Risk Assessment: Guidance for CDEM Group Planning

Director's Guideline for Civil Defence Emergency Management Groups [DGL 23/22]

Resilient New Zealand
Aotearoa Manahau

New Zealand Government

Risk assessment: guidance for CDEM Group planning

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Authority

This guideline has been issued by the Director of Civil Defence Emergency Management pursuant to s9(3) of the Civil Defence Emergency Management Act 2002 (CDEM Act). It provides assistance to CDEM Groups conducting risk assessments to inform CDEM Group planning. Section 53 of the CDEM Act specifies that CDEM Group plans must take account of Director's guidelines.

This document, along with further information about the Agency, is available on the NEMA website www.civildefence.govt.nz.

National Emergency Management Agency
PO Box 5010
Wellington 6145
New Zealand
Tel: +64 4 830 5100
Fax: +64 4 817 8554

Email: emergency.management@nema.govt.nz
Website: www.civildefence.govt.nz

Foreword

CDEM Groups play a key role in supporting the safety and wellbeing of communities in Aotearoa. CDEM Group planning is the means by which Group partners identify the specific challenges, arrangements, work programmes and priorities for each Group to support their communities. An understanding of the risks to be managed and the current risk management in place within a Group's area is the first step in effective planning.

This Guideline recognises that CDEM Group risk assessment and risk management fits within a broader framework for risk management and building resilience in each Group's area. It provides the contextual and theoretical information for CDEM Groups to build their understanding of the purpose and value of risk assessment to fulfil the Group's purpose and functions.

This Guideline provides CDEM Groups with a clear methodology for understanding the risks in their areas, and using that information to inform decision making regarding risk management initiatives across the 4Rs. It provides a step-by-step methodology for Groups to better understand the specific consequences to be managed from a range of hazards and to consider not only what could happen, but also the most practical solutions for reducing and managing impacts on people, property, taonga and services in the Group's area.

This Guideline enables the development of a comprehensive suite of risk summaries over time. This resource will ensure each CDEM Group will be better placed to reduce risks where practical and build readiness and resilience for better response and recovery for future emergencies. The Guideline also provides a mechanism to ensure a consistent approach to risk planning across the sector, regardless of the size of the CDEM Group, and utilising best practice risk methodologies.

Finally, the Guideline is accompanied by a suite of tools, templates and resources for use by CDEM Groups to practically apply the Guideline's methodology in their areas.

Gary Knowles

Director of Civil Defence Emergency Management

Contents

Section 1 Introduction and context

This section introduces this Guideline and includes information on its purpose, audience, structure, key terms, scope and use. The introduction also introduces the reader to the context for risk assessment as part of Civil Defence Emergency Management (CDEM) Group planning.

The goal of civil defence emergency management planning is to support the resilience of communities through a risk reduction, readiness, response and recovery approach to managing risk arising from hazards.

1.1 About this guideline

Purpose and audience

The purpose of this Guideline is to support a CDEM Group to undertake an informed and robust risk assessment, using nationally consistent methods, as part of CDEM Group planning processes. A risk assessment is fundamental to enabling effective risk reduction, and for setting in place the necessary arrangements for readiness, response and recovery. These 4Rs are the cornerstones of increasing community resilience, which is the primary goal of all CDEM Group planning. This Guideline outlines the process of risk assessment as part of CDEM Group Plan development and review. It also outlines how risk assessment is integrated with the wider hazard risk management functions of councils and partner agencies within the CDEM Group's area. The CDEM Group work programme within the Group Plan should clearly reflect the outcomes of the risk assessment process.

The primary audience for this Guideline is the CDEM Group member council(s), and other partners represented on the Coordinating Executive Group (CEG). The Guideline encourages the involvement of a broader range of partners and stakeholders within a Group's area, including but not limited to: iwi/hapū; community and volunteer organisations; researchers; and the private sector.

Structure

This guideline has the following main sections:

- *Section 1: Introduction* – an introduction to this guideline, including key terms used.
- *Section 2: Steps to conduct risk assessment* as part of CDEM Group planning:
    - Step 1: *Establish the context* – establishes the purpose, objectives, scope and criteria of the risk assessment.
    - Step 2: *Communicate and consult* – describes the importance of identifying and including relevant stakeholders throughout the risk assessment process.
    - Step 3: *Identify risks* – outlines the process of identifying, understanding and recording potential risks.
    - Step 4: *Analyse risks* – establishes levels of risk based on the likelihood and consequence of hazards.
    - Step 5: *Evaluate and treat risks* – outlines the considerations for reviewing levels of risk, taking into account current risk

management measures, and guides the process for identifying opportunities for further risk management measures.
    - Step 6: *Monitor and review* – describes processes to ensure risk assessments remain fit for purpose and up to date.
- *Section 3: Practical application* of CDEM Group risk assessment methodology, using the tools and templates which accompany this Guideline.
- *Section 4: Appendices* – information, templates, and forms which support the practical application of this guidance.

Use of icons

The following icons are used in this guideline:

Indicates a template, resource or tool is provided in the appendices or in the online toolbox

Indicates more information is available in another document or website

Indicates an action and/or documentation step for CDEM Groups as they follow the process shown in this Guideline

Relationship to other plans and guidelines

In order to properly understand the context of this Guideline, users are strongly encouraged to read it in conjunction with:

The National Disaster Resilience Strategy Rautaki ā-Motu Manawaroa Aituā

Director's Guideline: CDEM Group Planning [DGL 09/18]

Director's Guideline: Strategic Planning for Recovery [DGL 20/17]

Director's Guideline: Tsunami Evacuation Zones [DGL 08/16]

Director's Guideline: Assessment and Planning for Tsunami Vertical Evacuation [DGL 21/18]

1.2 Key terms

This section defines key terms used in this guideline.

CDEM Group

A consortium of local authorities working together to deliver civil defence emergency management for their area as described in the CDEM Act 2002. The Group is supported by partner agencies, notably emergency services and lifeline utilities operating within their area.

Consequence

An impact of a hazard event that can be expressed quantitatively (e.g. units of damage or loss, or the monetary value of impacts), semi-quantitatively (e.g. high, medium, low level of impact) or qualitatively (a description of the impacts). The vulnerability and exposure of elements is considered in combination with the characteristics of a hazard to determine the severity of consequences.

Elements

People, property, taonga and services that are to be assessed for consequence. For example, the physical and mental wellbeing of people are elements of the social environment.

Environments

A means to frame the different elements we value that can be impacted by hazards. These are:

- ***Social Environment (Rohe Tangata)*:** population, social structures and cultural values
- ***Economic Environment (Rohe Ōhanga)*:** economic activity, financial systems, employment, income, and resources
- ***Built Environment (Rohe Tūranga Tangata)*:** residential, commercial, industrial and agricultural buildings, infrastructure and key lifeline utilities
- ***Natural Environment (Rohe Taiao)*:** biophysical environment and ecosystems, natural resources and heritage, productive land, oceans, and freshwater systems.

Exposure

The number, density or value of elements we value that are present within an area subject to one or more hazards i.e. within a hazard zone, and that may experience potential loss or harm.

Frequency

The number of event occurrences within a given time period.

Hazard

The CDEM Act defines hazard as ‘something that may cause, or contribute substantially to the cause of, an emergency’. The definition of emergency in the Act describes situations requiring the application of CDEM.

The National Disaster Resilience Strategy combines these definitions for easier understanding by stating, “A hazard is a potentially damaging event, entity, phenomenon or (malicious or non-malicious) human activity, which may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. Hazards can be single, sequential or combined in their origin and effects.”

Likelihood

Likelihood is defined as the probability or chance of an event and is usually described quantitatively as a ratio (e.g. 1 in 10), percentage (e.g. 10%) or value between 0 and 1 (e.g. 0.1), or qualitatively using defined and agreed terms (e.g. unlikely or possible).

Maximum credible event	A hypothesised worst-case event for the geographical area being considered that can be used as a hazard scenario. The scenario may have a very low likelihood and should align with the reasonable expectations for hazard planning. For example, the *Tsunami Evacuation Zones Director's Guideline* (DGL 08/16, MCDEM 2016) states that considering the maximum tsunami expected over a period of 2,500 years is reasonable. Scientific and technical expertise will assist with determining both "maximum" and "credible".
People, property, taonga and services	A term used to encompass the valued things that should be considered in a risk assessment. These people, property, taonga and services are grouped under the social, built, economic and natural environments. Within this Guideline these valued things are collectively referred to as elements.
Residual risk	The risk that remains unmanaged, even when effective risk treatments (risk management measures) are in place.
Resilience	The ability to anticipate and resist the effects of a disruptive event, minimise adverse impacts, respond effectively post-event, maintain or recover functionality, and adapt in a way that allows for learning and thriving.
Risk	The CDEM Act defines risk as 'the likelihood and consequences of a hazard'. To determine the likelihood and consequences for particular hazards, the basic components of risk must be understood, namely: **Hazard component**: where hazards occur, how often they occur, what scale or magnitudes are possible, what areas can they affect, how rapid their onset, and their duration. **Exposure component**: what are the people, property, taonga and services (elements) in the region that could be affected by hazards, how are they measured, are they fixed or mobile? **Vulnerability component**: how resistant to damage or harm are the elements? What are the inherent factors such as demographics of communities or the local building stock or critical nodes within lifeline networks that influence how much harm will result when a hazard occurs? The scale of the risk is determined by the intersection of these three components. If any one of these components changes, the scale of the risk also changes (Figure 1).

Figure 1 The components of risk indicating the way a reduction in any one component decreases overall risk.

More detail on identifying the components of risk and their use within a risk assessment is provided in *Step 3* and *Step 4* of *Section 2* of this Guideline.

Risk acceptance

An informed decision to accept a defined level of risk.

Risk summary

A document which captures the current understanding of the risks and risk management measures for a particular hazard. It could include:

- the type of hazard
- the context of the hazard, including historic events and the way it is measured or described
- the frequency, likelihood and extent of the hazard
- the vulnerability and exposure of elements at risk
- the range of scenarios assessed for the given hazard
- uncertainty or confidence rating based on levels of knowledge and/or availability of evidence
- description of current risk management and risk treatments
- whether the risk is evolving or changing due to environmental trends
- any known future risk treatment options; and
- a date for review and date last reviewed.

Risk register

The term risk register is used to describe the collated, summary information on risks assessed by the CDEM Group, housed in one location or document. A risk register will typically not include the broader pool of information used to

analyse each of the risks; this information is maintained separately among various risk owners and contributing agencies.

Risk treatment

Measures taken to manage the consequences or likelihood of a hazard (e.g. through risk avoidance, reduction/mitigation or risk transfer). Normally, not all risk can be mitigated, resulting in residual risk. In line with the 4Rs approach, planning and operations for readiness, response and recovery are valid risk treatments. Well executed arrangements will lessen the consequences of an event, hasten recovery and offer opportunities for further risk reduction.

Uncertainty

Uncertainty is the state, even partial, of deficiency of information related to understanding or knowledge of an event, its consequence, or likelihood (ISO 31000).

Note: The CDEM Act (s7) enables a precautionary approach to be taken:

All persons exercising functions in relation to the development and implementation of civil defence emergency management plans under this Act may be cautious in managing risks even if there is scientific and technical uncertainty about those risks.

Vulnerability

The conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards.

1.3 How to use this Guideline

Risk assessment and risk managment theory

Risk assessment is part of the risk management cycle, whereby risk is identified, analysed, evaluated, treated, and management is communicated, monitored and reviewed. This Guideline sets out a step-by-step explanation of the risk management process to support a CDEM Group in understanding the context and approach to undertaking a risk assessment. The structure includes all steps of the risk management cycle and provides the context for where risk assessment sits within this cycle.

All Groups are advised to use this Guideline as a reference document to further their understanding of risk assessment terminology, processes and the place of risk assessment in informed decision-making.

This Guideline is intended to support the CDEM Group's planning process. It provides detail and explanation on the importance of risk assessment for decision making. It provides the context and rationale for a CDEM Group-led risk assessment based on the international risk management standard ISO 31000. The aim is to ensure CDEM Group planning is underpinned by a robust and shared understanding of local hazards, and the risks they pose to communities.

Practical application

This Guideline includes an online toolbox containing a set of standardised tools and resources which support Groups to conduct risk assessments. While use of these tools is not a requirement, it is strongly recommended to ensure the CDEM Group Plan is informed by an appropriate level of risk information which supports decision-making. The Guideline may also be used as a reference document, without using these tools, provided that the Group uses a methodology that is consistent with ISO 31000 and which provides similarly granular analysis of risk to support plan development.

The online toolbox provides practical information, including templates, guides and examples to:

- *Prepare* for the risk assessment process and develop the materials required in order to use the risk analysis and summary tool
- *Conduct* a multi-agency, cross-discipline risk assessment workshop and develop the information necessary to populate risk summaries (profiles)
- *Analyse* and use the results of your risk assessment.

The resource symbol (left) is used throughout this Guideline to indicate the availability of a tool or resource in the online toolbox that can support application of the material discussed.

1.4 The Context for a CDEM Group risk assessment

Supports requirements under the CDEM Act 2002

The CDEM Act defines risk as 'the likelihood and consequences of a hazard' and a hazard as 'something that may cause or contribute substantially to an emergency'.

Under s17(1)(a),

The functions of a Civil Defence Emergency Management Group, and of each member, are to —

in relation to relevant hazards and risks, —

(i) identify, assess, and manage those hazards and risks:

(ii) consult and communicate about risks:

(iii) identify and implement cost-effective risk reduction:

Undertaking a structured risk assessment fits the requirement to identify and assess risks, assists with consultation and communication of risk information and provides an evidence base for the mitigation of risk.

Under s49, a CDEM Group plan must state and provide for civil defence emergency management necessary to manage the hazards and risks within the Group's area. The purpose and process for this planning is outlined within the *Director's Guideline CDEM Group Planning [DGL 09/18]*. The CDEM Group Plan documents the hazards and risks within the Group's area. It also outlines the civil defence emergency management through which member councils, partner agencies, and communities of interest are to address those

risks. Risk assessment to develop a shared understanding of hazards and risks is thereby an important first step in planning for effective risk management across the 4Rs.

Importantly, risk assessment enables understanding of what could happen that would result in an emergency, before it happens. It is thereby the means by which the benefits of implementing effective risk reduction, to lessen potential impacts, can be identified. In the same way, a risk assessment can support requirements for strategic planning for recovery for those impacts which are not readily avoided.

A CDEM Group Plan must not be inconsistent with the National Disaster Resilience Strategy (2019), and must take account of guidelines, codes and technical standards issued by the Director of Civil Defence Emergency Management. All such guidelines, codes and standards are designed with the expectation that risks are being appropriately assessed at the Group level.

Supports alignment of hazard risk management across the consortium of local authorities and other CDEM Group partners

A CDEM Group risk assessment is not an end unto itself. Rather, it can inform the development and implementation of policies or operational services within the Group, its member council(s) and partner organisations. The aim is that a consistent, shared understanding of hazards and risks enables more integrated and coordinated approaches to managing them. This in turn will lead to better resilience outcomes for communities.

Beyond underpinning the CDEM Group Office's planning and operational activities, the risk assessment can also be used to inform a member council's broader strategies, planning and regulatory processes whenever hazards and risks need to be considered. Councils' long-term and annual plans, resource management plans and policy statements, iwi management plans[1], spatial and future growth planning, transport planning and asset management plans can all contribute to the management of risk alongside the CDEM Group Plan.

On the same basis, the risk assessment can be used by partner agencies in CDEM, most notably the emergency services and lifeline utility operators.

National context and National Assessments

The National Emergency Management Agency and other central government agencies conduct risk assessments at the national level for a wide range of hazards and threats. These assessments use a standardised risk assessment methodology to identify, assess and compare nationally significant risks. Current risk management arrangements are evaluated as part of these processes. This enables agencies to take coordinated approaches to shared challenges and opportunities for improving New Zealand's strategic management of risk, and to better integrate national policies and practice in support of local efforts. This Guideline, and in particular the Toolbox resources, align with the national level methodology including steps to describe hazards, assess consequences of a scenario on a range of

[1] Iwi/hapū management plans are resource management plans prepared by an iwi, iwi authority, rūnanga or hapū. They are generally prepared as to help iwi and hapū exercise their kaitiaki roles by identifying issues regarding the use of natural resources in their area, see Saunders et al, 2017 for more detail.

elements, the use of a standardised consequence table, and the documentation of risk management arrangements.

The first National Climate Change Risk Assessment (NCCRA) has now been published by the Ministry for the Environment. This Guideline aligns with NCCRA process in that the methodology is also based on ISO 31000, and hazards, exposure and vulnerability are used to determine levels of risk. The domains of interest for the NCCRA (human, cultural, economic, built and natural) largely align with those outlined in this Guideline. As with this Guideline, consideration of individual elements to ensure that the outputs better support planning, is also a key feature.

National and international context - National Disaster Resilience Strategy

In 2019, the National Disaster Resilience Strategy (NDRS) came into effect. This document outlines a long-term vision for building resilience in New Zealand framed around three main goals and eighteen objectives. This Guideline is intended to support CDEM Groups to demonstrate and document how their CDEM Group planning aligns with the goals and objectives of the NDRS. The NDRS in turn demonstrates how New Zealand intends to meet the priorities of the United Nations' Sendai Framework for Disaster Risk Reduction (SFDRR).

Alignment of this Guideline with the NDRS and the SFDRR supports CDEM Groups, through comprehensive risk assessment and risk management, to play a critical role in meeting New Zealand's international commitments and national resilience goals. Group level risk assessments are specifically aligned with the NDRS objectives (summarised below) as follows:

Objective 1. *Identify and understand risk scenarios and use this to inform decision-making.*

CDEM Groups undertake risk assessment to identify the drivers and components of risks in their area and to inform their Group Plans.

Objective 2. *Put in place organisational structures and identify necessary processes to understand and act on reducing risks.*

CDEM Groups lead risk assessments with relevant stakeholders. CDEM Groups, through their elected representatives and coordinating executives, oversee the management of risks in their area.

Objective 3*. Build risk awareness, risk literacy, risk management and risk assessment capability.*

CDEM Groups bring together a broad range of stakeholders to assess risk and develop a shared understanding of risks and risk management in their area.

Objective 6*. Understand the economic impact of disaster and disruption.*

Risk assessment includes determining consequences across different domains, including the economic impacts to communities and regions.

Risk assessment informs other NDRS Objectives through the identification of risk management gaps and opportunities, and enabling risk-informed reduction, readiness, response and recovery planning.

Te Ao Māori

Any comprehensive risk assessment process in New Zealand needs to include Māori world views and the concepts of taonga. This reflects the status of Māori as Tangata Whenua and the principles of the Treaty of Waitangi/Te Tiriti o Waitangi.

When engaging with Māori, the CDEM sector should be realistic about expectations, being cognisant of capacity constraints, while still ensuring Māori are given full and early opportunity to participate. Consider existing ways councils and CDEM Group agencies work with iwi and hapū and other Māori interests in processes and planning. Existing practice and relationships should be drawn upon as a guide to iwi/hapū expectations for engagement and participation.

Scope of this Guideline

The Act establishes an all hazards approach to emergency management in New Zealand. Comprehensive emergency management across the 4Rs includes reducing risks where practical to do so. Where this is not practical, the aim is to develop readiness for, undertake response to, and manage recovery from, the consequences of emergencies.

Accordingly, this Guideline emphasises an 'all hazards' approach to risk assessment. This means considering all hazards that could create risks in a CDEM Group's area, regardless of whether they originate within the area, and whether they are natural, technological, biological, or security-related in origin. This Guideline also acknowledges that while hazards and threats may differ, the consequences to be managed are often similar (e.g. wildfires, earthquakes and terrorism can all result in the displacement of households and disruptions to lifeline services).

This Guideline describes in detail the risk assessment process required for CDEM Group planning and explains where CDEM risk assessment sits within the wider context of risk management for a district or region.

Outlining the steps to follow for managing a risk once assessed, for example adding new requirements within an RMA (Resource Management Act) plan or investing in additional response capability, is outside the scope of this guideline. Similarly, the assessment process outlined within this Guideline aims to assist with the prioritisation of risk management needs at a higher or strategic level across a Group's area. It does not preclude that more detailed investigations and assessments may be needed when developing options for managing a particular risk, and to meet requirements for doing so within other planning and policy processes.

1.5 Risk assessment within the CDEM planning framework

Risk assessment as a discrete and as an ongoing process

This section introduces the steps required to complete a robust risk assessment to support the CDEM planning process (*Figure 2*). The steps are consistent with the process set out within international standards for risk management (*Figure 3*).

Risk assessment for CDEM planning can be thought of as involving two phases.

The first phase is an intensive and singular process undertaken as the first stage of the CDEM Group's Plan development or review processes. This phase focuses on providing an overview and synthesis of all knowledge across hazards and risks. It aims to compare relative risks, identify gaps and management needs, and set priorities for addressing them.

The second phase is an ongoing series of activities throughout the CDEM planning cycle. It involves continued monitoring and review of the outcomes from the first phase. It also involves refining assessment information and findings to support risk management. The aim is that these activities can link to councils' and partner agencies' broader policy and operational processes. These processes have their own planning cycles and budgetary processes in which risk assessment information, in terms of its timing, detail and format, will need to align to. This phase can also involve more targeted and refined assessments to cover the attributes of a particular hazard, or to meet the specific needs of a community.

CDEM Group planning and the wider risk management framework

The CDEM Group risk assessment is informed by and, in turn informs, a broad context that includes other council and partner agencies' planning, regulatory and non-regulatory tools, as well as the local hazardscape, and the attributes, aspirations and values of the communities and peoples of the Group's area. It should also seek to understand trends that may influence exposure and vulnerability to hazards. Understanding this context at the outset ensures that the risk assessment is focused on what is important and achievable.

A CDEM risk assessment seeks to identify the most challenging scenarios a Group may face, and to identify opportunities for addressing vulnerabilities or exposures common to more than one hazard. Its intent is to provide a shared understanding that can be used to discuss gaps and opportunities and priorities for civil defence emergency management across all 4Rs, with a particular focus on the actions and activities that will be outlined in the CDEM Group plan.

The CDEM Group risk assessment process, and accompanying review of existing risk management across the 4Rs, provides the basis for establishing new and revised actions for the Group plan over the following five years. This process therefore aims to methodically identify and prioritise the best means for building upon current risk management.

Furthermore, by undertaking a broad stocktake, with a focus on key gaps, opportunities and synergies, the process enables the coordination and integration of planning documents and work programmes of all agencies. The CDEM Group plan can then demonstrate the alignment of community and agencies' aspirations and priorities across the many aspects that contribute to hazards and emergency management.

