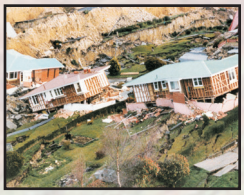
AENZ

# Managing Landslip Risk

## *Improving Practice*



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# Managing Landslip Risk

## Improving Practice

**Prepared for**
**EQC**

*CAENZ is an independent-think tank and research facilitator funded by grants and sponsorships. CAENZ's mission is to advance social progress and economic growth for New Zealand through broadening national understanding of emerging technologies and facilitating early adoption of advanced technology solutions.*

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**Issued:** June 2007



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# PREFACE

In New Zealand in the last few years there have been a significant number of large landslips reported in the media.

Prolonged periods of heavy rainfall and the increased development on hillsides and coastal areas are likely to have been the major contributing factors to these slips. In many cases they have caused major disruptions to communities and have shown there is a real need to be able to predict – and therefore prevent – slips from happening.

This CAENZ report reviews the framework within which landslide hazard mitigation planning, land-use and building consenting are carried out.

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It recommends that to be more effective there needs to be greater communication between all parties to determine if changes to existing systems and processes are required.

The challenge now is for all parties – professional, institutional and legislative – to come together, share information, and support each other to improve landslip management practices in New Zealand.

*Garry Poole, Chief Executive*
*Wellington City Council*

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# EXECUTIVE SUMMARY

Landslips present a range of hazard risks to communities and as such are an important focus for the Earthquake Commission (EQC). Over the last decade an average $10M annually in claims payments have resulted from landslips, with almost three times that occurring in 2006, a particularly wet year in various places.

The Earthquake Commission has legislated responsibility to facilitate research and education about matters relevant to natural disaster damage, methods of reducing or preventing natural disaster damage, and the insurance provided under the Earthquake Act. Previously EQC has commissioned reports into landslip risk, and now as it strengthens its research activities and seeks to maximise their benefits, it has commissioned a fresh look at the issue of community vulnerability to landslip risk.

This report scans key issues which surround the management of landslip risk such as technical knowledge, professional practice and changing risk environments.

The present system that links research through to practice is increasingly complex with significant discontinuities that limit the development and implementation of best practice. It is suggested that a co-ordinated approach is required to ensure maximum benefit.

The report presents a draft integrated risk management framework within which the various organisations involved, from pure research and technical assessment, through to land use planning, can consider how to best integrate their activities. The integrated risk management framework provides organisations with options for improving engagement and coordinating efforts that need to be further explored.

# 1 INTRODUCTION

## 1.1 Background

Earthquake Commission (EQC) landslip claims have averaged $10M per year over the last decade, but increased significantly to $26M, $24M and $38M for 2004, 2005, and 2006 respectively. Anecdotal evidence also suggests that beyond damage to domestic premises, recent damage to commercial premises, roads and other infrastructure has also been substantial.

EQC has previously (1999) commissioned research into geological and regulatory aspects of landslip risk[1]. This research found that 40% of landslip claims analysed involved slopes that had been modified by engineering works. It also found some deficiencies in both professional practice and local government regulatory control of the building consent process.

Concerned over the landslip vulnerabilities identified with many claims and realising the lack of progress in addressing the broader issue of landslip risk to New Zealand, EQC desires to find ways to reduce the risk through better practice.

This report includes a brief review of current issues surrounding the management of landslip risk in NZ, including those associated with:

- Technical (knowledge and tools)
- Professional (use and availability of knowledge)
- Organisational (central and local government approaches)
- Legislative (Building Act and the Resource Management Act).

The purpose of the review is to identify how current investments and practices in landslip risk management can be improved across the range of government, private and professional organisations involved. A suggested management framework is outlined within, that could allow all participants to better focus their activities and achieve better outcomes through a more integrated approach to landslip risk assessment and mitigation.

## 1.2 Landslip Definitions

The Earthquake Commission Act (1993) defines landslips as "...movement (whether by way of falling, sliding, or flowing, or by a combination thereof) of ground-forming materials composed of natural rock, soil, artificial fill, or a combination of such materials, which before movement formed an integral part of the ground ... but does not include the movement of ground due to below ground subsidence, soil expansion, soil shrinkage, soil compaction or erosion...". For EQC purposes the definition includes creep movement and failure of retaining walls and the retained ground.

