

Benchmarking the readiness of road  
controlling authorities to meet their  
obligations under the Civil Defence and  
Emergency Management (CDEM) Act 2002  
October 2010

A. Dantas and S. Giovinazzi  
University of Canterbury, New Zealand

ISBN 978-0-478-36453-8 (print)  
ISBN 978-0-478-36452-1 (electronic)  
ISSN 1173 3756 (print)  
ISSN 1173-3764 (electronic)

NZ Transport Agency  
Private Bag 6995, Wellington 6141, New Zealand  
Telephone 64 4 894 5400; facsimile 64 4 894 6100  
research@nzta.govt.nz  
www.nzta.govt.nz

Dantas, A and S Giovinazzi (2010) Benchmarking the readiness of road controlling authorities to meet their obligations under the Civil Defence and Emergency Management (CDEM) Act 2002. *NZ Transport Agency research report no.409*. 90pp.

University of Canterbury  
Private Bag 4800  
Christchurch 8140

This publication is copyright © NZ Transport Agency 2010. Material in it may be reproduced for personal or in-house use without formal permission or charge, provided suitable acknowledgement is made to this publication and the NZ Transport Agency as the source. Requests and enquiries about the reproduction of material in this publication for any other purpose should be made to the Research Programme Manager, Programmes, Funding and Assessment, National Office, NZ Transport Agency, Private Bag 6995, Wellington 6141.

Keywords: benchmarking, CDEM Act 2002, emergency management, road controlling authorities.

## An important note for the reader

The NZ Transport Agency is a Crown entity established under the Land Transport Management Act 2003. The objective of the Agency is to undertake its functions in a way that contributes to an affordable, integrated, safe, responsive and sustainable land transport system. Each year, the NZ Transport Agency funds innovative and relevant research that contributes to this objective.

The views expressed in research reports are the outcomes of the independent research, and should not be regarded as being the opinion or responsibility of the NZ Transport Agency. The material contained in the reports should not be construed in any way as policy adopted by the NZ Transport Agency or indeed any agency of the NZ Government. The reports may, however, be used by NZ Government agencies as a reference in the development of policy.

While research reports are believed to be correct at the time of their preparation, the NZ Transport Agency and agents involved in their preparation and publication do not accept any liability for use of the research. People using the research, whether directly or indirectly, should apply and rely on their own skill and judgment. They should not rely on the contents of the research reports in isolation from other sources of advice and information. If necessary, they should seek appropriate legal or other expert advice.

# Acknowledgements

This research report was produced as part of the NZ Transport Agency (NZTA) Research Programme and also supported by the Foundation for Research Science and Technology (FRST) of New Zealand through the Resilient Organisations research programme.

We would like to thank all the road controlling authorities that shared their knowledge and experience about emergency plans, procedures and events. In particular, we would like to thank the Road Controlling Authorities Forum for giving us the opportunity to introduce the method and findings of this research to its members.

Additionally, we would like to thank the professionals involved in emergency management and the participants of the lifeline/CDEM groups who contributed their understanding of the CDEM Act 2002. They are:

- John Lamb (Canterbury Lifelines Group)
- Mark Constable (Ministry of Civil Defence & Emergency Management)
- Mark Gordon (AECOM)
- Harry O'Rourke (Auckland Regional Council, Civil Defence)
- Lisa Roberts (Auckland Regional Council, Civil Defence)
- John Norton (Consultant)
- Rian van Schalkwyk (Great Wellington Regional Council)
- Deven Singh (Wellington City Council)
- Richard Mowll (NZTA, Wellington)
- Joseph Flanagan (NZTA, Auckland).

The research team wishes to thank the members of the steering group, who provided valuable guidance and comments throughout the project. They were:

- David Bates (NZTA, Wellington)
- Ian Cox (NZTA, Wellington)
- Ian Maxwell (Auckland City Council)
- Jacinda Harrison (Ministry of Transport)
- Jim Stevens (Auckland Regional Council – Civil Defence)
- Jon Mitchell (Environment Canterbury – Civil Defence)
- Murray Sinclair (Christchurch City Council – Civil Defence)
- Peter Connors (NZTA, Christchurch)
- Richard Smith (Ministry of Civil Defence & Emergency Management)

We would like to express our appreciation to our colleague, Frederico Ferreira, who assisted in several parts of this research.

Finally, we would like to express our gratitude to the peer-reviewers (David Brunson, Kestrel Group; Dr. Erica Seville, Risk and Strategies Research and Consulting; and Stuart Woods, MWH NZ Ltd) who provided constructive criticism, comments and suggestions to enhance the findings of this research project.

# Contents

- Executive summary .....7
- Abstract .....8
- 1 Introduction .....9
  - 1.1 Background and motivation ..... 9
  - 1.2 Research objectives ..... 10
  - 1.3 Research method ..... 10
  - 1.4 Report structure ..... 12
- 2 Literature review ..... 13
  - 2.1 Benchmarking..... 13
    - 2.1.1 Benchmarking definition ..... 13
    - 2.1.2 Reasons for and perceived benefits of benchmarking ..... 14
    - 2.1.3 Types of benchmarking..... 14
    - 2.1.4 The benchmarking process ..... 15
    - 2.1.5 Example of benchmarking techniques ..... 16
    - 2.1.6 Benchmarking applied to transport studies..... 18
  - 2.2 Review of the CDEM Act 2002 and other relevant documentation..... 19
    - 2.2.1 The importance of lifeline utilities ..... 20
    - 2.2.2 Duties of lifeline utilities under the CDEM ACT 2002..... 21
    - 2.2.3 Function to the fullest possible extent..... 21
    - 2.2.4 Transport sector ..... 23
- 3 Expectations and requirements for RCAs under the CDEM Act 2002..... 24
  - 3.1 Identification of potential interviewees ..... 24
  - 3.2 Questionnaire development ..... 24
  - 3.3 Results of interviews ..... 25
  - 3.4 Analysis of results..... 25
- 4 The benchmarking framework..... 27
  - 4.1 The design of the benchmarking framework..... 27
  - 4.2 The scoring and marking systems ..... 31
    - 4.2.1 Option score ..... 32
    - 4.2.2 Indicator score ..... 33
    - 4.2.3 Criterion score ..... 33
    - 4.2.4 Expectation score..... 34
    - 4.2.5 Readiness score ..... 34
- 5 Case study..... 36
  - 5.1 Implementation and promotion of the web-based survey ..... 36
  - 5.2 Results of the web-based survey..... 37
    - 5.2.1 Outstanding performance level..... 39
    - 5.2.2 Comprehensive performance level..... 40
    - 5.2.3 Adequate performance level ..... 41
    - 5.2.4 Basic performance level..... 43
  - 5.3 Feedback of results to participant RCAs and the RCA Forum ..... 43
  - 5.4 The most common areas of significant shortcomings ..... 44

6	Conclusions .....	46
7	References.....	48
	Appendix A: Questionnaire about expectations and requirements for RCAs under the CDEM Act 2002 .....	51
	Appendix B: Results of the questionnaire about expectations and requirements for RCAs under the CDEM ACT 2002 .....	54
	Appendix C: Self-assessment benchmarking questionnaire .....	64
	Appendix D: Option scores .....	73
	Appendix E: Worked example.....	82
	Appendix F: Results of the benchmarking survey .....	88
	Appendix G: Feedback to the best participant RCA .....	89

## Abbreviations and acronyms

CDEM	Civil Defence and Emergency Management.
CA	Contractual arrangements.
COLS	Corrected ordinary least squares.
DEA	Data envelopment analysis.
EVA	Economic value added.
FHWA	Federal Highway Administration.
GIS	Geographic information systems.
MoU	Memorandum of understanding.
MCDEM	Ministry Civil Defence and Emergency Management.
MAM	Mutual aid mechanisms.
NZTA	New Zealand Transport Agency.
OECD	Organisation for Economic Co-operation and Development
OLS	Ordinary least squares.
RCA	Roading controlling authority.
RP	Response plan
SDEA	Stochastic data envelopment analysis.
SFA	Stochastic frontier analysis.
TFP	Total factor productivity

# Executive summary

This report introduces a conceptual framework for benchmarking the level of preparedness of road controlling authorities (RCAs) in New Zealand to meet their obligations under the Civil Defence and Emergency Management (CDEM) Act 2002. The Act states that the road network, among the other lifeline **utilities, should be able to ‘function to the fullest possible extent during and after an emergency’**. The proposed benchmarking framework aims to assess how well RCAs are matching these obligations.

This research aimed to address the following key research questions:

- How should the requirements for lifeline organisations (as specified in the CDEM Act 2002) be interpreted?
- To what extent are RCAs currently meeting these requirements?
- **What specific aspects of RCAs’ planning arrangements are in the most serious need of improvement, and are there ways to encourage more sharing of best practice?**

The main research objective was to develop a self-assessment benchmarking tool that would enable RCAs to evaluate themselves and to develop plans for improving their emergency response and recovery planning arrangements. The research was divided into specific research objectives to:

- **gain a better understanding of RCAs’ obligations under the CDEM Act 2002**
- develop and verify the consistency and robustness of a set of key performance indicators, which are representative of the critical success factors in emergency management
- **develop a conceptual framework for benchmarking RCAs’ performance** in regards to the 4Rs (reduction, readiness, response and recovery)
- produce a self-assessment tool for benchmarking the readiness of RCAs to meet their obligations under the CDEM Act 2002.

The research was developed in seven stages, namely:

- 1 Literature review
- 2 Understanding what is required of RCAs by the CDEM Act 2002
- 3 Design of a benchmarking framework and of a self-assessment tool for benchmarking
- 4 Testing the proposed benchmarking framework and self-assessment tool on pilot case studies with RCAs
- 5 Distribution and promotion of the self-assessment tool for benchmarking RCAs
- 6 Discussion of the benchmarking results and of potential solutions for improving the consistency of **RCAs’ readiness**
- 7 Analysis and conclusions.

A web-based survey tool was created based upon the self-assessment benchmarking framework and questionnaire. This tool was created using the SurveyMonkey internet platform and was implemented and released for the participation of RCAs. A total of 53 responses were gathered, but only 26 were considered valid and complete. Responses considered non-valid (12) included mainly the participation of a non-RCA organisation or multiple participations from the same RCA. A total of 15 surveys were uncompleted.

