CARE OF THE SITE	
9.1	The Contractor was requested to take due care not to damage any building(s) on site. The Contractor was also informed that any damage to the existing condition of any building(s) would have to be made good, at its own cost.	Contractor
10.0	SAFETY AND SECURITY ISSUE	
10.1	The Engineer/Senior Engineer stressed on the importance of health and safety on site. The Contractor was requested to ensure that all his workmen should be properly equipped with personal protective equipment.	Contractor
10.2	The Contractor informed that he would have a Health and Safety Officer on site.	
11.0	AOB	
11.1	The representative of the MHL informed the committee that he was unable to proceed with land acquisition exercise for the project as eight owners' National Identity Card (NIC) had not yet been obtained. The MHL also informed that the whole procedure would take approximately one and a half months, at the earliest. The MPI requested the representative of the MHL to address this issue urgently.	MHL
11.2	The NDRRMC & CCPL had proposed to assist the MHL in obtaining the missing NICs.	NDRRMC/ CCPL
11.3	The FS indicated that wayleave for felling of identified trees could only be obtained after the land acquisition exercise.	MHL/MPI
11.4	The MoE informed that school holidays would be from 15 th July to 13 th August 2017. MPI requested the Contractor to prioritise works around the school.	Contractor
11.5	The MPI requested the Contractor to give priority to work items not requiring land acquisition procedures. In this respect, a coordination meeting had been scheduled for Wednesday 12 th July 2017.	Contractor
11.6	The Contractor requested three copies of working drawings.	MPI
12.0	END OF MEETING	
12.1	The meeting ended at 11.30 hrs.	

Contract	LANDSLIDE MANAGEMENT COUNTERMEASURE WORKS AT CHITRAKOOT PHASE II	Meeting No. 02
Venue	Chitrakoot	
Date	7 September 2017	
Time	10 00 hrs	
Subject	Assess overall progress of work on site and to follow up on outstanding issues	

Present

SR No.	Name	Designation	Institution/Company	Contact No.
1.	M. K. Mosaheb (Chairman)	Engineer/Senior Engineer (E/SE)	Ministry of Public Infrastructure and Land Transport (MPI)	601 1600
2.	M. Gobin	E/SE	MPI	601 1600
3.	R. M. Nohur	Trainee Engineer (TE)	MPI	601 1600
4.	V. Ramchurn	Technical Officer (TO)	MPI	601 1600
5.	R. Mahadeo	TO	MPI	601 1600
6.	I. Gooda Sahib	TO	MPI	601 1600
7.	M. La Fleur	Site Agent	Sotravic Ltée	5947 3908
8.	S. Rose	Site Agent	Sotravic Ltée	5942 7339

Absent (with Apologies)

JICA Expert

Circulation

All present & absent

Senior Chief Executive, MPI & LT

Director (CE) – Mr. T. Parbhunath

Deputy Director – Mr. R. Ramdhan

Lead Engineer – Mr. D. Chinasamy

Project File (MPIP/A/482/C/PhII V2)

MINISTRY OF PUBLIC INFRASTRUCTURE & LAND TRANSPORT

Civil Engineering Section

[Notes of Meeting #2]

Item No.	Description	Action By
1.0	CONTRACTUAL MATTERS	
	Contract Price → MUR 39,951,188.60 inclusive of VAT and contingency sum of Rs 2,000,000	
	Start Date → 20 July 2017	
	Intended Completion Date → 16 December 2017	
	Contract Period → 150 Days	
	Amount of Liquidated Damages → 0.1 % of contract price per day	
	Expiry date of Insurance cover → 30/11/2017 (Maintenance Period: 01/12/17 to 30/11/18)	
2.0	SUBJECT OF MEETING	
2.1	The Engineer/Senior Engineer, Mr. M. K. Mosaheb, of the Ministry of Public Infrastructure & Land Transport (PI Division) welcomed members present for the meeting which had as objective to assess the overall progress of work on site and follow up on outstanding issues.	
3.0	APPROVAL OF PREVIOUS NOTES OF MEETING	
3.1	The notes of site meeting No. 1 were read and approved.	
4.0	PROGRESS OF WORKS	
4.1	New Channel NCH1 in Fourth portion: <ul style="list-style-type: none"> • Excavation: 100% • Casting of blinding layer: 100% • Reinforcement: 75% • Casting of base: 30% 	
4.2	New Bridge NB1 in Fourth portion: <ul style="list-style-type: none"> • Excavation: 100% • Casting of blinding layer: 100% • Reinforcement: 50% • Casting of base: 100% 	
4.3	Upgrading of Existing Affluent in Fourth portion: 90%	
4.4	Upgrading of Existing Affluent in Second portion: <ul style="list-style-type: none"> • Excavation: 100% • Masonry wall: 40% 	

MINISTRY OF PUBLIC INFRASTRUCTURE & LAND TRANSPORT

Item No.	Description	Action By
4.5	Blind Ditch Type A and Open Blind Ditch Type C (First portion): <ul style="list-style-type: none"> • Felling of tree(s) and Cleaning of site: 100%. 	
4.6	School boundary wall and drain: <ul style="list-style-type: none"> • Hoarding: 100% • Demolition: 80% • Excavation works not yet started 	
4.7	Overall percentage completion of the Works: 10	
5.0	A.O.B	
5.1	The MPI informed the Contractor that the new Programme of Works had been received.	MPI
5.2	The MPI informed that an Application for Payment from the Contractor had been received and would now be processed.	MPI
5.3	The MPI informed the Contractor that no Compliance Certificate had yet been received and urged the latter to send these as soon as possible.	Contractor
5.4	The MPI requested the Contractor to carry out the works around the school since necessary wayleave from the City Council of Port Louis had long been obtained. A copy of the letter bearing reference OM 603/CE414/2016 dated 01 August 2016 from the City Council of Port Louis had been handed over to the Contractor during the meeting.	Contractor
5.5	The MPI confirmed that approval had been given for the 3mm waterproofing membrane.	Contractor
5.6	The Contractor expressed concern that the horizontal drilling to be carried out adjacent to the existing site office might further worsen its condition. It was agreed that a decision concerning this issue would be taken at a later stage.	MPI
5.7	The Contractor highlighted that the length of the affluent as per Item 4.4 was 22.5 m instead of 20.0 m as per the drawings.	
5.8	The MPI requested that site meetings should be attended by the Contractor's Contract Manager and Registered Engineer.	Contractor
6.0	END OF MEETING	
6.1	The site meeting ended at 11.40 a.m.	