This definition certainly does not cover all events that might be termed landslips. The recent GNSS draft Guidelines (2007)[2] provide a thorough discussion of terminology and its legislative basis, identifying as well where gaps exist. It also provides approaches to classification of landslides relevant to New Zealand practice.

# 2 LEGISLATIVE OVERVIEW

## 2.1 Introduction

Hazard management in New Zealand is dispersed over a number of agencies. Government departments, local councils, private business, and professional associations share responsibility through a variety of functions for improving New Zealand's preparedness and response to natural hazard events. This section briefly outlines the legislative framework and the roles and responsibilities for both central and local government in relation to landslip hazards.

## 2.2 Legislative Framework

The Earthquake Commission (EQC) has a function (Part I, section 5(1)(e) of the Earthquake Commission Act 1993):

> *"To facilitate research and education about matters relevant to natural disaster damage, methods of reducing or preventing natural disaster damage, and the insurance provided under the Act".*

Besides the Earthquake Act 1993 there are three other key pieces legislation relating to landslip hazards, these are the Resource Management Act 1991 (RMA), the Building Act 2004 (BA) and the Civil Defence Emergency Management Act 2002 (CDEMA). It should be noted that there is no hierarchy amongst these; rather they sit along side each other[2,3].

The RMA addresses sustainable management of natural and physical resources as managed via the provisions of district and regional plan documents, the environmental effects of landuse and other activities.

The BA aims to improve control of, and encourage better practices in, building design and construction, and requires territorial authorities to consider natural hazards in granting or refusing building consents. The CDEMA has increased the role and functions of civil defence organisations, and sets out responsibilities of government departments, lifeline utilities and emergency services in reducing hazard risk.

## 2.3 Roles And Responsibilities Of Government

For central government it is important to note that:

- The Ministry for the Environment may prepare national policy statements and national environmental standards, which may relate to restrictions on the use of land. Under the RMA the Ministry has an interest in how local government addresses requirements for monitoring and research on natural hazards.
- The Ministry for Civil Defence and Emergency Management has a role in national level emergencies.
- The Department of Building and Housing has the role of administering the Building Act 2004 (currently under revision), which, by way of the NZ Building Code, contains minimum performance levels with respect to land stability.
- Crown Research Institutes and universities are engaged in hazards science, education and social uptake. They obtain funding from the Public Good Science Fund and their commercial ventures.

For local government it is important to note that:

- Under the RMA both regional councils and territorial authorities have responsibilities for hazard management: the former for identifying important issues, and providing policy and regulatory control on these; and the latter for providing consenting permission via district plans for subdivision and land use approvals. Both may include provisions to plans and policy statements to address natural hazards for resource management purposes.
- Under the CDEMA local authorities have extensive planning functions for risk avoidance, risk management and emergency response.

While legislative responsibilities may be complete it is most certainly the case that accountability is not, and the efforts to find

cohesion are at best ephemeral[4]. Further detail on this issue is highlighted in the following section of this report.

# 3 ISSUES IN CURRENT TECHNICAL AND PROFESSIONAL ASSESSMENT PRACTICE

## 3.1 Introduction

The Resource Management Act 1991 and Building Act 2004 provide the main regulatory environment for landslip prevention from subdivision through to individual site development. Regulatory authorities mostly rely on slope stability assessments received from geotechnical practitioners in the private sector to manage the consenting process. There is no professional regulation of slope stability assessors per se.

## 3.2 Managing Landslip Risk

It is unrealistic to expect to be able to eliminate the occurrence of landslips in urban areas, much of which is a natural process. However, it is generally recognised that bad practice can increase the probability of slips occurring on any urban slope while good practice will usually reduce this probability.

It is noteworthy that slope instability in residential areas is commonly related to excess rainwater arriving at a site, often due to inadequate attention to or blockage of stormwater drainage. In that sense, risk reduction can be as much a matter for competent engineering and management of stormwater collection and disposal systems as attention to geotechnical factors.