Figure 2 aligns risk management within CDEM planning, and demonstrates how risk assessment, as the foundation for risk management, is at the heart of CDEM Group plan development. It also shows the way the CDEM Group plan supports and complements other planning and activities of councils and partner agencies, and therefore links to their business activities as a whole.

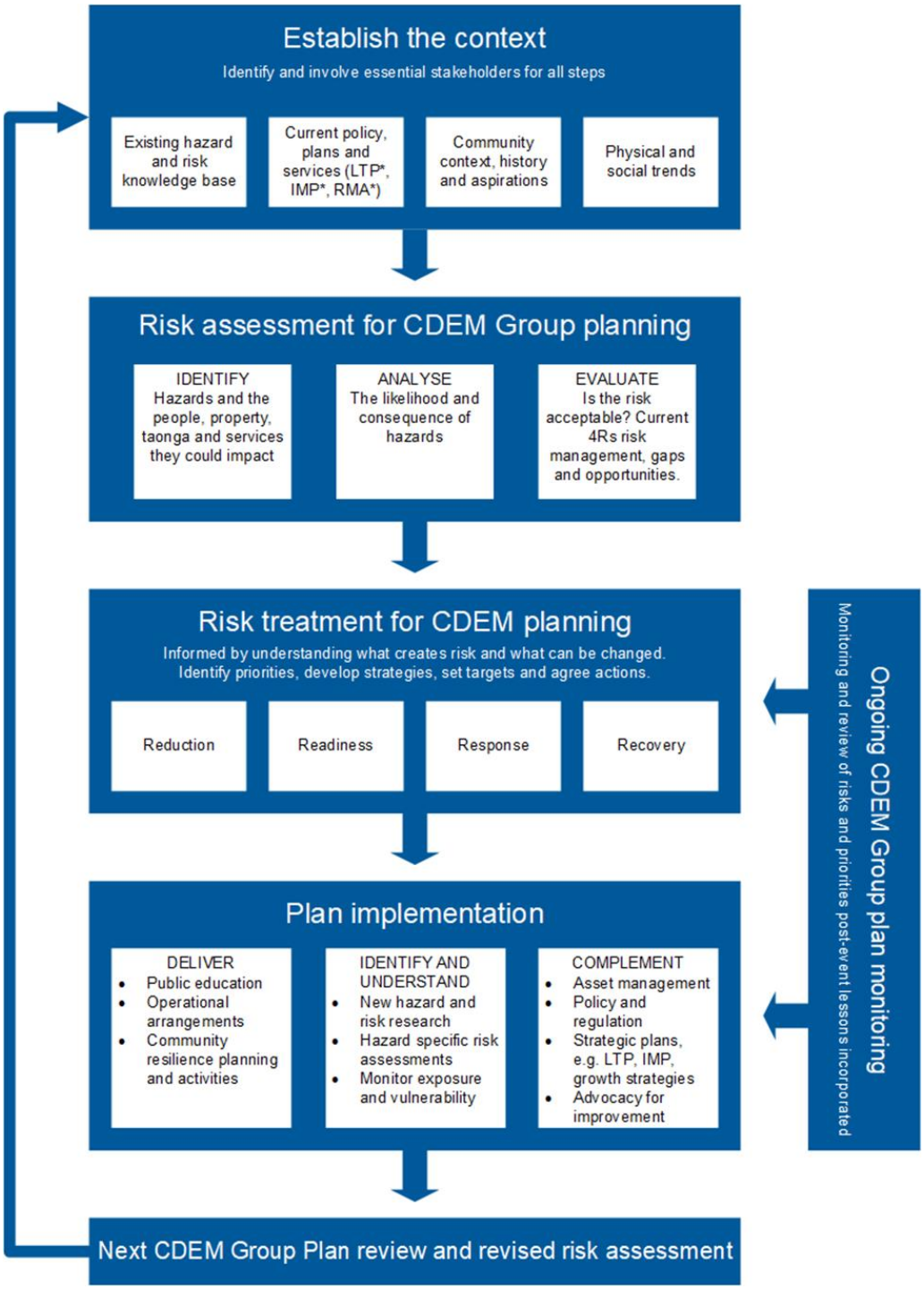

Figure 2 CDEM risk assessment within a wider risk assessment and management framework.
*** Long Term Plan (LTP), Iwi/Hapū Management Plan (IMP), Resource Management Act (RMA)**

1.6 Development of a comprehensive understanding of risk over time

An iterative process

A CDEM Group risk assessment consistent with this Guideline requires substantial preparation and engagement. It is recommended that the CDEM Group prioritise assessment of hazards considered to be of most concern first, before building up a comprehensive picture of risk over time.

It may take a Group months or years to develop a fully populated risk register, in which individual consequences are well understood and a review and updating process is well-embedded.

Building a risk register

A comprehensive risk register will include contextual descriptions of hazards, the outputs of risk assessments and summaries of how risks are managed. It requires an investment in time to develop and maintain, though repays this effort by providing a 'one-stop' comprehensive picture across all hazards when communicating, assessing, or treating risks.

All risk assessments will require an understanding of the elements in the Group's area that may be affected by hazards. It is recommended that the Group collates this information prior to any risk assessment. The CDEM Group should also assemble available contextual information as outlined in *Figure 2*. The Group should also assemble the current understanding of hazards in the Group area, including any specific scenarios or risk assessments that have been developed. Key data and outputs of this study can then be populated into risk summaries to form the basis of the Group's risk register. Keeping a list of sources and dates for this information is also useful for updating the register.

Once this contextual information is available, each hazard and the scenarios that will be used for risk assessment can then be considered by the Group, and as risk assessments are undertaken, this information can be added to risk summaries (profiles).

1.7 Overview of the risk management process

Risk management standard

The ISO standard 31000:2009 *Risk management – Principles and guidelines* outlines the steps and considerations required for a methodical understanding and management of all types of risk (*Figure 3*). This Guideline follows the Standard's approach, providing the CDEM Group with a robust framework for undertaking a risk assessment for its area.

The key steps within the risk management process follow sequentially and then repeat as a cycle to ensure risk management remains current. However, communicating and consulting with stakeholders, as well as monitoring and reviewing progress and results, should occur iteratively throughout each stage of the process. This is to ensure that:

- Groups have a comprehensive understanding of changing and emerging risks and the effects of changes in risk management that have implications for the CDEM Group

- stakeholder agencies and subject matter experts are involved throughout all steps of the process to ensure that a full range of knowledge and skills are drawn upon
- key decision-makers and partners agree with the results of the risk assessment, and thereafter, are willing to 'own' their part of shared management of the risks across the 4Rs
- monitoring during the assessment process identifies gaps, uncertainties and anomalies in understanding of risk, or undertaking the process in itself, that could hamper results
- monitoring and reviewing following the process enables identifying trends and changes in risks and determining the efficacy of management treatments over time.

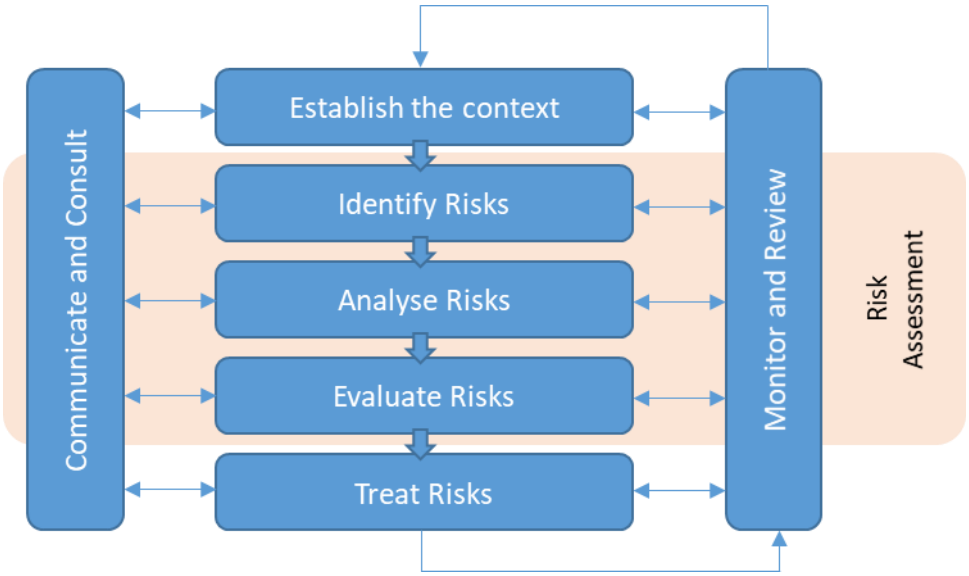

Figure 3 The risk management process as outlined in AS/NZS 4360:2004 Risk management[2]

Using other risk assessment methodologies

The purpose of this Guideline is to support Groups to take a consistent approach to risk assessment. A CDEM Group may choose to use an alternative risk assessment methodology from that provided in the tools accompanying this Guideline. However, any alternative methodology should align with, and include (or provide equivalent outputs to) all the steps described in this Guideline.

The results of any alternative method should be able to be transferred into a risk summary (e.g. Appendix E) containing the following:

- hazard scenario

[2] Note: Due to licensing restrictions, the process diagram (*Figure 3*) used throughout this Guideline is based on AS/NZS 4360, a predecessor of ISO 31000. While minor changes have been made to the names of each stage to align with *Figure 3* (e.g. 'Identify risk' in place of 'Risk identification') this Guideline remains consistent with ISO 31000 in all other respects.

- scenario likelihood
- the consequence rating to elements across the four environments
- the uncertainty (confidence level) of the assessment

The process should describe risks to individual elements as the combination of likelihood and consequence, and the assessment should produce information that can be compared across hazard scenarios and environments and used to inform priority setting and work plans.

Section 2 Risk assessment as part of CDEM Group planning

Risk management process steps for CDEM Groups

This section provides a summary of each step of the risk management cycle, within a CDEM Group planning context. The risk assessment process outlined in ISO 31000 has been adapted in this Guideline for CDEM Groups. The steps listed below are addressed in separate sections of this Guideline.

The **first** and **second** steps are to clearly establish the scope and context for the risk assessment and ensure that the correct organisations/individuals are involved to provide the necessary expertise and experience for each step.

This is the basis for the communication and consultation necessary throughout this process. Recording and reporting should occur at all stages of the process.

The **third**, **fourth** and **fifth** steps are the sequential processes of risk identification, risk analysis and risk evaluation/treatment.

The **sixth** step is monitor and review. This step describes the activities required to monitor and review the risk assessment process, and the review activities following CDEM Group Plan development.

2.1 Step 1: Establish the context

It is important to consider the context within which the risk assessment is to be undertaken, and how its outputs are to be used.

Establishing the context (*Figure 4*) enables all participants to understand:

- the purpose of the assessment
- the area and communities that will be considered
- who needs to be involved
- what criteria will be used for deciding which risks matter; and
- how to determine risk tolerance and whether current management is adequate or not.

The assessment process will likely have some constraints placed upon it, as well as present some opportunities. Constraints could include the resources available and access to key decision-makers and information during the process. Opportunities could include linking the process to upcoming reviews of councils' other planning documents, or to communities' current willingness to increase their resilience to particular hazards.

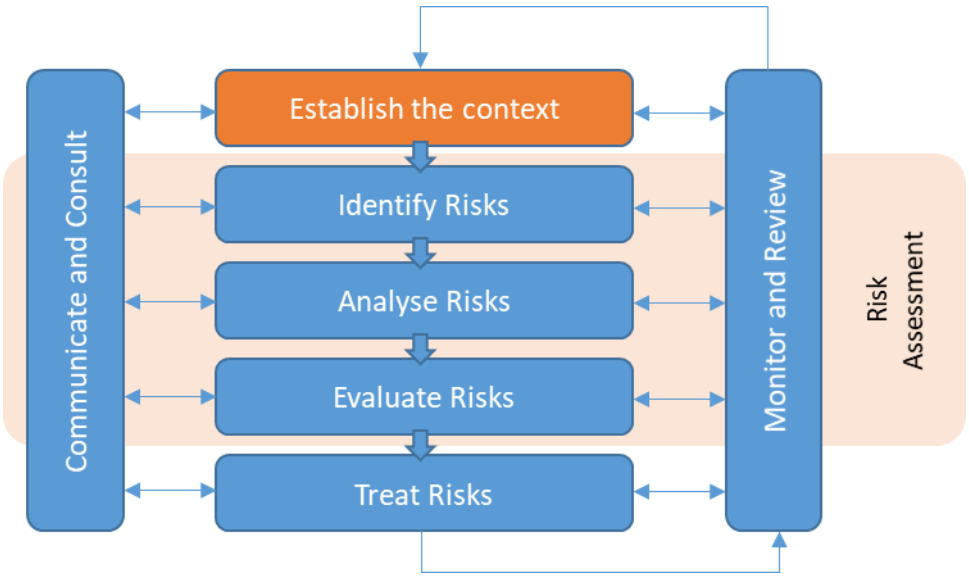

Figure 4 Establish the context, Step 1 of the risk management process.

The following should be agreed as part of the CDEM Group's process for documenting the context of their planned risk assessment.

Purpose

A common understanding among stakeholders that risk assessment should inform strategic priorities, objectives, actions and delivery across the 4Rs within the CDEM Group Plan and support the broader context for risk management across all agencies in order to manage risks to acceptable levels.

Alignment

Outline how risk assessment aligns with national-level strategies and guidelines e.g. the National Disaster Resilience Strategy, and the broader hazard risk and emergency management systems that councils and partner agencies operate within. This demonstrates that 4Rs risk management is also delivered by means beyond CDEM Group planning such as councils' wider system of policies, planning and activities.

2.1.1 Scope

During the scope-setting process, it is useful to think about the resources which participants may need to ensure consultation and discussions are focused and well-informed. Clarify with all those involved what the risk assessment will include and what is not included. The CDEM Group members should agree the scope before undertaking risk identification and analysis to ensure that expectations are managed and that suitable resources can be made available to ensure a successful process. The scope should cover agreement on the seven aspects outlined in the sections below.

Stakeholders

Identify all external agencies and units within councils that will be engaged during the risk assessment process (see *Step 2: Communicate and consult*). External agencies could include lifeline and welfare services agencies, central

government departments and representatives of the community or business groups. The public are stakeholders in that CDEM Group Plans and the National Disaster Resilience Strategy are fundamentally concerned with the wellbeing of communities. In order to undertake risk assessment and make use of the outputs for planning, it is necessary to consider the medium to long-term objectives of the community.

Information needs and sources

Consider the information that is required to undertake and inform the risk assessment. Information will be required on the key characteristics of the CDEM Group's area such as population and geospatial data. This should include a description of information sources as well as agreeing the level of quality required before information will be considered.

Scope of hazards

A summary of the hazards relevant to the CDEM Group that could give rise to emergencies and that will be considered for detailed risk assessment.

Scope of consequences

A summary of the types of consequences that will be assessed. This should relate to the fundamental purpose of the risk assessment and, in the case of a CDEM Group, will relate to the four environments. This will be explained in more detail in *Step 3: Identify risks* and *Step 4: Analyse risks*. For example, for the purposes of the scoping process, the CDEM Group could document that they will include assessment of impacts of hazards on elements across the social, economic, built and natural environments.

Scope of likelihood

The CDEM Group should consider the range of likelihoods most appropriate for CDEM Group planning. For example, the CDEM Group should consider prioritisation and action planning for events that are low likelihood but have higher consequences (such as volcanic eruptions or tsunami), so the scope should state that the assessment is not limited to events that are likely to occur within a five year planning timeframe.

Project management

The scope should include the key timelines, milestones and detail the type of outputs that will be produced, e.g. reports, tables, individual risk summaries etc.

Process and methods

The CDEM Group should review and agree the approach for each step of the risk assessment process. More detail on the types of processes and methods that could be useful is provided in the next subsection.

2.1.2 Processes and methods

Because a CDEM Group risk assessment involves a broad range of stakeholders, information types and sources, a variety of methods and processes may be useful to the CDEM Group. The CDEM Group should identify which methods may be used for each risk assessment step, based on the:

- agencies represented and the expertise of stakeholder participants
- types of information available for each step; and
- purpose of each step.

Processes and methods which CDEM Groups currently use, or could find useful, are summarised below.

Literature and document review

A literature and document review involves reviewing and summarising the key information from all relevant documents related to hazards, risks and risk management in the region. This includes considering reports and plans for hazards from outside the region which may have local effects. For example, the review of tsunami hazard in New Zealand (2013 Update) (Power, W. 2013) report is likely to be of interest to all CDEM Groups.

When considering all steps of the risk management process, the following documents are likely to provide useful information:

- Council plans (e.g. current CDEM Group Plan, Long Term Plan, regional policy statement, district plan and other plans)
- Iwi/hapū management plans
- Hazard specific plans
- Hazard research reports and articles
- Historical records of past events, including descriptions of the hazard and related consequences
- Existing risk assessments and risk modelling reports
- Post-event reports from prior emergencies
- Contingency plans for specific hazards
- Post-exercise reports
- Research or information reports into demographic make-up and social trends
- Other local or national strategies (for example those authored or prepared by NGOs or other organisations)

The purpose of a literature review is to synthesise and make accessible the wide range of information available on a particular topic. The results of the literature review can be summarised and displayed as brief reports, tables, graphs, maps and presentations for use in *Step 3: Identify risks*, *Step 4: Analyse risks* and *Step 5: Evaluate and treat risks*.

Modelling, mapping and geospatial analysis

Mapping involves the visual, geospatial display of information. Maps can be useful tools for showing the extent and intensity/magnitude of hazards, as well as information about the exposure of elements. All mapping, modelling and geospatial analysis requires base data. The availability and quality of data controls the possibilities for mapping and modelling of hazards, exposure, vulnerabilities and consequences.

Maps are a powerful communication tool, able to show information about past events. With the inclusion of modelling and geospatial analysis, maps assist

with an understanding of what is exposed, and what could happen in future events. Geospatial datasets or maps that can be used for risk assessment include the following:

- Hazard maps: e.g. flood or tsunami inundation maps – can show historic events or modelled scenarios
- Hazard planning maps such as tsunami evacuation zone maps and fault avoidance zones
- Hazard susceptibility maps: e.g. maps showing which slopes are more likely to have landslides based on geology and slope angle
- Hazard probability maps: e.g. likelihood of different shaking intensities over the next year in an earthquake aftershock zone
- Demographic and economic information, such as statistical tables and maps e.g. information from Stats NZ
- Asset maps: built infrastructure (including lifeline utilities), building use category, heritage and cultural sites, critical and/or community facilities locations
- Environmental base maps: slope angle, ground cover, elevation
- Planning maps: growth plan maps, district plan maps
- Specific analysis
    - Tsunami evacuation models
    - Loss modelling for specific hazard scenarios e.g. those produced using the RiskScape software or similar models.

Mapping, modelling and geospatial analysis methods could be useful for *Step 3: Identify risks*, *Step 4: Analyse risks* and *Step 5: Evaluate and treat risks*.

Subject matter expert and stakeholder workshops

Workshops can provide a productive forum for drawing upon a wide range of expertise and views. A workshop should have a clear purpose and structure. For example, the purpose might be to assess and document "How well we understand the consequences of volcanic eruptions in our region, and what risk management policies, plans and activities are in place to manage the risk of this hazard?". The workshop structure might involve a combination of facilitated presentations, brainstorming, group discussion, quantitative or qualitative assessment and reporting back, to develop the agreed outputs.

'Subject matter experts' refers to specialists from a wide range of backgrounds, not only hazards scientists/analysts and risk assessment specialists. For example, the inclusion of health service representatives and community liaison/development specialists could provide important insights into communities with particular vulnerabilities or needs. Asset managers can provide information about the vulnerability or resilience of networks and facilities to different types and scales of hazard events. Representatives of the business sector can provide insight on economic impacts and losses. See *Step 2: Communicate and consult* for more information on the types of experts that could be included.

Workshops could be used most effectively for *Step 3: Identify risks*, *Step 4: Analyse risks* and *Step 5: Evaluate and treat risks*.

Surveys, focus groups and interviews

Surveys, focus groups and interviews can produce new and targeted data and information to support risk assessment. These methods can be used with stakeholders and subject matter experts, or with wider audiences such as community members in particular hazard zones or vulnerable groups.

Each method has advantages and disadvantages based on the time and effort required to collect and analyse the information, the number of participants that can be included, and the level of detail of the information gained. For example, in a community with a localised flood risk, focus groups might be a useful method to get feedback on the level of understanding among residents and visitors around awareness of, and preparedness for, floods. The focus group could also investigate the communities' tolerance for flood risk and willingness to invest in improvements. Conversely, a survey of the entire region might be more useful for gaining a base level understanding of which public alerting channels have the greatest reach.

Such methods do not replace the need for a risk analysis workshop, where interdependencies can be explored and consensus reached on the credible level of consequence to each element.

Information gained from surveys, focus groups and interviews may also be useful to evaluate mitigation options and the community's appetite for risk. See *Step 5: Evaluate and treat risks*.

Summary reports and peer review

The CDEM Group is likely to have a strong understanding of some of the more frequently occurring or priority hazards and risks in their area. In these cases, updates to the risk information for a particular hazard could be conducted by exception. That is, the existing risk assessment, provided it aligns with the process within the risk management standard, can be considered to be valid; however, when new information or changes in policy or practice indicate a change in hazard, exposure or vulnerability, a renewed assessment is required. The changes could indicate an increase in risk, for example a new residential development in a coastal area exposed to tsunami. It could also indicate a decrease in risk, for example improvements in flood control systems, or relocation or strengthening of critical infrastructure in hazardous locations.

To demonstrate the CDEM Group has identified and documented the context for the Group risk assessment: agree and record the purpose and scope, documentation (e.g. project management plan) and processes that will be used for each step of the CDEM Group's risk assessment and record these as part of the documentation process for the CDEM Group Plan development.

2.2 Step 2: Communicate and consult

The CDEM Group, through its planning process, puts in place arrangements throughout its area for hazard risk management across the 4Rs. Basing the 4Rs planning on the risk assessment will ensure this planning process is robust. Considerable expertise is available to the CDEM Group from its constituent members and other stakeholder agencies and groups. The involvement of these key stakeholders throughout the risk assessment process is critical. Communication and consultation with stakeholders should occur at all steps of the risk management process (*Figure 5*).