These are the main findings of the survey:

- There are RCAs that have outstanding readiness practices in place, as the result of a significant commitment to and understanding of the CDEM Act 2002 requirements and expectations.
- A small minority of participant RCAs do not meet the requirements of the CDEM Act 2002. These RCAs had significant shortcomings in terms of their ability to fulfil their requirements under the CDEM Act 2002.
- It is not statistically possible to use the survey results to express the level of readiness of all RCAs. Nevertheless, the results show that RCAs are working towards a high level of performance.
- As there is the potential that some responses reflect ‘aspirational’ rather than ‘current’ readiness, there may be a need to create and implement audit schemes to verify the validity of the answers provided by the participant RCAs.

Feedback from the industry, given at the RCA Forum, was that the benchmarking framework and the self-assessment tool should be incorporated as part of RCA practice. It was suggested that the RCA Forum should facilitate the implementation of the self-assessment tool. Also, the researchers were encouraged to make the results of the participant RCAs that reached the outstanding level of readiness publically available. This would require permission from the RCAs to relax the confidentiality arrangements.

Further research could address a series of supplementary items, such as: study the relative weights and/or importance of the identified expectations of civil defence and lifeline groups; examine the main differences in readiness between RCAs, considering their characteristics (eg population, area of coverage, types of roading assets under analysis); develop auditing schemes to verify whether the RCAs actually have evidence supporting their self-assessment.

## Abstract

This research develops an assessment tool and provides initial findings of whether RCAs are meeting their obligations under the Civil Defence and Emergency Management (CDEM) Act 2002, which states that the road network, among the other lifelines utilities, should be able to **‘function to the fullest possible extent during and after an emergency’**. A self-assessment benchmarking tool was developed and implemented in order to allow road controlling authorities (RCAs) to evaluate themselves and develop plans for improving their emergency response and recovery planning arrangements. Based on our study of the CDEM Act 2002, we conceptualised a multi-criteria assessment, which included three main expectations in terms of meeting the CDEM Act 2002 requirements. The self-assessment tool was applied to a case study, which gathered 26 valid responses from participant RCAs. The results revealed that most of the participant RCAs met the requirements of the CDEM Act 2002. These results were presented to the roading industry and their feedback was that the benchmarking framework and the self-assessment tool should be incorporated into RCA practice. It is recommended that subsequent work be conducted in terms of developing auditing schemes that verify whether the RCAs have evidence that supports their self-assessment.



# 1 Introduction

This report introduces a conceptual framework for benchmarking the level of preparedness of road controlling authorities (RCAs) in New Zealand to assess whether they meet their obligations under the Civil Defence and Emergency Management (CDEM) Act 2002. The Act states that the road network, among the **other lifeline utilities, should be able to** ‘function to the fullest possible extent during and after an emergency’.

The following sub-sections describe the background, motivation, research objectives, research method and structure of this report

## 1.1 Background and motivation

According to the CDEM Act 2002, RCAs have a considerable amount of responsibility and play a fundamental role in response and recovery activities in the event that a civil defence emergency occurs. Under the coordination of the CDEM Group (or local) civil defence controller, local and regional roading authorities must use their resources to help minimise disruptions and keep the community safe. Without efficient RCAs, access to damaged areas may be compromised and this may result in delays in response and reconstruction activities, which in turn may generate irreparable losses for New Zealand.

Recent events have demonstrated that the ability of land transport networks to respond to emergencies is vital and saves lives, reduces costs and helps communities to recover from crises. No large-scale events impacting upon large and densely populated areas have been observed in New Zealand, possibly due to the short history of European settlement (160 years) (Cole et al 2005). Nevertheless, Britton and Clark (2000) estimated that while less than three people a year have died in natural disasters over the last 50 years, annual flood losses have on average amounted to NZ\$180 million and earthquake losses to about NZ\$15 million, over that period. Flooding in the Manawatu-Wanganui area in 2004 led to four bridges being destroyed, 21 bridges seriously damaged, 2500 people displaced, and close to NZ\$400 million lost due to business disruption (Flood Review Team 2004).

RCAs have made significant efforts to prepare themselves for civil defence declarations. Throughout the country, various roading organisations have initiated several projects to improve their planning arrangements including assessments of asset vulnerability, development of communication protocols, training of staff, etc. These efforts have been developed on an ad-hoc basis, and are generally focused on the immediate and perceived needs of regional and local RCAs. There is a need for a more holistic **assessment of the current strengths and weaknesses of the RCAs’ emergency response and recovery** arrangements and the priority actions required to fulfil their CDEM Act 2002 obligations.

**Scientific and technical reports have also highlighted the need to research RCAs’ resilience in the face of major disruption events. Natural hazard events (such as Manawatu 2004, and Tauranga and Matata 2005) and simulation exercises (eg Capital Quake’06, Pandora’07, Marconi’07, Icarus’07) have highlighted that** other response organisations (such as the emergency services, CDEM controllers and other lifeline utilities) expect a lot from RCAs, but there is very little known about how efficiently they would deal with a civil defence declaration. A Ministry of Civil Defence and Emergency Management (MCDEM) workshop on **‘National Health and Transport Issues’, held in Wellington in September 2007, is a further demonstration** of how urgent and relevant this issue is in New Zealand.

This project builds on earlier research reports in the key topic area of risk management of transport systems. Various research reports have targeted key elements of the risk management process as defined by the New Zealand Risk Management Standard (AS/NZS 4360:1999). For example, Seville and Metcalfe

(2005) focused on developing a hazard risk assessment framework for the New Zealand state highway network. Brabhaharan (2001) and Brabhaharan (2002) explored how natural hazard risk management could be implemented for the road network in New Zealand, with Brabhaharan et al (2006) proposing certain key factors and criteria to be considered in deciding the level of performance required for roads in New Zealand after a disaster. Taking the findings of these previous researchers into consideration, this project targeted the analysis and improvement of the required performance for RCAs before and after crises events.

Internationally, this project followed in the footsteps of similar initiatives conducted by the US Department of Transportation Federal Highway Administration (FHWA), which focused on the definition of best practices (FHWA 2007a) and common issues (FHWA 2007b) in emergency transportation operations preparedness and response.

In this context, this research aimed to address the following key research questions:

- How should the requirements for lifeline organisations (as specified in the CDEM Act 2002) be interpreted?
- To what extent are RCAs currently meeting these requirements?
- **What specific aspects of RCAs' planning arrangements are in the most serious need of improvement, and are there ways to encourage more sharing of best practice?**

## 1.2 Research objectives

The main research objective was to develop a self-assessment benchmarking tool that would enable RCAs to evaluate and to develop plans for improving their emergency response and recovery planning arrangements.

The research was divided into specific research objectives to:

- **gain a better understanding of RCAs' obligations under the CDEM Act 2002**
- develop and verify the consistency and robustness of a set of key performance indicators, which are representative of the critical success factors in emergency management
- **develop a conceptual framework for benchmarking RCAs' performance in regards to the 4Rs** (reduction, readiness, response and recovery)
- produce and test a self-assessment tool for benchmarking the readiness of RCA to meet their obligations under the CDEM Act 2002
- pilot an initial application of the tool with a range of RCAs and analyse initial results against critical success factors at collective level.

## 1.3 Research method

The research was developed in seven stages:

- Stage 1 - Literature review: This involved studying all the relevant definitions of benchmarking, RCAs, CDEM Act 2002 and the supporting documentation. Relevant methods and techniques that have been implemented at an international level to assess the readiness of road networks and organisations to cope with and manage crisis events were reviewed. International benchmarking

techniques and case studies that assess the performance of road networks and organisations during emergency response and recovery were also analysed at this stage.

- Stage 2 – Understanding what is required of RCAs by the CDEM Act 2002: A detailed and critical analysis of the CDEM Act 2002 was conducted as the first step of the proposed research. Interviews were performed with relevant personnel, including representatives of the Ministry of Civil Defence and Emergency Management (MCDEM), civil defence controllers, representatives of lifeline groups, local territorial authorities, and the NZ Transport Agency (NZTA) managers and their consultants and contractors. The interviews were conducted in Auckland, Wellington and Christchurch. These three cities were selected as target areas for the interviews because of their importance in New Zealand, their growing populations and their risk-prone characteristics.

The interviews were designed to help the research team gain a better understanding about the expectations and requirements of RCAs under the CDEM Act 2002 coming from:

- Civil Defence and other emergency management or strategic organisations, due to their strong need for an effective transportation system to run response and recovery activities after a crisis event
- other lifeline organisations, due to their intrinsic dependence on transport organisations
- the community.

The interview results were used to formulate the strategic goals that RCAs should target to meet the requirements of the CDEM Act 2002 and to better understand the perspectives of civilian road users and emergency response and recovery-related organisations.

- Stage 3 – Design of a benchmarking framework and of a self-assessment tool for benchmarking. The results of stages 1 and 2 formed the base definition of the benchmarking framework within the research. They were used to define: 1) the objectives and techniques for the benchmarking assessments; 2) the targets for RCAs; 3) the performance metrics to be adopted to qualitatively and quantitatively measure the current ability of RCAs to meet the requirements of the CDEM Act 2002 and to monitor future progress toward that and; 4) the preliminary scoring of the self-assessment tool for benchmarking RCAs. This stage also included the preliminary design of a self-assessment tool for benchmarking RCAs.
- Stage 4 – Testing the proposed benchmarking framework and self-assessment tool on pilot case studies with RCAs. The consistency and robustness of the set of key performance indicators defined in stage 3 were calibrated and validated using a series of pilot case studies. The performance objectives required under the CDEM Act 2002 (results of task 1) and the performance metrics (defined as a result of task 3) were introduced to and discussed with participating RCAs.
- Stage 5 – Distribution and promotion of the self-assessment tool for benchmarking RCAs. Based upon the benchmarking questionnaire, a user-friendly and web-based survey tool was created allowing RCAs to self-assess their performance towards the fulfilment of CDEM Act 2002 requirements. Three approaches were used to promote participation in the survey: 1) personal email invitation; 2) web-site call-outs; 3) presentation to the RCA Forum in Wellington.
- Stage 6 – Discussion of the benchmarking results and of potential solutions for improving the consistency of RCAs' readiness. Data and benchmarking results gathered via the self-assessment tools were processed and presented during a final workshop involving RCAs. The benchmarking results were used to identify improvements and innovation by helping each participating RCA understand the external environment and by promoting organisational learning.

- Stage 7 - Analysis and conclusions. The results of the case studies were used to assess whether or not the objectives of the research were achieved and to make recommendations about potential further initiatives that could improve the resilience of RCAs.