Contract	LANDSLIDE MANAGEMENT COUNTERMEASURE WORKS AT CHITRAKOOT PHASE II	Meeting No.
Venue	Chitrakoot	03
Date	28 September 2017	
Time	10 00 hrs	
Subject	Assess overall progress of work on site and to follow up on outstanding issues	

Present

SR No.	Name	Designation	Institution/Company	Contact No.
1.	M. K. Mosaheb (Chairman)	Engineer/Senior Engineer (E/SE)	Ministry of Public Infrastructure and Land Transport (MPI)	601 1600
2.	K. Mohabuth	Trainee Engineer (TE)	MPI	5970 9016
3.	R. M. Nohur	TE	MPI	601 1600
4.	V. Ramchurn	Technical Officer (TO)	MPI	601 1600
5.	R. Mahadeo	TO	MPI	601 1600
6.	I. Gooda Sahib	TO	MPI	601 1600
7.	M. Lafleur	Site Agent	Sotravic Ltée	5947 3908
8.	S. Rose	Site Agent	Sotravic Ltée	5942 7339
9.	M. Rajcoomarsing	Commercial	Sotravic Ltée	5252 8206
10.	A. Bacorisen	Contract Administration	Sotravic Ltée	5942 7337
11.	J. Gopal	Contract Administration	Sotravic Ltée	5704 1260
12.	J. Francois Ko	Geotechnical Department	Sotravic Ltée	5252 8212
13.	K. Bhuckory	Project Coordinator	JICA Expert	5962 6930
14.	T. Iwasaki	Geotechnical Engineer	JICA Expert	5842 4929

Absent

Circulation

All present & absent

Senior Chief Executive, MPI & LT

Director (CE) – Mr. T. Parbhunath

Deputy Director – Mr. R. Ramdhan

Lead Engineer – Mr. D. Chinasamy

Project File (MPIP/A/482/C/PhII V2)

MINISTRY OF PUBLIC INFRASTRUCTURE & LAND TRANSPORT

Civil Engineering Section

[Notes of Meeting #3]

Item. No.	Description	Action By
1.0	CONTRACTUAL MATTERS	
	Contract Price → MUR 39,951,188.60 inclusive of VAT and contingency sum of Rs 2,000,000.	
	Start Date → 20 July 2017	
	Intended Completion Date → 16 December 2017	
	Contract Period → 150 Days	
	Amount of Liquidated Damages → 0.1 % of contract price per day	
	Expiry date of Insurance cover → 30/11/2017 (Maintenance Period: 01/12/17 to 30/11/18)	
2.0	SUBJECT OF MEETING	
2.1	The Engineer/Senior Engineer, Mr. M. K. Mosaheb, of the Ministry of Public Infrastructure & Land Transport -PI Division (MPI) welcomed members present for the meeting which had as objective to assess the overall progress of work on site and to follow up on outstanding issues.	
3.0	APPROVAL OF PREVIOUS NOTES OF MEETING	
3.1	The notes of site meeting No. 2 were read and approved.	
4.0	PROGRESS OF WORKS	
4.1	New Channel NCH1 in Fourth portion: <ul style="list-style-type: none"> • Reinforcement: 100% • Casting of base: 100% • Channel wall: 95% • Fencing: 15% 	
4.2	New Bridge NB1 in Fourth portion: <ul style="list-style-type: none"> • Reinforcement: 100% • Casting of wall: 100% • Casting of slab: 100% • Handrail: Not yet started 	
4.3	Upgrading of Existing Affluent in Fourth portion: 95%	
4.4	Upgrading of Existing Affluent in Second portion: 95%	
4.5	Blind Ditch Type A and Open Blind Ditch Type C in the First portion: <ul style="list-style-type: none"> • Excavation: Not yet started 	
4.6	School boundary wall and drain:	

MINISTRY OF PUBLIC INFRASTRUCTURE & LAND TRANSPORT

Civil Engineering Section

[Notes of Meeting #3]

Item No.	Description	Action By
	<ul style="list-style-type: none"> • Hoarding: 100% • Demolition of boundary wall: 100% • Demolition of existing road drains: 20% 	
4.7	Stone pitching in Third portion: 15%	
4.8	Overall percentage completion of works: 20%	
5.0	LAND ACQUISITION	
5.1	<p>The MPI handed over to the Contractor photocopies of 7 Consent Forms (Serial Numbers 6, 7, 8, 9, 23, 29 and 36) during Coordination Meeting No. 6 held on 27 September 2017.</p> <p>The Contractor requested a copy of the map with the plot locations, numbers and landowners' names.</p>	MPI
5.2	The Contractor requested for the consent from the landowners with Serial Numbers 29, 30, 31 and 35 prior to undertake excavation works of the horizontal drainage HD3.	MPI
5.3	The MPI informed the Contractor that permission from the landowner to start the upgrading of River Type 1 and Type 2 in the Second portion was still being awaited. The collaboration of the City Council of Port Louis (CCPL) was requested on this matter during a meeting held on 27 September 2017. The representatives of the Council agreed to look into the matter, at the earliest.	CCPL
6.0	PAYMENT	
6.1	The Contractor was informed that the Application for Payment No. 1 did not include Cession of Rights for materials on site. The Contractor agreed that materials on site would not be certified by the MPI for this Application for Payment.	MPI
7.0	AOB	
7.1	<p>The Contractor informed the MPI that household grey wastewater and rainwater were being discharged into the existing drain adjacent to the school.</p> <p>The MPI requested the Contractor to submit a methodology to tackle this issue, for approval.</p>	Contractor
7.2	The MPI had taken note of the Contractor's Programme of Work (PoW) submitted under cover of letter bearing reference STC471/LO/AB/015 dated 1 September 2017. In this respect, the Contractor was informed that the PoW was not acceptable since it extended to February 2018 (i.e. beyond the contractual Intended Completion Date). The MPI requested the latter to submit a new PoW as soon as possible covering the period from the Start Date to the Intended Completion Date, for necessary approval.	Contractor
7.3	The MPI confirmed receipt of a set of compliance certificates from the Contractor.	MPI
7.4	The MPI submitted 3 sets of drawing No. G433/ST25 for the 3 additional bridges in the Fourth portion and one bridge in the Third portion. The Contractor had been requested to submit a cost estimate of same by Monday 2 October 2017, for necessary approval	Contractor
7.5	The MPI confirmed the use of the slotted uPVC pipe (as per the sample shown during the meeting) instead of the perforated uPVC pipe, upon the request of the Contractor. However, the spacing between the slots should be 50 mm instead of 100 mm.	Contractor

MINISTRY OF PUBLIC INFRASTRUCTURE & LAND TRANSPORT

Item. No.	Description	Action By
	The Contractor was also instructed to position the slots of the uPVC pipe on the top, as discussed and agreed during the meeting.	
7.6	The MPI, after consultation with the JICA Expert, approved the use of the 3.7mm thick horizontal drainage pipe. The relevant Standards/Specifications had been previously forwarded by the Contractor. It was made clear to the Contractor that the Bill Item would be adjusted accordingly.	Contractor
7.7	The Contractor was again informed that site meetings should be attended by both the Contractor's Contract Manager and Registered Engineer.	Contractor
8.0	END OF MEETING	
8.1	The site meeting ended at 11.30 a.m.	