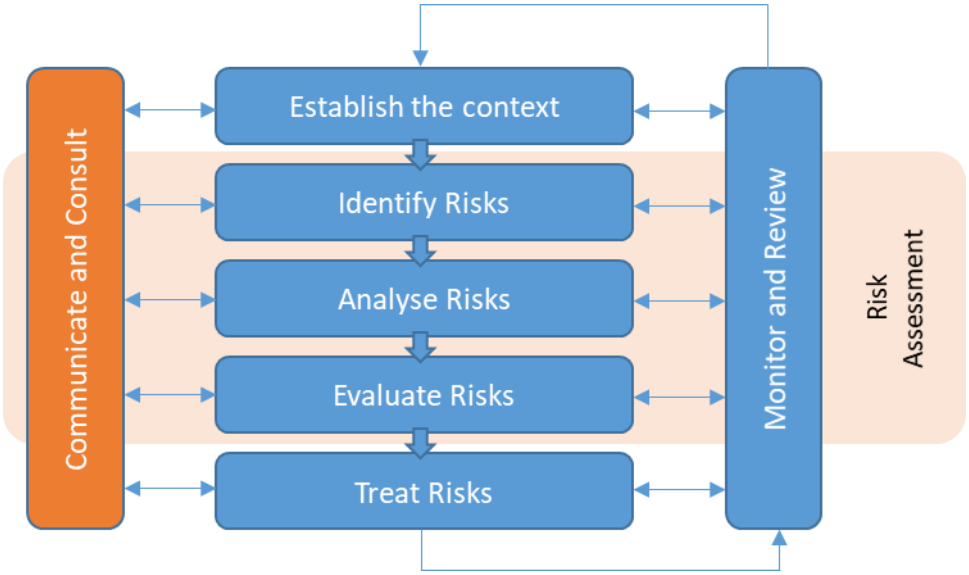

Figure 5 Communicate and Consult, an ongoing part of the risk management process. In this document referred to as Step 2 for ease of navigation.

The CDEM Group should seek to involve as broad a range of agencies as possible in the risk assessment process. This will allow CDEM Groups and other agencies responsible for risk management to identify gaps and opportunities and to make informed decisions about prioritisation of resources, planning and activities. The nature of communication and consultation and the agencies/representatives involved will likely differ for each step, depending on the purpose of the step.

Risk assessment steps and suggested stakeholder involvement

Communicate and consult: engagement with a broad range of stakeholders should occur throughout the process, with specific involvement dependent on the step being undertaken. For example, while only some may be involved in the risk identification step, all should be advised of the outcomes of the risk assessment.

Monitor and review: as an ongoing process throughout the risk assessment to ensure robustness, and as a formal step to revisit the risk assessment outputs, this step will require broad and ongoing engagement. For the former, those involved in each step and the governors or sponsors of the CDEM risk assessment should be involved as the steps progress. For the latter, involve those who have access to baseline and ongoing data or information on the main contributors to risk (hazards, exposure and vulnerability) and those who are implementing work programmes or initiatives based on the outcomes of

the risk assessment. This will ensure trends or changes in risk and risk management are taken into consideration.

Establish the context: involve those who can contribute valuable contextual information regarding the scope, purpose, timeline and methods to be used for the risk assessment. Involve those who will contribute information or be required to use the outputs of the risk assessment for planning and decision-making.

Identify risks: involve those that have expertise, evidence or experience related to either hazards and hazards scenarios; and/or related to exposure and/or vulnerability of elements.

Analyse risks: involve those that have evidence related to, or an understanding of, the possible consequences of hazards in the CDEM Group's area. An understanding of vulnerability and capacity of elements is particularly valuable in this step. Involve independent facilitators/assessors to test and challenge assumptions during the risk analysis process.

Evaluate risks: involve those that have an understanding of community, political and private sector goals and aspirations. Involve those who can explore options for managing risks and determine which risks are acceptable, and which risks might require further intervention. This step needs to include those with the authority to evaluate the priorities, benefits and disadvantages of risk management options and to implement the preferred options.

Treat risks: involve those that have a mandate or responsibility for funding and implementing risk management measures.

Suggestions are provided below for the appropriate stakeholders to involve in the risk assessment process.

Key stakeholders from within councils

Note: not all stakeholder groups/partners will be required for every step of the process. Ensure that the correct expertise and interests are involved for a robust and comprehensive assessment. The following council officials undertake activities that are related to managing risks within the 4Rs framework and should ideally be included in the CDEM Group planning risk assessment process:

- Civil Defence Emergency Management Group Office staff
- Hazard analysts and geospatial (GIS) specialists
- Policy planners, including land-use planners, transport planners, growth planners etc.
- Flood control/management units
- Asset managers (e.g. three waters, roads) and service provision units
- Building consent and resource consent regulatory staff
- Community relations, development or engagement units
- Communications teams (public education/information)
- Business continuity and organisational risk managers
- Hazardous substance/pollution monitoring regulatory staff

- Appointed Group Recovery Managers
- Other council staff as appropriate for each step

Consideration should also be given to how to involve governance – councillors and executive leadership – in critical aspects of the process. For example, aspects important to them could be establishing the context and criteria for risk evaluation

Key partners and stakeholders outside council

Other partners and stakeholders outside council that may provide valuable input:

- Iwi and hapū
- District health boards and health service providers
- Emergency services (NZ Police, Fire and Emergency New Zealand, ambulance services etc)
- Lifeline utility providers
- Science, research and technical experts (e.g. from CRIs, universities, private sector)
- National Emergency Management Agency (e.g. Regional Emergency Management Advisors)
- Welfare services agencies
- Representatives of the local business and community sectors
- Private sector (e.g. Chamber of Commerce)
- Cultural heritage organisations (e.g. Heritage New Zealand)

The value of broad engagement

Drawing upon the collective knowledge, experience and expertise of stakeholders at each step of the process will ensure that the CDEM Group has a comprehensive understanding of the risks associated with each hazard and importantly, the risk management already in place.

For example, the inclusion of community engagement teams will assist with identifying community vulnerabilities that may result in greater needs for support before, during and after emergencies. Likewise, the involvement of the river/flood management unit of a council will ensure understanding of specific risks and risk management measures for different catchments.

Identify the range of stakeholders required for a comprehensive risk assessment including their areas of expertise and in which steps of the risk assessment process they should participate. Include those with specialist knowledge of the social, built, economic and natural environments. It is important to involve those managing hazard risks across one or more of the 4Rs. This will ensure there is appropriate representation to develop a clear picture of the risk, and the risk management measures in place, as well as for identifying priorities, gaps and opportunities. This information should be recorded in the context section of the CDEM Group's risk assessment documentation.

2.3 Step 3: Identify risks

Risk identification (*Figure 6*) is the first step in understanding "what could happen". It involves gathering relevant information and describing the components of risk, namely:

- the hazards present within, or that can impact upon, the Group's area, and the key characteristics of each hazard
- the elements that could be negatively affected by hazards

Risk identification provides base information that makes a risk assessment possible. The process involves the identification of all hazards that can affect the Group's area as well as the elements that could be impacted. It is important to note risks identified for assessment should be beyond 'business as usual' (BAU). Risks to be assessed should be those that require a significant, coordinated, multi-agency response. Risk identification does not include an analysis or description of the likelihood of particular hazard scenarios or the scale of consequences associated with these scenarios; this process is covered in *Step 4: Analyse risks*.

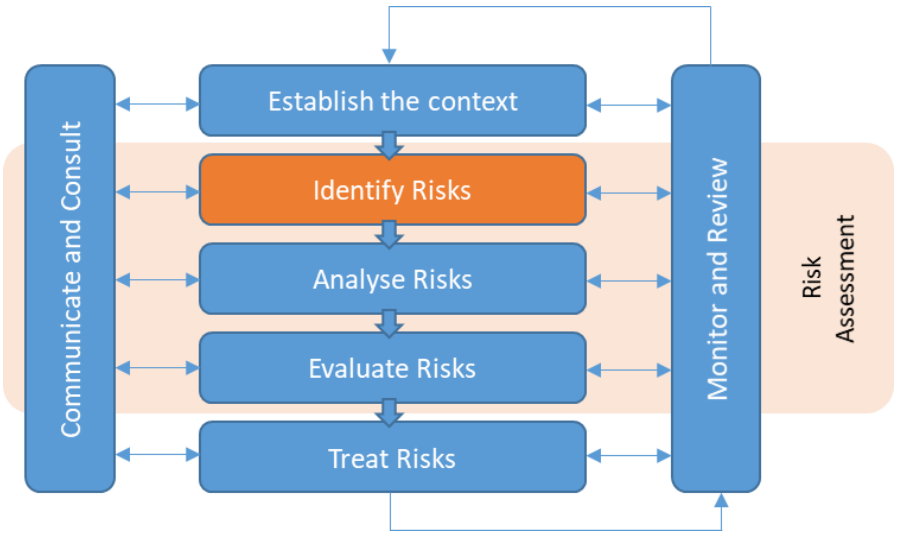

Figure 6 Risk Identification, Step 3 of the risk management process

All hazards approach

An ‘all hazards’ approach to risk management requires the identification of a wide range of hazards. All hazards that might give rise to an emergency and that might require a coordinated, multi-agency response should be considered. This includes hazards where the CDEM Group is not the lead agency but may be called upon to assist. For the purpose of this Guideline, hazard is a broad term that includes natural, societal, biological and technological hazards as well as malicious threats. In order to make hazard identification easier, hazards can be grouped into broad themes such as natural and human-driven or Biological, Technological, etc. (e.g. *Table 1*).

It is important to consider the required reduction, readiness, response and recovery measures (e.g. activities and planning) that are common to all hazards and those that are specific to particular hazards. While all hazards should be identified at the CDEM Group level, the focus of an all hazards approach may often be to identify the many common consequences of these hazards that require management. This is because, in many cases, it is not possible to manage the hazard directly, for example the physical occurrence of an earthquake. As such, addressing earthquake risk will, as much as is practicable to do so, focus on reducing vulnerability and exposure of communities to anticipated consequences prior to an event, and preparing for and recovering from realised consequences in an event. Much of this management could be the same as, or similar to, that needed for managing the consequences of a tsunami, flood or other local hazard.

Taking an all-hazards approach means the CDEM Group can address common sets of consequences across different hazards in a consistent and efficient manner. Hazard specific consequences could also be identified requiring additional risk management measures. The relative need for, and value of, these additional measures can be considered alongside those of generic measures, and also measures that may be required for managing specific consequences identified for other hazards.

Broad engagement

Hazard identification relies on multiple sources of information. As described in *Step 1: Establish the context* and *Step 2: Communicate and consult*, consideration should be given to including a wide range of relevant stakeholders and using a combination of processes and methods to gather information on hazards; for example, through a facilitated group ‘brainstorming’ session. The hazard identification methodology chosen should be suitable for the context and risk management purpose.

Table 1 Example of grouping hazards to assist with hazard identification. This list is not exhaustive. CDEM Groups should consider other hazards of relevance to their area.

Geophysical and Hydrometeorological	Biological	Technological	Security
Avalanche (snow) Coastal hazards (king tides, inundation and erosion) Drought Earthquake Flood Heatwave Landslide/mudslide/rock fall Land subsidence Severe storms and weather (wind, hail, snow, thunderstorm, tornado) Tsunami Volcanic activity Wildfire	Animal pests and diseases Food safety (note: could be biological, technological or security) Human disease (communicable and vector-borne) Plant pests and diseases	Air/water/land contamination Fires/explosion Hazardous substances Infrastructure failure Oil spill Radiological event Transport incidents	Cyber incident Major criminal act (e.g. terrorism)

Threshold for CDEM Group risk assessment

The CDEM Group may identify a wide range of hazards that could have consequences for its area. Depending on local circumstances, some hazards could pose low risks and not require multiagency coordinated planning effort. As such, these hazards may only require a high assessment or can be given a lower priority for further assessment behind that of more significant hazards in the area. The following criteria can assist the Group to determine the level of risk assessment required across a range of hazards.

1. The risks arising from the hazard are agreed to be negligible

Where all relevant stakeholders agree that the risks from a hazard are negligible, and are adequately managed through current BAU arrangements, further risk analysis may provide no additional value. However, any new information, such as significant changes in the hazard, or in the exposure (e.g. new development) or vulnerability of elements at risk from this hazard, should trigger a review of the risk and its associated risk management. Note, changes could result in an increase or a decrease in risk. Both outcomes merit a review of the risk and risk management measures in place.

This includes all hazards that typically do not require multiagency, multifunctional 4Rs management. For example, traffic incidents, while associated with a high life safety risk, do not require multiagency, multifunctional 4Rs management in almost all instances.

2. A thorough understanding of the hazard and risk is already available

A CDEM Group may already have a mature, comprehensive understanding of a hazard and its associated risks. This could include detailed scientific hazard and risk modelling that is available to the CDEM Group and provides a thorough understanding of:

- the hazard and the vulnerability and exposure of elements to the hazard
- the likelihoods and consequences for a range of possible hazard scenarios; and
- any gaps in information or understanding that create uncertainty in the risk assessment.

3. The hazard risk is largely managed by national agencies (e.g. terrorism)

For nationally led hazards, and their associated risks, the local response may be largely confined to delivery of contingent support services in an emergency, such as the coordination of welfare services. The reduction elements of risk management for these hazards is largely outside of the role of the CDEM Group members and partner agencies and providing scenario-specific consequences to prepare for these risks may be too difficult or uncertain. In such cases, a review of all supporting and coordination activities and roles and responsibilities (e.g. welfare services coordination arrangements and public information coordination) may be all that is required, and a detailed hazard specific risk assessment is therefore neither feasible nor necessary.

Identify hazards that will be included in the CDEM Group Plan "hazard and risks" section and describe which will not require detailed risk assessment. Record, in that section, the reasons why a detailed assessment will not be required for these hazards. Note: It may be useful to complete parts of *Step 2: Communicate and consult* to agree the thresholds.

Hazard characteristics

Identifying the characteristics of a hazard enables the understanding of potential consequences and their likelihoods. For each hazard, the following information is required to undertake risk analysis and determine the best options for risk management:

- Frequency of the hazard – how often do events occur, and how likely are they to occur in the future (see *Likelihood* section)? Will climate change influence the hazard?
- Magnitude of the hazard – what is the scale for measuring the extent or intensity of hazard events?
- Location of the hazard – is it associated with specific location(s), or could it occur anywhere within the region? Is it external to the region but could have impacts within the region?

- Sources for the hazard, what are the conditions and triggers that could initiate this hazard?
- Duration of the hazard event – how long will it last?
- Onset time of the hazard – how rapidly after it is triggered will impacts occur?
- What is the range of phenomena the hazard could produce e.g. shaking, ash fall or inundation?
- Cascading hazards – is the hazard likely to be caused by other hazards, and/or could it trigger or exacerbate other hazards when it occurs?
- Uncertainty regarding the hazard – how robust is knowledge about the hazard, or how much natural variability and uncertainty is there in the physical attributes of the hazard and associated phenomena?

By characterising hazards in a standard way, the CDEM Group may identify measures which are effective across risks related to a range of hazards. For example, land-use planning rules for a coastal area, which include a set-back from the coast to reduce the risk to property or infrastructure from coastal erosion and inundation, could also reduce tsunami risk by reducing the exposure of people and property within a tsunami hazard zone.

See the example risk summary template provided in *Appendix G* for the types of information that could be included in a hazard characterisation section of a risk summary for each hazard of interest

Cascading and concurrent hazards

While cascading or concurrent hazard events can result in significant impacts, this guideline recommends Groups first gain a baseline understanding of risk using single hazard scenarios based on a common likelihood (e.g. the Maximum Credible Event for each hazard type). Once a baseline has been established, Groups may wish to investigate other, more complex events, depending on Group priorities. In a single hazard scenario, direct impacts should be included but additional hazards should not. For example:

An earthquake hazard scenario may have associated landslide, rock fall, and liquefaction hazards. The scenario may also note that the ground is saturated due to a month of high rainfall (as this will exacerbate liquefaction) but should not include a concurrent flood event if the flood is not the result of the earthquake (e.g. earthquake induced failure of a stop bank).

2.3.1 Social, built, economic and natural environments, and elements

The CDEM Act describes four environments that are fundamental to community wellbeing: the social, built, natural, and economic environments. Each of these environments includes a range of elements (people, property, taonga and services) that can be affected by hazards. Using the framework provided by the environments, the CDEM Group should develop a comprehensive list of elements to be considered in risk assessments. An example list is provided in *Table 2*, which uses the CDEM environments described below.

Taonga

While taonga is not an environment, it is important to incorporate in the CDEM Group risk assessment process. Taonga can be considered as the treasures of Te Aō Māori, including socially or culturally valuable objects, resources, phenomenon, ideas and techniques within each Group's area. However, the interpretation as applied in this Guideline can also be considered in a broader sense as the cultural and social treasures of all communities in the Group's area. That is, the social and cultural values, traditions, practices and knowledge of all peoples and communities, including the ability to participate in cultural and community activities. Local iwi/hapū management plans may help the Group to identify environmental, cultural, economic and spiritual aspirations and values; mātaraunga Māori research and/or areas of cultural significance; and other taonga.

How culture sustains us in times of upheaval is officially recognised in the National Disaster Resilience Strategy, and culture is a key area for consideration for communities and emergency management organisations alike. Cultural life, including cultural practices and events, institutions, heritage buildings and taonga, are important to our wellbeing, and for maintaining a sense of normality and comfort during and following emergencies. Each CDEM Group risk assessment should recognise the cultural taonga of their area when considering impacts to the social environment.

The social, built, economic and natural environments are summarised below.

Social environment

This environment relates to the health, wellbeing, safety and security of people and communities. Specific impacts on people's health include physical harm (death and injuries) as well as non-physical aspects of health, including psychological injury. The social environment also includes intangible and tangible taonga, things that contribute to the wellbeing of communities, such as cultural and heritage sites, community groups, networks and support systems. Government (central and local) services that support community wellbeing are included.

Social *functions* and *services* that could theoretically be delivered from alternate locations (e.g. education services) are also included in this environment. Any consequences for the built, economic or natural environments are also likely to have direct or cascading consequences on the social environment (e.g. loss of property or housing is likely to have impacts on psychosocial health and wellbeing).

Built environment

The built environment refers to structures and critical infrastructure, including the purpose-specific services and functions they provide that cannot be delivered by other means. For example, the functions of a road are not fully replaced by other modes of transport such as rail, shipping or air.

The risk assessment will need to take into account specific buildings and infrastructure that support the wellbeing of communities. For CDEM Groups, consequences to residential dwellings are an important consideration. This is because, due to direct damage or other reasons, the dwelling may not be accessible/habitable resulting in the displacement of people.

Economic environment

This environment describes the impact on economically productive assets and disruptions to the economic system. More specifically, it refers to the

economic impacts to local government, the private sector, communities and individuals arising from hazard events. This includes the impact on employment and livelihoods and the significant productive sectors within a CDEM Group's area. Each CDEM Group will require an understanding of key productive or strategic sectors in their area. Consideration should be given to sectors which support local employment, businesses, primary production and industry, and the likely immediate, medium and long-term impacts on the community if these critical economic sectors were lost or disrupted.

Natural environment

The natural environment includes native and (valued) introduced flora and fauna, as well as ecosystems and the services they provide (e.g. healthy soil, water, kaimoana, etc.). The environment has the capacity to assimilate some waste and pollution, though this capacity could be altered or exceeded in an emergency. The natural environment provides the foundation for New Zealand's primary sector and, to a significant degree, the tourism sector. When assessing the risk to the natural environment, an understanding of the natural resources, biodiversity, ecosystems, and the ecosystem services they provide (e.g. habitat for kaimoana, filtering and absorbing waste) is critical; e.g. understanding the local impacts on wellbeing and the economy if irreversible degradation of highly utilised groundwater systems was to occur.

Other environments

Other frameworks may describe environments in different terms. For example, the National Disaster Resilience Strategy and the Treasury's Living Standards Framework refer to *capitals.* The National Climate Change Risk Assessment uses *domains*. The environments used in this Guideline align with the National Disaster Resilience Strategy "Model of a resilient nation" which is structured around social, cultural, economic, built, natural and governance capitals for resilience (MCDEM 2019, p19) (*Table 2*). The CDEM Group may find it beneficial to map their elements (people, property, taonga and services) to one or more of these other frameworks to demonstrate the linkages between the risk assessment for CDEM Group planning and the broader work programmes of their agencies.

Elements

Creating a list of exposed elements (people, property, taonga and services) provides the context required for comprehensively evaluating measures available for risk management (see *Step 5: Evaluate and treat risks*). When each element is assessed separately within a risk assessment, more practical measures to reduce or manage the risk can be investigated. Risk can also be considered from collating the consequences to a number of elements using an "all-of-environment" or "total consequences" perspective.

A list of suggested elements is provided in the consequence table (*Appendix E*) and in the 'elements' tab of the Risk Analysis and Summary Tool available in the online toolbox. A summary is provided in *Table 2*.

Table 2 An example of a list of elements that support regional and community wellbeing that could be included in a CDEM Group risk assessment.

CDEM environment:			
Social	**Built**	**Economic**	**Natural**
NDRS* capitals:			
Social, cultural, governance	**Built**	**Economic**	**Natural**
People's health and safety: • casualties • illnesses and injuries (including psychosocial) Access to: • accommodation • health services** • education** • welfare services • essential consumer products • community and govt. services Social wellbeing Cultural wellbeing***	Residential buildings Commercial and industrial buildings Govt. and non-commercial buildings Emergency facilities Lifeline utilities: • Potable water • Storm/wastewater • Telecommunications • Electricity • Fuel • Reticulated gas • Land transport Ports and airports	Costs to individuals Costs to businesses, commerce and industry Impacts on key economic sectors Individual businesses Jobs/employment Regional productivity Livestock	Air quality and ecosystem services Freshwater quality and associated ecosystem services Marine water quality and ecosystem services Soil quality and associated ecosystem services Impacts to biodiversity

***National Disaster Resilience Strategy (MCDEM, 2019)**

****Note: These services can be delivered in alternate locations and not only at the buildings designed for these uses, although the level of service and ease of delivery is likely to be restricted.**

*****Cultural wellbeing may include impacts to recreational assets, food/kai gathering areas or locations of worship.**

2.3.2 Describing and characterising elements

Once the elements to be included in the risk assessment have been identified, they need to be described and quantified so these values can be used to determine exposure and calculate impacts. This subsection describes how this can be achieved.

Developing a baseline understanding of elements at risk

A description of elements begins with an understanding of their number, value or amount, and also where they are located. For example, for people, what is the total population within the region, and what is the spatial population density?