## 3.3 Availability and Application of Hazards Information

Published information on the extent and characteristics of previous slope instability in any area normally provides a useful guide to landslip hazard potential.

In Wellington, for example, a 1:50,000 scale geological map and accompanying report published in 1996[5] gives geological hazards associated with principal map units, slope instability being associated mainly with colluvium* and greywacke** bedrock. The report identifies storm-induced "shallow-seated regolith (i.e. colluvium) slides with debris flows from the heads of gullies" as being common, as well as small bedrock failures. It also notes how "....major rock defects are sub-parallel to the predominantly steeply dipping bedding, so large bedrock slides are rare in the Wellington region".

There are many other papers and reports on Wellington slope stability characteristics[eg: 6,7,8,9,10,11.]

Similar levels of scientific information are now available in most major urban areas in NZ where slope stability is an issue. Whether it is made use of effectively by consultants or decision-makers is arguable, and reasons for any lack of uptake need to be examined further.

## 3.4 Professional Qualifications and Capability

Slope stability assessment is a specialist field, and it is important that only those with the appropriate training and practical experience be responsible for such work. It falls within the professions of both geology and civil engineering. However, that is not to say that all geologists and civil engineers will necessarily have the required skills and experience for carrying out a slope stability assessment. For example, a geologist who has specialised in mineral resource assessment may be no more appropriate to the task than the civil engineer who has spent most of his/her working life in structural engineering or designing roads.

Specialisation within both fields has led to the development of engineering geology and geotechnical engineering as disciplines in their

* Superficial mantle of rock fragments, silt, and clay

** Interbedded sandstone and mudstone, typically weathered to yellow-brown "rotten rock" to depths of up to 30 m

own right and it is these practitioners (in what is now collectively known as the "geotechnical sector") who are most suited to carrying out slope stability assessments. The designations "*Engineering Geologist*" and "*Geotechnical Engineer*" were defined by Professor P.W. Taylor, in a submission to the Commission of Inquiry into the Abbotsford Landslip Disaster, as follows:

> *"The* engineering geologist *has a thorough knowledge of geology, and also some knowledge, acquired by academic training or through experience or both, of the methods of engineering analysis as applied to geotechnical problems. Instead of the "purely scientific" approach of the traditional geologist, he is trained to apply his knowledge in assisting in the design and construction of civil engineering works. He is capable of understanding the problems faced by engineers and of communicating with them in a way which is of value in making engineering decisions".*
>
> *"Amongst civil engineers, some specialise in* geotechnical engineering. *Either by post-graduate university studies, or by practical experience and private study, such engineers have specialist knowledge of soil mechanics, foundation engineering and possibly rock mechanics".*

Notwithstanding the general suitability of the engineering geologist and geotechnical engineer for carrying out slope stability assessments, the limitations of both should be recognised; there are few who have a thorough understanding of both geology and engineering. Consequently, particularly for sites with complex geology or those involving less conventional building structures or stabilisation measures, interaction between the engineering geologist and geotechnical engineer is important.

Such interaction is, regrettably, uncommon. Geotechnical engineers, mainly because of the current nature of professional recognition, are more likely to project manage slope stability projects than engineering geologists and, albeit unwittingly, tend to overlook the need to sufficiently involve the latter. However, the converse can also apply.

## 3.5 Practitioner Competence

The previous review[1] of EQC landslip files showed that claims have commonly arisen because of:

- inadequate site investigation
- inappropriate house siting from hazards external to the property
- inadequate engineering design of retaining walls
- lack of consideration of excavation effects on adjoining properties
- lack of recognition of development on landslips
- subdivision plan differs from site plan on which geotechnical investigation was carried out.

Reasons for any inadequate professional practice are likely to include absence of internal systems for implementing readily available "best practice" guidelines[12,13,14], ineffective mentoring or continuing professional development programmes for staff, inadequate internal or independent review processes, and lack of resistance to budget/client constraints. Another problem, arising out of specialization, is that not all geotechnical professionals will have the necessary experience to competently carry out slope stability assessment work in the urban territorial authority regulatory context.