Contract	LANDSLIDE MANAGEMENT COUNTERMEASURE WORKS AT CHITRAKOOT PHASE II	Meeting No.
Venue	Chitrakoot	04
Date	26 October 2017	
Time	10 00 hrs	
Subject	Assess overall progress of work on site and to follow up on outstanding issues	

Present

SR No.	Name	Designation	Institution/Company	Contact No.
1.	M. K. Mosaheb (Chairman)	Engineer/Senior Engineer (E/SE)	Ministry of Public Infrastructure and Land Transport (MPI)	601 1600
2.	R. M. Nohur	Trainee Engineer	MPI	601 1600
3.	R. Mahadeo	Technical Officer	MPI	601 1600
4.	I. Gooda Sahib	Technical Officer	MPI	601 1600
5.	M. Hiu	Contract Manager	Sotravic Ltée	59426694
6.	J. Gopal	Contract Administration	Sotravic Ltée	57041260
7.	K. Rajiah	Site Manager	Sotravic Ltée	59427335
8.	M. Lafleur	Site Agent	Sotravic Ltée	5947 3908

Absent

Circulation

All present & absent

Senior Chief Executive, MPI & LT

Director (CE) – Mr. T. Parbhunath

Deputy Director – Mr. R. Ramdhan

Lead Engineer – Mr. D. Chinasamy

Project File (MPIP/A/482/C/PhII V2)

MINISTRY OF PUBLIC INFRASTRUCTURE & LAND TRANSPORT

Civil Engineering Section

[Notes of Meeting #4]

Item No.	Description	Action By
1.0	CONTRACTUAL MATTERS	
	Contract Price → MUR 39,951,188.60 inclusive of VAT and contingency sum of Rs 2,000,000.	
	Start Date → 20 July 2017	
	Intended Completion Date → 16 December 2017	
	Contract Period → 150 Days	
	Amount of Liquidated Damages → 0.1 % of contract price per day	
	Expiry date of Insurance cover → 30/11/2017 (Maintenance Period: 01/12/17 to 30/11/18)	
2.0	SUBJECT OF MEETING	
2.1	The Engineer/Senior Engineer, Mr. M. K. Mosaheb, of the Ministry of Public Infrastructure & Land Transport -PI Division (MPI) welcomed members present for the meeting which had as objective to assess the overall progress of work on site and to follow up on outstanding issues.	
3.0	APPROVAL OF PREVIOUS NOTES OF MEETING	
3.1	The notes of site meeting No. 3 were read and approved with the following amendments: - <ul style="list-style-type: none"> • Item 5.2 Serial Number 29 to read 24. 	
4.0	PROGRESS OF WORKS	
4.1	New Channel NCH1 in Fourth portion: <ul style="list-style-type: none"> • Fencing: 50% 	
4.2	New Bridge NB1 in Fourth portion: <ul style="list-style-type: none"> • Casting of slab transitions: 100% • Handrail: 100% 	
4.3	Upgrading of Existing Affluent in Fourth portion: 95% <ul style="list-style-type: none"> • Raising of masonry wall : Not started 	
4.4	Upgrading of Existing Affluent in Second portion: 100%	
4.5	Blind Ditch Type A in the First portion: <ul style="list-style-type: none"> • Excavation: 100% • Membrane: Started 	
4.6	Open Blind Ditch Type C in the First portion: <ul style="list-style-type: none"> • Excavation: Started 	

MINISTRY OF PUBLIC INFRASTRUCTURE & LAND TRANSPORT

Civil Engineering Section

[Notes of Meeting #4]

Item No.	Description	Action By
4.7	Catchment Basin CB1 in First portion: <ul style="list-style-type: none"> • Excavation: 100% 	
4.8	Horizontal Drainage in First portion: Not yet started	
4.9	Vehicular Bridge BR7 in First portion: <ul style="list-style-type: none"> • Excavation: 100% 	
4.10	Blind Ditch Type X (112m) in First portion: <ul style="list-style-type: none"> • Excavation: 90% • Geotextile membrane: Started • Waterproof membrane: Started • Aggregate: Started 	
4.11	School boundary wall and drains: <ul style="list-style-type: none"> • Demolition of existing road drains: 100% A. Drain Type 6 (70m): <ul style="list-style-type: none"> • Geotextile membrane: 60% • Waterproof membrane: 60% • Perforated pipe: 60% • Aggregate: 60% • Reinforcement: 40% • Formwork: Started B. Drain Type 7 (98m): <ul style="list-style-type: none"> • Geotextile membrane: 80% • Waterproof membrane: 80% • Perforated pipe: 80% • Aggregate: 80% 	
4.12	Stone pitching in Third portion: 80%	
4.13	Overall percentage completion of works: 35 %	
5.0	LAND ACQUISITION	
5.1	The MPI handed over to the Contractor photocopies of 3 Consent Forms (Serial Numbers 24 and 30, 35) during previous Coordination Meetings. Outstanding Consent Forms included Serial Numbers 12 and 31, as at to date.	MPI
5.2	The MPI requested the Contractor to carry out the pegging exercise for Drain Type B (102.46m) in the First portion to determine if the drain would pass through Plot SN. 27.	Contractor

MINISTRY OF PUBLIC INFRASTRUCTURE & LAND TRANSPORT

Civil Engineering Section

[Notes of Meeting #4]

Item No.	Description	Action By
5.3	The MPI informed the Contractor that the City Council of Port Louis (CCPL) would issue a letter to Mr. Hurrynarain in due course, prior to the start of the Upgrading of Rivers Type 1 and 2. The Contractor should await instructions to prior proceed with the works at this location	MPI CCPL
6.0	PAYMENT	
6.1	The Contractor confirmed receipt of Payment Certificate No. 2	
6.2	The MPI confirmed receipt of Application for Payment No. 3 and informed that it was being processed.	MPI
6.3	The Contractor was informed that the Application for Payment No. 3 also did not include Cession of Rights for materials on site. The Contractor agreed that the MPI would not certified materials on site for this Application for Payment.	MPI
7.0	AOB	
7.1	The MPI noted that water was not observed in Open Blind Ditch Type A during excavation. Emphasis was laid on the fact that excavation works for the Horizontal Drainage HD-A1 could had started earlier.	Contractor
7.2	The MPI informed the Contractor that owing to non-submission of a Programme of Work (PoW), difficulty was encountered to assess the overall progress. A working session would be set up by the Contractor with the MPI, prior to issuing the PoW.	Contractor
7.3	The MPI confirmed that the set of compliance certificates had been checked and found to be satisfactory.	
7.4	The Contractor was reminded to send cost estimates for the following items, at the earliest- Additional bridges - Additional 5m for the initial 120m NCH1 (Fourth portion) - NCH1 masonry wall transitions to the NB1 (Fourth portion) - Masonry wall for affluent upgrading - Additional 11m of Drain Type 7 without boundary wall around the school	Contractor
7.5	The Contractor requested details for raising of the masonry wall built as part of the upgrading of existing affluent in the Fourth portion. The MPI would submit the detail at the earliest.	MPI
7.6	The Contractor requested for details of the drain at the entrance of the school.	MPI
7.7	The MPI again noted the absence of the Contractor's Registered Engineer during the site meeting.	Contractor
8.0	END OF MEETING	
8.1	The site meeting ended at 11.30 a.m. and the next meeting had been scheduled for Thursday 16 November 2017 at 10.00 a.m.	