To understand how different hazards could affect elements, additional information about their exposure and vulnerability is required. Exposure describes how many people, properties, taonga or services could be affected by a hazard. Vulnerability describes how susceptible they are to the impacts of the hazard in question. More detail is provided below.

Count or value descriptor

How will elements at risk be measured? What are the units, scales or word descriptors that can be used to describe the total amount or value? For example:

- Numerical counts: e.g. number of people, households, buildings
- Type counts: e.g. total value of an economic sector in $NZ, or the demographic age breakdown of a population
- Ratio counts: e.g. population density (people per sq. km)
- Service or function delivery-based counts: e.g. number of customers supplied with water or electricity from a network
- Qualitative descriptors: such as the sensitivity level of data or the cultural value of taonga and knowledge.

The count or value is used to measure exposure and vulnerability.

Location

The location of elements affects which hazards they are exposed to, as well as whether there are options for physically avoiding a hazard, or opportunities for geographically localised risk management measures. Considerations include whether the elements have:

- a fixed location (e.g. built infrastructure)
- a mobile location (e.g. people, vehicles)
- a non-geographic location (e.g. community support networks).

Exposure

Exposure refers to the type and number of things that could potentially be affected by a given hazard. The level of exposure will differ depending on the hazard being considered. For elements with fixed locations, exposure can be dependent on whether a hazard occurs only in certain zones (such as flooding of low-lying ground adjacent to water courses). Importantly, the value for exposure can be 'nil or insignificant'; for example, for hazards occurring in a remote and undeveloped part of the Group's area.

To develop a comprehensive understanding of the exposure of elements, a range of data and information will be required. This could include statistical information on population counts, movement and demographics, council building records, infrastructure network maps and other key sources. There are likely to be people and assets in some locations that are exposed to multiple hazards.

Vulnerability

Vulnerability is the susceptibility of elements to the damaging effects of a hazard. Vulnerability is a complex concept and will vary depending on the hazards and the things at risk (people, buildings, infrastructure and economy, etc.). For example, for wildfire hazards, wooden buildings are more vulnerable than concrete and steel buildings, and during a heatwave, infants are more vulnerable than adults as they are less able to tolerate extreme temperatures. For elements in the built environment, vulnerability is likely to be controlled by construction material type, age, maintenance and design.

It can be challenging to determine the vulnerability of elements to a range of different hazards. There are some established methods available. Fragility functions are equations that can be used to describe the expected levels of damage to buildings and infrastructure when different physical forces are applied, such as seismic shaking, ground acceleration or water depth and velocity. These functions are typically used in loss modelling tools (e.g. RiskScape) or in engineering design.

There are a range of factors identified by social scientists that can contribute to people's vulnerability, although this can differ depending on the hazard type. Some of these factors include:

- Impaired/low levels of mobility (e.g. infants, elderly or mobility disabled)
- Impaired/low levels of comprehension (e.g. infants, people with intellectual disabilities)
- Unfamiliarity with hazards (e.g. new to an area, or from a country or region where certain types of hazards are not present)
- Those with communications challenges (e.g. English as a second language, living in a location with limited telecommunications coverage)
- People dependent on others for survival or transport (includes young children/infants and dependent adults, as well as people in state or institutional care)
- Limited resources (e.g. no vehicle, limited financial means)
- Chronic or otherwise debilitating health conditions.

For example, for hazards such as flood and tsunami, where people need to evacuate in a timely manner to a safe location following a warning, people at-risk must:

- be able to receive and understand a warning
- comprehend the importance of the warning
- know what action to take or be able to follow instructions
- have the means and ability to take the correct actions.

Community resilience or engagement teams in councils and/or community health providers, and/or welfare service agencies can potentially provide valuable insights to the CDEM Group on community vulnerabilities in their region.

Functional dependencies

Where an element relies on another element to function, for example telecommunication services require electricity to function. Therefore, a disruption to one element may impact a range of dependent elements even when they are not physically impacted.

Example: quantifying the exposure and vulnerability of houses to flooding

The following hypothetical example demonstrates this process. The Revir River is the main river of Noiger Region and it floods on average every 10 years to levels mostly below one metre depth across the lowest part of the floodplain. The total number of houses in the entire Noiger Region is 170,000. The number of houses in the floodplain of Revir River is 5,000. While most houses in the region have garages and storage on the ground floor, with living areas above, 100 houses have living spaces on the ground floor. Therefore, 5,000 houses are exposed to Revir River floods, and 100 of these are particularly vulnerable to losses from this hazard, because of their design.

Identify the elements within the social, built, natural and economic environments that will be included in the CDEM Group risk assessment. Also, identify the range of hazards to be assessed. This information will be used during the risk analysis to determine the consequences that must be managed in the region; see *Step 4: Analyse risks.* Through identification of common vulnerabilities or exposures to different hazards, opportunities for more effective risk management may be identified and more effectively evaluated (see *Step 5: Evaluate and treat risks*).

2.4 Step 4: Analyse risks

Risk is a combination of the likelihood and consequences of hazards. For each hazard the CDEM Group is assessing, there are likely to be a range of possible scenarios and associated consequences. The purpose of the risk analysis (*Figure 7*) is to determine the range and complexity of consequences to be managed, and to have this information available for risk evaluation and decision-making (see *Step 5: Evaluate and treat risks*). A standardised approach to determining likelihood and consequences provides a robust and transparent platform for a CDEM Group to use when considering priorities for the CDEM Group Plan.

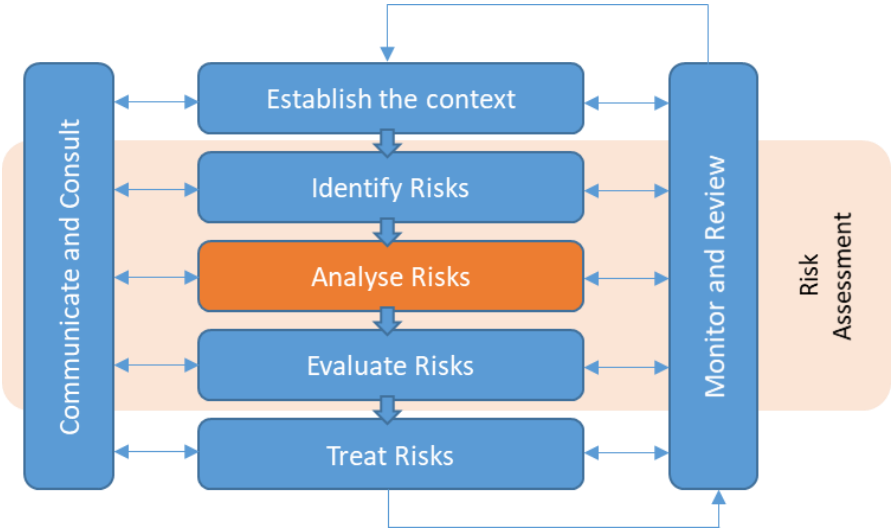

Figure 7 Analyse risks, Step 4 of the risk management process.

Scenario-based approach to understanding and managing risk

To gain a full picture of risks posed by a hazard and establish priorities to improve risk management measures, a CDEM Group should consider risks across a range of hazard scenarios. A scenario-based approach allows the Group to explore a range of events that could happen in their area in a standardised way. It provides a platform for a common understanding of likelihood, consequences and risks.

This section outlines methods to determine the level of risk associated with the impacts of hazards, and is structured around the following topics:

- Likelihood scales
- Consequence scales
- Choosing hazard scenarios for risk analysis
- Describing risk levels
- Summarising the risks for each hazard.

Tools, including a Risk Analysis and Summary Tool are provided to support this Guideline and assist the CDEM Group to undertake standardised assessments of likelihood and consequences for their chosen hazard scenarios. Other tools, such as RiskScape (a New Zealand developed software by GNS and NIWA) can be used to calculate quantitative consequences and loss such as number of buildings damaged, infrastructure damage and human loss for different scenarios to inform and input into the Risk Analysis and Summary Tool.

2.4.1 Likelihood

Scenario likelihood

Likelihood describes the probability of a particular scale and intensity of a hazard occurring in a given location. Likelihood can be communicated in quantitative or qualitative measures. Quantitative measures include chance and frequency. For example, likelihood could be described as the probability of a future event in terms of the percentage chance of occurrence in any given year. Qualitative measures include the use of descriptors such as “rare”, “unlikely” or “almost certain”.

Estimates of likelihood should be based on a comprehensive range of sources. These will vary for different hazard types such as environmental, technological and biological hazard types. Sources include:

- Historical information (e.g. records of past floods)
- Scientific data (e.g. paleotsunami database, active fault database)
- Scientific modelling (e.g. New Zealand National Seismic Hazard Model)
- Research reports on hazards and risks applicable to the Group's area
- Measures in place to reduce the likelihood of technological or biological hazard events occurring
- Local and community knowledge including mātauranga Māori
- Other information that takes into account current circumstances and future probabilities (such as climate change).

Under an 'all-hazards' approach, a wide variety of hazards need to be considered. These range from those with well-established and relatively well understood phenomena (e.g. floods, coastal inundation), through to rare and uncertain hazards (e.g. tsunami and large earthquakes) and hazards which are undergoing rapid change (e.g. infrastructure failure).

Describing the likelihood of a hazard in quantitative terms

The most straightforward way to determine the likelihood of a hazard scenario is to look at the historical record and calculate how often the hazard has occurred at the relevant scale e.g. how often have magnitude 7+ earthquakes occurred in a given area. This is referred to as the Average Recurrence Interval (ARI) which can be calculated by dividing the timeframe assessed by the number of hazard events that have occurred. For example, if three M7.0 earthquakes have occurred over a 300-year time-period, then the ARI would be 100 years. However, it is usually necessary to have a longer record or a greater number of events than this example to be confident that an ARI estimate is reasonable.

Another quantitative term that may be used to describe likelihood is the Annual Exceedance Probability (AEP). The AEP describes the chance of a specific event (or a larger event) occurring within a 12-month period. An AEP is often used to describe natural hazards with a long and comprehensive evidence base.

For many hazards, the lack of adequate historical records makes it difficult to calculate likelihood with certainty. This is further complicated where the likelihood of a hazard is expected to change over time, for example, the frequency of floods and severe weather is likely to increase due to climate change. In such situations, it is vital that historical information is not relied upon solely, and other information sources such as scientific knowledge or models are incorporated.

For some hazards, the rapid pace of change means that even well-categorised historical information provides little relevant and robust information to the present situation. This is particularly relevant for technological hazards, where the rapid pace of technological development results in evolving hazards. In such cases, it may be more appropriate to rely more on expert opinion and a

semi-quantitative estimation of likelihood rather than attempting to gather sparse quantitative data.

Qualitative descriptors

In order to be able to compare across hazards, likelihood is often assessed using qualitative descriptors or classifications, a common set of accepted terms that equate to a likelihood scale. It is common practice to adopt either a logarithmic or exponential scale in order to distinguish between the different likelihoods possible for different hazard types, e.g. each step on the scale corresponds to an increase in likelihood by a factor of 10. A standard likelihood table is provided (*Table 3*).

Uncertainty and best judgement

There may be significant uncertainty associated with the likelihood of hazard scenarios. This could be because the likelihood itself is changing due to influences such as climate change on rainfall patterns, or because there is a limited record available to determine frequency. Best judgement (including expert advice) may be required where there is insufficient data or evidence to determine a reliable estimate of likelihood. When best judgement is used, it is beneficial to agree and document the decision-making process. This reduces the potential bias and provides a clear record of how the likelihood of a hazard has been determined.

It is important to keep in mind the end purpose of the CDEM Group risk assessment is not to achieve precise values for risk but to understand the relative scale and manageability of risks. The assessment can then inform discussion and decision-making about management priorities, strategies, budgets and work programmes. Where uncertainty and gaps are seen as a barrier to understanding the risk, the assessment can highlight where further research or information gathering can assist.

Describing and comparing likelihoods for different hazards

Regardless of the nature of the hazard it is important that a CDEM Group can compare likelihoods using a common scale. For example, it can be difficult to determine whether a hazard scenario for flood that has 5% chance of occurring over 10 years has a higher likelihood of occurrence than a pandemic scenario with a likelihood of “rare” as they are described using different scales. The standard likelihood table below (*Table 3*) presents a method for comparing likelihood classifications alongside likelihood description, the chance of occurrence in any given year and average recurrence interval. Such a table is useful when comparing the likelihood of a range of different hazards, some with a strong evidence base for their frequency and some that have never occurred. The Risk Analysis and Summary Tool contains a likelihood converter to convert ARI and AEP into a qualitative likelihood descriptor. See *Appendix B* for further detail.

Table 3 Standardised likelihood table*

Likelihood Classification	Likelihood Description	AEP (%)	ARI (Annual Return Interval in years) (indicative)
Rare	Almost certainly not likely to occur but cannot be ruled out	<0.1	>1,000 years
Unlikely	Considered not likely to occur	0.1 - <1	100 to <1,000 years
Possible	Could occur, but is not expected to	1 - <10	10 to <100 years
Likely	A good chance that it may occur	10 - <63	1 to <10 years
Almost Certain	Expected to occur if all conditions are met	≥63	Less than 1 year

*Note each row down for all scales shown in *Table 3* indicates a ten times greater likelihood of occurrence than the row above.

Ensure that each risk assessed includes an understanding of the likelihood for that risk. This can be probabilistic or scenario-based but if one hazard is assessed probabilistically, then all hazards should be similarly assessed. Likelihood should be able to be described in the same scale for all risks, for example in qualitative descriptions or annual exceedance probabilities. This may require the use of a conversion table such as that shown in *Table 3* or through the use of the likelihood conversion tool in the toolkit that accompanies this guideline.

2.4.2 Consequence

Consequence describes the outcome and effects of a hazard scenario. Consequences are a measure of impacts to the things we care about, and generally relate to significant outcomes e.g. human wellbeing, damaged infrastructure and lost economic productivity. As with likelihood, consequences can be measured quantitatively (e.g. number of injuries, monetary value) or qualitatively as a category (e.g. high, medium, low) or through descriptive statements.

Consequences are those impacts that are expected based on the current conditions and taking into account the current risk management measures in place. Consequences should be assessed taking into account current CDEM Group practice (e.g. early warning systems) and the wider risk management for that hazard currently in place (e.g. a flood management scheme). As each hazard could result in many potential consequences, a wide range of information sources should be used to support consequence assessment.

Consequence scales

Consequence scales, similar to likelihood scales, provide a standardised way to assign the level of impact on elements, and helps to ensure each hazard is

assessed in a consistent, robust manner. A scale based on agreed consequence thresholds will assist CDEM Group members and stakeholders when using a range of sources, information and expertise to come to an agreed level of consequence. A consequence table with standardised scales for all the elements included in *Table 2* is provided in the online toolbox that accompanies this Guideline, and is also shown in *Section 4*.

Describing and measuring consequences

Levels of consequences are determined by applying hazard scenarios to the elements in the Group's area. As with likelihood, the use of common terms, scales and measures assists with developing a shared understanding, which can then be used to inform prioritisation and decision-making. The Group should determine standardised methods for assessing consequences from hazard scenarios that take into account the exposure and vulnerability of the elements.

Consequence thresholds

Standardised base thresholds for the levels of consequence provide consistency and transparency when developing a method for assessing risks for a wide range of elements. For example, standard thresholds ensure that there is agreement that what is considered a 'major' consequence for one element is equivalent to a 'major' for another element with regards to how the impact is experienced by communities. It is expected that for any given hazard scenario, the consequence levels will vary for different elements. For example, in a major flood, if evacuations are effective, population casualties will likely be insignificant, but the impact on access to habitation could be major.

Base thresholds are the first step in developing an element-by-element standardised consequences table such as the one provided in the online Toolbox. There should be a clear step-change between each level on the consequences scale. For example, when showing the shift from insignificant to minor or from major to extreme. The base thresholds for the scale used in the consequence table accompanying this Guideline are shown in *Table 4*.

Consequence tables

Consequence tables set out a range of consequence levels for all elements being assessed and describe the associated nature of impacts which meet the given consequence level, across a range of impact types.

A standard consequence table is available in the online toolbox and is shown in *Appendix E*. If a Group chooses to develop their own method for assigning consequences, they should ensure there is equivalence across the domains and elements, for example, does the way the Group describes a major impact on social wellbeing align with what would be considered a major impact on jobs and employment? Groups that develop comprehensive consequences tables for their risk assessments, through adopting and adapting the one provided in the Guideline toolbox, are encouraged to share these with neighbouring or similar Groups to support knowledge and practice sharing for risk assessment.

Note: Many of the scales provided in the standard consequence table use qualitative "bins" to show the level of impact, based on the scale of impacts to communities. The CDEM Group can adapt these bins to quantitative values if the data is available to support this.

Table 4 Examples of base thresholds for developing a standardised consequences table for a CDEM Group area. These thresholds match the standard consequence table provided in the toolbox and shown with example element-by-element scales in Section 4.

	Insignificant	Minor	Moderate	Major	Extreme
Social	No impact or negligible impact on people and/or social and cultural wellbeing	Minor impact on people and/or social and cultural wellbeing	Moderate impact on people and/or social and cultural wellbeing	Major impact on people and/or social and cultural wellbeing	Extreme impact on people and/or social and cultural wellbeing
Built	No impact or negligible impact on structures and the services/ functions they provide	Minor impact on structures and the services/ functions they provide	Moderate impact on structures and the services/ functions they provide	Major impact on structures and the services/ functions they provide	Extreme impact on structures and the services/ functions they provide
Economic	No impact or some local impact to the economy and financial systems	Minor impact to the economy and financial systems	Moderate impact to the economy and financial systems	Major impact to the economy and financial systems	Extreme impact to the economy and financial systems
Natural	No impact on the natural environment and the ecosystem services provided	Minor impact on the natural environment and the ecosystem services provided	Moderate impact on the natural environment and the ecosystem services provided	Major impact on the natural environment and the ecosystem services provided	Extreme impact on the natural environment and the ecosystem services provided

Develop a standard method for determining the consequences associated with each risk the Group is assessing. Thresholds or base indicators are useful to minimise bias and ensure that impacts are comparable across different elements such as people's health and wellbeing, lifeline utilities and the natural environment.

The results of loss modelling, economic models, review of past event impacts and/or expert judgement may be required to determine consequences.

2.4.3 Choosing hazard scenarios for risk assessments

Risk management requires an understanding of the policies, planning and procedures required for events of varying scale. Risk management measures may include activities that are specific to one type of hazard, for example tsunami evacuation zone mapping, or may include activities that are applicable to a wide range of hazards, e.g. welfare services arrangements for response and recovery. Risk assessment provides fundamental information for the management of risk. Because each hazard can give rise to events of varying scale from insignificant to extreme, the use of hazard scenarios can assist with determining the risk level, and the required risk management measures. It is important for a CDEM Group to understand where the current risk management measures across all 4Rs are working well and where the greatest challenges or opportunities lie.

Where modelling or information on the risks associated with a hazard of particular interest for the Group's area is currently inadequate then additional effort will be needed to develop and agree on credible scenarios as part of the CDEM Group's risk analysis. It is recommended that over time, a CDEM Group consider *at least* two scenario types at different scales of event for each hazard, in order to assist planning and prioritisation. *Table 5* shows the scale of scenarios in descending order from highest consequence to lowest.

Table 5 Scenario types and their descriptions

Scenario scale	Description
Outlier event	Considered to be a statistical outlier that cannot reliably be predicted, these are extremely rare and could have catastrophic consequences that would be unmanageable, or even difficult to comprehend (e.g. a large meteor strikes a major city). Due to the limited ability to predict extreme events, they are unlikely to be useful for risk assessment purposes.
Maximum credible event (MCE)	Possible, worst-case events, likely to be associated with significant consequences. Events must be realistic, even if highly unlikely, and be underpinned by a degree of expert knowledge on what magnitude of event is possible – e.g. for Taranaki volcanic hazard, a large and prolonged volcanic eruption including a collapse of the cone. These types of scenarios are recommended for CDEM Group risk assessments.
Most likely/ mid-range event	Describes an event or series of events, which have a higher likelihood of occurrence than the MCE and are likely to require a co-ordinated response by the CDEM Group e.g. a localised but disruptive rainstorm which results in flooding of an urban area, evacuations, school closures and multiple, small landslides and temporary road closures throughout a region.
Routine or regular events	Frequently occurring events that are managed as a 'business as usual' or routine activity and result in largely negligible consequences, e.g. earthquakes that people feel but which cause no damage. Unlikely to require CDEM consideration or planning.

Considering which hazard scenarios to use

Figure 8 shows the distribution of events commonly associated with natural hazards. The most extreme events in terms of consequences are typically the least likely to occur. For CDEM risk management purposes, the most useful hazard scenarios are often the challenging scenarios, that are possible but have not been previously experienced, and will require considerable risk management across the 4Rs, i.e. maximum credible events. Recognising the effectiveness of risk management in place for day-to-day events or more likely events is also important (see *Step 6: Monitor and review*). Likewise, it is also important to recognise that with time the maximum credible event scenario for a hazard may change due to underlying factors such as climate change.

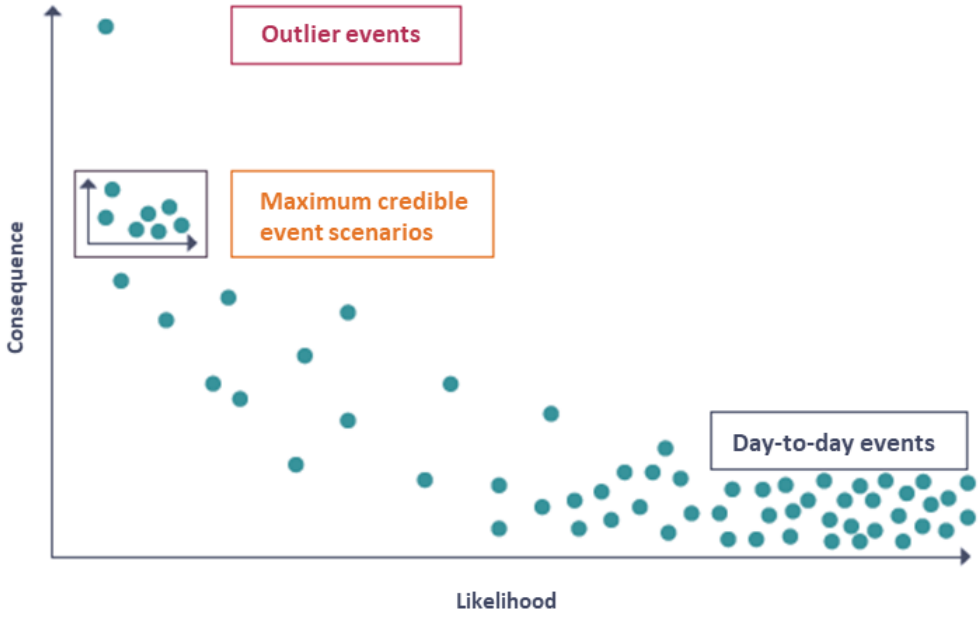

Figure 8 Diagram illustrating the inverse relationship between likelihood and consequence for a range of theoretical events.