## 1.4 Report structure

This report is divided into six chapters. Following this introductory chapter, a literature review of the previous research and the theoretical concepts underpinning this research effort is presented. Chapter 3 summarises the studies conducted to identify the expectations and requirements for RCAs under the CDEM Act 2002. Chapter 4 presents the design of the benchmarking framework. Chapter 5 presents a series of case studies, which focus on the implementation of the benchmarking tool and subsequent participation of RCAs. Analysis and conclusions including main findings, limitations and recommendations for further research are presented in chapter 6.

## 2 Literature review

The objective of this chapter is to summarise the main concepts and documents that support the development of the benchmarking framework and of the self-assessment tool. To this end, the relevant benchmarking methods/techniques are presented here. We also present a brief summary of the existing and supporting documentation about the CDEM Act 2002.

### 2.1 Benchmarking

#### 2.1.1 Benchmarking definition

Several dictionary definitions of the words benchmarking and benchmark are provided below:

Webster's (2006) dictionary defines benchmark as:

*a point of reference from which measurements may be made ... something that serves as a standard by which others may be measured or judged.*

Dictionary.com (2006) defines benchmarked, benchmarking, benchmarks:

*To measure a rival's product according to specified standards in order to compare it with and improve one's own product*

*Benchmarking is the continuous process of measuring products, services, and practices against the toughest competitors or those companies recognised as industry leaders (Camp 1989).*

*Benchmarking is the search for industry best practices that will lead to superior performance (Camp 1989).*

**[. . .] benchmarking is the process of continually comparing a company's performance on critical customer requirements against that of the best in the industry (direct competitors) or class (companies recognised for their superiority in performing certain functions) to determine what should be improved (Vaziri 1992).**

Although many definitions of the terms exist, there is consensus that benchmarking is a structured process that facilitates the improvement of current organisational standards by adopting superior practices. Benchmarking is applied in many traditional areas of performance (mainly at the output stage) to assess the organisation's current state.

Some articles on benchmarking in the international literature explore certain aspects of comparative data analysis techniques, while other papers examine entire benchmarking processes, including the identification of best practices for organisational adaptation. There are some noticeable differences between comparative performance assessments, benchmarks and benchmarking in the literature.

Dattakumar and Jagadeesh (2003) examine the existing literature on benchmarking, reviewing 382 publications in total, for the purpose of providing insights into the growth and development of the benchmarking concept. These publications include specific papers in national and international journals, and all have been put into one of four categories:

- 1 Publications dealing with general aspects or the fundamentals of benchmarking (170)
- 2 Papers discussing specific applications/case studies in benchmarking (164)

3 Publications that look at innovations/extensions/new approaches in benchmarking (27)

4 Publications discussing benchmarking in a way that is applicable to the education sector (21).

### 2.1.2 Reasons for and perceived benefits of benchmarking

Benchmarking is the process by which organisations look at the ‘best’ businesses in an industry and try to imitate their styles, level of service and processes. This practice helps organisations to determine what they could be doing better. Benchmarking is valuable to organisations because it exposes them to many different ideas, processes, approaches and concerns (Allan 1997) in terms of their business, operational and customers’ practices. Benchmarking makes it possible to identify the gap between where the organisation would like to be and where it actually is. This gap provides a measure of the amount an organisation would like improve (Finch and Luebbe 1995). In the short run, ignoring this gap and refusing to change will decrease the organisation’s ability to survive in the long run.

Companies engage in benchmarking for a variety of reasons. They use it:

- to increase productivity and individual design
- as a strategic tool
- to enhance learning – selling or hearing about **another company’s processes and how they work can** help employees to see that there may be a better way to compete (Brookhart 1997)
- to identify growth potential – benchmarking can cause a necessary change in the culture of an organisation. After a period of time in the industry, an organisation may become too practised at looking for growth opportunities internally. Benchmarking helps the company to look elsewhere for potential areas of growth
- as a vehicle to improve performance – benchmarking also allows companies to learn new and innovative approaches to issues that, in turn, provide the basis for training. Benchmarking acts as a vehicle to improve performance by assisting in the setting of goals that have already been proven achievable. It shows companies that there are other ways of enhancing an organisation (Fuller 1997).

### 2.1.3 Types of benchmarking

According to Elmuti and Kathawala (1997) there are four different types of benchmarking:

- Internal benchmarking describes benchmarking against operations. It is one of the simplest forms of benchmarking, as most companies have similar functions inside their business units. Determining the internal performance standards of an organisation is the main objective (Matters and Evans 1997)
- Competitive benchmarking is used with direct competitors. Done externally, competitive benchmarking’s goal is to compare companies that operate in the same markets and have competing products, services, or work processes (Finch and Luebbe 1995)
- Functional or industry benchmarking is performed externally against industry leaders or the best functional operations of certain companies. The benchmarking partners are usually those who share some common technological and market characteristics. This type of benchmarking also seems to concentrate on specific functions. Because there are no direct competitors involved in this process, the partners are more willing to contribute and share. A disadvantage of this type of benchmarking is the cost to the already overwhelmed benchmarked companies (Matters and Evans 1997)
- Process or generic benchmarking focuses on the best work processes. Instead of benchmarking the business practices of a company, similar procedures and functions are emphasised – this can be done

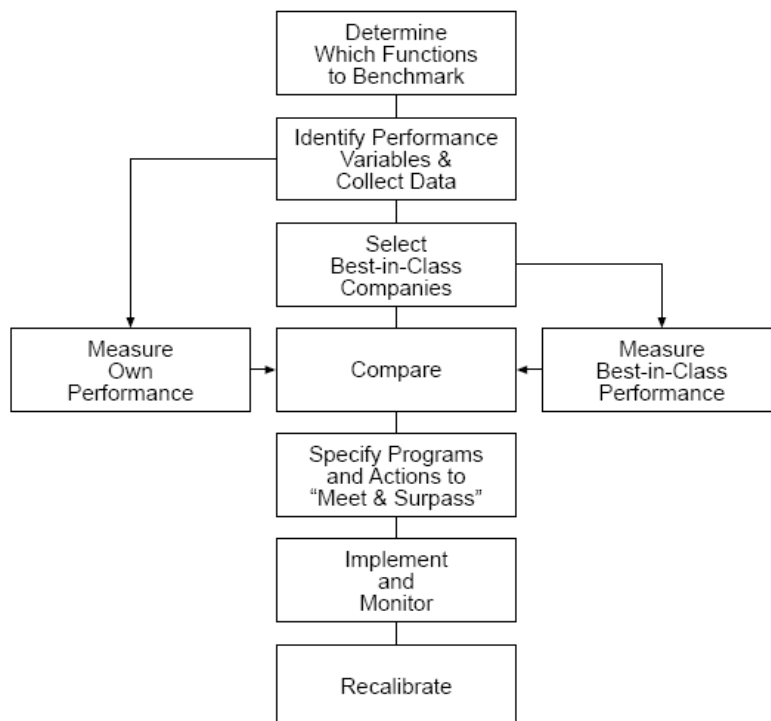
across dissimilar organisations. Although it is thought to be extremely effective, it is difficult to implement. Generic benchmarking requires a broad conceptualisation of the entire process and a careful understanding of the procedures (Finch and Luebbe 1995; Matters and Evans 1997).

#### 2.1.4 The benchmarking process

Benchmarking is a very structured process consisting of several steps. These steps are often provided in a model. It should be noted that even though the process is very structured, this should not complicate what is essentially a simple idea. In short, 'the structure should not get in the way of the process'.

Most models of the benchmarking process include the following steps, according to Bateman (1994) (figure 2.1).

Figure 2.1 The benchmarking process adapted from Bateman (1994, p6)



The benchmarking process consists of five stages (Matters and Evans 1997; Camp 1989), namely:

- 1 Planning the exercise - identifying the strategic intent of the benchmarking for the business or process according to the company's main goals. This consists of identifying, on the one hand, the actual processes to be benchmarked and, on the other hand, the user's expectations. Finally, the critical success factors that are linked to successful business results have to be determined in order to benchmark. It is important to recognise that benchmarking is a process not only of deriving quantifiable goals and targets, but also of investigating and documenting the best practices, which can help achieving expected goals.

Relevant questions during the planning phase of the exercise include: What is to be benchmarked? To whom or to what will the performance of the companies under analysis be compared? How will the data be collected?

- 2 Forming the benchmarking team – identifying team members chosen from various areas of the organisation, who will be involved in the benchmarking exercise.
- 3 Collecting the data – gathering information on the company under analysis and on best-practice companies. It is worth highlighting that there is no one way to conduct benchmarking investigations. Rather, there is an infinite variety of ways to obtain required data – and most of the data needed is readily and publicly available (Camp 1989).
- 4 Analysing data for gaps – determining how companies under analysis relate to the benchmarked company and identifying performance gaps and their possible causes.

Relevant questions in this phase include: Why are the benchmarking organisations better than other analysed organisations?; By how much?; What best practices are being used by the benchmarking organisations **that can be anticipated?; How can the benchmarking organisations' practices be** incorporated or adapted for use in our organisation?

- 5 Taking action – using benchmark findings to set operational targets for change. It involves carefully incorporating new practices into the operation and ensuring that benchmark findings are incorporated in all formal planning processes. Steps include: 1) Gaining operational and management acceptance of benchmark findings; 2) Clearly and convincingly demonstrating findings as correct and based on substantive data; 3) Developing action plans; 4) Communicating findings to all levels of the organisation to obtain support and commitment and to encourage a sense of ownership.

The aforementioned steps will help converting benchmark findings, and the operational principles based on them, into specific actions. Maturity will be reached when best practices from the benchmark organisations will be incorporated in the other analysed organisations processes, ensuring their superiority in managing processes and fulfilling users' expectations.

### 2.1.5 Example of benchmarking techniques

There are many analytical techniques that can be used in benchmarking. They are usually applied to measuring the relative efficiency and performance of different organisations.

Among the most common benchmarking techniques are:

- Data envelopment analysis (DEA) is a non-parametric frontier method first introduced by Charnes et al (1978). Compared with other benchmarking methods (Goncharuk 2008) the DEA method can provide a number of advantages as it:
  - offers an opportunity to include a few inputs and outputs in a model that allows efficiency to be estimated without calculating a sole parameter of input or output
  - allows other choices besides the functional form of the production function
  - allows efficiency analysis in cases where it is difficult to explain the relationship between numerous resources and outputs of an industrial system
  - enables the estimation of the contribution of each input to the overall efficiency (or inefficiency) of the companies and of the level of inefficiency of each input
  - enables the estimation of other kinds of efficiency, for example, economic efficiency as well as technical efficiency.