Contract	LANDSLIDE MANAGEMENT COUNTERMEASURE WORKS AT CHITRAKOOT PHASE II	Meeting No.
Venue	Chitrakoot	05
Date	7 December 2017	
Time	10 00 hrs	
Subject	Assess overall progress of work on site and to follow up on outstanding issues	

Present

SR No.	Name	Designation	Institution/Company	Contact No.
1.	M. K. Mosaheb (Chairman)	Engineer/Senior Engineer (E/SE)	Ministry of Public Infrastructure and Land Transport (MPI)	601 1600
2.	Dr. T. Iwasaki	JICA Expert	JICA	5842 4929
3.	M. Gobin	Engineer/Senior Engineer (E/SE)	MPI	601 1600
4.	C. Abeeluck	Engineer/Senior Engineer (E/SE)	MPI	601 1600
5.	R. M. Nohur	Trainee Engineer	MPI	601 1600
6.	V. Ramchurn	Technical Officer	MPI	601 1600
7.	R. Mahadeo	Technical Officer	MPI	601 1600
8.	I. Gooda Sahib	Technical Officer	MPI	601 1600
9.	M. Hiu	Contract Manager	Sotravic Ltée	5942 6694
10.	A. Bacorisen	Engineer	Sotravic Ltée	5942 7337
11.	J. Gopal	Quantity Surveyor	Sotravic Ltée	5704 1260
12.	M. Lafleur	Site Agent	Sotravic Ltée	5947 3908
13.	J. F. Ko	Site Agent	Sotravic Ltée	5252 8212

Absent

Circulation

All present & absent

Senior Chief Executive, MPI & LT

Director (CE) – Mr. T. Parbhunath

Deputy Director – Mr. R. Ramdhan

Lead Engineer – Mr. D. Chinasamy

Project File (MPIP/A/482/C/PhII V3)

MINISTRY OF PUBLIC INFRASTRUCTURE & LAND TRANSPORT

Civil Engineering Section

[Notes of Meeting #5]

Item No.	Description		Action By
1.0	CONTRACTUAL MATTERS		
	Contract Price	→ MUR 39,951,188.60 inclusive of VAT and contingency sum of Rs 2,000,000.	
	Start Date	→ 20 July 2017	
	Intended Completion Date	→ 16 December 2017	
	Contract Period	→ 150 Days	
	Amount of Liquidated Damages	→ 0.1 % of contract price per day	
	Expiry date of Insurance cover	→ 30/11/2017 (Maintenance Period: 01/12/17 to 30/11/18)	
2.0	SUBJECT OF MEETING		
2.1	The Engineer/Senior Engineer, Mr. M. K. Mosaheb, of the Ministry of Public Infrastructure & Land Transport - PI Division (MPI) welcomed members present for the meeting which had as objective to assess the overall progress of work on site and to follow up on outstanding issues.		
3.0	APPROVAL OF PREVIOUS NOTES OF MEETING		
3.1	The notes of site meeting No. 4 were read and approved.		
4.0	PROGRESS OF WORKS		
4.1	New Channel NCH1 in Fourth portion: 95% <ul style="list-style-type: none"> • Pedestrian bridges: Not started 		
4.2	<ul style="list-style-type: none"> • Upgrading of Existing Affluent in Fourth portion: 100% 		
4.3	Blind Ditch Type A (35.5m) in the First portion: <ul style="list-style-type: none"> • Overall: 95% 		
4.4	Open Blind Ditch Type C (52m) in the First portion: <ul style="list-style-type: none"> • Overall: 95% • All concreting done. • Fencing in progress. 		
4.5	Catchment Basin CB1 in First portion: <ul style="list-style-type: none"> • Reinforcement & Concrete works: Not started 		
4.6	Horizontal Drainage (3) in First portion: <ul style="list-style-type: none"> • Excavation: 100% • Drilling: 100% 		

MINISTRY OF PUBLIC INFRASTRUCTURE & LAND TRANSPORT

Civil Engineering Section

[Notes of Meeting #5]

Item No.	Description	Action By
	<ul style="list-style-type: none"> • Perforated pipes: 100% • Reinforcement & Concrete works: Not yet started. 	
4.7	Vehicular Bridge BR7 in First portion: <ul style="list-style-type: none"> • Reinforcement: 100% • Casting of RC base: 100% • Wall formwork: 100% • Slab: Not yet started. 	
4.8	Blind Ditch Type X (112m) in First portion: <ul style="list-style-type: none"> • Overall: 100% 	
4.9	Drain Type B (102.46m) in First portion: <ul style="list-style-type: none"> • Excavation: 100% • Geotextile membrane: 100% • Waterproof membrane: 100% • Aggregate: 100% • Pipe: 100% • Reinforcement: 50% 	
4.10	Horizontal Drainage (2) in First portion: <ul style="list-style-type: none"> • Excavation: 100% • Drilling: Not yet started. 	
4.11	School boundary wall and drains: <ul style="list-style-type: none"> A. Drain Type 6 (70m): <ul style="list-style-type: none"> • Overall: 85% B. Drain Type 7 (87m): <ul style="list-style-type: none"> • Overall: 80% 	
4.12	Upgrading of existing River Type 1 (56.5m) & River Type 2 (31.0m) in Second portion: <ul style="list-style-type: none"> • Felling of trees started. • Excavation not started 	
4.13	Covered Drain Type 3 (16m) in Second portion: <ul style="list-style-type: none"> • Excavation: 100% • Geotextile membrane: 100% • Waterproof membrane: 100% • Aggregate: 100% 	

MINISTRY OF PUBLIC INFRASTRUCTURE & LAND TRANSPORT

Item No.	Description	Action By
	<ul style="list-style-type: none"> • Pipe: 100% 	
4.14	Open Blind Ditch Type 5 (40m) in Second portion: <ul style="list-style-type: none"> • Excavation: 100% • Geotextile membrane: 100% • Waterproof membrane: 100% • Aggregate: 100% • Pipe: 100% • Reinforcement: 100% • Concreting: In Progress • Fencing: Not yet started. 	
4.15	Catchment Basin CB2 in Second portion: <ul style="list-style-type: none"> • Excavation: 100% 	
4.16	Drain with Steel Grating Type 4 (9.5m) in Second portion: Not yet started.	
4.17	Stone pitching in Third portion: 90%	
4.18	Blind Ditch Type A (24m) in Third portion: 90%	
4.19	Drain Type 10 (60m) in Third portion: <ul style="list-style-type: none"> • Excavation: 100% • Geotextile membrane: 100% • Waterproof membrane: 100% • Aggregate: 100% • Pipe: 100% • Reinforcement: 35% • Casting of RC base: 20% 	
4.20	Catchment Basin CB4: Not yet started	
4.21	Overall percentage completion of works: 60%	
5.0	LAND ACQUISITION	
5.1	The Contractor informed the MPI that Drain Type B (102.46m) in the First portion would not pass through Plot SN. 27.	
5.2	The MPI informed the Contractor that the City Council of Port Louis (CCPL) had issued the relevant letter to Mr. Hurrynarain. The Contractor could now proceed with the Upgrading of existing Rivers Types 1 and 2.	Contractor

MINISTRY OF PUBLIC INFRASTRUCTURE & LAND TRANSPORT

Civil Engineering Section

[Notes of Meeting #5]