Historic or paleo hazard event scenarios

The CDEM Group may find it beneficial to revisit well-known, historic hazard events and apply them to the current exposure and vulnerability of elements. Such scenarios can be useful as an indicator of increases in exposure but could also reflect improvements in reducing vulnerability. For example, modelling the shaking intensities and ground accelerations of the 1931 Hawke's Bay earthquake, which resulted in widespread building collapse of unreinforced masonry, and determining consequences for today's elements.

Modelled hazard scenarios

CDEM Groups may have the inputs available to use consequence modelling tools such as the RiskScape software developed by GNS Science and NIWA. Such tools can provide a standardised method to determine consequences from a range of hazards. When using loss modelling tools, it is important to note the likelihood of each hazard scenario under consideration, so that overall risk level may be determined. For example, flood hazard scenarios for a number of exceedance probabilities may be available (e.g. 100- or 200-year ARI); for each of these, the expected consequences, and therefore the overall risk level, will differ.

Probabilistic hazard models

The CDEM Group may have highly detailed probabilistic modelling for some hazards. This modelling can be used to determine which scenarios contribute most to the overall hazard. For example, for earthquakes, probabilistic modelling can improve understanding of which active faults in the region are more likely to produce strong shaking and other seismic hazards. The Group may choose to complete a risk analysis for the maximum credible event on the largest active fault, and also for lower magnitude events on the same fault or earthquakes on smaller faults.

2.4.4 Describing hazard scenarios

Scenario description

For any given event, a summary of the scale and nature of the hazard is required to determine the consequences. Those participating in the risk analysis require an understanding of:

- what type of hazard phenomena are associated with the scenario, e.g. for a maximum credible event (proximal) volcanic eruption scenario, the following are possible: airborne ash and ash fall, lahar, pyroclastic surge, toxic gases, and ground shaking and deformation
- which locations will be exposed to the identified hazards, noting this is likely to vary hazard by hazard
- the intensity of hazard phenomena (e.g. water depth and velocity for flooding; thickness of ash for volcanic eruption)
- the onset time and duration of the hazard.

Scenario descriptions should be based on a range of sources, using where available: scientific evidence, historical data/records and local knowledge and expertise. Some judgement may be required, and the degree of uncertainty associated with the scenario should also be noted.

Scenario likelihood

For each scenario that a CDEM Group considers, the likelihood will need to be determined. The likelihood can be based on quantitative, semi-quantitative or qualitative information. Regardless of the method used to determine likelihood, all hazard scenarios considered by the Group should be described using the same scale. See the *likelihood section* for more detail.

Scenario summaries

Identify and document appropriate hazard scenarios to support the Group's understanding of risks for its area. Scenarios should be of a similar type, preferably maximum credible event scenarios for each hazard of interest. These types of scenarios will ensure the Group can consider the full range and magnitude of consequences that could result.

2.4.5 Assessing consequences

Individual consequence

The consequence of each element should be assessed individually. This allows specific expertise on vulnerability and exposure for each element to be drawn upon to determine consequences and to support more informed conversations about the options available for treating risk. For example, representatives from the local DHB(s) can provide an assessment of the consequences of a large earthquake on the provision of health services, or council asset managers could describe how the same event would impact their three waters network. This does not mean considering each individual building, person or substation, but assessing the consequences to each individual type of element. For example, considering the total harm to the physical health of all people in the Group's area, or total damage to residential buildings, or to the electricity network.

The degree of consequences may be difficult to determine based on available information. When estimating the consequences from types of events that have not occurred previously in the Group's area, it may be helpful to draw upon modelling tools such as RiskScape or draw upon events from elsewhere in New Zealand or overseas. While it is not essential to gain a precise measure of consequences for each element, the assessment should indicate the relative scale of consequence per element. The value of element by element assessment is the ability to consider a particular element across a range of hazard scenarios and use this information for risk treatment.

Where the level of consequences on one element will influence the scale of consequences to other elements, the dependencies should be noted, and the elements assessed in a logical order. For example, it will likely be useful to determine the scale of consequences to each of the lifeline utilities before determining social and economic consequences. A power failure, for example, will have resultant social and economic consequences.

The consequence and resultant risk level (when combined with scenario likelihood) for each element assessed provide a useful platform for evaluating whether individual risks are acceptable and what treatments might be appropriate.

Overall consequences

An overall consequence score is a useful way to view the overall impact of a hazard scenario. It should be noted however that in order to leverage the granular nature of the risk analysis process and the rich contextual information related to each element, evaluation of treatment options should be undertaken by reviewing individual elements across all scenarios.

There are several methods for calculating an overall consequence score. *Table 6* describes the advantages and disadvantages of some common methods. Note: The Risk Analysis and Summary Tool that accompanies this guideline uses the logarithmic method.

The same calculation method is used to determine the overall risk level of the hazard scenario.

Table 6 Options for developing overall consequences scores

Method	Advantage	Disadvantage
Logarithmic* (total and within each environment)	Retains importance of extreme and major scores without overly biasing total or environment scores (Note: Default method used by the Risk Analysis and Summary Tool)	Somewhat complex and may require additional explanation for decision-makers
Average of all scores (total or within each environment)	Simple	Can blur important information on extreme/major impacts on specific elements by averaging extreme scores
Highest score sets the consequence level (total or within each environment)	Simple Importance of high/major impacts retained	When many elements are assessed, one or two high scores could bias the overall score if the remainder of impacts are insignificant

*More information on the logarithmic calculation method can be found in *Appendix D*

Identify and record the method the Group will use for combining all scores to derive a total consequence score for each hazard. Refer to *Table 6* for available methods.

2.4.6 Risk levels

To assist with CDEM Group planning, risk levels can be considered in the following ways:

- the risk associated with each particular social, built, economic or natural element for a particular hazard scenario (i.e. the combination of scenario likelihood with the individual consequence level of the element)
- the combined environment risk level of a given scenario (the combination of scenario likelihood and the combined consequence score of all elements related to a specific environment such as the social environment)
- the overall risk level (the combination of scenario likelihood and the combined consequence score of all elements related to a single hazard scenario).

The overall risk level (likelihood x consequences) provides a useful visual summary of the hazard scenarios the Group has assessed and can be used

for prioritisation, although should not be the only consideration (see *Step 5: Evaluate and treat risks*).

Simple risk matrix

A risk matrix shows the level of risk based on the combination of likelihood and consequence. If Groups use the Risk Analysis Summary Tool the risk matrix is created automatically along with a range of other graphs visualising aspects of the assessment. The standard risk matrix is provided below (*Table 7*).

Table 7 Risk Matrix example

		Consequence				
		Insignificant	Minor	Moderate	Major	Extreme
Likelihood	Almost certain	Medium	High	Very high	Critical	Critical
	Likely	Medium	High	Very high	Very high	Critical
	Possible	Low	Medium	High	Very high	Very high
	Unlikely	Low	Low	Medium	High	Very high
	Rare	Low	Low	Low	Medium	High

2.4.7 Confidence levels

Capturing the significance of uncertainty or gaps in understanding

Evaluation of risk based on likelihood and consequence requires considerable information and expertise, particularly for unknown or new/emerging hazards.

Using a confidence rating shows the level of confidence that the Group has in the risk assessment. This rating can be useful during risk management decision-making (e.g. encourages a precautionary approach) or for priority and action planning (e.g. prioritise seeking further information on a hazard, or exposure and vulnerability).

Table 8 provides descriptions for five confidence levels (lowest to highest) based on:

- Supporting evidence
- Relevant expertise
- Participant agreement

A confidence rating such as lowest, low or moderate can show that the Group has undertaken the risk assessment to the best of their ability based on the information available, but there are areas of uncertainty or gaps in information.

Table 8 Example Confidence Table – Adapted from the National Emergency Risk Assessment Guidelines (AIDR 2015)

	Supporting Evidence	Expertise	Participant Agreement
Lowest	• No historical events • No scientific model	No expertise is available	Fundamental disagreement of assessment
Low	• Anecdotal information of historical events • Scientific model which could be applied with significant modification	Expertise is available	Disagreement of major aspects of assessment
Moderate	• Historical event of similar magnitude in a comparable community of interest • Relevant scientific model available	Relevant expertise is used to make decision	Disagreement of minor aspects of assessment
High	• Recent historical event of similar magnitude in a directly comparable community of interest • Good scientific model available	Relevant expertise is highly influential in the decision	Agreement of assessment
Highest	• Recent historical event of similar magnitude to that being assessed in the community of interest • Highest quality scientific model	Relevant and demonstrated expertise available and highly influential in making the decision	Strong agreement of assessment

2.4.8 Risk summaries (profiles)

Developing a risk summary

The process of risk identification and analysis for each hazard generates valuable information that should be captured in a standardised way. A risk summary or profile should be an updateable document, reviewed as necessary (see *Step 6: Monitor and review*). This allows the Group to track changes in risks and risk management measures over time and have all necessary information in one location. An example of the structure and typical contents of a risk summary is shown in *Appendix F*. A template is available in the online toolbox.

As a minimum the summary should include:

- the name of the hazard
- the context for the hazard – description of the hazard characteristics such as units of measurement, location it may occur, historical events, level of understanding
- understanding of the magnitude and frequency of the hazard
- understanding what triggers the hazard, whether it can occur as a trigger to other hazards or be triggered by other hazards

- understanding of whether the hazard is evolving due to external drivers such as climate change
- the exposure and vulnerability of the people, property, taonga and services to the hazard
- any risk analysis ratings for specific hazard scenarios
- confidence levels associated with the risk assessment
- risk management measures in place across all 4Rs and including roles and responsibilities, activities, polices and arrangements undertaken by CDEM partners and within the wider framework
- any priorities for action and work to correct gaps in understanding.

2.5 Step 5: Evaluate and treat risks

All assessed elements should be evaluated to determine whether the current risk management measures in place meets the requirements and expectations of CDEM Group members and the wider group of stakeholders, including those at risk. The evaluation step (*Figure 9*) involves agreeing whether, taking into account current risk management, to accept or tolerate the risk as it is, or whether additional measures are required to manage it. This evaluation should also consider how the risk could increase or change over time.

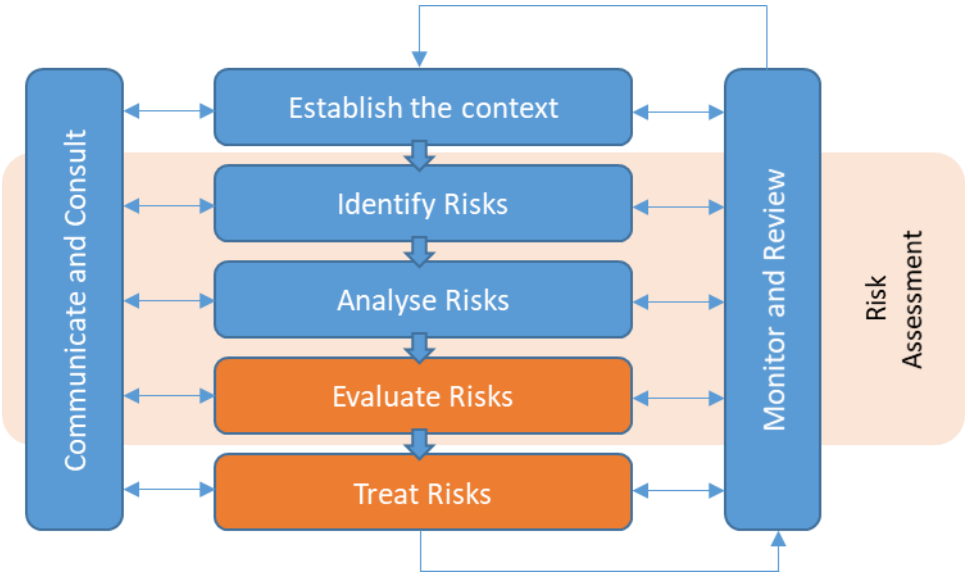

Figure 9 Evaluate and treat risks, step 5 of the risk management process.

Any additional or improved means to manage risks should be considered across the 4Rs, though ideally with an emphasis on reduction and readiness if possible. Treatment options can be specific to one hazard or risk. Alternatively, they can be generic measures that support the management of a range of hazards or risks, through addressing common exposures or vulnerabilities.

This section describes the considerations for a CDEM Group undertaking the risk evaluation process. The Group should be able to demonstrate how the

results of their risk assessment will be used to address identified gaps in the current management of risks.

Determining the best means to manage risk can be challenging. The level of in-depth consideration of the issues and options required may be beyond that which can be achieved during the CDEM Group Plan development process. The measures included in the CDEM Group Plan could specify the first or next step in a process that will lead to the desired result. The intent is that the risk assessment provides a robust and evidence-based process for setting the goals, objectives, targets and actions that are included in the plan.

2.5.1 Residual risk levels and risk acceptance

The CDEM Group should base all decision-making on residual risk levels. Residual risk is the risk that remains after taking into account existing risk treatment measures. The Group should also focus on those aspects of the risk that it can manage. For example, the consequences of building damage in an earthquake will vary depending on the seismic performance rating (vulnerability) across the building stock as a whole. While councils do not set national codes and standards for buildings, they have some opportunity to implement these; for example, through polices relating to earthquake-prone buildings. Councils also contribute to risk management measures for residual risk arising from the consequences of building damage such as casualties, the need for shelter, disruption to lifeline utilities and businesses.

Determining the residual risk that must be managed requires a clear understanding of the effectiveness of the measures that are currently in place. Decision-making on the appropriate measures to manage different risks is based on what is acceptable and what is achievable.

Levels of residual risk acceptability

Acceptable risks

Where risks are negligible, or so minimal that no further mitigation measures are required.

Tolerable risks

Where opportunities (benefits) to be had by living with the risk are balanced against potential adverse consequences (losses) if the risk was realised. Tolerable risk is a willingness by society or a community (although perhaps not by every individual) to live with some level of risk as the only practicable answer. It requires considering how best to manage the risk across the 4Rs. Concepts such as achieving risk levels that are “as low as reasonably practicable” (ALARP) are often used in this context.

Intolerable risks

Where risks are considered too high regardless of the benefits the activity may bring. Risk reduction is required, and often avoidance measures are the best option, such as prohibiting new development and supporting the retreat of existing development.

What is considered to be acceptable may vary, depending on the hazard and its associated risks

A CDEM Group is expected to "encourage communities to achieve acceptable levels of risk" as set out in the CDEM Act. This will likely include the acceptance of tolerable risks, especially in terms of development and activities already in place in locations with a pre-existing hazard.

The challenge can be to determine what the acceptable level of risk is, for different hazards. It is likely there will be diverse views on risk acceptability from CDEM Group members and from within communities. Risk acceptance levels are aligned to benefits and trade-offs. For example, communities and individuals balance the benefits of living, working and playing in areas that are exposed to hazards such as volcanic ash fall or storm surge. These benefits are weighed against the trade-off that public resources must be dedicated to reduction, readiness, response and recovery activities such as funding for monitoring and warning systems, public education and evacuation planning for volcanic eruptions or tsunami. In some cases, where the area of exposure is well understood, the trade-offs may include restrictions on land-use or rules around development e.g. minimum floor heights for structures or set-backs from active faults.

CDEM Groups may wish to refer to the *Director's Guideline on Strategic Planning for Recovery [DGL 20/17]* for more detail on engaging communities in conversations about risk tolerance and understanding local values and local risk management priorities.

Risk acceptance will vary depending on the risk characteristics and the circumstances related to the hazard. The acceptability of some risks may also change over time. These changes in acceptance can be influenced by societal expectations, understanding of new and emerging risks, or recent significant events. The CDEM Group will need to take into consideration the 'risk appetite' of stakeholders during its CDEM Group Plan priority setting and actions planning.

The CDEM Group should aim to achieve risk management measures and treatments that reduce residual risk levels to at least tolerable levels, consistent with the ALARP principle.

Throughout the process it is essential that good records are kept which document how decisions were made. Good records will ensure decisions are defendable and provides context to future risk management activities.

2.5.2 Current CDEM risk management measures and context

Consider the wider decision-making context

Risk management by CDEM Group members is not limited to activities and priorities within the CDEM Group Plan e.g. flood mitigation measures and land-use planning. It is important that the CDEM prioritisation process recognises, and is complementary to, other resourcing and policy-setting mechanisms for risk management measures. Any policy, plan or activity that has implications for the exposure or vulnerability of people and assets should be identified by the CDEM Group and taken into account when identifying risk management gaps, opportunities and priorities. This process could include a review of the following:

- Group Welfare plans
- Long Term Plans (e.g. spending priorities that may address exposure or vulnerability)
- Growth (spatial) plans and strategies (new developments may mean new exposure of elements to hazards)
- Resource management regional policy statement, and regional and district plans
- Iwi/hapū management plans (especially in relation to natural hazard/resource management and community resilience)
- Asset management plans (activities including upgrading or installation of new assets)
- Catchment or coastal management plans that include hard and soft engineering mitigation structures (e.g. stop banks, dunes)
- Community development plans supporting community resilience outcomes
- Community Response and Recovery Plans
- Information technology strategies where new hardware or software systems will also be beneficial for emergency management (e.g. new social media channels that could be used for public education or as a warning channel).
- Reserve management plans
- Conservation plans
- CDEM Group Plans
- Lifeline Group Plans
- Any other relevant plans

The CDEM Group should examine the CDEM Group plan currently in effect, and in particular, the risk assessment and the current CDEM priorities and action plan. This document, alongside the results of any new risk analysis, should provide the basis for priority setting in the new CDEM Group Plan under development. The most important considerations should be:

- Are there any significant changes in risk that would warrant a change in CDEM priorities, policies or actions?

- Given all the other instruments in place across agencies including policies and plans, is there a clear need for additional CDEM focussed activities to manage this risk?
- If risk levels have significantly changed between risk assessments, are the reasons for the changes fully understood?
- Have the activities and priorities delivered under the previous CDEM Group Plan been effective? Have they resulted in a reduction in risk? Do they have an adequate focus on risk reduction and recovery?
- Are they based on new information or experiences? Have the priorities of communities and/or decision-makers changed?

Gaps and uncertainties

The CDEM Group's risk assessment may identify gaps in understanding of hazard or risks that require further research and additional assessment to ensure the risk is managed appropriately. It may also identify areas where risks are evolving or there is considerable variability or uncertainty regarding the likelihood and/or consequences of the risk. In these cases, the risk prioritisation and action planning should take a precautionary approach, ensuring that the CDEM risk management measures and options adopted are taking this uncertainty into account.

2.5.3 Future risk management – CDEM Group planning

CDEM priorities and action planning

The CDEM Group should identify priorities based on:

- understanding of current risk management measures in place across the 4Rs undertaken by CDEM Group members and partner agencies within the area
- the risks requiring additional management, as determined through the evaluation process
- any clearly identified gaps in policy, planning, operations, systems, public awareness and preparedness
- risks that are intolerable
- any significant changes or likely changes in risk that have occurred since the previous CDEM planning process or will occur during the life of the new CDEM Group Plan
- windows of opportunity to build upon existing work or changes e.g. an upcoming Long-Term Plan review or a community's desire for more resilience following its recent experiences of an emergency; and
- most importantly, aspects of risk management the CDEM Group, its members and key partners are able to influence and/or progress towards achieving a defined outcome.

Prioritisation can then lead to "first-pass" action planning. For example, an urgency scale which places risks into broad groupings based on the actions

required. *Table 9* provides an adapted version of an urgency table developed for the *United Kingdom Climate Change Risk Assessment* (2017).

Consider the prioritisation level assigned. Does the risk rating have any implications for planning process? Should the highest risk score always be the highest priority, or do moderate consequence events that occur at a high frequency provide a greater challenge for the Group?

Table 9 Prioritisation table example – adapted from HM Government (2017)

More action needed	New, stronger or different policies, planning or activities (considering all 4Rs) – over and above those already planned – are needed in the next five years to reduce residual risk.
Research or knowledge sharing required	Research or greater shared understanding is required to fill gaps or reduce uncertainty in order to assess whether additional action is required to manage this risk.
Sustain current action	Current or planned levels of activity are appropriate, but continued implementation of these policies or plans is needed to ensure that the risk continues to be managed in the future.
Watching brief	The evidence in these areas should be kept under review, with long-term monitoring of risk levels, and risk management plans, policies and activities, so that further action can be taken if necessary.

Risk management options and treatments

In general, options for risk management include reducing risk, preventing new risk, accepting risk or transferring risk.

Accepting risk can be considered the “do nothing” option and is appropriate where the residual risk or the priority of the hazard risk is so low that no additional actions are considered necessary.

Transferring risk ensures physical losses such as damage to buildings or infrastructure do not become economic losses. The most common form of risk transfer is insurance, whereby the restoration and/or rebuild cost related to physical damage is covered by insurance.

Avoidance of risk may require a substantial change in practice and for built environment including infrastructure situated within hazards zones. This option may only be available through retreat or relocation.

Risk reduction can be generally grouped into three categories: options for reducing the hazard phenomena, options for reducing exposure to hazards, and options for reducing vulnerability. Each of these reduction options is covered in more detail below.

Reduce the hazard

For most natural hazards, it is not possible to alter the natural phenomena underlying a hazard. For example, it is not possible to reduce the magnitude or change the location of an earthquake, a windstorm or a tsunami. This

option is more applicable to deliberate threats or technological hazards. Flood hazard may be managed through structural defences that change a river's extent from a natural floodplain to a controlled channel. However, structural measures, such as stop banks, are only effective up to a specified design level and may provide communities with a false sense of security by reducing the impact of small events, resulting in increased development within floodplains and therefore increased exposure.

Reducing long-term or short-term exposure

A reduction to long-term exposure means a permanent change to the number of elements exposed to particular hazards, rather than a temporary change provided by measures such as evacuation during tsunami events. A reduction in long-term exposure is effectively the avoidance of hazards and is most applicable to hazards that have well understood locations and/or extents. For example, land-use rules that control development on active faults or in flood hazard zones.