Issues with the quality of geotechnical practice are not confined to New Zealand. For example, in the latest (September, 2006) issue of "Australian Geomechanics", (a professional newsletter), Professor John Atkinson, City University of London, noted how, because of skill shortages "Too much ground engineering is being done by people not competent enough to do it and as a result a lot goes wrong. Many of the best British ground engineers are busy sorting out problems created by others". In the same publication, shortage of suitably qualified graduates entering the profession has also been identified as an issue. Professor John Small, Director

of the Centre of Geotechnical Research, University of Sydney, notes that it is apparent "that there is a shortage of good students who wish to specialise in geotechnical engineering and this has led to fewer graduates possessing these specialist skills worldwide".

## 3.6 Regulatory Compliance and Process

Studies in the USA have shown that in places where there is both competent geotechnical assessment and effective regulatory control, over 95% of landslip losses can be effectively and economically mitigated[15]. In particular, without effective regulatory control, the potential exists for stability issues to be overlooked by council processing staff who do not have local knowledge, geotechnical expertise, or access to a hazards register.

A further problem can arise where people "behind the counter" are constantly changing, so that there is no build-up of experience to cope with the work[1].

As well as administering the execution of regulations arising out of the relevant legislation, territorial authorities are also responsible for ensuring design and construction requirements are carried out as intended.

Unfortunately there have been cases where a construction producer statement was issued, and yet the slope subsequently failed. When checked, what was constructed was found to differ materially from that which had been signed off. In other cases, cut slopes have failed because the construction procedure was not appropriate[1] (e.g., done in one sequence, when a staged excavation would have been better).

Some territorial authorities maintain approved practitioner lists[16], and retain consultants to monitor these matters[1], as they would not normally employ specialist staff for this purpose. They thus fulfil their statutory obligations by requesting applicants or their consultants to certify that their stability assessments provided meet consent requirements.

## 3.7 Provision of Process Guidelines

Efforts to provide guidelines to assist in practical, front line decision-making have received mixed success. The first one (Riddolls & Grocott Ltd., 1999: Assessment of Geotechnical and Development Factors involved in EQC landslip Claims) recommended a standard procedure for dealing with slope stability matters be developed and implemented within the building consent process throughout the country. This report (for the Earthquake Commission) has never been formally implemented because of the lack of collective approach with the professional community.

The second (Saunders, W, Glassey, P. Draft – Guidelines for Assessing Planning Policy and Consent Requirements for Landslide Prone Land. GNS Science Miscellaneous Series 7, February 2007) is currently in draft but likely to suffer a similar fate. While this latter work was funded for its development and completion, no monies are available for implementation and maintenance. Unless involved organisations collectively agree to manage the implementation of these guidelines their usefulness in improving decisions on landslip risk will never be realised.

## 3.8 Sector Support

Interviews with selected individuals from government research and building organisations, as well as from commercial interests, while limited, are indicative of substantive interest in improving the management of landslip risk.

Core areas of interest include improving the collection, storage and accessibility of geotechnical data, and using a standardised process for assessing risk. They have been identified as difficult tasks in the current environment because they involve local government, consultancies and research organisations, amongst others, all of whom have different needs and resources with limited inter-communication.

# 4 FRAMEWORK FOR ACTION

## 4.1 Introduction

The national and local governance structure of New Zealand has been in place for more than 15 years, allowing sufficient time to assess its success in delivering quality decisions on public risk management, in this case, landslip risk. Clearly there are successes and weaknesses, many of the latter being related to:

- The effectiveness of stakeholders in managing, disseminating and applying existing natural hazard information
- The extent to which natural hazards are considered by local authorities in relation to other issues, and how natural hazard expertise is valued.
- The extent to which local authorities are developing their internal capacity to ensure the appropriate natural hazard information is obtained and disseminated to their communities.
- Whether there is a need for a national approach or policy in respect to the acceptable level of risk and for objective indices of risk.
- The transparency of liability amongst central government, local government, developer and individual, and the effect of recent changes to s106 RMA on council liability.
- The requirements of local authorities for taxpayer and ratepayer-funded natural hazard science.
- The success of the current FRST funding approach in developing the required natural hazard science knowledge to meet local authority needs as end users and funding partners.
- The influence of the commercial imperative of the Crown Research Institutes on access to natural hazard information for the public good.
- The extent to which the tertiary education sector is developing the future expertise required.
- Whether the various pieces of legislation impacting upon natural hazards are dealt with in consideration of built environment are sufficiently understood and whether the gaps or confusions are sufficiently identified.
- How local authorities have committed to the inclusion of appropriate consent conditions in addressing the impacts of natural hazards and in bringing peer reviews to improve certainty of decisions.
- Whether local authorities are ensuring that the appropriate natural hazard information is available and managed, and integrated into regional and district policy and plans, and whether this raises liability issues.
- How well risk information is communicated to all stakeholders.