Item No.	Description	Action By
6.0	PAYMENT	
6.1	The Contractor informed the MPI that it had not yet received Payment Certificate No. 3 (End of Sept 2017). The MPI confirmed that the claim had already been processed. The Payment Certificate would be forwarded to the Contractor by fax.	MPI
6.2	The Contractor also informed the MPI that Application for Payments No. 4 (End of Oct 2017) & No. 5 (End of Nov 2017) had already been sent.	MPI
7.0	AOB	
7.1	The MPI informed the Contractor that the JICA Expert would undertake a final site visit on Friday 15 th December 2017. The JICA Expert requested the Contractor to have an update with respect to the overall progress of works on that day.	Contractor
7.2	The MPI informed the Contractor that owing to non-submission of a Programme of Work (PoW), difficulty was encountered to assess the overall progress. A working session would be set up by the Contractor with the MPI, prior to issuing the PoW.	Contractor
7.3	The MPI confirmed receipt of the Contractor's cost estimates for the outstanding items and informed the latter that it would be processed subsequently.	MPI
7.4	The Contractor was informed that the new masonry wall which was constructed as part of the upgrading of existing affluent in the Fourth portion would not be raised.	Contractor
7.5	The committee was made aware that an inhabitant was not agreeable to the construction of a soakaway in his yard. A meeting may subsequently be organised with all parties to look into the problem.	All
7.6	The MPI again noted the absence of the Contractor's Registered Engineer during the site meeting.	Contractor
7.7	The Contractor informed that works on the site would stop from 27 th December 2017 to around 09/10 th January 2018. The Contractor confirmed that all works would be accordingly secured to avoid any incident during his absence from site.	Contractor
8.0	END OF MEETING	
8.1	The site meeting ended at 11.15 a.m.	

Appendix 3.1.4

Technical advice for supervision (1)

Technical advice for supervision (1)

Through the construction period, some technical advice was given by the JICA experts as part of supervision of the countermeasure construction. Four members of the MPI/LMU, JICA expert and contractors (total of 7 participants) inspected the construction site on 20th September 2017.

1 Excavation near the house for horizontal drilling

After digging a 3 m deep pit to conduct the horizontal drilling (HD-2), the house near the pit inclined downward. As for the cause, the ground is soft, and the pit was too close to the house (distance was 1 m or less). Therefore, the following advice was given from JICA expert (refer to Figure 1),

- ✓ The impact of the excavation must not extend to the house.
- ✓ In this case, the distance from the house to the pit should be more than 3 m.

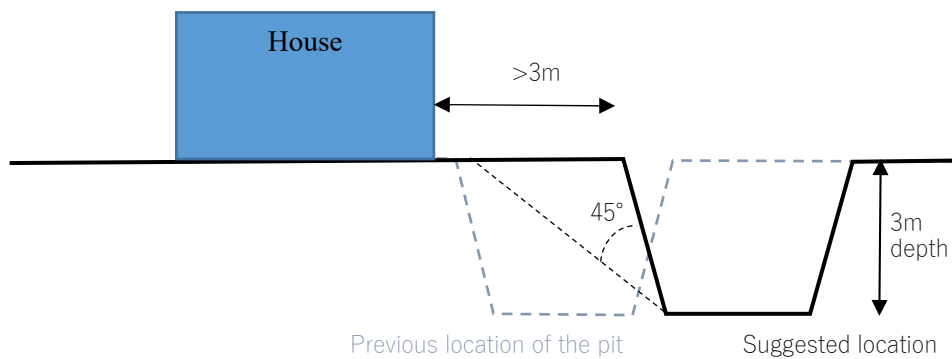


Figure 1 Suggested location of excavation near the house (Source: JET)



Photo 1 Suggested location of excavation near the house (Source: JET)

2 Location of open-brained ditch, BD-1

A part of Open-brained ditch, BD-1, is impeded by a big rock. Therefore, the JICA expert suggested placement of Open-brained ditch (Figure 2) which avoids the big rock (20 September 2017). There is no functional decline resulting from this option.

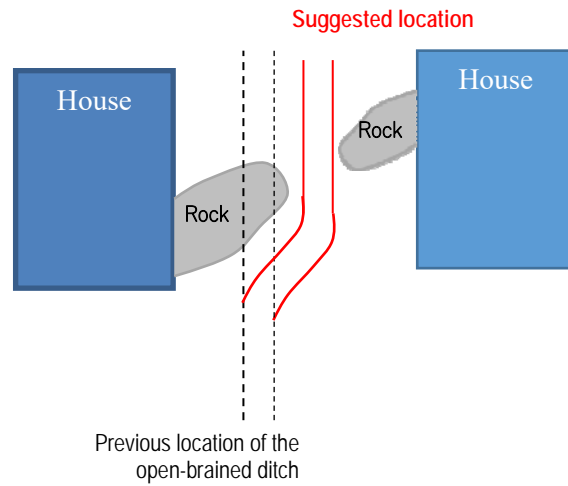


Figure 2 Location of open-brained ditch, BD-1 (Source: JET)



Photo 2 Location of open-brained ditch, BD-1 (Source: JET)



Photo 3 Site meeting for countermeasure, open-brained ditch, BD-1 (Source: JET)

Appendix 3.1.5

Technical advice for supervision (2)

Technical advice for supervision (2)

Through the construction period, some technical advice was given by JICA expert as part of the supervision of the countermeasure construction. Six members of the MPI/LMU, JICA expert, MHL and others (a total 17 participants) inspected the construction site on 27th September 2017.

1 Materials of the horizontal drainage

The materials (PVC: polyvinyl chloride pipe) of the horizontal drainage are prescribed by the TOR with the following specifications: $\phi 40$ mm and thickness 5 mm. However, this pipe is not available in Mauritius. Therefore, the JICA expert suggested materials with the same specifications ($\phi 40$ mm, thickness 3.6 mm) as materials used in Japan

2 Hole pitch for blind ditch pipe

PV pipe, 200 mm in diameter, is used as a pipe for Blind ditch. When the PV pipe is processed as a perforated pipe, the diameter and distance of the hole are as follows:

- ✓ Perforation rate of the pipe is more than 2%; this is a general specification in Japan.
- ✓ Consideration will be given to holes with a diameter of 10 mm, 12 mm, 16 mm, and 20 mm.
- ✓ Four cases shown in the list below adapt to specifications (perforation rate is more than 2%).
- ✓ The contractor can choose specifications among four cases in consideration of ease of work

Hole Pitch for the Blind Ditch Pipe

Diameter [mm]	Circumference [mm]	Width of the Perforation area [mm]	Length of the Perforation area [mm]	2/3 Surface area/1m [mm ²]	Diameter of the hole : ϕ [mm]	Hole pitch [mm]	Number of holes every 1m	2/3 Perforation rate [%]
200.0	628.3	418.9	1000.0	418866.7	8.0	50.0	160	1.9%
						75.0	65	0.8%
						100.0	40	0.5%
					10.0	50.0	160	3.0%
						75.0	65	1.2%
						100.0	40	0.8%
					12.0	50.0	160	4.3%
						75.0	65	1.8%
						100.0	40	1.1%
					16.0	50.0	160	7.7%
						75.0	65	3.1%
						100.0	40	1.9%
20.0	50.0	160	12.0%					
	75.0	65	4.9%					
	100.0	40	3.0%					

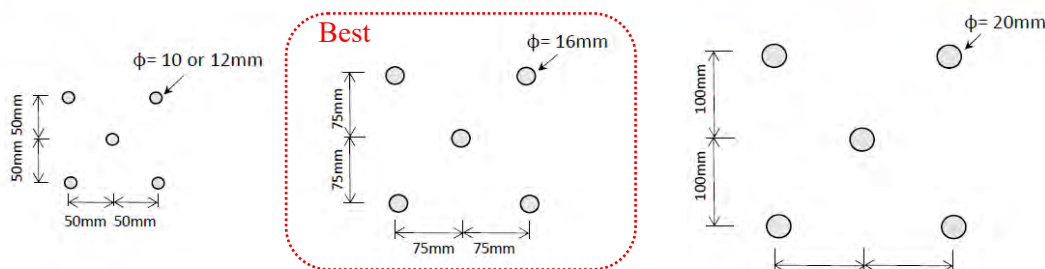


Figure 1 Study of the hole pitch for blind ditch pip (Source: JET)

3 Height of the wall for New Channel NCH1

JICA expert suggested that the side wall at a bend (near BR-6) of the New Channel, NCH1, should be built higher than the current height to prevent scattering of the water.