A reduction in short-term exposure means the temporary change in the exposed elements that is provided by activities such as evacuation of people or relocation of movable assets during hazard events. Such measures typically require:

- a significant understanding of potential hazard extents or exposure areas (e.g. mapping tsunami evacuation zones)
- methods for detecting hazards and determining threat levels
- planning and public communications channels to alert those at risk
- public education and pre-planning for response so those at risk know what to do and when to do it.

Reducing vulnerability

Reducing vulnerability means decreasing the inherent factors that influence how severe the loss will be if a hazard occurs.

Social vulnerability applies to a range of impacts to people including physical or psychosocial harm, or losses in terms of the economic, cultural, social or spiritual wellbeing of people. Factors that influence the vulnerability of people include: people's awareness of threats, decision-making capability, resources and ability to prepare and act, and the capacity to absorb and recover from losses.

For other types of tangible assets such as built and infrastructural assets, vulnerability is largely controlled by the design and construction materials of assets and how they respond to various hazard phenomena. Vulnerability is often described through fragility curves or relationships, whereby the degree of expected loss can be calculated based on the intensity or magnitude of a hazard; for example, the performance of a building to different intensities of seismic shaking. Vulnerability for these types of assets is often reduced through improvements in design and materials.

For less tangible things such as the value of the natural environment, community cohesion, cultural values and wellbeing, vulnerability can be described as the factors which control the ability to absorb shocks without resulting in long term impacts.

Agreeing priorities and action planning

The CDEM Group members and relevant stakeholders should agree the priorities for action and identify realistic timeframes for implementing new policies, plans, activities, resources etc. in a comprehensive action plan.

Risk options example

Example only: A CDEM Group with a significant risk from local source tsunami reviews its current risk management measures following the process provided in the *Director's Guidelines for Tsunami Vertical Evacuation [DGL 21/18]*. Following an evacuation modelling exercise, the Group recognised that several hundred people are unlikely to be able to travel out of the evacuation zones before the first waves arrive. Reasons in this example include:

- the lack of an efficient route for pedestrians across a stream, making the escape route more circuitous
- the lower travel speeds of residents in a rest home and of infants in a childcare centre.

All participants in the exercise agreed that this number of people at risk is not tolerable. The Group therefore includes in its action planning, measures to reduce the residual risk from local source tsunami. This includes exploring the practicality and cost of a footbridge across the stream, and working alongside the childcare centre and rest home to support their evacuation planning. The Group then models or evaluates the effectiveness these measures are likely to have. If the residual risk remains intolerable after these measures are in place the Group will then explore additional treatments, including considering tsunami vertical evacuation.

Document the level of residual risk for all hazards of interest after the following are taken into account:

- All current CDEM risk management activities for the hazard.
- Other current and planned activities, policies, planning and arrangements that influence the residual risk level for each hazard.

Note that:

- some measures will be beneficial for managing the risk for more than one hazard
- risk management across the 4Rs includes activities that are not part of the CDEM Group action plan or priorities.

Building on this information, record the risk management priorities, and action plan activities and goals to be included in the CDEM Group Plan. These should take into account the 'risk appetite' of key stakeholders, identified gaps and opportunities for risk management and any areas of uncertainty that could be addressed.

2.6 Step 6: Monitor and review

Society, technology and the natural environment are dynamic. Changes can affect aspects of the risk assessment process from the creation of new hazards and risks, changes in exposure and vulnerability, through to new techniques for managing risk. Equally, the way in which risks are viewed changes over time. Underlying trends such as climate change and demographic changes can influence the scale of risks that must be managed. Ensuring monitoring and review occurs at all stages of the risk assessment process (*Figure 10*) will ensure the assessment is up to date and fit for purpose.

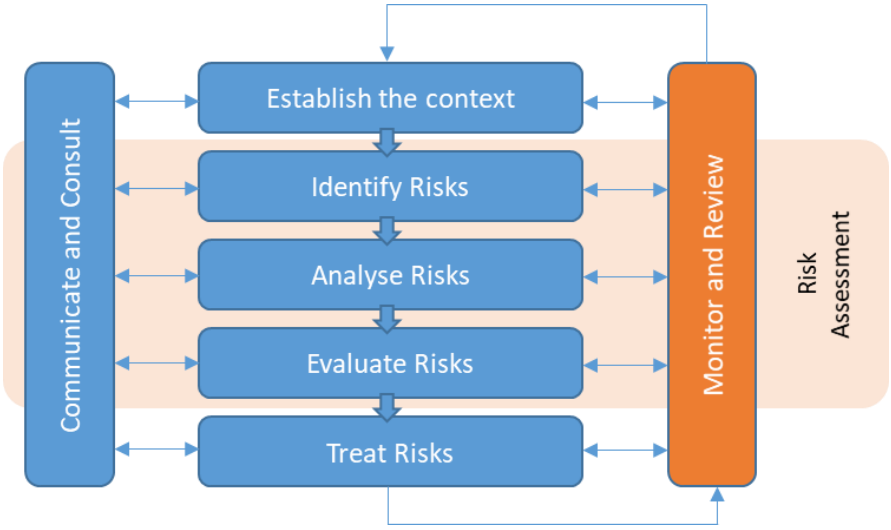

Figure 10 Monitor and review, step 6 of the risk management process

2.6.1 Monitoring

The purpose of monitoring risks

A risk assessment process must be adaptive, and the results regularly reviewed and updated, in order to continue to provide value. Failure to do so means that decisions will be made on outdated or potentially inaccurate information.

In *Step 2: Communicate and consult* a list of stakeholders was identified that can provide the information required to perform a comprehensive risk assessment. These stakeholders are also key users of the risk assessment. For example, stakeholders can use it to inform improvements in operations and business practise, and to encourage the development of greater resilience and support funding proposals.

Monitoring and review are related processes that create an ongoing feedback loop to incorporate new information into risk assessment and the management of risk.

Post-event reviews

Emergencies and significant hazard events add to the body of knowledge on a hazard and its potential consequences. The CDEM Group should review, and if necessary, update the risk assessment and risk summary to reflect any lessons or new understanding.

Feedback loop

Maintaining a feedback loop with stakeholders ensures that the risk assessment process is a 'live' one, with new information driving improved risk practice, which provides greater benefits to users and stakeholders.

Stakeholders and the subject matter experts who support a particular business activity are the best placed for identifying new and relevant information for risk. For example, council hydrologists will be charged with actively monitoring for new information on climate patterns, river models, and land-use that may impact the risk of local flooding. Where they identify new information that is relevant to risk, this should be analysed and incorporated into the risk summary. It is important to track these changes and ensure that a version control system is established. This helps provide a record, but also importantly helps to inform whether the risk management measures in place are effectively reducing risk or maintaining risk at acceptable levels.

It should be noted that this process relates to changes that are iterative in nature. However, there will be cases where new information has such a significant impact on risk that it may necessitate a complete review of the risk assessment.

Ensure all risk summaries/profiles have a clear version control system.

Develop and maintain a change log that records new information provided by stakeholders, and what was done with this information, e.g. risk summary updated.

Develop a process for regular reporting on risks and any changes to your risk register.

2.6.2 Review

A systematic review is a formal process that is initiated to regularly review the risk assessment process, for example every five years as part of the CDEM Group Plan review. This provides an opportunity to determine if the risk assessment methods adopted are still valid and to undertake a more formal scan for new and emerging information, including new and emerging hazards.

This process should follow steps 1 to 5 as outlined in this document, in order to identify new information that might influence the results and includes:

- Horizon and environmental scanning to identify new and emerging risks
- Incorporating any new information on the context and how this may have changed e.g. strategic direction of the organisation
- Deliberately seeking out relevant new information on the likelihood and consequence of risks
- Review recent events to update baseline historic information

- Measuring the success of implemented risk treatments
- Discussions with subject matter experts and stakeholders in order to understand relevant new information, for example on the likelihood and consequence of risks
- Ongoing interactions with stakeholders and active consideration of how risk tolerance changes over time.

Establish a timetable and process for reviewing the Group risk summaries/profiles and determine if any risk assessments need updating based on new information or other changes. Keep stakeholders informed of outcomes and any future review.

Section 3 Practical application

This section provides CDEM Groups with an overview of the tools and resources which accompany this Guideline. This section is specifically designed to support an end-to-end process to:

- *Prepare for the risk assessment* process and develop the materials required to run a workshop and use the Risk Analysis and Summary Tool
- *Conduct a risk assessment workshop* and develop the information necessary to populate risk summaries (profiles)
- *After the workshop* analyse and use the results of the risk assessment.

3.1 Preparing for a CDEM Group risk assessment

Project planning

The CDEM Group risk assessment should be considered as any other multi-step process involving diverse stakeholders and partners. The Group will need to develop a project plan with timelines, objectives, engagement, outputs and project risks. A well-developed project plan will ensure the Group has undertaken the context and scoping step of the risk management process.

The risk analysis step in particular requires careful preparation to ensure that workshops draw upon the expertise and experience of partners and stakeholders efficiently and effectively. For this reason, the preparation steps are laid out in a particular order.

Preparing pre-workshop materials and resources

It is strongly recommended the CDEM Group prepare the following before finalising timeframes for risk assessment workshops:

1. A risk assessment project plan
2. A risk assessment communications plan for partners and stakeholders
3. The customised Consequence Table to reflect the Group's social, built, economic and natural profile
4. Specific hazard scenarios – maximum credible events scenarios for each hazard selected for assessment
5. Material which aids the assessment, including maps and tables describing the region or descriptions of the economic and built elements within the Group's area. For example, the location of hospitals and the level of service at each; population density and deprivation maps etc.
6. Workshop materials: presentations, handouts, etc.

Note: The *Confidence table* provided in the toolbox does not require customisation or scaling.

To support each stage, a range of resources are provided in the toolbox. The next sections describe, in detail, how to use the tools and resources.

This Guideline does not provide information regarding the development of project or communications plans on the assumption that all Groups are familiar with developing such plans.

3.1.1 Preparing the Consequence Table

Purpose

The consequence table is not designed to determine a precise or exact measure of consequence. Instead it supports the assignment of relative consequence scores for a range of hazard scenarios across a set of elements. The table allows workshop participants to work from a standardised set of criteria to develop a common understanding of the impacts. The use of the same criteria and elements across a range of hazard scenarios allows Groups to explore common consequences and to use this information to support informed risk management.

Customising the Consequence Table

The consequence table template is designed to support a standardised approach to the assignment of consequence levels, while maintaining the ability of CDEM Groups to customise criteria to match the social and economic profile of their region. The template contains sample economic, social, built and natural tables and includes a list of suggested elements.

While customising the consequence table, CDEM Groups should consider the following aspects:

- Scalability: Adjusting the scale of numerical criteria to ensure they are appropriate for the Group's region (e.g. population, number of households etc). For example, an impact on 100 households might be considered 'moderate' in the context of a CDEM Group with a small population, but "minor" for a Group containing tens of thousands of households.
- Adding new elements (people, property, taonga and services): The elements provided in the template are not exhaustive. There may be additional elements relevant to the CDEM Group. For example, under the natural environment, a Group may choose to add the element "Coastlines and estuaries". Note: each new element requires the development of criteria for each consequence level, aligned to the base criteria.
- Amending the criteria of existing elements: The Group may wish to modify the existing criteria to better suit their needs. For example, the Group may choose to replace quantitative criteria such as displaced households with qualitative descriptions. These changes should reflect the data available to the Group and their ability to determine quantitative or qualitative impacts.
- Removing elements: Some of the elements provided in the template may not be applicable to the Group. For example, not all Groups will want to assess the impacts of hazards on reticulated gas supply if this utility is not available to their communities.

Social Environment Considerations: scale, duration and recoverability	Base Descriptors				
	No impact or negligible impact on people and/or social and cultural wellbeing	Minor impact on people and/or social and cultural wellbeing	Moderate impact on people and/or social and cultural wellbeing	Major impact on people and/or social and cultural wellbeing	Extreme impact on people and/or social and cultural wellbeing
	Consequence Level				
Elements	Insignificant	Minor	Moderate	Major	Extreme
Deaths	No deaths	1 - 2	3-10	11-99	>100
Injuries and illness - including psychological impacts	No significant change in illnesses and injuries	Noticeable short-term rise in numbers of people affected	Many affected, short-term recovery for all	Many affected. Long-term recovery for some, short-term recovery for most	Many affected. Permanent impacts on some people, long recovery for many
Households in need of accommodation	No alternative accommodation required	Some, localised/short term alternative accommodation required	Widespread short term or localised long-term alternative accommodation required	Widespread, long-term alternative accommodation required	Widespread need for permanent alternative accommodation
Displaced households	Negligible displacement	X-XX household and/or short duration	XX-XXX households medium term	XXX-XXX households long-term	>XXX households long-term and permanent displacement
Welfare services - emergency finance and other essential services support	No increase in demand	Noticible short-term rise in demand	Widespread short-term rise in demand	Widespread medium term rise in demand	Widespread, permanent increase in demand
Education services - access to preschool, school and tertiary services	No impact on services	Isolated and short term disruption	Multiple short term service disruption	Widespread short to medium term service disruption	Widespread, long term service disruption
Community services - local government and not for profit community support services	No impact on services	Isolated and short term disruption	Multiple short-term service disruptions	Widespread short-medium term service disruption	Widespread, long term service disruption
Social wellbeing and connectedness - participation and inclusiveness	No impact	Some communities affected for a short time	Many communiites affected for a shorrt time	Widespread impact on communities, medium term, some connections lost	Communites permanently lost, many communities disconnected/lose particpation long-term
Access to essential consumer products	No impact on supply	Isolated and short term disruption	Multiple short term disruptions	Widespread short to medium term disruptions	Widespread, long term disruption, loss of some supply chains
Cultural wellbeing - ability to participate in cultural life, recreation, rituals and activities, taonga	No impact	Some people unable to participate in cultural life and / or express their cultural identity - short term	Many people unable to participate in cultural life and/or express their cultural identity - short term	Many people unable to participate in cultural life and / or express their cultural identity - medium term	Many experience permanent loss of taonga, cultural identity, or ability to participate
Companion animals - pets, companion animals, non-production animals	No impact	<10 companion animals lost, killed or abandoned and unable to be reunited with owners	10-50 companion animals lost, killed or abandoned and unable to be reunited with owners	50-100 companion animals lost, killed or abandoned and unable to be reunited with owners	>100 companion animals lost, killed or abandoned and unable to be reunited with owners

Figure 11 The *Social* environment editable template. The base indicators are shown in the coloured green-to-red scale at the top of the page. A full size version can be found in Appendix E.

Consistency, version control and record keeping

The CDEM Group should use the same version of the consequence table for all hazards assessed. The consequence table should not be modified to suit a particular scenario by the removal or addition of elements. This allows for the consistent analysis and comparison of impacts across a range of scenarios. This applies even where no impact is expected. For example, a scenario focused on flooding in Fiordland should still consider the consequence to rail lines, as rail lines are present elsewhere in Southland and may be impacted by other scenarios. In the case of a Fiordland flood the impact on rail lines would be rated insignificant.

If new information requires further customisation of the Consequence Table, version control should be used to ensure each assessment records which consequence table was used. Modifications should be kept to a minimum and fully documented in order to retain the highest level of comparability across scenarios.

3.1.2 Preparing hazard scenarios

Hazard scenarios are prepared prior to the workshop

The first workshop should consider two or three hazard scenarios (for a full day workshop). The scenarios should be of a consistent scale e.g. the maximum credible event.

Some Groups may have pre-existing scenarios from previous work such as past assessment or projects such as AF8. Where this is the case the scenario should be reviewed to ensure it is still valid and to determine the likelihood.

If a suitable scenario is not available for a given hazard the Group should work with relevant experts to develop a scenario and associated likelihood.

It is recommended that scenarios be developed before workshop dates are set to ensure the scenario is ready, reviewed and fit for purpose.

Essential information on each hazard scenario

The role of workshop participants is to determine the consequence of the scenario to each element. Workshop participants should not attempt to change the scenario during the workshop. For this reason, it is essential to have a well-developed, defendable scenario including the:

- Magnitude, scale, location and/or extent of hazard phenomena. For example, shaking intensity maps for an earthquake scenario, flood extent and depth maps for a flood scenario. Consider if the scenario is associated with a particular location, e.g. coastal zones for tsunami, or variable, e.g. disease outbreak.
- Onset time and duration of the scenario. For example, earthquake shaking, and other phenomena such as liquefaction and landslides will be instantaneous, the duration of the event is brief; a volcanic unrest and eruption period may last days to years, and an infectious disease outbreak, weeks to months.
- Likelihood of each chosen scenario. Using the Risk Analysis and Summary Tool or the likelihood table (*Table 3*), convert the likelihood into a descriptor such as likely or unlikely. For example, the geological record and scientific expertise have determined that the probability of a major fault rupture for a given scenario is 1% over the next 100 years. This would equate to a likelihood of “rare”.

Developing the hazard scenarios - support from researchers and experts

Hazard scenarios are developed by subject matter experts, drawing upon the evidence and knowledge available to the CDEM Group. The Group can draw upon existing research reports, models, CDEM Group exercises, historical information and local knowledge including mātauranga Māori understanding of the environment. When developing or reviewing hazard scenarios, consider the diversity of ways researchers can contribute. For example, participation in a hazard scenario development workshop or by undertaking a peer review. Where new hazard scenarios are needed, and time is sufficient, consider partnerships with universities, whereby a postgraduate student develops the scenario for their research in partnership with the Group in a mutually beneficial arrangement. During the risk analysis workshop, the scenario will be presented to workshop participants who may then focus on the consequences of the scenario.

Hazard scenario example / checklist

The editable workshop PowerPoint provided in the toolbox includes an example hazard scenario presentation, showing the type of information participants could draw upon in workshops. The hazard scenario outline in the slides presumes that maps, models or historical information are provided to participants when available.

3.1.3 Workshop preparation

Participants and facilitation

To explore the full range of consequences of interest to the Group, it is important to ensure broad participation from those who are charged with managing assets (e.g. lifeline utilities, reducing vulnerability, e.g. council asset

managers, and those that can provide knowledge and/or evidence on the social, cultural, economic, and environmental impacts of hazards).

The facilitator should ideally not be a staff member of the CDEM Group Office. This is so CDEM Group Office staff can participate in workshops and provide their expertise and experience. An additional benefit of using an independent facilitator is that someone who has not been involved in previous emergency responses can bring an 'honest broker 'approach. This means they can test assumptions and request evidence to ensure that the participants draw upon knowledge and judgement wider than the most familiar or most recent events.

Workshop invitations

Invite participants early and include essential information about the purpose and goals of the workshop. This could be laid out in a one-page overview that describes the scope and the hazard scenarios. Information provided to participants should also explain that the workshop will explore the consequence of scenarios on elements using standardised tools. Make it clear participants are being invited because of their specific knowledge on either the hazard or an element of the social, built, economic or natural domain.

Pre-workshop resources

One or two weeks prior to the workshop, provide participants with information on the hazard scenarios which are to be assessed during the workshop. This should include enough information to allow them to draw upon their expertise, experience and available information relevant to potential consequences. For example, participants may have access to results of previous CDEM exercises, research reports, post-event reports, modelling, historical records, or oral and written local knowledge. Participants should be encouraged to bring relevant information to share with the other workshop participants (e.g. a map showing the power distribution network).

Sharing the consequence table ahead of the workshop is not recommended as it may result in participants developing entrenched views on impacts rather than reaching consensus based on the input of other participants.

3.2 Running a CDEM Group risk assessment workshop

Presentations

Before the workshop, agree who will present and facilitate each stage. It is recommended that the Group Manager welcomes participants and provides the overview of the workshop and its purpose, leaving the methodology overview and facilitation to the workshop facilitator.

Data entry and notes

To allow the facilitator to focus on moderating the discussion, a separate note taker should be used to record data into the consequence and confidence columns of the Risk Analysis and Summary Tool. It is also essential to record contextual notes which provide the background for each decision made by workshop participants.

Venue facilities and layout

The optimal layout is a U-shaped table set-up to ensure all participants can see the facilitator, the screen, and all other participants.

Workshop agenda

Sample half and full day agendas are available in the toolbox. The agenda should include a welcome, introductions, purpose, presentations, risk assessment, and wrap-up. The agenda should allow ample time to work through the first scenario analysis. The first analysis will take longer as participants become comfortable with the consequence table and exploring interdependencies. It is recommended no more than three scenarios be attempted during a full day workshop.

3.2.1 Introduction to the session

Welcome and introductions

Welcome the participants and ask everyone to introduce themselves and their role. This will help the facilitator to target specific elements to individual participants to kickstart discussion and support discussion between participants to ensure interdependencies are fully explored

Introduce the independent facilitator and any observers/technical advisors (e.g. NEMA staff).

Provide a safety briefing and describe the venue's facilities and amenities.

Purpose and agenda

Outline the plan for the day and the purpose of the assessment, explaining the link between an understanding of risk and the development of the CDEM Group plan. Describe the outcomes sought and explain why you have brought together this particular group of people. Introduce the schedule for the day including breaks and the expected finish time.

Scope

Explain that while the hazard scenarios and likelihood have been set by a group of experts, the consequences of each scenario have not. Explain that collectively, participants will contribute their expertise to build a picture of the impacts to the social, built, economic and natural environments to build an overall understanding of the risks that each scenario gives rise to.

Remind participants that they are being asked to think about the entire Group area, not just their own district or city. Any specific local issues should be captured in the contextual notes. For example, workshop participants, upon reviewing the criteria, may consider that the scenario will result in a major consequence for a given town but only a moderate consequence when the whole region is considered. It may be necessary to remind participants throughout the workshop to ensure decisions are made based on the whole region. This is especially important for scenarios which have a significant but localised impact such as a wildfire.

Introduce the methodology

Explain to participants the process used, including the explanation of scenarios and the subsequent assignment of consequence and confidence to each element under assessment. Take participants through the resources provided, including the consequence and confidence tables.

Explain that the hazard scenario will be assessed element by element, with participants asked to qualify why they have reached their decision and their confidence in the decision. While agreement on rankings (e.g. insignificant,

minor, major) is ideal, when there are gaps in knowledge or uncertainty, this can be expressed by assigning a lower confidence score. A lower confidence score is a useful indicator that further information should be sought before a decision is made regarding the management of the risk.

It is important to stress the need to review the consequence table from right to left, considering the maximum possible consequence which could result to a given element, assuming the scenario outlined has occurred.

When describing the confidence table, it is important to explain to participants that it should be used as a guide only and that any of the line items can be used to guide their selection of confidence.