These issues were noted in an earlier CAE study of planning for natural hazard risk[3] and remain valid.

As a consequence of this and the continuing limitations of hazard risk management, it is the authors' opinion that a new paradigm is required, one that integrates three critical perspectives: holistic approach, systems methodology, and shared outcomes.

## 4.2 Taking a Systems Perspective

Natural systems, such as weather and ecology, provide structure and opportunity for human life. In seeking to manage human interactions with these systems, people develop systems of governance, financial management, health and education, legal, technology, transportation and communications, to name a few. As we live in natural systems and design and manage our own management systems in response, taking a systems perspective must be a critical basis for risk management. The need to do so is increasing.

Managing organisational contributions within this complex system for public risk management is challenging. Maximising effectiveness requires an understanding of the contributions and needs of others and in working with them to provide an integrated, comprehensive approach to landslip risk management.

Options for engagement exist at several levels, including:

- Having an awareness of system needs so participants can ensure effective placement of their investments;
- Forming collaborative partnership between the technical, professional and regulatory organisations to cooperatively establish priorities, promote best practice, etc.; and
- Facilitating, and where appropriate offering leadership, to such a partnership.

The latter two options are growing in importance as systemic risk, the risk that occurs within and amongst system elements, is increasingly recognised as a significant emerging issue[17].

On a national scale this is due to, for example:

- Increases in population density and urbanisation.
- Strong links between physical, social and economic risks.
- Increased vulnerability with respect to technological, social and natural risks.
- Increased uncertainly (associated with climate variability and weather systems) around certain weather/climate generated hazards and about natural hazard patterns and frequencies.

This systemic risk context is highly relevant to the management of landslip risk.

Also, as landslip risk management is but one element of government's public risk management responsibilities; it is unlikely to be successfully treated as a separate issue. Issues surrounding landslip risk management can be expected to have commonality with other public risk management issues.

While this commonality may expedite the transfer of risk management improvements it might also mean that broad change may be required, which will prove challenging to achieve within current governance systems.

## 4.3 Integrated Risk Management Framework

An outline for an integrated risk management framework is set out below in Table 1 to establish:

- Broad awareness of what agencies are involved, their roles and responsibilities, and the guiding legislation and policies.
- An assessment of the success of this "system" to prompt best practice decisions on landslip risk.
- Understanding of the systemic risks; what strengths and weaknesses exist, why; and how the former can be promoted and how the latter might be remedied.
- The opportunities for participation in improving the overall system and to maximise organisational interests.
- A logical sequence of steps to work towards developing the framework.

The framework emphasises the need to understand and integrate all the organisations and control elements together. The framework can be summarised as follows:

1 It logically begins with a need to understand landslip risk in the broadest possible way, then identifying what organisations are involved and the opportunities for working together and any risks therein.

2 It then sets out the need for managing relationships both with formal communications and with networking.

3 It then identifies a series of interwoven strategies important for building and managing the framework. Desired outcomes and recommended actions are offered for each. The strategies are:

   — Legislative Framework

   — Data and Information

   — Methodologies, Benchmarking, Standards, and Guidelines

   — Regulatory Process Improvement

   — Education

   — Professional Development

   — Accreditation.

4 It is completed with monitoring and reporting strategies.

This framework can be managed collectively with participants contributing their input, facilitating interaction and interchange amongst themselves, and at times exercising leadership

over identified tasks.

There is also opportunity to contribute essential secretariat functions. The strategic gain from participation would be in maximising the benefits from each organisation's investment in its own responsibilities (in science, regulation, or legislation, for example).