Various applications have been observed in the scientific literature (Duffy et al 2006; Friesner et al



2005; Perez et al 1998; Verma and Gavirneni 2006; Graham 2005; Hilmola 2007; Mathiyalakan and Chung 1996).

- Ordinary least squares (OLS) and corrected ordinary least squares (COLS) are parametric regression-based techniques. The first step in using OLS and COLS techniques is to define an equation which describes the relationships between a dependent variable (eg **a company's costs**) and several explanatory variables (representing the organisation's **operating conditions** and demand). The techniques then estimate a set of coefficients applying to each variable and defining a line that best fits the data. COLS is an extreme version of the OLS regression technique, based on the presumption that the lowest data point defines efficient costs rather than simply being an outlier reflecting data measurement problems or other extraneous factors, and on the assumption that the estimated OLS gradient is still valid at the frontier.
- Stochastic frontier analysis (SFA) is a stochastic parametric technique that allows for the stochastic, probabilistic treatment of inefficiency. SFA has its starting point in the stochastic production frontier models, which measure the technical efficiency based on the concept of production function, defined as the ratio of observed output to maximum feasible output. The maximum attainable output for a given technology and level of inputs defined as the production possibility frontier is modelled using the concept of technical efficiency.
- Engineering models are techniques of comparative performance analysis based on an idealised benchmark specific to each regulated industry, including the topology and density of the service territory, and not a cross-comparison of similar companies. This method identifies an optimal level of efficiency by which a company can be compared, thereby avoiding the problems that arise in a yardstick measure based on the similarity of companies and their production data. The needs of an industry are identified in order to design a benchmark that most adequately reflects the optimal way in which to satisfy predicted demand. Among engineering models, the model company approach combines both engineering efficiency (an analysis of the physical configuration of the network components of an industry) and economic efficiency (the application of least-cost functions to determine optimal operating costs) to design an optimised model of the organisation or industry.

Agrell and Bogetof (2007) distinguish between parametric and non-parametric benchmarking techniques on the one hand and between deterministic and stochastic models on the other hand. They organised these into a 2x2 matrix (figure 2.2).

#### 2.1.5.1. Parametric versus non-parametric models

In modern benchmarking literature, parametric models are defined as having *a priori* defined parameters except for a finite set of unknown parameters that are estimated from data. Non-parametric models are characterised by being much less restricted *a priori*. Only a broad class of functions is fixed *a priori* and data is used to estimate the parameters.

#### 2.1.5.2. Deterministic versus stochastic models

In stochastic models, it is recognised that individual observations may be affected by randomness and the impact of the random elements on the benchmarking results is somehow accounted for. In non-stochastic, namely, deterministic models, the random phenomena are not accounted for.

Figure 2.2 Benchmarking model taxonomy (after Agrell and Bogetof 2007)

	Deterministic	Stochastic
Parametric	Corrected Ordinary Least Square (COLS) Greene(1997), Lovell(1993), Aigner and Chu(1968)	Stochastic Frontier Analysis (SFA) Aigner, Lovel and Schmidt (1977), Batesee and Coelli (1992), Coelli, Rao and Battese (1998)
Non-Parametric	Data Envelopment Analysis (DEA) Charnes, Cooper and Rhodes(1978), Deprins, Simar and Tulkens(1984)	Stochastic Data Envelopment Analysis (SDEA) Land, Lovell and Thore(1993), Olesen and Petersen (1995), Weyman-Jones(2001)

### 2.1.6 Benchmarking applied to transport studies

The scientific literature on the application of benchmarking to transport studies covers a wide variety of cases. These cases largely focus on comparing the observed versus the ideal or desired level of performance of transport systems and processes. The significant highlights of these applications are summarised below:

- Sarkis and Talluri (2004) evaluated airport performance and identified useful benchmarks for improving the operations of inefficient performers. Data envelopment analysis (DEA) was used to benchmark airport operations. DEA computed the relative efficiencies of airports, following which a clustering method was used to identify benchmarks for improving poorly performing airports. Efficiency values for a given airport are based on four resource input measures that include airport operational costs and the number of airport employees, gates and runways, and five output measures that include operational revenue, passenger flow, commercial and general aviation movement and total cargo transportation.
- Haworth et al (2003) assessed the safety performance of Australia's road transport industry against the safety performance of similar industries in a range of Organisation for Economic Co-operation and Development (OECD) countries. The purpose was to guide the development of future policies that could improve the safety of the Australian road transport industry, and to provide a focus for the national heavy vehicle safety strategy.
- Oum and Yu (2004: **measured and compared the operating efficiency performance of the world's major airports. In particular, this paper presented the results of the airports' variable factor productivities (VFP) after removing the effects of the variables beyond managerial control.**
- Yoshida and Fujimoto (2004) evaluated the relative efficiency of Japanese airports by applying two distinct methods, namely data-envelopment analysis and endogenous-weight total factor productivity (TFP). Both methods found that the airports on artificial islands were more efficient than those on the mainland, and that, excluding those on islands, third-category airports were less efficient than others.
- Tongzon (2001) applied DEA to compare the efficiency of ports around the world against their Australian counterparts. The author concludes that DEA is more flexible than other conventional

efficiency measures derived from the stochastic production frontier or economic value added (EVA), which are based on a production function estimation involving many inputs and one output.

Overall, our literature review of benchmarking showed there was a wide variety of techniques and approaches that could have been adopted in this research project. These techniques were applied to several different problem areas, which mostly focused on quantitatively measuring relative efficiency of different organisations based upon the data representing production inputs and outputs. Even though the potential of such techniques is acknowledged, they do not necessarily apply to benchmarking the readiness of RCAs, due to the limited relevance of quantitative indicators of readiness and the characteristics of RCAs. Such a conclusion is further substantiated by the findings of a recent study about New Zealand engineering lifeline activity and level of integration in RCA management practices, and their relationship to the resilience of roading networks to natural hazards (Gordon and Matheson 2008). They recommended that New Zealand should develop a simple benchmarking tool based on the following criteria: level of lifeline organisation; hazard identification; asset vulnerability (failure) assessment by utility; impact (consequences) assessment; planning and implementation of mitigation actions; community awareness; lifeline relationships; and application of technology (eg GIS). The key aspect of this recommendation is simplicity, because RCAs have to initially develop an appreciation of benchmarking before they embark on applying sophisticated techniques such as DEA, COLS, SFA and OLS.

## 2.2 Review of the CDEM Act 2002 and other relevant documentation

The CDEM Act 2002 replaced the Civil Defence Act 1983 and created a framework within which New Zealand can prepare for, deal with, and recover from local, regional and national emergencies.

The 2002 Act:

- promotes sustainable management of hazards
- encourages and enables communities to cope with acceptable levels of risk
- provides for planning and preparation for emergencies, and for response and recovery
- requires local authorities to coordinate planning and activities
- provides a basis for the integration of national and local civil defence emergency management
- encourages coordination across a wide range of agencies, recognising that emergencies are best dealt with on a multi-agency basis.

The Act requires that a risk management approach be taken when dealing with hazards. The likelihood of the event occurring and its consequences must be considered when evaluating the risks associated with a particular hazard. As part of this comprehensive approach to civil defence emergency management (CDEM), all hazards (not only natural hazards) must be taken into consideration.

The primary goal for communities is to be self-reliant. Communities should aim to reduce the likely impact of emergency events by both preparing for them and being able to respond effectively to them on their own. To encourage this, regional cooperation and coordination are paramount and together form one of the cornerstones of the Act. Full community participation is also key. All sectors with an interest in CDEM are accountable for ensuring that their communities are aware of, and committed to, effective CDEM.

The most relevant issues raised by the CDEM Act 2002 concerning lifeline utilities, and in particular the road network and organisations, are summarised and briefly explained in the following sub-sections. The CDEM Act 2002 is supported by four documents published by the Ministry of Civil Defence & Emergency Management, two of them specific for lifelines utilities, namely:

- *Working together: lifeline utilities & emergency management: director's guidelines for lifeline utilities* (DGL 3/02) ISBN 0-478-25455-5. (MCDEM 2002).
- *Lifelines and CDEM planning: civil defence emergency management best practice guide* (PG1/03) ISBN 0-478-25456-3. (MCDEM 2003).
- *Guide to the national civil defence emergency management plan*. (MCDEM 2006a).
- *Declaration: director's guidelines for CDEM sector* (DGL05/06) ISBN 0-478-25474-1. (MCDEM 2006b).

### 2.2.1 The importance of lifeline utilities

**New Zealand's lifeline utilities have to cope with the challenges posed by a broad range of potential natural and technological hazards. Flooding is New Zealand's most costly natural hazard, causing an average NZ\$1251 million damage per year. The country's most dangerous potential natural hazard is earthquakes, especially in the large urban centres such as Wellington and Christchurch.** The most underrated natural threat to the northern regions comes from volcanic eruptions. Exposure to technological and other man-made hazards – such as the 1998 Auckland power crisis – is increasing as growing urban populations put pressure on inadequate infrastructure, and technology becomes ever more complex.

In addition, deregulation in the telecommunications, transport, energy and other lifeline sectors have generally resulted in the dispersion of lifeline services. These new individual components may not function in a coordinated, cross-sectoral manner. While a commercially focused approach has enhanced financial risk management, often the same cannot be said for physical risk management.

Following a series of reviews, New Zealand has determined that it will improve the ability of emergency management sectors to manage hazards, respond to and recover from disasters, and to coordinate limited resources. The importance of these initiatives is heightened by the utility sector reforms of the past 15 years.

Lifeline utilities are defined in Schedule 1 of the CDEM Act 2002, either by name or by class. The national road network, including state highways, is recognised as a lifeline utility in Schedule 1 of the CDEM Act 2002.

In a civil defence emergency, life-threatening situations will always be given first priority. The economic and social viability of communities, and of the nation as a whole, however, depends upon the continued operation and prompt restoration of lifeline utilities.

Lifeline utilities have a significant CDEM role to play in New Zealand (CDEM 2002). Lifeline utilities are responsible for strengthening relationships within and across sectors, and for committing to actions that ensure the continuity of operations and delivery of services to essential CDEM activities during and after an emergency event.

It is essential that lifeline utilities are resilient in the face of emergencies and that their emergency **planning is integrated with the wider community's CDEM planning, so that both** are effective. Effective planning can only be guaranteed through sound relationships between utility providers themselves and with local government and the emergency services.