A sample PowerPoint template is provided in the toolbox which provides a framework for these discussions.

3.2.2 Workshop presentations

Regional context presentation

After welcoming the participants and conducting housekeeping, the workshop should begin with a presentation of the context of the area under assessment. This is important to ensure all participants are working from the same set of assumptions.

It can be helpful to describe the region based on the four environments outlined in the consequence table. This will help participants consider the correct context at each stage.

Content should include the population of the region, significant towns, major industries, critical assets and other notable aspects. For example, a workshop in Otago should note the special demographic profile of the Queenstown Lakes District.

The sample workshop PowerPoint, located in the toolbox, contains sample slides for this presentation.

Hazard scenario presentation - Draw upon available expertise

The scenario which is to be assessed should be presented by a person with relevant expertise in the hazard. For example, a FENZ representative for a wildfire/urban fire scenario.

The presentation should cover the initiation/trigger for the scenario and the way the scenario progresses (e.g. the intensity, range and the types of phenomena that will result). For example, a scenario involving a large earthquake should include a map of expected shaking intensities, ground rupture and deformation areas, as well as landslide and liquefaction susceptibility zones. A fire scenario should include the ignition location and the expected fire shape over several time periods (e.g. 2, 4 and 6 hours). It should also include wind direction and smoke/ash effects, etc.

The scenario should avoid detailing the impacts of the scenario as these will be assessed by workshop participants. For example, the scenario may state that the local hospital is within the fireground, but it should not comment on the level of impact on health services or the fate of the building.

Assessment process presentation

The sample PowerPoint mentioned above contains slides explaining the assessment process - this should be used as the basis for this presentation. It is important during this presentation to remind participants that:

- The consequence table should be read from right to left, selecting the maximum possible consequence.
- It is not necessary to align to all three rows of the confidence table before selecting a confidence level. The confidence table should be used as a guide.
- The assessment is for the whole CDEM Group region.
- The assessment should be conducted on the basis that the scenario is happening. Changes to the scenario or its likelihood during an assessment can distract from the assessment of the consequence and confidence.

3.2.3 Determine the consequence, confidence and risk of elements

Analyse the consequences for each element within the scenario

Using their understanding of the scenario, participants should use the consequence table to collectively select the maximum possible consequence for each element. This should be conducted by consensus where possible or by using a simple vote if necessary. The facilitator may direct specific elements to individual participants where relevant to start the conversation before inviting other participants to discuss.

When assigning the consequence level, participants need to consider the exposure and vulnerability of the element. For example, "how many residential dwellings, commercial and other buildings are in a flood hazard area?" or "within the flood hazard area, are there any vulnerable groups of people that will have barriers to receiving warnings or evacuating?".

The discussion should be captured in contextual notes within the Risk Assessment and Summary Tool. The notes provide a rich source of information which decision makers can use when considering mitigation measures (see *Step 5: Evaluate and treat risks*).

Example

A flooding scenario is outlined to workshop participants. The event involves multiple streets within a town being submerged in fast flowing water.

Workshop participants review the consequence table and work together to select a consequence level for each element.

The first element the workshop considers is "*Households in need of accommodation*" The workshop participants review the appropriate row from right to left. They decide that in **the context of the whole region** an extreme impact (Widespread need for permanent alternative accommodation) will not occur, nor will a major impact (Widespread, long-term alternative accommodation required).

Social Environment Considerations: scale, duration and recoverability	Base Descriptors				
	No impact or negligible impact on people and/or social and cultural wellbeing	Minor impact on people and/or social and cultural wellbeing	Moderate impact on people and/or social and cultural wellbeing	Major impact on people and/or social and cultural wellbeing	Extreme impact on people and/or social and cultural wellbeing
	Consequence Level				
Elements	Insignificant	Minor	Moderate	Major	Extreme
Deaths	No deaths	1 - 2	3-10	11-99	>100
Injuries and illness - including psychological impacts	No significant change in illnesses and injuries	Noticeable short-term rise in numbers of people affected	Many affected, short-term recovery for all	Many affected. Long-term recovery for some, short-term recovery for most	Many affected. Permanent impacts on some people, long recovery for many
Households in need of accommodation	No alternative accommodation required	Some, localised/short term alternative accommodation required	Widespread short term or localised long-term alternative accommodation required	Widespread, long-term alternative accommodation required	Widespread need for permanent alternative accommodation

Continuing to review the consequence table from right to left, participants conclude a moderate consequence level is appropriate (Widespread short term or localised long-term alternative accommodation required) on the basis that one town within their region will require long term alternative accommodation.

The person undertaking data entry captures notes outlining the conversations which occur as the group work to reach their decision. In particular, they note which part of the moderate criteria was used.

> ~~*Widespread short term*~~ ***or*** *localised long-term alternative accommodation required*

The workshop participants now consider their level of confidence in the consequence level they have chosen.

Select a confidence level

After a consequence level has been assigned participants should use the confidence table to indicate their level of confidence in their decision. The confidence table has three criteria for assessment of confidence. These are:

- Supporting evidence, e.g. scientific models or information regarding similar historical events was used in the decision
- The necessary expertise is available in the room, e.g. a question regarding power networks requires input from someone with knowledge of the network in order to assign a high level of confidence
- The agreement of participants. Failure to obtain consensus among workshop participants should result in the assignment of a lower confidence score.

Example continued

Participants now consider their confidence in the decision made above. Reviewing the confidence table they conclude that while they agree on the maximum consequence level, and the scenario is based on extensive research and modelling, they didn't have participants in the room with expertise regarding the length of time the houses will be unable to be occupied. Taking these aspects into account the group select a moderate confidence.

The person undertaking data entry records the conversation and notes that follow up with experts will increase the level of confidence in the assessment.

Risk level

The Risk Analysis and Summary Tool combines the scenario likelihood (identified during the development of the scenario) with the consequence level, to assign a risk level based on the risk matrix (*Appendix F*). The tool also assigns an overall level of risk using the scenario likelihood and combined consequence score outlined above.

Example continued

Because the workshop is using the Risk Analysis and Summary Tool, the risk level for each element, and the overall risk level are automatically calculated and displayed within the tool.

3.3 After the workshop

After the workshop, the consequence and confidence ratings for each element should be reviewed, along with the contextual notes. If an element has been assigned a low level of confidence, further information should be sought. This may involve following up with an agency not represented at the workshop or seeking expert advice on an aspect of the scenario's impacts. This is also the time to ensure the contextual notes make sense and clarify any shorthand notes while memory of the workshop is still fresh.

3.3.1 Viewing the results

The Risk Analysis and Summary Tool provides a range of outputs which help identify trends and patterns in the data gathered during workshops. The outputs are described further in *Appendix B.5* and include:

- A risk overview table where risk levels assigned to each element can be viewed across all assessed scenarios
- An element analysis tool which compares the impacts of all scenarios on individual elements
- A risk by environment chart showing the risk level by scenario, broken into each environment
- A consequence by environment chart showing the consequence level by scenario, broken into each environment
- The Risk Matrix, which plots each scenario by summary consequence and risk level, to provide an overview of the relative position of each scenario.

3.3.2 Evaluating consequences scores and risk scores

It is necessary to complete a range of hazard scenarios before attempting to evaluate consequence or risk scores using the yellow tabs within the Risk Analysis and Summary Tool. These tabs allow for comparison across multiple scenarios and the identification of elements most impacted. It also allows for the identification of treatment options which mitigate risks arising from a range of sources.

While this DGL focuses on risk at an element by element level, it may also be necessary to understand the overall consequence and risk level of a hazard scenario.

There are several options for summarising results, each with benefits and limitations (*Table 6*). The Risk Analysis and Summary Tool uses a logarithmic

process to calculate a combined consequence score for each scenario. The logarithmic method ensures severe consequences for one element are not diluted by minor consequences for other elements.

The logarithmic method also ensures overall ratings are based on consequence levels and not influenced by the number of elements assessed. More information regarding these methods is provided in *Appendix D*, including worked examples.

Similarly, consequence scores can be summarised by element across a range of different scenarios. This can be useful to direct investment to areas which treat the impact of a range of hazard types on a specific element (e.g. bridges).

3.3.3 Exporting results to a risk register

While the Risk Analysis and Summary Tool is suitable to store individual elements, ratings and notes, it may also be necessary to present the information in other, more accessible ways. This could include reports, PowerPoint presentations or other formats. The toolbox contains a Risk Summary Template which is useful to present information about each hazard including the background to the hazard, known risks, existing controls and potential treatments.

Data could also be presented by element or environment, across multiple scenarios, providing further insight into the data gathered during workshops.

The Risk Analysis and Summary Tool has features to support the exporting of graphs and data. These are outlined in *Appendix B.5*.

3.3.4 Monitoring and review

While risk assessment should be conducted on an ongoing basis as part of the risk management cycle, it may be necessary to re-evaluate risks early, if circumstances change. Such changes could include:

- New understanding of the hazard
- Demographic changes
- New land development

When new information is available it is useful to conduct a tabletop review to determine if the change is significant and should trigger a new risk assessment.

Section 4 Appendices

Appendix A References

National Emergency Risk Assessment Guidelines, 2015, Australian Institute for Disaster Resilience CC BY-NC

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Saunders, W.S.A., 2017. Setting the scene: the role of iwi management plans in natural hazard management. GNS Science Report 2017/30, p34.

Standards Australia International; Standards New Zealand, 2004. AS/NZS 4360: 2004: risk management. Standards New Zealand.

Appendix B Tools and templates

Introduction

To support the application of the Guideline, this section provides an overview of templates and tools available in the online toolbox.

The tools and templates available are:

- Workshop planning checklist
- Consequence table template
- Confidence table
- Workshop PowerPoint template
- Risk Analysis and Summary Tool
- Risk summary template

B.1 Workshop planning checklist

The workshop planning checklist can be used to ensure all steps are completed ahead of the risk assessment workshop. The list contains prompts for actions such as amending the consequence table, developing scenarios, creating the PowerPoint and printed materials.

B.2 Consequence table template

The consequence table template is available in the toolbox. The template should be customised to fit the demographic and economic profile of your region. Any changes to the elements assessed should also be updated in the template along with updated criteria. Screenshots of sample consequence tables are provided in *Appendix E*

B.3 Confidence table

Once a consequence level has been assigned to an element, workshop participants should assess the level of confidence they have in their decision. The **confidence table** provides a consistent way to evaluate confidence based on supporting evidence, available expertise and participant agreement. The table is designed to be nationally consistent and shouldn't be amended.

Confidence Table

	Lowest	Low	Moderate	High	Highest
Supporting Evidence	• No historical events • No scientific model	• Anecdotal information of historical events • Scientific model which could be applied with significant modification	• Historical event of similar magnitude in a comparable community of interest • Relevant scientific model available	• Recent historical event of similar magnitude in a directly comparable community of interest • Good scientific model available	• Recent historical event of similar magnitude to that being assessed in the community of interest • Highest quality scientific model
Expertise	No expertise is available	Expertise is available	Relevant expertise is used to make decision	Relevant expertise is highly influential in the decision	Relevant and demonstrated expertise available and highly influential in making the decision
Participant Agreement	Fundamental disagreement of assessment	Disagreement of major aspects of assessment	Disagreement of minor aspects of assessment	Agreement of assessment	Strong agreement of assessment

Figure 12 Confidence Table

B.4 Workshop PowerPoint template

The workshop PowerPoint template provides a framework for the creation of a PowerPoint for use in the risk assessment workshop. The template contains slides for each section, content suggestions and explanatory notes. Several slides are also provided to explain the environments and risk assessment process to workshop participants.

B.5 Risk Analysis and Summary Tool

The Risk Analysis and Summary Tool provides a central place to store and analyse data gathered as part of the risk assessment process. The tool also automates much of the calculation process, providing instant risk ratings without the use of a risk matrix and manual calculation.

Before using the Risk Analysis and Summary Tool it is necessary to complete the following steps:

- Establish the context
- Communicate and consult
- Identify risks and select elements for assessment
- Develop the consequence table
- Develop the scenario

Symbols

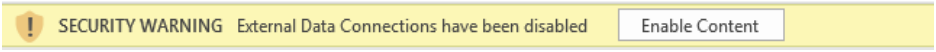
Columns marked with a calculator symbol are auto calculation columns. These columns are locked for editing.

Columns marked with a pencil require data entry.

Important Notices

1) The Risk Analysis and Summary Tool is a macro enabled workbook.

If the following security warning is displayed, 'enable content' must be selected to enable all features.



2) The tool must be saved as a macro enabled workbook (.xlsm file) at all times.

Saving the tool as .xls or .xlsx will permanently remove most features. If the workbook is saved incorrectly the following warning will display on the 'Introduction' tab. The only way to resolve this issue is to download a new copy of the tool and transfer all data from the broken tool.

Warning this tool must be saved as a .xlsm file. Please download a new copy from the NEMA website.

B.5.1 Steps to use the Risk Analysis and Summary Tool

Step 1: Complete the Scenarios Tab

Once scenarios have been developed, details should be recorded in the 'Scenarios' tab.

Hazard	Scenario	Code	Likelihood	Percentage of Elements Assessed				Scenario Notes
				Economic	Built	Social	Natural	
Cyclone	Bola	Cy-Bola	Almost Certain	100%	100%	100%	100%	
Cyclone	Fehi	Cy-Fehi	Likely	100%	100%	100%	100%	
Flood	2004 event	Fl-2004 event	Almost Certain	100%	100%	100%	100%	
Landslide	Manawatu	La-Manawatu	Rare	100%	100%	100%	100%	
Earthquake	AF8	Ea-AF8	Unlikely	100%	100%	100%	100%	

Figure 13 Screenshot of the Scenarios tab

The tab has columns for the:

- Hazard type (e.g. 'Flood')
- Scenario name (e.g. 'Taupo' or 'MCE')
- Code (see below for explanation)
- Likelihood (see below for explanation)
- Percentage of elements assessed across each environment (see below for explanation)
- Scenario Notes

The **code** is used in graphical outputs such as the risk overview table and graphs to identify individual scenarios. It is formed using the first two letters of the hazard name, hyphenated with the scenario name. To ensure graphic outputs are legible – keep scenario names short and descriptive.

The Risk Analysis and Summary Tool requires a **likelihood** descriptor to determine the risk level for each element assessed. If a scenario has an annual exceedance probability (AEP) or annual recurrence interval (ARI), these can be converted into a descriptor using the 'Likelihood Converter' tab (see the Scenario Likelihood section below).

The **percentage of elements assessed** is a helpful 'at-a-glance' way to determine the progress of the assessment for each scenario. The progress score reflects the number of elements which have been assigned a consequence rating, as a proportion of the total number of elements listed in the elements tab.

Step 1a: Scenario Likelihood – Page 36

Using the information in your scenario summary, determine the qualitative likelihood term (e.g. rare, possible) for each scenario.

To use the likelihood converter, enter an AEP or ARI into the appropriate field. A qualitative likelihood descriptor will be displayed in the bottom box. Take care to ensure the correct descriptor is used, i.e. AEP left-hand side, ARI right-hand side.

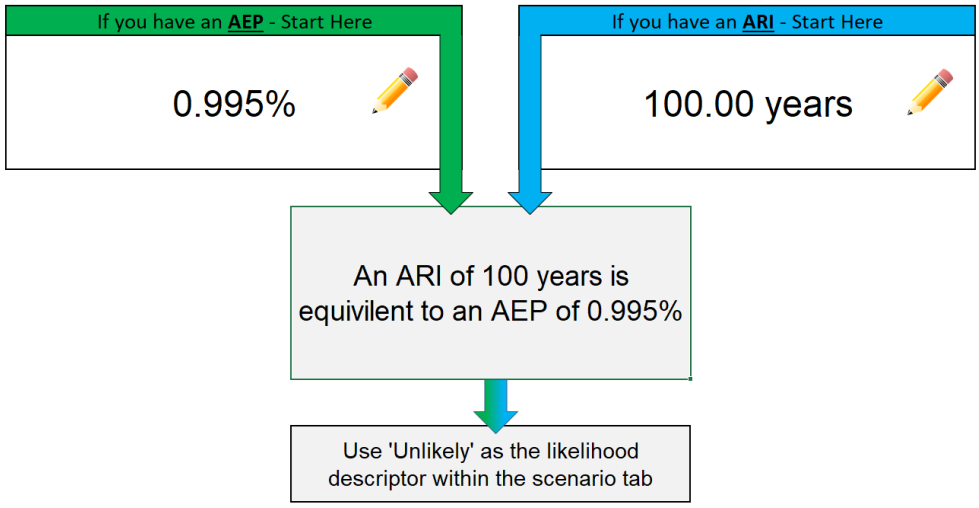


Figure 14 Screenshot of the likelihood converter

Step 2: Update Elements

The elements tab contains elements listed on the consequence table template. Any changes to the elements in the sample consequence table should be reflected on this tab.

Built	Social	Economic	Natural
Number of residential buildings requiring assessment	Deaths	Costs to Individuals	Air quality and associated ecosystem services
Number of commercial buildings requiring assessment	Injuries and illness	Costs to Businesses, Commercial entities and Industries	Impacts to biodiversity
Number of government and non commercial buildings requiring assessment	Households in need of accommodation	Costs to Local and Central Government	Freshwater quality (ground and surface water) and associated ecosystem services
Damage or loss of access to emergency facilities, impacting function (incl health)	Displaced households	Impacts on Key Economic Sectors	Marine water quality and associated ecosystem services
Impacts to Potable Water	Welfare services	Impacts on employment	Soil quality and associated ecosystem services
Impacts to Storm and Wastewater	Impacts on important community and cultural events	Impacts on Regional Productivity	
Impacts to Reticulated Gas	Impacts on education services		
Impacts to Land Transportation (road, rail)	Impacts on community services		
Impacts to Ports and Airports	Social capital		
Impacts to Telecommunications	Access to essential consumer products		
Impacts to Fuel Distribution	Cultural capital		
Supply of Electricity			

Figure 15 Screenshot of the Elements tab

Lists must not contain empty rows between filled rows.

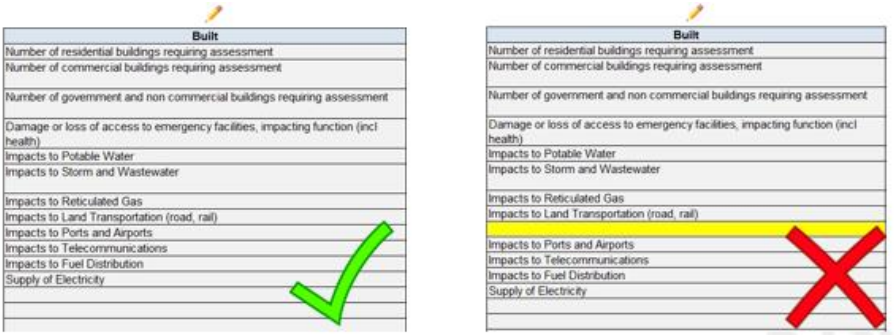


Figure 16 Screenshot of the Elements tab. Lists within this tab must not contain empty rows

Step 3: Complete pre-workshop rows within the Risk Analysis tab

Before the risk assessment workshop, the following columns should be filled out for each element, i.e. one element per row for each scenario being assessed.

- Hazard
- Scenario
- Environment
- Element
- Likelihood

Select the scenario you are analysing **first**. Once the scenario is selected from the drop-down list, the hazard and likelihood columns will automatically populate using the information entered in the **Scenarios** tab.

Using the drop-down menus, select an environment followed by an element. Complete this process for all scenarios and elements requiring assessment.

Hazard	Scenario	Environment	Element	Likelihood
Cyclone	Cy-Bola	Built	Number of residential buildings requiring assessment	Almost Certain
Cyclone	Cy-Bola	Built	Number of commercial buildings requiring assessment	Almost Certain

Figure 17 Screenshot of columns B-F of the Risk Analysis tab

Step 4: During the risk assessment workshop – Pages 45-48

1) Assign a consequence and confidence level for each element and add notes

During the risk assessment workshop, workshop participants collectively assign each element (entered in the previous step) a level of consequence based on the scenario. Participants then select a confidence level based on their collective confidence in their decision. It is important that decisions regarding the consequence and confidence are based on the criteria tables provided in the online toolbox. See pages 32-47 of the Guideline for more information.

For each element fill in the following:

- Consequence
- Confidence
- Risk Level
- Risk Assessment Notes

Likelihood	Consequence	Confidence	Risk Level	Sort By Risk Level / Unsort	Risk Assessment Notes
Almost Certain	Insignificant	Highest	Medium		The reason for the choice of consequence and confidence can be outlined here. This can be very helpful during later consideration of identified risks
Almost Certain	Moderate	Highest	Very High		The reason for the choice of consequence and confidence can be outlined here. This can be very helpful during later consideration of identified risks
Almost Certain	Insignificant	Moderate	Medium		The reason for the choice of consequence and confidence can be outlined here. This can be very helpful during later consideration of identified risks

Figure 18 Screenshot of columns F-J of the Risk Analysis tab

For each element, once the consequence level has been entered into the tool, a risk level is automatically calculated. The tool does this by combining the chosen consequence level with the scenario likelihood using the risk matrix.

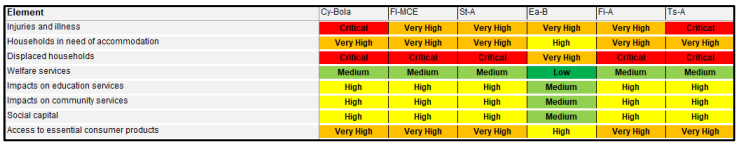
To aid the risk evaluation and risk treatment stages, it is essential that contextual information is recorded in the 'Risk Assessment Notes' column outlining the basis for each decision.

Step 5: After the risk assessment workshop – Pages 69-70

Yellow Tabs - Tools for analysis and evaluation

Yellow tabs within the Risk Analysis and Summary Tool provide various graphical ways to view data gathered during workshops. Some tabs can be exported to file. See the export features listed below.

Tab	Description
Risk Overview Table	The risk overview table aids analysis of risk by allowing users to identify elements which have consistently high-risk levels across multiple scenarios. By considering elements across multiple scenarios, risk reduction measures which address common exposure or vulnerability characteristics can be employed, increasing their efficiency and effectiveness.
Element Analysis	The element analysis tab allows users to select individual elements and review the total risk level across all scenarios. *Export to .csv and .png*
Risk by Environment	Risks by environment displays the risk level of all assessed scenarios, across the four environments. This graph allows users to identity environments with high impacts for further analysis *Export to .csv and .png*
Consequence by Environment	The consequence by environment tab allows users to review consequence across the four environments. This tab is useful for identifying impacts that, while unlikely, could have significant consequences. *Export to .csv and .png*
Risk Matrix	The risk matrix plots each scenario using the log average process outlined in *Appendix D*.