## 4.4 Implementing the Framework

The first step is for an organisation to provide the initial leadership in identifying potential participants and working with them to substantiate the framework and to begin to address its elements.

Key potential participants would appear to be:

- Earthquake Commission
- Department of Building And Housing
- GNS Science
- Property Insight
- Local Government New Zealand (and selected regional and territorial councils)
- Standards New Zealand
- The Parliamentary Commissioner of the Environment
- Foundation for Research Science and Technology/MORST
- Insurance Council of New Zealand
- Ministry for the Environment
- Ministry of Civil Defence and Emergency Management
- IPENZ
- New Zealand Planning Institute
- Hearing Commissioners
- Professionals (lawyers, engineers, geologists, planners)

# 5 CONCLUSIONS

Many organisations and professional groups are currently engaged in the management of landslip risk, each responding to their particular responsibilities. A review of current practice has identified a number of issues affecting the quality of associated decision making, such as practitioner competence and organisational capacity, implementation of best practice guidelines, and discontinuous coordination amongst regulatory authorities.

While some of these issues may be attributed to individual actions generally, they reflect a system failure. Achieving significant reduction in landslip loss goes beyond technical practice issues, into such matters a landuse planning, regulatory provision, human performance, and changes in risk environments. Challenges exist within and particularly between these elements, leading to the conclusion that a systemic approach is required to address these issues.

No one organisation or institution owns the problem. Improving the practice of landslip risk management requires addressing these challenges within a framework that is shared across the organisations involved. Without such coordination then, for example, process guidelines will not be used systematically in decision making, nor will individual science contributions be either maximised in terms of priority or in terms of effective transfer to practitioners.

While recognising that the integrated risk management framework offered herein requires considerable work to bring organisations together in substantiating the framework and in providing its continuing management, it is difficult to see how anything less will bring significant improvement in the management of landslip risk in New Zealand.

# 1. ANALYSIS

**This step is required to inform Participants**

| Activity | Desired Outcome | Recommended Actions |
|---|---|---|
| **Strategic Awareness** | There is a clear understanding of the causes of landslip-related risks, their extent, and future projections, within which to focus participation. | ▪ Review landslip occurrences for number, location, cause, costs, etc.<br>▪ Assess causes and trends (to determine importance of task).<br>▪ Assess international practice for possible contributions. |
| **Advocacy Analysis** | Participants are aware of the critical points to participate in the development and application of expertise and knowledge, and in the design and management of the regulatory regime utilised by government. | ▪ Develop "map" of current roles and responsibilities of all those involved, as well as understanding their plans and politics, and how to best interact with each. |
| **Stakeholder Analysis** | Participants understand what stakeholders presently contribute to landslip risk management and what role they might be willing to accept in managing the framework. | ▪ Consult with stakeholders to determine what current activities exist, their effectiveness, concerns and future plans, and how each may partner. |
| **Risk Assessment** | Participants appreciate the risks associated with participating to ensure the best possible decision making relating to the built environment of NZ. | ▪ Prepare a risk map of the necessary participation opportunities in the decision-making for the built environment. This means assessing the possible success of each intervention, any barriers, and options for addressing these.<br>▪ Then devise a plan to address using the activities below (and others as required) |

**These activities will define the others below.**

*Table 1: Integrated Risk Management Framework*

# 2. RELATIONSHIP MANAGEMENT

**This step is required to build relationships participants need to develop to play an effective role in managing Landslip risk.**

| Activity | Desired Outcome | Recommended Actions |
|---|---|---|
| **Communications (outward focussed and related to the development of the Framework)** | Professionals, their associations and local authorities are aware of the implications of poor landslip risk management and the need for this Framework.<br>Participants' role, process and desired outcomes are known with respect to this exercise. | ▪ Ensure messages are identified, clarified, and delivered consistently in publications, websites, conferences, etc.<br>▪ Adopt a clear communications strategy for its engagement with stakeholders. |
| **Networking**<br>**(long term co-ordination on the Framework)** | This Framework is managed collectively by partners. | ▪ Link to other professional groups important to the success of this initiative (engineering, geotechnical, planning, etc.).<br>▪ Link to key central and local government management and technical processes. |