## 2.2.2 Duties of lifeline utilities under the CDEM ACT 2002

Lifeline utilities represent significant parts of the national infrastructure and have obligations under section 60 of the Act. According to MCDEM (2006b), every lifeline utility provider, identified in Schedule 1 of the CDEM Act 2002, must:

*A) Ensure that it is able to function to the fullest possible extent, even though this may be at a reduced level, during and after an emergency;*

*B) Make its plan for functioning during and after an emergency available to the Director of CDEM in writing, on request;*

*C) Participate in the development of the National CDEM Strategy and civil defence emergency management plans;*

*D) Provide, free of charge, any technical advice to any CDEM group or the Director of CDEM that is reasonably required by that group or by the Director;*

*E) Ensure that any information that is disclosed to the lifeline utility is only used by the lifeline utility, or disclosed to another person, within the guidelines of the CDEM Act 2002.*

It is important to highlight the different roles of emergency management plans and emergency response plans in this context. On one hand, emergency management plans are documents that state and provide for the hazards and risks to be managed at the appropriate level (national, regional or local). They are also used to describe arrangements necessary to meet identified hazards and risks. They are normally seen as strategic level documents that should guide organisations in achieving high levels of reduction, readiness, response and recovery, before any event occurs. On the other hand, emergency response plans are documents that deal with specific arrangements in terms of pre-established protocols that should guide decision-making and resource allocation during an event. They are perceived as operational level documents, which define roles, standards and procedures that may be adopted by the involved organisations.

## 2.2.3 Function to the fullest possible extent

The Act reinforces that it is not an option to be unprepared. The legislation requires that lifeline utilities **are 'able to function to the fullest possible extent, even though this may be at a reduced level, during and after an emergency'**. According to the Director's guidelines for lifeline utilities (MCDEM 2002), this requirement reflects the commercial realities of private utilities, and the community expectations of the performance requirements of public utilities.

The Act does not alter the scope or scale of utility business responsibilities, nor does it shift any responsibility. Utility managers must determine risk, asset and emergency management processes, and thus they also determine the level at which a utility is able to function during and after an emergency.

Lifeline utility providers are expected to plan for emergencies and to be able to implement procedures to ensure the continuity of **their service to the 'fullest possible extent'**. The phrase 'fullest possible extent' refers to what is possible in the circumstances; this cannot be specified in absolute terms – some events could put a utility totally out of action. A key goal is that the loss of any single utility does not result in a flow-on failure effect in other sectors.

Measures of the fullest possible extent could include:

- strong relationships
- sound risk management

- identification of the likely physical impact of particular hazards on systems
- identification of additional capability that can be called on in case of emergency.

**It is, however, the MCDEM's role to provide guidance on what it means for a lifeline utility to be 'capable' as defined in the Act. Being 'capable' means being able** to continue operating or providing a service, particularly in support of essential civil defence emergency management activity. Lifeline utility providers need to determine what effects each hazard may have on their organisation, and prioritise the demands that arise as a result. Lifeline utility providers need to work cooperatively with those around them to develop plans for dealing with that demand.

A continuity plan, particularly if developed in isolation, does not ensure capability. The relationships and understandings developed through cooperative planning are as important as the plan itself. A risk management process must therefore promote effective relationships. The Act introduces the idea of having regional CDEM Groups to promote understanding of respective risk management practices.

Lifeline utilities are expected to make their plans for functioning during and after an emergency available to the Director of the Ministry of Civil Defence & Emergency Management, if requested. Such plans are protected from disclosure for purposes other than those authorised under the Act. According to the **Director's guidelines for lifeline utilities** (MCDEM 2002), it is unlikely the Director will exercise this ability; however, as utilities are expected to voluntarily enter into cooperative planning.

**While all participants can expect to understand each other's responsibilities and roles during emergencies,** such cooperation does not require disclosure of commercially sensitive material.

Cooperative planning means sharing the relevant aspects of risk and continuity planning such as:

- hazard analysis and operational consequences (eg network locations and hazard overlays)
- the demand/restoration hierarchy, including how services sustain CDEM-critical activity and other utilities
- emergency response and recovery arrangements for response coordination.

The Ministry operates a National Crisis Management Centre (NCMC) in Parliament Buildings to provide the government with the ability to monitor, assist with or manage an event according to its severity. During an emergency of national significance, the NCMC may call together a pre-determined group of lifeline advisors to assist with decision-making. The Director may call upon any lifeline utility provider during such an event to provide specialist technical advice.

Utilities (national, regional or local) may also be asked by CDEM groups to provide technical advice free of charge. Such requests are likely to arise in two ways:

- Utility input to the CDEM group plan development process as discussed in the preceding pages of this document. The emphasis is on gaining mutual understanding of each other's risk management arrangements and how the agencies involved in the group plan may work together to address residual risk.
- Technical advice to operational staff within a CDEM group during response to an emergency (eg confirmation of restoration priorities, timing and processes, and advice as to the success of alternate planning).

Utility service restoration priorities are to be determined by individual utilities as part of response and recovery, noting the variables such as event type and impacts. Wherever possible, as part of restoration,

the following should be considered as a list of priorities to ensure the alignment of services being restored:

- public health and safety (hospitals/ambulance)
- emergency management (Police, Fire Service, emergency operations centres)
- lifelines infrastructure (energy, communications, water and transport)
- vulnerable sectors (immobile or vulnerable groups of people such as those in rest homes or prisons)
- isolated communities
- key areas (eg CBDs)
- commercial producers
- residential zones.

#### 2.2.4 Transport sector

The Transport Emergency Management Coordination Group (a cluster coordinated by the Ministry of Transport) has been formed to consider strategies for a coordinated response to an emergency that involves a failure or breakdown of critical transport infrastructure.

Along with the responsible government agencies, MCDEM engages with the Transport Emergency Management Coordination Group to develop contingency plans (or further develop existing plans) that support the transport system by:

- contributing to rapid damage assessments of status and likely recovery times from road, rail, air and marine transport infrastructure
- identifying critical interdependencies and resource shortfalls (including contractual support) for CDEM supporting action
- implementing a process for deciding regional infrastructure recovery priorities.

The CDEM sector needs to be able to:

- provide logistical and other support to expedite transport sector response and recovery
- support the contingency arrangements of the transport sector to lessen the social and economic impacts during long-term recovery or in the face of a reduction in service.

## 3 Expectations and requirements for RCAs under the CDEM Act 2002

This section describes the tasks and activities involved in identifying the expectations and requirements of RCAs under the CDEM Act 2002. We were specifically interested in obtaining in-depth information about what emergency-related organisations expect from RCAs. Based upon the identification of these expectations, we focused on defining the strategic goals that RCAs should target to meet the CDEM 2002 **Act's requirements**.

Our study of these expectations and requirements comprised four sequential stages, namely the identification of potential interviewees, the development of a questionnaire, the processing of interview results and the analysis of those results. The following subsections describe each of these stages in detail.

### 3.1 Identification of potential interviewees

**Given this research task's objective, it was necessary to limit the number of interviewees to a selected** group of individuals who could quickly and efficiently express their expectations of RCAs. Considering the resource and time limitations and interviewees availability, 12 interviewees were selected based on a desire to cover each of the following:

- representatives from the MCDEM
- representatives from civil defence controllers
- individuals with long-standing expertise and practical experience in managing disasters
- representatives from lifeline groups
- representatives from councils in the major metropolitan areas (Auckland, Wellington and Christchurch).

Due to ethics standards and confidentiality agreements with the interviewees, this research project has treated their participation with extreme confidentiality. Interviewees are identified, hereafter, as numbers (1, 2, 3..., 12).

### 3.2 Questionnaire development

Based on the study of the CDEM Act 2002 and its supporting documentation (refer to section 2.2), a questionnaire was developed. The questionnaire (comprising 11 questions) is presented in appendix A.

**The questions are divided into three main parts, which aim to ascertain interviewees':**

- understanding of **the CDEM Act 2002 statement '...ensure that it is able to function to the fullest possible extent, even though this may be at a reduced level, during and after an emergency...'**
- **expectations of how RCAs' emergency management and continuity plans are developed**, presented and shared
- **expectations of how RCAs' technical advice will be provided.**



### 3.3 Results of interviews

The interviews were conducted in Auckland, Wellington and Christchurch from August to September 2008. The interview recordings were transcribed to facilitate the analysis of the answers. In some cases interviewees provided their answers in written form, filling in the questionnaire or providing general answers to several questions.

The answers were summarised in a tabular format using all the available material (appendix B). For each question, key words that represented the interviewee's main idea were extracted. In a few cases the interviewee's exact words were reproduced, to avoid any distortion of the answers. Tables B1 to B10 show the answers to parts 1, 2 and 3 of the questionnaire. Various interviewees did not respond to different questions due to a lack of specific knowledge about them. Also, interviewee 12 only provided specific answers to questions in part 1 of the questionnaire, because his/her organisation holds that '...this is largely an operational matter...'. The grey cells in tables B1 to B10 are used to show that no answer was provided.

### 3.4 Analysis of results

In terms of the general interpretation of the CDEM Act 2002, all interviewees expressed a similar understanding of the expectations on RCAs. This was particularly noticeable in part 1 of the questionnaire, which focused on the conceptual aspects of the CDEM Act 2002 and RCAs. Even though the interviewees expressed themselves slightly differently, their overall messages were similar. Their understandings can be summarised in four statements. They are:

- RCAs must have well-prepared and implemented plans
- RCAs should participate in lifeline groups
- RCAs should be able to quickly assess and share damage information
- RCAs must have arrangements that guarantee the supply of additional resources, if needed.

**It is important to highlight the implications of the words 'must' and 'should' in these statements.** One expresses an obligation or strict requirement ('must') and the other a suggestion or recommendation ('should'). Overall, interviewees were very specific and vocal regarding the need for well-prepared and implemented plans and the need for arrangements regarding additional resources. The interviewees also **expressed the need for RCAs to participate in lifeline groups and stated that the RCAs' damage assessment needed to be received as soon as possible.**

**Interviewees also expressed similar views about their expectations of RCAs' continuity plans and technical advice.** The same message was expressed in different ways regarding continuity plans. Interviewees felt that they should be should be: 1) often updated; 2) practical and use simple terms to explain planned actions; and, 3) the result of comprehensive participation of all internal and external users. As for technical advice, the interviewees expressed the need for timely and up-to-date information about road closures (location, duration, required resources) and planned actions.