Element	Cy-Bola	FI-MCE	St-A	Ea-B	FI-A	Ts-A
Injuries and illness	Critical	Very High	Very High	Very High	Very High	Critical
Households in need of accommodation	Very High	Very High	Very High	High	Very High	Very High
Displaced households	Critical	Critical	Critical	Very High	Critical	Critical
Welfare services	Medium	Medium	Medium	Low	Medium	Medium
Impacts on education services	High	High	High	Medium	High	High
Impacts on community services	High	High	High	Medium	High	High
Social capital	High	High	High	Medium	High	High
Access to essential consumer products	Very High	Very High	Very High	High	Very High	Very High

Figure 19 Screenshot of the Risk Overview Table

A filter drop-down (top left) contains a list of all hazards for which a scenario has been entered in the 'Scenario' tab. This filter is most useful if the Group has completed several scenarios for a particular hazard. By selected a single hazard, only scenarios related to that hazard are shown.

Export to .png

The final tab provides tables for reference only. Templates for printing are provided in the online toolbox.

2) Export to .PNG

An export button on each graph allows the current view to be exported as a .png file.

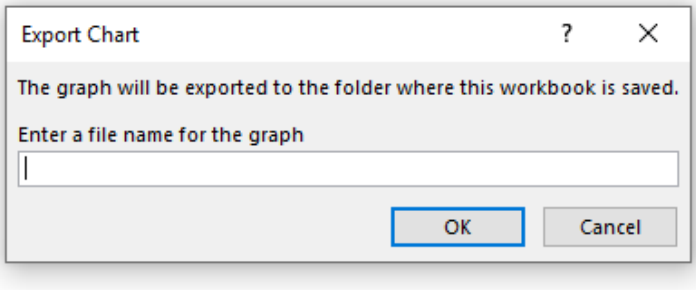


Figure 20 Export chart dialog box

A box will appear asking for a file name. The file will be saved to the same location as the Risk Analysis and Summary Tool. If a file with the same name already exists in this location, the system will prompt for a different file name.

Once the file has been exported, the system will show a confirmation message.

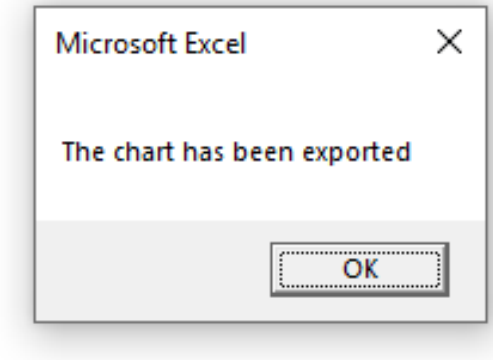


Figure 21 Confirmation dialog box

3) Export to .CSV

Data from graphs (excluding the risk matrix) can be exported as a .CSV file. The file can be used to recreate and customise the graph as required. The

export process for the .CSV file is the same as the process for .PNG file export (outlined above).

Note .csv files provide numbers in place of descriptors for risk and consequence levels. The following table provides a quick reference for converting numbers back to risk or consequence levels.

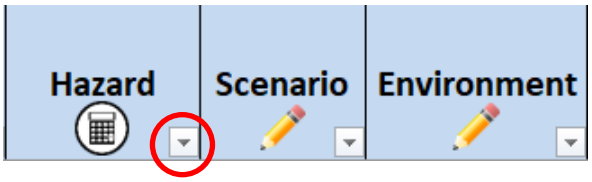
Number in .csv file	Risk Level	Consequence Level
1	Rare	Insignificant
2	Unlikely	Minor
3	Possible	Moderate
4	Likely	Major
5	Almost Certain	Extreme

4) Additional features

Elements within the risk analysis tab can be sorted and filtered to aid evaluation.

To sort elements by risk, use the ‘sort’ and ‘unsort’ buttons at the top of the ‘Risk level’ column.

To filter by hazard, scenario, environment, element or any other column, use the filter buttons (circled) at the top of each column.



B.6 Risk summary template

The risk summary template provides an example layout for summarising all information regarding a specific hazard. The template provides the context, details of the risk analysis and risk rating and overview of risk evaluation. The reverse side provides an overview of the hazard across all 4Rs. If Groups wish to develop their own summary sheets the minimum suggested headings for developing content are listed on page 48.

A sample profile is provided in *Appendix G*

Appendix C Likelihood calculations: ARI and annual exceedance probability

Note: The following is for information only. The Risk Analysis and Summary Tool available in the online toolbox includes a likelihood converter which can be used to convert ARI and AEP into a qualitative descriptor for use in the risk assessment.

Where an Annual Return Interval (ARI) is the only information available, an annual exceedance probability can be calculated using the formula below:

Equation 1

$$AEP = \left(\frac{\left(\exp\left(\frac{1}{ARI}\right) - 1 \right)}{\exp\left(\frac{1}{ARI}\right)} \right) * 100$$

AEP = the percentage likelihood of occurrence between 1 and 100.

ARI = the average return interval.

The table below provides a range of annual exceedance probabilities with equivalent annual recurrence intervals (rounded) and likelihood descriptors.

Note: an event that happens on average once per year, is not guaranteed to occur within any given year, so the probability is lower than 100%; that is, it is likely to happen, but not certain to happen.

Annual Exceedance Probability (AEP %)	Average Return Interval (ARI) (Rounded)	Qualitative descriptor
63	1	Almost certain
18	5	Likely
9.5	10	Possible
4	25	Possible
2	50	Possible
1	100	Possible
0.4	250	Unlikely
0.2	500	Unlikely
0.1	1,000	Unlikely
0.04	2,500	Rare

Appendix D Logarithmic averaging of risk and consequence scores

Note: The following is for information only. The Risk Analysis and Summary Tool, available in the online toolbox, calculates both overall and environment scores using a logarithmic scoring system.

A logarithmic scoring system is presented as best practice for determining an overall consequences score which is then combined with the likelihood to determine the risk level. This method captures the importance of high scoring impacts while avoiding an artificially high score in situations where only one element receives a high consequence score while all others are low. It can also be used to compare the scores for separate environments, for example pandemic or other health emergencies will likely score very high in all social impacts including people's health but have negligible effects on the built and natural environments.

Such information can be useful in CDEM planning as it allows CDEM Group members to see which impacts are manageable and which may require special planning or management.

To allow for calculation the risk and/or consequence level is represented as a number shown in Table 10.

Table 10 Conversion values for risk / consequence calculation.

Risk level / **Consequence** level	Number for calculation
Critical / **Extreme**	1
Very High / **Major**	2
High / **Moderate**	3
Medium / **Minor**	4
Low / **Insignificant**	5

Logarithmic Method

Each risk assessment requires participants to consider how a specified hazard scenario may impact a range of elements across each environment. This is done by assigning a consequence level to each element based on a consequence criteria table. To determine an overall consequence score, a logarithmic formula is applied. This formula averages all consequence scores and reflects the significance of higher-level consequence scores for those that must manage the risk. The method is as follows:

$$Overall\ Consequence = \log_{10}\left(\frac{10^{Consequence\ 1} + 10^{Consequence\ 2} + 10^{Consequence\ 3} + \ldots + 10^{Consequence\ n}}{n}\right)$$

Other Methods

The guideline provides two additional methods with which to calculate the overall consequence rating. Note: the following methods are not supported by the Risk Analysis and Summary Tool.

Averaging All Scores

This method employs a simple additional and division approach.

$$Score\ (or\ ranking) = \left(\frac{Consequence\ 1 + Consequence\ 2 + Consequence\ 3 + \cdots + Consequence\ n}{n}\right)$$

Select the Highest Score

This method uses the highest consequence score for an individual element to represent the overall consequence.

$$Score\ (or\ ranking) = max(Consequence\ 1, Consequence\ 2, Consequence\ 3, \ldots, Consequence\ n)$$

Appendix E Sample Consequence tables

Social Environment Considerations: scale, duration and recoverability	Base Descriptors				
	No impact or negligible impact on people and/or social and cultural wellbeing	Minor impact on people and/or social and cultural wellbeing	Moderate impact on people and/or social and cultural wellbeing	Major impact on people and/or social and cultural wellbeing	Extreme impact on people and/or social and cultural wellbeing
	Consequence Level				
Elements	**Insignificant**	**Minor**	**Moderate**	**Major**	**Extreme**
Deaths	No deaths	1 - 2	3-10	11-99	>100
Injuries and illness - including psychological impacts	No significant change in illnesses and injuries	Noticeable short-term rise in numbers of people affected	Many affected, short-term recovery for all	Many affected. Long-term recovery for some, short-term recovery for most	Many affected. Permanent impacts on some people, long recovery for many
Households in need of accommodation	No alternative accommodation required	Some, localised/short term alternative accommodation required	Widespread short term or localised long-term alternative accommodation required	Widespread, long-term alternative accommodation required	Widespread need for permanent alternative accommodation
Displaced households	Negligible displacement	X-XX household and/or short duration	XX-XXX households medium term	XXX-XXX households long-term	>XXX households long-term and permanent displacement
Welfare services - emergency finance and other essential services support	No increase in demand	Noticible short-term rise in demand	Widespread short-term rise in demand	Widespread medium term rise in demand	Widespread, permanent increase in demand
Education services - access to preschool, school and tertiary services	No impact on services	Isolated and short term disruption	Multiple short term service disruption	Widespread short to medium term service disruption	Widespread, long term service disruption
Community services - local government and not for profit commuinity support services	No impact on services	Isolated and short term disruption	Multiple short-term service disruptions	Widespread short-medium term service disruption	Widespread, long term service disruption
Social wellbeing and connectedness - participation and inclusiveness	No impact	Some communities affected for a short time	Many communiites affected for a shorrt time	Widespread impact on communities, medium term, some connections lost	Communites permanently lost, many communities disconnected/lose particpation long-term
Access to essential consumer products	No impact on supply	Isolated and short term disruption	Multiple short term disruptions	Widespread short to medium term disruptions	Widespread, long term disruption, loss of some supply chains
Cultural wellbeing - ability to participate in cultural life, recreation, rituals and activities, taonga	No impact	Some people unable to participate in cultural life and / or express their cultural identity - short term	Many people unable to participate in cultural life and/or express their cultural identity - short term	Many people unable to participate in cultural life and / or express their cultural identity - medium term	Many experience permanent loss of taonga, cultural identity, or ability to participate
Companion animals - pets, companion animals, non-production animals	No impact	<10 companion animals lost, killed or abandoned and unable to be reunited with owners	10-50 companion animals lost, killed or abandoned and unable to be reunited with owners	50-100 companion animals lost, killed or abandoned and unable to be reunited with owners	>100 companion animals lost, killed or abandoned and unable to be reunited with owners

Built Environment Considerations: scale, duration, ability to relocate function/service and recoverability	Base Descriptors				
	No impact or negligible impact on structures and the services/functions they provide	Minor impact on structures and the services/functions they provide	Moderate impact on structures and the services/functions they provide	Major impact on structures and the services/functions they provide	Extreme impact on structures and the services/functions they provide
	Consequence Level				
Elements	Insignificant	Minor	Moderate	Major	Extreme
Number of residential buildings unusable due to damage	Negligible impacts	≤50	51-250	1000-9,999	>33% or >10,000, long-term
Number of commercial buildings unusable due to damage	Negligible impacts	≤10	11-100	101-500	>33% or >500 and/or CBD non functional long-term
Number of government and non-commercial buildings unusable due to damage	Negligible impacts	≤10	11-100	101-500	>33% or >500 or major non-commerical functions non-functional long-term
Damage or loss of access to emergency facilities, impacting function (incl health)	Negligible impacts	≤5	6-10	11-25	>33% or >25 emergency functions non-functional long-term
Impacts to potable water services	Negligible impacts	Isolated and short term disruption	Multiple short term service disruptions	Widespread short to medium term service disruptions	Widespread, long term service disruption
Impacts to Storm and Wastewater services	Negligible impacts	Isolated and short term disruption	Multiple short term service disruptions	Widespread short to medium term service disruptions	Widespread, long term service disruption
Impacts to Reticulated Gas	Negligible impacts	Isolated and short term disruption	Multiple short term service disruptions	Widespread short to medium term service disruptions	Widespread, long term service disruption
Impacts to Land Transportation (road, rail)	Negligible impacts	Short term minor closures	Short term minor closures and/or critical link closure	Medium term closures, including critical links	Long term critical closures
Impacts to Ports and Airports	Negligible impacts	Temporary disruption/closures	Short term disruption and/or temporary major hub closure	Major hub - Medium term disruption/closure	Major hub - Long term disruption
Impacts to Telecommunications	Negligible impacts	Isolated and short term disruption	Multiple short term service disruptions	Widespread short to medium term service disruptions	Widespread, long term service disruption
Impacts to Fuel Distribution/Availability	Negligible impacts	Isolated and short term disruption	Multiple short term service disruptions	Widespread short to medium term service disruptions	Widespread, long term service disruption/closure
Impacts to Electricity Supply	Negligible impacts	Isolated and short term disruption	Multiple short term service disruptions	Widespread short to medium term service disruptions	Widespread, long term service disruption

*BAU = Business as usual

Economic Environment Considerations: scale, duration and recoverability	Base Descriptors				
	No impact or some local impact to the economy and financial systems	Minor impact on the regional economy and financial systems	Moderate impact on the regional economy and financial systems	Major impact on the regional economy and financial systems	Extreme impact on the regional economy and financial systems

	Consequence Level				
Elements	**Insignificant**	**Minor**	**Moderate**	**Major**	**Extreme**
Direct losses to individuals	No impact	A small number of people affected with minimal financial losses	Many individuals with financial losses	Many people affected, with large financial losses	Whole of community impacts with large financial losses
Direct losses to businesses, commercial entities and industries	No impact	Short term disruption and/or minimal impact to profitability	Medium-term loss of value/ output and/or localised business failure	Long-term loss of value/ output and/or localised business failures	Permanent loss of value/ output and/or widespread business failure
Direct losses to Local and Central Government	No impact	Short-term increases in costs	Medium term increase in costs, minimal loss of assets	Long term increases in costs, some loss of assets	Long term costs increases, and significant loss of asset value
Losses and disruption to the Region's Key Economic Sectors/Industries/Employers	No impact	Short term loss of output for a key sector	Medium term loss of output for a key sector	Long term loss/closure of of a key sector	Permanent closure of key economic sector(s)
Direct impacts on employment/job sector	No impact	Short-term disruption to employmen	Medium-term reduction in employment	Medium to long term reduction in employment	Widespread, permanent job losses
Total financial losses (replace percentage with GRP values - see toolbox for Regional Product Value)	<1% of Gross Regional Product	1-2% of Gross Regional Product	2-3% of Gross Regional Product	3-4% of Gross Regional Product	>4% of Gross Regional Product

Natural Environment	Base Descriptors				
	No impact on the natural environment and the ecosystem services provided	Minor impact on the natural environment and the ecosystem services provided	Moderate impact on the natural environment and the ecosystem services provided	Major impact on the natural environment and the ecosystem services provided	Extreme impact on the natural environment and the ecosystem services provided

	Consequence Level				
Elements	Insignificant	Minor	Moderate	Major	Extreme
Air quality and associated ecosystem services	No impact	Temporary, localised impact	Sustained localised impact, or widespread short-term impact	Widespread, harmful degradation of air quality	Permanent, harmful degradation of air quality
Soil quality and associated ecosystem services	No impact	Temporary, localised impact	Sustained localised impact, or widespread short-term impact	Widespread, degradation of soil quality and loss of ecosystem services	Permanent, degradation of soil quality and loss of ecosystem services
Freshwater quality, ground and surface water, wetlands and associated ecosystem services	No impact	Temporary, localised impact	Sustained localised impact, or widespread short-term impact	Widespread degradation of water quality	Permanent degradation of water quality, harmful to aquatic life
Marine environment and ecosystem services	No impact	Temporary, localised impact	Sustained localised impact, or widespread short-term impact	Widespread loss or degradation of the marine environment	Permanent loss or degradation of the marine environment, harmful to marine life
National parks, forests and bush reserves	No impact	Temporary, localised impact	Widespread impacts to forest and bush, medium-term recovery	Widespread impacts on forest and bush - long-term recovery	Permanent widespread loss of forest and bush

Appendix F Risk Matrix

		Consequence				
		Insignificant	**Minor**	**Moderate**	**Major**	**Extreme**
Likelihood	**Almost Certain**	Medium	High	Very High	Critical	Critical
	Likely	Medium	High	Very High	Very High	Critical
	Possible	Low	Medium	High	Very High	Very High
	Unlikely	Low	Low	Medium	High	Very High
	Rare	Low	Low	Low	Medium	High

Appendix G Risk summary (profile) example

Please see the summary sheet template in the online toolbox. Screenshot examples are provided below.

Example Risk summary – Earthquake

Context

Hazard definition and context

Define and describe the hazard, including how it can occur and what phenomena are associated with the hazard. *E.g. Earthquake hazards include shaking, ground acceleration, land deformation, liquefaction. Earthquakes often trigger co-seismic landslides, which can also lead to dam break floods. Earthquakes can trigger tsunami through underwater land deformation or co-seismic landslides under- or into- water. Earthquake shaking can also trigger seiche waves in enclosed water bodies, such as lakes, harbours and bays.*
Describe the historical context of the hazard including significant historical events.
Describe links with other hazards (e.g. triggered by, or could trigger other hazards).

Magnitude and frequency

Provide information on whether this hazard has eventuated in the past
Describe the number or rate of occurrence, usually for a given time period
Provide a high level summary of the consequences from past events.

Magnitude	Annual average	In general
4.0 - 4.9	352.05	1 per day
5.0 – 5.9	27.26	2 per month
6.0 – 6.9	1.63	3 per 2 years
7.0 – 7.9	0.26	1 per 4 years
8.0 and over	0	1 per century

Example: Frequency of New Zealand Earthquakes (1960 to 2016). Source: GeoNet

Exposure

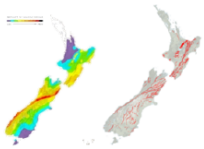
Describe people, property and services exposed to the hazard, including regionally- and nationally-significant assets. Include a summary of the count or value of people, property and services in the area exposed to the hazard e.g. number of people living within 100m of known faults.

Vulnerability

Describe how the people, property and services exposed to the hazard are vulnerable to the hazard. E.g. identified earthquake prone buildings, rigid pipe networks.
Describe how people, property, taonga and services may be vulnerable to this particular hazard – what controls the degree of damage e.g. construction type for buildings, ability to evacuate quickly for people.

Modelling, mapping and geospatial analysis

Include any maps or visual representations of the hazard you may have.



Risk Analysis

Scenario descriptions

Scenarios

Maximum Credible Event
For example: A magnitude 7.5 earthquake on the Wellington Fault mid-afternoon on a weekday. Major shaking (MMVI-IX) in the region, landslides and ground deformation. Seiching in the Wellington harbour and liquefaction in some coastal and riverside areas.
Mid-Range Event
Earthquake M6-6.5 within 50km of Wellington. Shaking intensities up to MMVII

Uncertainty / Confidence Level

Indicate the relative confidence in the data and/or assumptions and judgements used in developing the Risk Profile. Document any critical gaps in information

Summary of consequences to people, property and services

Using the four recovery environments describe potential impacts to people and other assets of value.

Social environment

Scenario one: Describe the key impacts to people and the social environment.
Scenario two: Describe the key impacts to people and the social environment.

Economic environment

Scenario one: Describe the key impacts to the regional economy.
Scenario two: Describe the key impacts to the regional economy.

Built environment

Scenario one: Describe the key impacts to buildings and infrastructure.
Scenario two: Describe the key impacts to buildings and infrastructure.

Natural environment

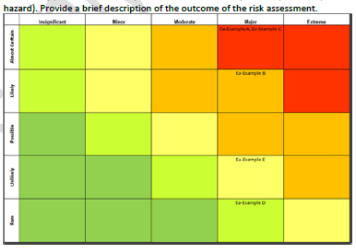
Scenario one: Describe the key impacts to the natural environment and ecosystem services.
Scenario two: Describe the key impacts to the natural environment and ecosystem services.

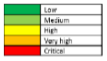
Risk Rating: Choose an item.

Based on the maximum credible event risk rating.

Risk Matrix

Insert a copy of the risk matrix provided in the Risk Analysis Tool (filtered by hazard). Provide a brief description of the outcome of the risk assessment.





Risk rating key
Combined likelihood and consequence ratings

Risk Evaluation

Refer to risk management page overleaf when completing this section.
Discuss the risk acceptability, priority and risk management opportunities.
Link to risk management of other hazards as appropriate, including where the hazard exposure is co-located with other hazards and there may be opportunities for addressing common vulnerabilities or exposure.

Version:
Date: Click or tap to enter a date.

Note: Additional text and diagrams can be continued on next page

Author:
Next review date: Click or tap to enter a date.

Risk management

Risk Management Framework

Describe policies, plans and arrangement across council and agencies that contribute to the management of risk for this hazard.

Reduction

Discuss existing, proposed or in development measures, that could be taken to reduce the risk, either by reducing the likelihood, exposure or vulnerability. These can include short, medium and long-term initiatives.
Note: you cannot typically remove all risk, so this section is more about proposing optimal levels of treatment

Likelihood

Text

Exposure

Text

Vulnerability

Text
Key references
- List key reference documents and legislation that support reduction

Key agencies
- List key agencies that support reduction and describe their role

Readiness and Response

Use this space to further document current measures that assist with emergency (incident, crisis, etc.) readiness and response
Examples may include: warning systems, SOP's, logistics and welfare/financial considerations, staff capability, budgets, insurance, critical networks or relationships

Warning systems

Text

Capability development

Text

Public education

Text

Operation plans and procedures

Text
Key references
- List key reference documents and legislation that support readiness and response

Key agencies
- List key agencies that support readiness and response and describe their role

Recovery

Use this space to further document current measures that assist with recovery.
Examples may include: recovery structures and arrangements, welfare/financial considerations, staff capability, budgets, insurance, critical networks or relationships

Recovery structures

Text

Strategic recovery plans

Text

Capability development

Text
Key references
- List key reference documents and legislation that support recovery

Key agencies
- List key agencies that support recovery and describe their role

Version:
Date: Click or tap to enter a date.

Note: Additional text and diagrams can be continued on next page

Author:
Next review date: Click or tap to enter a date.