*Table 1: Integrated Risk Management Framework (cont'd)*

# 3. ADVOCACY STRATEGIES

**This step is important for getting the work done.**

| Activity | Desired Outcome | Recommended Actions |
|---|---|---|
| **Legislative Framework** | Legislation and national policies in place create the opportunity for good governance and best practice decision making at all levels.<br>Liabilities arising from decisions on landslip risk are known. | ▪ Assess existing legislation for completeness.<br>▪ Identify and assess central government roles and responsibilities to identify strengths and gaps, and to develop any required solutions.<br>▪ Assess how liabilities are managed within and across governments. |
| **Data and Information** | Relevant data and information is publicly available.<br>Other publicly funded data and information important to landslip risk management is made readily available.<br>Suitable technologies are available to expedite decisions. | ▪ Data and information is made readily available as required.<br>▪ Identify these sources, the value of their contributions and all access issues.<br>▪ Identify technologies, software and data protocols that are commonly, or should be commonly available. |
| **Research** | Research requirements necessary to improve understanding are known and acted upon. | ▪ In consultation with practitioners, tertiary education institutions, CRI's and funding agencies to develop an agenda for research, set priorities and assist in securing financing.<br>▪ Identify areas where funding can assist in the uptake of science in decision making.<br>▪ Identify and support pilot studies on the application of new approaches. |
| **Methodologies, Benchmarking, Standards, and Guidelines** | External professional fraternity has the appropriate "tools" to address landslip risk management issues<br><br>Programme and project managers are aware of landslip risk and how best to manage it. | ▪ Review existing "tools" for adequacy and where necessary set out strategy to fill critical gaps where these are relevant (what gaps, who can partner, what priority, etc)<br>▪ Establish work plan, contributors, finances, partners, etc to update/modify/create related methodologies, benchmarked processes and information, standards and guidelines.<br>▪ Manage development of work plan<br>▪ Promote relevant "tools" through workshops, conferences, etc.<br>▪ Maintain vigil on adequacy and evolving needs<br>▪ Best practise is identified and promoted.<br>▪ Monitoring of revised standards and guidelines<br>▪ Develop risk-based management methodology to assist managers of projects/programmes to improve decision making on landslip risk. |

| | | |
|---|---|---|
| **Regulatory Process Improvement** | Local Government planning, consents, compliance and policy processes allow for the successful applications of the landslip risk management advice. | ▪ Identify critical areas that have to be prepared for any revised approach (legislation, planning and policy, etc, human behaviour, awareness, etc)<br>▪ Develop change needs for each critical area, and how this might be achieved.<br>▪ Develop a plan to influence these critical areas (this might include engaging central government to change legislation or department polices, some might be done through awareness initiatives). |
| **Education** | Tertiary Institutions have appropriate awareness and training in their course work. | ▪ Identify Tertiary Institutions' current engagement.<br>▪ Develop engagement strategy messages, priorities, contacts, etc<br>▪ Engage Tertiary Institutions' to develop content with assistance as required<br>▪ Promote good uptake with appropriate recognition (student awards, TI awards) |
| **Professional Development** | Continuing professional development initiatives endorse landslip risk mitigation training etc where applicable. | ▪ Workshops<br>▪ Conference support<br>▪ Fellowships |
| **Accreditation** | Professional standards are maintained. | ▪ Identify professional accreditation needs. |

*Table 1: Integrated Risk Management Framework (cont'd)*

# 4. EVALUATION AND REPORTING

**Needed to complete the framework in giving management continual assessments of the progress of the initiative.**

| Activity | Desired Outcome | Recommended Actions |
|---|---|---|
| **Evaluation** | Participants' management is aware that its investment in landslip loss reduction is effectively contributing to the improvement of decision on landslip risk. | ▪ Develop reporting process for Framework with outcomes, outputs, timelines, etc.<br>▪ Identify appropriate methodology for "measuring the impact" of science investments. |
| **Reporting** | Partners to the Framework are aware of progress.<br>Participants are aware that their investment in the research programme is generating the desired outcomes. | ▪ Reporting schedule and process to be developed.<br>▪ Staff regularly report on progress made. This should incorporate input from partners. |

*Table 1: Integrated Risk Management Framework (cont'd)*

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