Despite their similar understandings of the expectations on RCAs, the interviewees conveyed a wide variety of opinions about the required levels of detail, presentation and frequency. In part 2 of the questionnaire, which dealt with continuity plans, answers about how RCAs should detail and present documentation showed significant variation. The same issue occurred in part 3 of the questionnaire, which dealt with how technical advice should be presented and updated. Most interestingly, we obtained

totally different answers to a number of questions from three interviewees who belonged to the same organisation.

There are two possible reasons for the diversity of these answers. The first is that the questionnaire was general and did not focus on a specific type of event. It is reasonable to assume that interviewees would express their opinions based upon their previous experience with certain types of events, which would not **necessarily be the same for all interviewees. The second potential reason is the interviewees' different** roles and geographical location. Each interviewee expressed opinions that would be based on how they currently interact with RCAs, which could be at a local, regional or national level. As a result they may have access to slightly different levels of information and they may have different needs/pressures.

## 4 The benchmarking framework

This chapter introduces the conceptualisation of the benchmarking framework, which focuses on a multi-criteria analysis of previously identified expectations (chapter 3). The following section describes how the benchmarking framework was designed, documenting its implementation and how it is used to assess RCAs' readiness. The second section of this chapter details the proposed RCA data scoring system.

### 4.1 The design of the benchmarking framework

Based on fundamental benchmarking techniques, the framework was designed using the following five steps:

- Step 1 - defining what needs to be benchmarked
- Step 2 - identifying comparable organisations to be benchmarked
- Step 3 - defining benchmarking criteria and indicators
- Step 4 - determining data collection method
- Step 5 - assessing the RCA's readiness level.

#### Step 1 - defining what needs to be benchmarked

The main objective was to determine whether RCAs are meeting the CDEM Act 2002 requirements.

The answers provided to the questionnaire about expectations and requirements for RCAs under the CDEM Act 2002 by the 12 interviewees (summarised in section 3 and fully presented in appendix B), were processed to identify the main expectations.

In particular, this was done focusing on the answer provided to the first question, Q1.1 In regards to Road Controlling Authorities (RCAs): What is your understanding of the following statement as part of CDEM Act 2002? 'Ensure that it is able to function to the fullest possible extent, even though this may be at a reduced level, during and after an emergency'.

First, the need for 'implemented plan', 'business continuity plans', 'arrangements' expressed by the majority of the 12 respondents was summarised in terms of the need to have 'emergency structures and arrangements'. This first identified expectation is in line with one of the duties of lifeline utilities under the CDEM ACT 2002 (MCDEM 2006), namely, 'every lifeline utility provider must make its plan for functioning during and after an emergency available to the Director of CDEM'.

Second, there was a common agreement among all the respondents on the need to be able to: 'do as much as possible and as soon as possible'; 'to provide access to the essential services and ensure essential deliveries'; and 'to re-establish services'. All these identified needs were summarised in term of an 'emergency management capacity' expectation.

**Finally, only one respondent (9) clearly stated the need for providing 'advice to controllers and lifelines and public'. This answer is in line with one of the duties identified for lifeline utilities (MCDEM 2006b, summarised in section 2.2.3), namely 'Provide, free of charge, any technical advice to any CDEM group or the Director of CDEM that is reasonably required by that group or by the Director'. This capability implies and requires the existence of qualified personnel, the possibility to communicate efficiently between organisations via information-sharing channels and using information-sharing protocols and coordination**

between cooperating organisations. A further expectation was therefore identified to summarise these **requirements as 'emergency management capability'**.

Further details and clarifications for the three identified expectations are provided below:

- 1 Emergency management structures and arrangements – RCAs are expected to: develop and maintain appropriate management structures and arrangements
- 2 Emergency management capability - RCAs are expected to develop and maintain suitably trained and competent personnel; exercise coordination and cooperation across the organisation; and enhance the capacity and adequacy of their information sharing
- 3 Emergency management capacity - RCAs are expected to assess the adequacy of their resources in terms of the quantity and suitability of equipment, facilities, personnel and finances; assess the adequacy of the road network they are responsible for in terms of robustness and redundancy; and arrange mutual aid mechanisms and contractual arrangements for emergency response and personnel.

## Step 2 - identifying comparable organisations to be benchmarked

This focuses on RCAs, which can be divided into one of two categories according to their area of influence – predominantly rural zones and metropolitan areas. Overall, they can be also categorised as:

- city councils
- district councils
- NZ Transport Agency, which controls state highway roading assets.

## Step 3 - defining benchmarking criteria and indicators

Based upon previous work conducted by FEMA (1997) and Kestrel (2006) as well as CDEM/lifeline groups' answers about their expectations (appendix B), a set of benchmarking criteria and indicators was identified. Tables 4.1, 4.2 and 4.3 present the criteria and indicators for each of the three identified expectations listed in Step 1 of this benchmarking framework. In particular, answers to questions Q1.3, Q1.4, Q2.1, Q2.2; and Q2.3 helped in defining the indicators and criteria for expectation 1, '**m**anagement structures and arrangements'. The answers provided to questions Q1.2, Q3.1 and Q3.2 were associated with the criteria and indicators for the '**m**anagement capability' expectation. Finally answers to questions Q1.5 and Q3.3 were adopted in the definition of the '**m**anagement capacity' criteria and indicators. Overall, these criteria and indicators attempted to capture the macro attributes of RCAs that reflect their current status in terms of the CDEM 2002 Act requirements.

Table 4.1 Criteria and indicators for expectation 1 - management structures

1	Criteria	Indicators	
Management structures	1.1 Emergency management (EM) plans *	A1	Existence/status of the EM plan
		A2	Damage assessment Items in the EM plan
		A3	Impact assessment Items in the EM plan
		A4	Provision for additional resources in the EM
		A5	Emergency management exercise in the EM plan
	1.2 Emergency response plans (RP)*	B1	Intra-agency distribution of the RP plan
		B2	Inter-agency distribution of the RP plan
		B3	Intra-agency awareness of the RP plan
		B4	Intra-agency practice of the RP plan
		B5	Inter-agency practice of the RP plan
		B6	Intra-agency exercise assessment

Table 4.2 Criteria and indicators for expectation 2 - management capability

2	Criteria	Indicators	
Management capability	2.1 Coordination and cooperation with lifelines and CDEM groups	C1	Frequency of presence
		C2	Participation in desk-top exercises
		C3	Participation in scenario-based exercises
		C4	Effective cooperation in planning
		C5	Readiness for cooperation in response
	2.2 Information sharing	D1	Levels of information sharing
		D2	Tools/standards to support IS
		D3	Software to support Information Sharing
		D4	Approval and testing of IS tools/standards
	2.3 Experience, training, awareness, leadership of decision makers	E1	Professional development strategies
		E2	Items to support professional development

Table 4.3 Criteria and indicators for expectation 3 - management capacity

E3	Criteria	Indicators	
Management capacity	3.1 Robustness and redundancy of the road network	F1	Processes and procedures for assessing robustness of the road components
		F2	Processes and procedures for assessing redundancy of the road network
	3.2 Rapid damage and impact assessment capacity	G1	Processes and procedures for quickly assessing the impact to the road network
		G1	Processes and procedures for quickly assessing the damage to road components

\* Refer to section 2.2.2. for a clarification on the differences between EM and RP.

E3	Criteria	Indicators	
		G3	Identification of response and restoration priorities
		G4	Check on assessment and restoration procedures
		G5	Software to support damage, impact assessment and priority identification
	3.3 Existing resources	H1	Management of critical physical resources
		H2	Management of human resources
		H3	Budget allocated for enhancing readiness
	3.4 Contractual arrangements (CA) and mutual aid mechanisms (MoUs) for emergency resources and personnel	I1	Existence of CA and MAM
		I2	Test and update of CA and MAM
		I3	Type of resources provided under CA and MAM

### Step 4 - determining data collection method

A questionnaire was created for RCAs to fill out in order to collect data about the assessment criteria and indicators defined in the previous step. The questionnaire comprised 35 questions, which covered all the expectations and their respective criteria and indicators. Appendix C presents the full questionnaire, which includes single and multiple-choice questions.

### Step 5 - assessing the RCA's readiness level

The RCA's answers to the questionnaire were processed in order to assign marks to each indicator. These marks were combined to obtain an average score for each criterion pertinent to the assessed indicators. Criterion scores were aggregated to obtain a score for each expectation. It is worth mentioning that an equal weight was attributed to all indicators and all criteria when combining their scores.

In order to visualise the results, we propose two graphical templates as shown in tables 4.4 and 4.5. They **represent, respectively, the RCA's performance for a selected criterion and expectation**. Criteria graphs are used to represent the results for the different criteria associated to a specific expectation. For example, table 4.4 shows an example of a criteria graph for expectation 1. The RCA scored 3.5 for criterion 1.1 and 4.6 for criterion 1.2. The graph shows that the RCA reached two different levels of performance (adequate and comprehensive). Expectation graphs have been employed to show the results for the three identified expectations and the overall level of readiness reached. Table 4.5 shows an example of an expectation graph. It demonstrates the slightly different scores (4.5, 4.1 and 4.1) in the three identified expectations and the overall readiness level (comprehensive=score 4.2).

Table 4.4 Example of a criteria graph for expectation 1

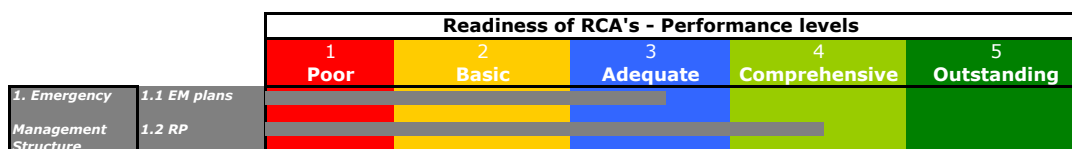


Table 4.5 Expectation graph: and overall level of readiness

		<b>Readiness of RCA's - Performance levels</b>				
		<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
		<b>Poor</b>	<b>Basic</b>	<b>Adequate</b>	<b>Comprehensive</b>	<b>Outstanding</b>
<b>E X P E C T A T I O N</b>	<b>1. Emergency Management Structure</b>					
	<b>2. Emergency Management Capability</b>					
	<b>3. Emergency Management Capacity</b>					
	<b>OVERALL</b>	<b>Significant Shortcoming</b>	<b>Further Development</b>	<b>Adequacy</b>	<b>Strength</b>	<b>Excellence</b>

The scores obtained for each criterion and each expectation were compared to a five-level readiness scale, as shown in table 4.6.