Figure 2 Bend (near BR-6) of New Channel, NCH1, needing building up (Source: JET)

4 Recommendation for existing culvert under the road

Regarding the existing culvert crossing the road located at the end of CH-3, the capacity is insufficient, and the following measures are recommended:

- ✓ Existing culvert should be converted into a bridge to secure sufficient drainage capacity.
- ✓ As a provisional measure until bridge construction, cleaning of the existing culvert should be carried out promptly.

CH-3 末端の道路を横断している既存のカルバートの能力が不十分なため、以下の処置を推薦する。

既存カルバートは、排水能力を確保するために橋に変更されるべきです。橋の建設までの暫定的な処置として、直ぐに既存カルバートを掃除するべきです。

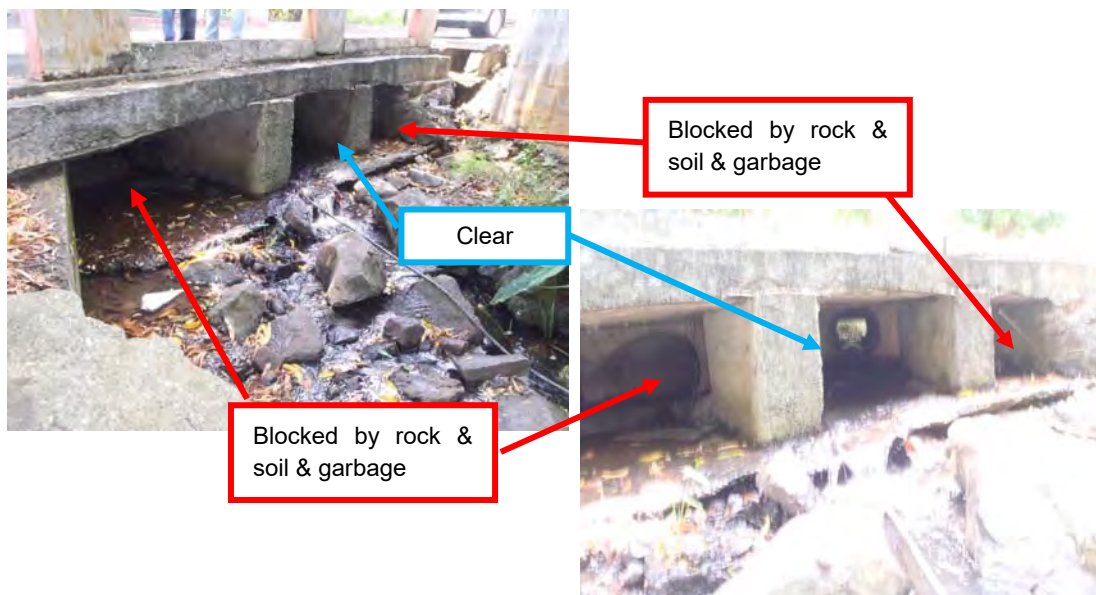


Figure 3 Current condition of the existing Calvert crossing the road

Appendix 3.1.6

Technical advice for supervision (3)

Technical advice for supervision (3)

Construction of the mini football ground in this landslide area

With reference to the above subject matter, Mr. M. K. Mosaheb and Mr. M. Gobin from MPI, and JICA expert conducted a site visit on 7th December 2017. The observations are as follows:-

- ✓ The site is located in the flat area behind the Premises of Chitrakoot Government School.
- ✓ The construction of the mini football ground will involve few modification of the topography. Therefore the construction of the mini football ground is possible in this landslide area.
- ✓ Synthetic Grass should be need instead of natural grass.

<Recommendations>

- ✓ The distance between the mini football ground and the existing extensometer should be more than 2m.
- ✓ The mini football ground should be surrounded with a fence of more than 4m.
- ✓ Surface drainage around a mini football ground should be constructed as shown in Figure 2, and it should be connect to the existing drain located on the road side.



Photo 1. Full view of the site (Source: JET)

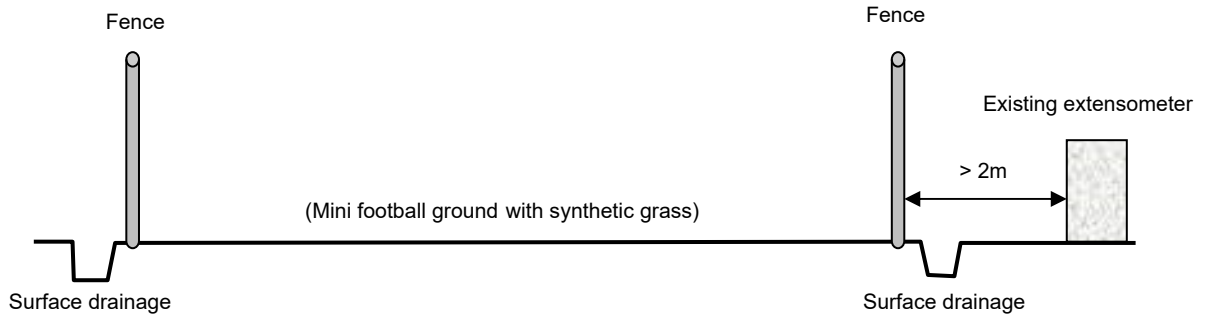


Figure 1. Cross section of the site (Source: JET)