Table 4.6 Performance levels

Level (score)	Performance
Poor (0-1)	area of significant shortcoming
Basic (1-2)	area requiring further development
Adequate (2-3)	area of adequacy
Comprehensive (3-4)	area of strength
Outstanding (4-5)	area of excellence

The results from the benchmarking process were used to:

- assign an overall level of readiness to each RCA from the combination of expectation scores
- identify areas for improvement, ie criteria and expectations where the RCA did not receive full marks
- compare the level of readiness achieved by the RCAs (at national, urban and rural level) and identify a benchmark
- extract lessons learned from other organisations during a benchmarking process that could be used to establish improvement targets and to promote change to current practices
- encourage RCAs to more adequately meet end-user customer and interdependent organisation requirements
- make RCAs aware of their capabilities, weaknesses and their potential and search for best practices.

## 4.2 The scoring and marking systems

This section details how RCAs' answers to the questionnaire were processed for a self-assessment of their readiness level. In particular, we describe the scoring and marking systems, which were adopted during steps 4 and 5.

In the multi-criteria assessment, the overall goal was to compute the readiness score ( $R$ ) of the participant RCA. This score was the result of combining multiple assessment dimensions (expectations), which were subdivided into further levels of analysis (criteria). Hence, the readiness score ( $R$ ) was subject to the combination of all answers given by the participant RCA. Given that the questionnaire comprised single

and multiple option questions, performance marks were assigned to all indicators, criteria and expectations.

The following sub-sections describe the scheme used to assign marks to each answer option in the questionnaire and to compute the respective scores for each level of analysis (indicator, criterion, expectation, readiness).

### 4.2.1 Option score

Marks were attributed to each single option in the questionnaire. Mathematically, the option score attributed to the  $j$ -th option proposed for  $i$ -th indicator of the  $c$ -th criterion and  $e$ -th expectation is represented with the symbol  $O_{ij}^{e,c}$ .

The option score attribution respects the following criteria:

- For single choice questions, the best answers accrue 100 marks; whereas other answers receive low marks. Figure 4.1 shows an example of score attribution for a single choice question.

Figure 4.1 Example of score attribution to the options proposed for a single choice question

<b>C3) How often does your organisation participate in scenario-based exercises with other lifelines utilities and CDEM groups in emergency events? (single choice)</b>	
<input type="checkbox"/> Whenever the exercises take place;	100
<input checked="" type="checkbox"/> Every 6 months;	100
<input type="checkbox"/> 6-12 months;	80
<input type="checkbox"/> Every year;	70
<input type="checkbox"/> 1-5 years;	60
<input type="checkbox"/> Never;	0
<input type="checkbox"/> Other (please specify).	

- For multiple-choice questions, either the possible answers received the same number of marks, which were the sum of the maximum score (100 marks), or the best answers accrued high marks. In this case, the maximum score was assumed to be 100 marks. If the sum of the scores was higher than the maximum marks, then only 100 marks were considered. Figures 4.2 and 4.3 show examples of multiple-choice questions and their score attribution.

Figure 4.2 Example of score attribution to the options proposed for a multiple choice question

<b>E1) How would you describe the professional development strategies and assessment programmes that your organisation is implementing? (multiple choices permitted)</b>	
<input type="checkbox"/> Developed according to organisational needs;	25
<input type="checkbox"/> Comprehensively implemented and evaluated;	25
<input type="checkbox"/> Regularly updated and improved;	25
<input type="checkbox"/> Effectively exercised to train response personnel and to improve his capability;	25
<input type="checkbox"/> Other (please specify).	
.....	



Figure 4.3 Example of score attribution to the options proposed for a multiple choice question

<b>A1) Choose the answer that best describes your organisation's emergency management plan</b> (multiple choices permitted)	
<input type="checkbox"/> No plans;	0
<input type="checkbox"/> In the process of developing plans;	20
<input type="checkbox"/> Plans complete for some department/functions (50%-90% complete);	40
<input type="checkbox"/> Plans complete for all department/functions (over 90%);	80
<input type="checkbox"/> Single-document;	10
<input type="checkbox"/> Multi-volume document;	20
<input type="checkbox"/> Other (please specify).	

The values of the option scores attributed to all 32 questions of the benchmarking questionnaire are presented in appendix D.

It is worth highlighting that the responses provided under the ‘other’ option had to be individually processed considering the following criteria: a) how the answer was relevant and pertinent to the question; b) non-significant answers were ignored; and c) attributed a zero score to ‘do not know’ answers.

### 4.2.2 Indicator score

This score was used to assess the performance level of each indicator, based on the participant RCA’s answer and is represented with the symbol  $I_i^{e,c}$ . The indicator score was evaluated in a range from 0 to 100,  $I_i^{e,c} (0 \leq I_i^{e,c} \leq 100)$ .

Mathematically, for single choice questions where  $n=1$ , the indicator score corresponded to the option score  $O_{ij}^{e,c}$  of the selected choice; for multiple choice questions where  $n>1$ , the indicator score was evaluated, summing up the option scores  $O_{ij}^{e,c}$  of the selected choices (equation 4.2).

$$I_i^{e,c} = \begin{cases} O_{ij}^{e,c}; & n = 1; \\ \sum_{j=1}^n O_{ij}^{e,c}; & n > 1; \end{cases} \tag{Equation 4.1}$$

Where  $n$  was the number of possible choices offered to the participant (either single choice  $n=1$  or multiple choice  $n>1$ ).  $I_i^{e,c}$  was the indicator score for the  $i$ -th indicator of the  $c$ -th criterion and  $e$ -th expectation and  $O_{ij}^{e,c}$  was the option score attributed to a participant’s answer.

### 4.2.3 Criterion score

This computes the readiness level achieved by the RCAs in each single criterion identified for the three expectations and is represented with the symbol  $C_{e,c}$ . The criterion score was evaluated in a range going from 0 to 5 ( $0 \leq C_{e,c} \leq 5$ ), corresponding to the five-level scale specified below:

- $0 \leq C_{e,c} < 1$  - Criterion fulfilled at a ‘poor’ level
- $1 \leq C_{e,c} < 2$  - Criterion fulfilled at a ‘basic’ level
- $2 \leq C_{e,c} < 3$  - Criterion fulfilled at an ‘adequate’ level
- $3 \leq C_{e,c} < 4$  - Criterion fulfilled at a ‘comprehensive’ level
- $4 \leq C_{e,c} \leq 5$  - Criterion fulfilled at an ‘outstanding’ level.

Mathematically, the criterion score was evaluated according to equation 4.2.

$$C^{e,c} = \sum_{i=1}^m \left( \frac{I_i^{e,c}}{20m} \right) \quad \text{(Equation 4.2)}$$

Where  $m$  was the number of indicators associated to the  $c$ -th criterion and  $C^{e,c}$  was the criterion score computed for the  $c$ -th criterion and  $e$ -th expectation.

#### 4.2.4 Expectation score

This score was used to compute the readiness level achieved by the participant RCA in each single expectation and is represented with the symbol  $E^e$ . The expectation score was evaluated in a range going from 0 to 5 ( $0 \leq E^e \leq 5$ ), corresponding to the five-level scale specified below:

- $0 \leq E^e < 1$  – Expectation fulfilled at a ‘poor’ level
- $1 \leq E^e < 2$  – Expectation fulfilled at a ‘basic’ level
- $2 \leq E^e < 3$  – Expectation fulfilled at an ‘adequate’ level
- $3 \leq E^e < 4$  – Expectation fulfilled at a ‘comprehensive’ level
- $4 \leq E^e \leq 5$  – Expectation fulfilled at an ‘outstanding’ level.

Mathematically, as shown in equation 4.3, the expectation score  $E^e$  was evaluated by summing up the criterion scores  $C^{e,c}$  for all the number of criteria,  $w$ , pertinent to the analysed expectation.

$$E^e = \frac{\sum_{c=1}^w C^{e,c}}{w} \quad \text{(Equation 4.3)}$$

#### 4.2.5 Readiness score

Ultimately, this score computed the participant RCA’s readiness level and is represented with the symbol  $R$ . The readiness score was evaluated by combining the expectation scores  $E^e$  for the three identified expectations, and ranged from 0 to 5 ( $0 \leq R \leq 5$ ), corresponding to the five-level readiness scale specified below:

- $0 \leq R < 1$  – ‘poor’ level of readiness
- $1 \leq R < 2$  – ‘basic’ level of readiness
- $2 \leq R < 3$  – ‘adequate’ level of readiness
- $3 \leq R < 4$  – ‘comprehensive’ level of readiness
- $4 \leq R \leq 5$  – ‘outstanding’ level of readiness.

Equation 4a represents the readiness score,  $R$ , which gave equal weight to all the options, indicators, criteria and expectations.

$$R = \frac{\sum_{e=1}^3 E^e}{3} \quad \text{(Equation 4.4a)}$$

where  $E^e$  was the expectation score evaluated for the  $e$ -th analysed expectation.

Combining equations 4.1, 4.2 and 4.3, the readiness score could be alternatively represented as equation 4.4b.

$$R = \begin{cases} \frac{\sum_e \sum_c \sum_i^w \sum_{ij}^m O_{ij}^{e,c}}{60m}; n = 1. \\ \frac{\sum_e \sum_c \sum_i^w \sum_j^m \sum_{ij}^n O_{ij}^{e,c}}{60m}; n \geq 1 \end{cases} \quad (\text{Equation 4.4b})$$

## 5 Case study

This chapter describes the implementation and testing of the proposed benchmarking framework (described in chapter 4). The objective was to assess the applicability and efficiency of the framework in terms of determining the readiness levels of RCAs.

The chapter is divided into three sections. The first section introduces the activities conducted during the implementation and promotion of the web-based survey tool. The second section presents the results of the web-based survey, while the third section discusses the feedback of results to participant RCAs and the outcomes following the RCA Forum. The fourth section summarises the most common areas of significant shortcomings, which were diagnosed in the analysis of the results.

### 5.1 Implementation and promotion of the web-based survey

The web-based survey tool was based upon the self-assessment benchmarking questionnaire (appendix C), using the SurveyMonkey internet platform ([www.surveymonkey.com](http://www.surveymonkey.com)). The web-based survey design took into consideration the fact that participant RCAs would have limited or no knowledge about this research project. The survey included an introductory note explaining its purpose, as well as a short executive summary of the research project. The introductory note also explained that the answers were confidential and that participant RCAs would receive feedback upon the completion of the project. The chosen layout displayed three logos clearly – those of the NZ Transport Agency (as the funding agency of this research project); the University of Canterbury; and the Resilient Organisations research programme. A survey progress bar was at the top of each page to allow the respondent to estimate the residual survey length and the remaining time required to complete the survey.