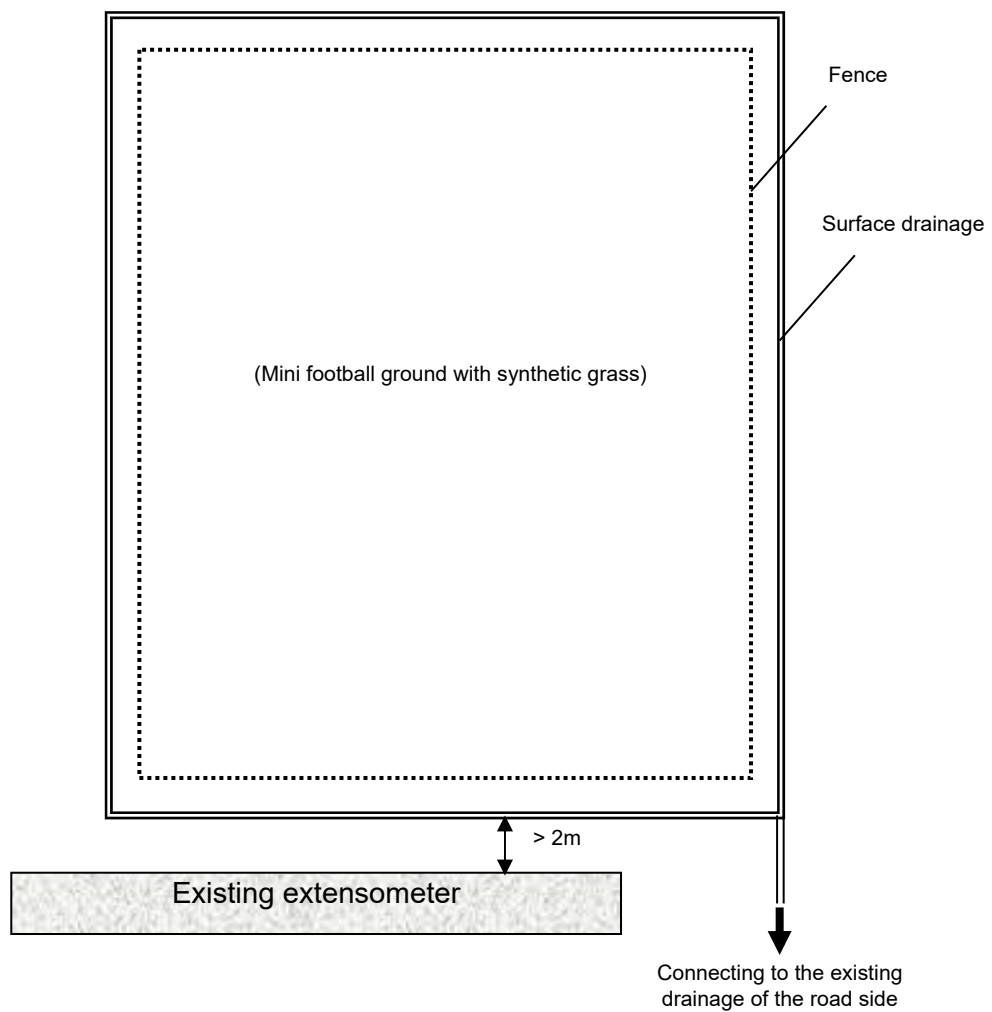


Figure 2. Plane map of the site (Source: JET)

Appendix 3.1.7

*Confirmation of the current
situation of the landslide
countermeasures in Chitrakoot
Phase 2*

Confirmation of the current situation of the landslide countermeasures in Chitrakoot: Phase 2

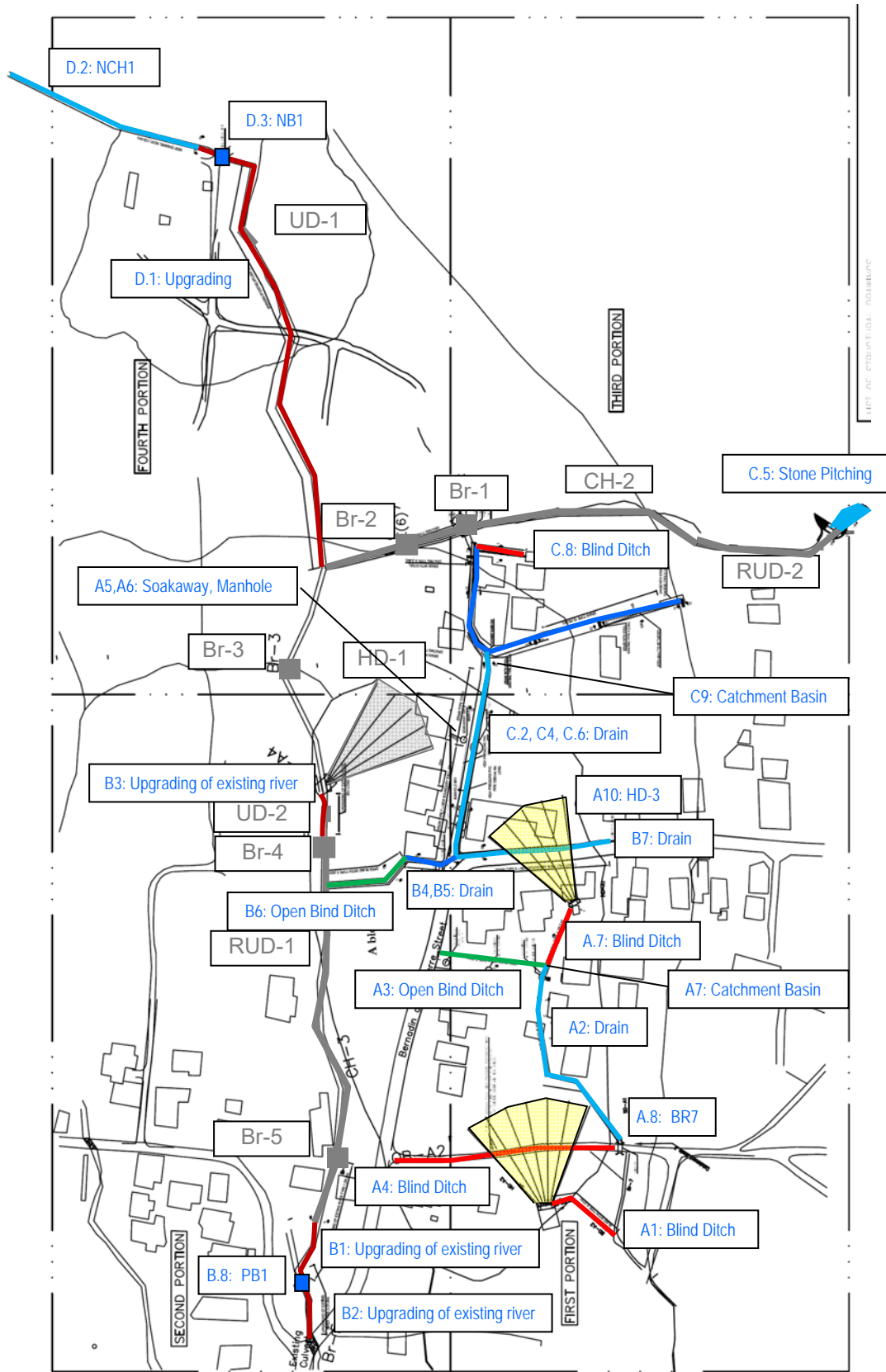


Figure 1 Location map of the countermeasure for Phase 2 in Chitrakoot (Source: JET)

As for Phase 2, the landslide countermeasure works (channel for flood, horizontal drainage, up-grade drainage and reinforced up-grade drainage) are planned to be constructed in Chitrakoot during this Project from 6th July 2017 to 31st January 2018. The work items and the quantity of the landslide countermeasures for Phase 2 are shown below. MPI and JICA Expert Team (JET) visited the site and confirmed the current situation of the landslide countermeasures for Phase 2 on 15th December 2017. The current situation and completion rate as of 15th December 2017 are shown in the table and photographs below. When the countermeasure is completed in the end of January, MPI will inform JICA expert of the completion of the work by email.

Table 1 Countermeasure works in Chitrakoot, Phase 2 (Source: JET)

ITEM NO.	DESCRIPTION	LENGTH/ X-SECTION (m)	Completion rate as of 15 th December 2017
FIRST PORTION - G433/ST17			
A.1	Blind Ditch Type A - G433/ST18	72.5	50%
A.2	Drain Type B - G433/ST18	102.46	80%
A.3	Open Blind Ditch Type C - G433/ST18	52	90%
A.4	Blind Ditch Type X - G433/ST18	112	100%
A.5	Soakaway and associated works - G433/ST18		0%
A.6	Manhole - G433/ST18		0%
A.7	Catchment Basin (CB1)- G433/ST19		50%
A.8	Vehicular Bridge (BR7) - G433/ST20	5.8 x 3.5	30%
A.9	Horizontal Drainage (HD2)- G433/ST21		50%
A.10	Horizontal Drainage (HD3)- G433/ST22		70%
SECOND PORTION - G433/ST23			
B.1	Upgrading of existing river type 1 - G433/ST24	56.5	0%
B.2	Upgrading of existing river type 2 - G433/ST24	31	20%
B.3	Upgrading of Existing Affluent	20	100%
B.4	Drain Type 3A G433/ST24	16	50%
B.5	Drain Type 4 G433/ST24	9.5	0%
B.6	Open Bind Ditch Type 5 G433/ST24	40	90%
B.7	Drain Type 6 and RC Wall - G433/ST25	70	85%
B.8	Pedestrian Bridge (PB1) - G433/ST25	3.565 x 2	0%
B.9	Catchment Basin (CB2)- G433/ST26		30%
THIRD PORTION - G433/ST27			
C.1	Drain with steel grating type 9 - G433/ST27	5	0%
C.2	Drain Type 7 - G433/ST28	37	90%
C.3	Drain Type 9 - G433/ST28	24.6	0%
C.4	Drain Type 7 and RC Wall - G433/ST28	70	80%
C.5	Stone Pitching – G433/ST28		95%
C.6	Drain with steel grating type 9A - G433/ST29	9	0%
C.7	Drain Type 10 - G433/ST29	143	20%
C.8	Blind Ditch Type A - G433/ST29	24	100%
C.9	Catchment Basin (CB4) - G433/ST29		30%
FOURTH PORTION – G433/ST30			
D.1	Upgrading of Existing Affluent – G433/ST31	50	100%
D.2	New Channel NCH1 – G433/ST31	120	100%
D.3	New Bridge NB1 – G433/ST32	4.4 x 2.5	100%



A1: Blind Ditch (Source: JET)



A.2: Drain (Source: JET)



A.3: Open Blind Ditch



A.4: Blind Ditch



A.7: Catchment Basin



A.8: Vehicular Bridge



A.9: Horizontal Drainage



A.10: Horizontal Drainage



B.2: Upgrading of existing river



B.3: Upgrading of Existing Affluent



B.4: Drain



B.6: Open Bind Ditch



B.7: Drain



B.9: Catchment Basin



C.2: Drain



C.4: Drain



C.5: Stone Pitching



C.7: Drain



C.8: Blind Ditch



C.9: Catchment Basin



D.1: Upgrading of Existing Affluent



D.2: New Channel NCH1



D.3: New Bridge NB1

Appendix 3.1.8

*Site inspection for the maintenance
of the countermeasure in
Chitorakoot*

Site inspection for the maintenance of the countermeasure in Chitorakoot

The inspection of the drainage condition was carried out on 6 March 2017 by MPI/LMU and JET, when the weather was clear and there was no rainfall. Therefore, only a little amount of drainage water was confirmed in the countermeasures. Even though, drainage was confirmed in the three following locations, and the quantity of flow of the drainage has been estimated.

➤ Surface water near bridge Br-1

Surface water which flowed into the channel CH-1 from the mountain side was confirmed near bridge Br-1. Although there was no rainfall, because the weather was clear when site inspection was carried out, according to the local people, there is 10 times the amount of surface water during heavy rain. All of this surface water is caught by CH-1.

The flow of this surface water was 26.4 litres a minute (refer to table 1).

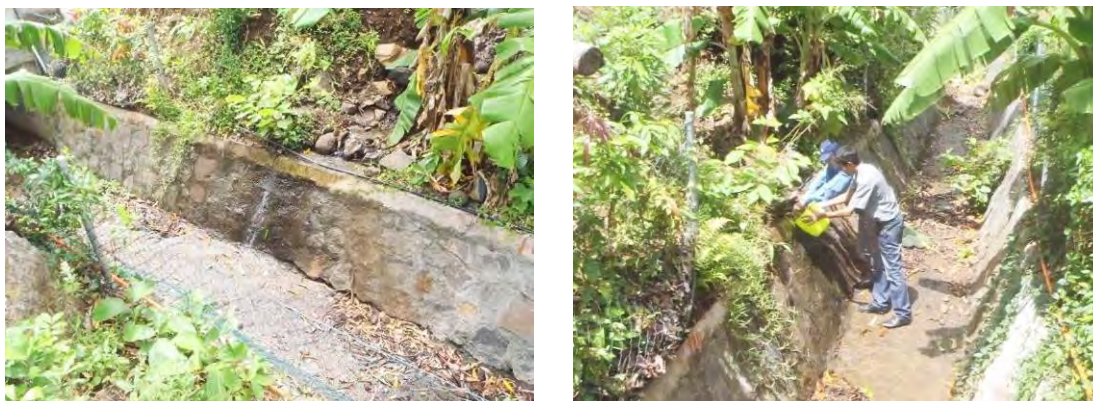


Photo 1 Surface water near bridge Br-1 (Source: JET)

Table 1 Result of the measurements drainage, Chitrakoot landslide, 6 March 2017 (source: JET)

No.	Location	Quantity [l]	Measurement Time [sec]	Drainage [l/min]	Average of the Drainage (Except the highest & lowest data) [l/min]
1	Surface water near bridge Br-1	6.1	16.0	22.7	26.4
2		5.5	13.0	25.4	
3		5.5	13.0	25.4	
4		6.6	14.0	28.3	
5		7.2	13.0	33.0	
6	HD-1	0.77	28.0	1.7	1.8
7		0.69	24.0	1.7	
8		0.76	26.0	1.8	
9		1.12	38.0	1.8	
10		0.70	23.0	1.8	

➤ Horizontal drainage HD-1

Groundwater was draining from two holes of the five drilling holes. Although there was no rainfall, because the weather was clear on 6 March 2017 when site inspection was carried out, according to the local people, the amount of drainage from horizontal drillings increase

around 2 or 3 times during heavy rain. All of this drained water is caught by the reinforced upgrade drainage, RUD-1. The quantity of flow of this horizontal drainage was 1.8 litres a minute (refer to table 1).



Photo 2 Measurement for horizontal drainage HD-1 (Source: JET)

➤ End part of Reinforced Upgrade Drainage, RUD-1

All the drainage caught by the drainage works constructed in Phase 1 is finally drained away to the river outside the landslide block through the end part of the reinforced upgrade drainage, RUD-1.

Although there was no rainfall because the weather was clear when site inspection was carried out on 6 March 2017, the quantity of flow of the drainage through RUD-1 was around 200 litres a minute. According to the photo taken during the rainy season in 2015 (refer to Photo 4), the flow of the drainage through RUD-1 was estimated to be around 1 or 2 m³ a second during heavy rain.



Photo 3 End part of the Reinforced Upgrade Drainage, RUD-1, March 2017

The flow of the drainage was around 200 litres a minute. (Source: JET)



Photo 4 End part of the Reinforced Upgrade Drainage, RUD-1, during the rainy season in January 2015 (Source: JET)