The self-assessment questionnaire was gradually presented on the computer screen throughout the web-based survey. The participant RCAs were allowed to review and/or change answers, without any time constraints. The questions were organised in a sequential order that followed the framework of the expectations, criteria and indicators (section 4.1). The survey was divided into sections according to the different expectations and into pages according to the different criteria. The questions were also numbered sequentially within each individual page. All questions in the benchmarking survey were closed-ended, ‘multi-choice’ questions, which meant that all the questions had a small or large set of pre-designed potential answers and participants were allowed to choose either one or multiple answers (Brace 2004). Each question covered all the possible answers, but all questions also included a field that could be used to record non-defined answers (categorised as ‘other’).

A web-based survey format has several advantages over the traditional mail or face-to-face methods. In addition to the fact that SurveyMonkey can be employed at no cost, the web-based survey allows for a dynamic interaction with participants. After emailing a survey invite, the responses are usually collected within the same day or within few days of receiving the email invite (Yun and Trumbo 2000). This gives the researcher the chance to instantaneously assess the characteristics of both the participants and their responses. A web-based survey allows participants to be easily tracked; the researcher can tell who has or has not responded to the survey and who has declined the survey invitation. The email address or name of the respondent can be associated with each individual survey response (Sheehan 2001). A possible disadvantage of an online survey is the ethical concern that unsolicited emails (or too many emails) may invade a person’s privacy (Yun and Trumbo 2000). Strong privacy policies and anti-spamming agreements within the applications available for creating an on-line survey control the sending out of invite messages

to prevent this from becoming an issue. SurveyMonkey (the self-service online survey application adopted for the creation and implementation of the on-line RCAs benchmarking survey) addresses the issue of intrusion by including an 'opt out' or 'remove link' field in the invitation email messages.

Three approaches were used to promote participation in the survey. They were:

- Personal **email invitation: using SurveyMonkey's email message tool, a unique survey link was created** for each potential participant. This feature allowed for the tracking of participants by their email addresses and thus controlled multiple submissions. An email list of all New Zealand local authorities was acquired from the Ministry of Internal Affairs. The list comprised over 550 recipients, all of whom were contacted.
- Web-site call-outs: announcements about the benchmarking survey were placed on websites of partnering organisations, such as the RCA Forum, INGENIUM and the IPENZ Transportation Group. These announcements directed potential participants to the project website ([www.resorgs.org.nz/RCA\\_Benchmarking.shtml](http://www.resorgs.org.nz/RCA_Benchmarking.shtml)). The main disadvantage of this approach was the fact that participants could remain anonymous, if they wished to participate.
- Presentation to the RCA Forum in Wellington: the research team presented the research method and the web-based survey process. The RCA Forum advertised the survey on its website.

## 5.2 Results of the web-based survey

Fifty-three people took part in the web-based benchmarking survey upon its public release on 21 February 2010; it was deactivated on 15 March 2010. Three RCAs requested a printed copy of the benchmarking survey, which was then used to provide the answers off-line (ie non-web-based survey). The research team subsequently recorded the answers on the web-based survey. The main reason that these RCAs wished to take part in an off-line survey was that staff felt the answers should originate from a group discussion, in order to achieve an accurate representation of the organisation's readiness.

Out of the total survey participants (53), only 41 responses were considered valid. A total of 12 responses were considered non-valid, because they included either participation of a non-RCA organisation (road contractors and consultants and regional councils) or were the result of multiple participations from the same RCA. Table 5.1 summarises the valid and non-valid responses according to their level of completion.

Table 5.1 Valid and non-valid responses and level of completion

		Response		Total
		Valid	Non-valid	
Level of completion	Fully completed	26	4	30
	Partially completed	3	5	8
	Not started	12	3	15
Total		41	12	53

The valid responses (given by 29 participant RCAs) were divided according to how complete they were:

- Completed survey: 26 RCAs provided answers to all the benchmarking questions
- Partially completed survey: 3 RCAs did not fully complete the benchmarking survey

The response rate (26 out of 76 RCAs, ie 33%) is considered satisfactory, even though it could be improved considerably. This rate would have been higher if the 12 RCAs that started the survey but did not proceed after the initial web-page had completed the survey. The response rate would have been further improved if the RCA managing the state highway network (NZ Transport Agency) had participated in the survey.

The results of the survey revealed that the RCAs had reached a ‘comprehensive level of readiness’; this could be surmised from the average readiness score of 3.29 (R=3.29). Having said that, one of the participant RCAs had only reached the ‘basic level of readiness’ (R=1.70), which is the lowest level of readiness. On the other hand, another of the participant RCAs had achieved an ‘outstanding level of readiness’ (R=4.60). Table 5.2 and figure 5.1 summarise the results for each level of readiness. In terms of the RCAs’ performance in each individual expectation, it is noted that it is rather similar to the overall readiness scores previously described as shown in figure 5.2.

Table 5.2 Summary of the overall readiness performance of RCAs

Readiness score	Readiness level	Performance	Observed proportion
$0 \leq R < 1$	Poor readiness	Area of significant shortcoming	0%
$1 \leq R < 2$	Basic readiness	Area requiring further development	7.69%
$2 \leq R < 3$	Adequate readiness	Area of adequacy	19.23%
$3 \leq R < 4$	Comprehensive readiness	Area of strength	53.85%
$4 \leq R \leq 5$	Outstanding readiness	Area of excellence	19.23%

Figure 5.1 Breakdown of the readiness performance of RCAs

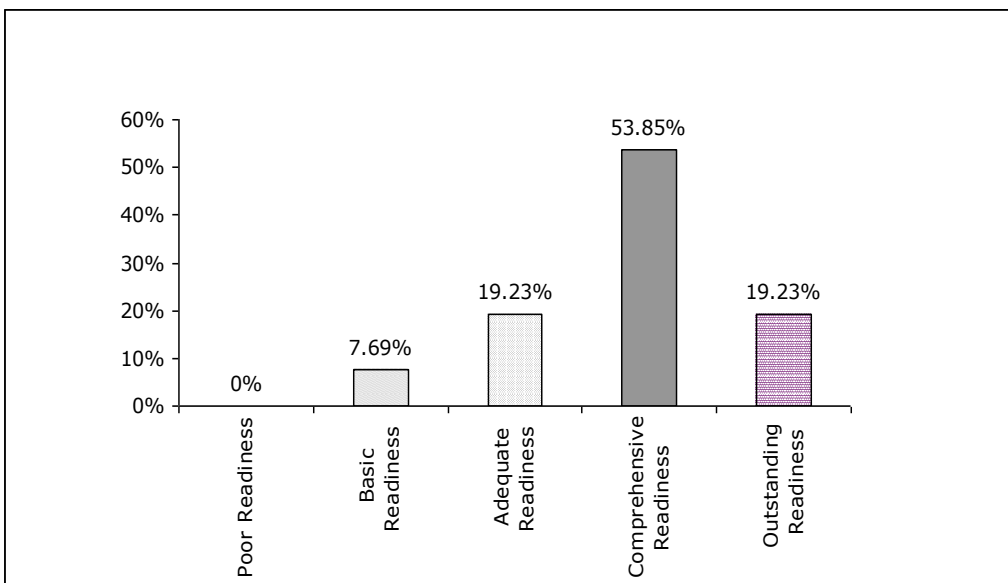
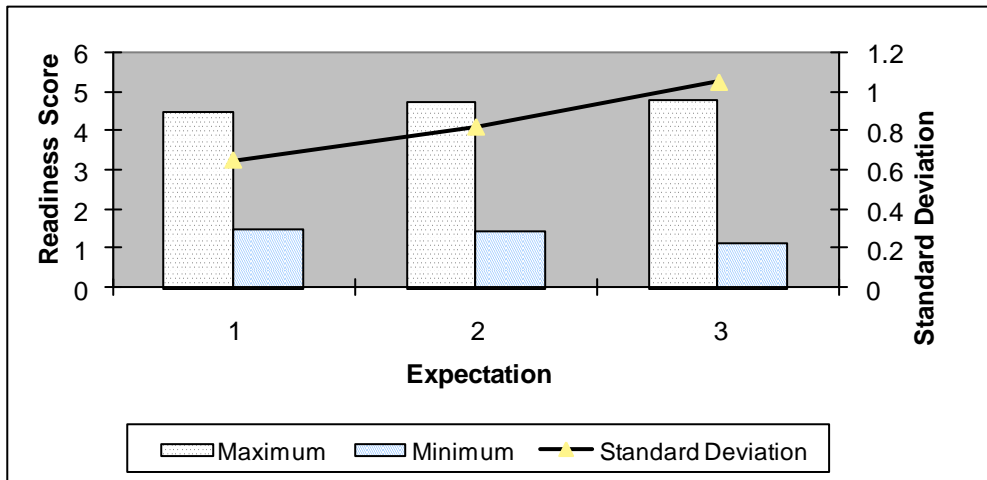
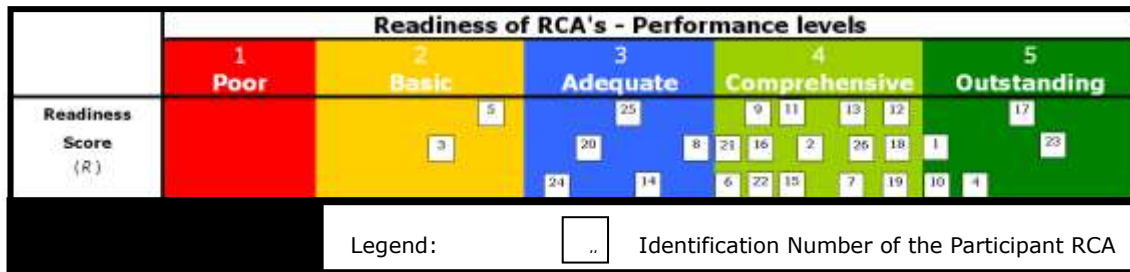


Figure 5.2 Distribution of the participant RCAs according to the performance level



The results can be presented according to the performance level of each participant RCA. Figure 5.3 uses identification numbers (IDs) to represent the position of various RCAs in each performance level. It is noted that 14 participant RCAs were considered to be at the comprehensive level of readiness. Due to privacy and ethical issues, the names of the participant RCAs are suppressed. They are instead referred to using their identification number (ID). Appendix F presents the summary of the results for all expectations, criteria and indicators.

Figure 5.3 Distribution of the participant RCAs according to their performance level



The following subsections describe the results for each of the performance levels.

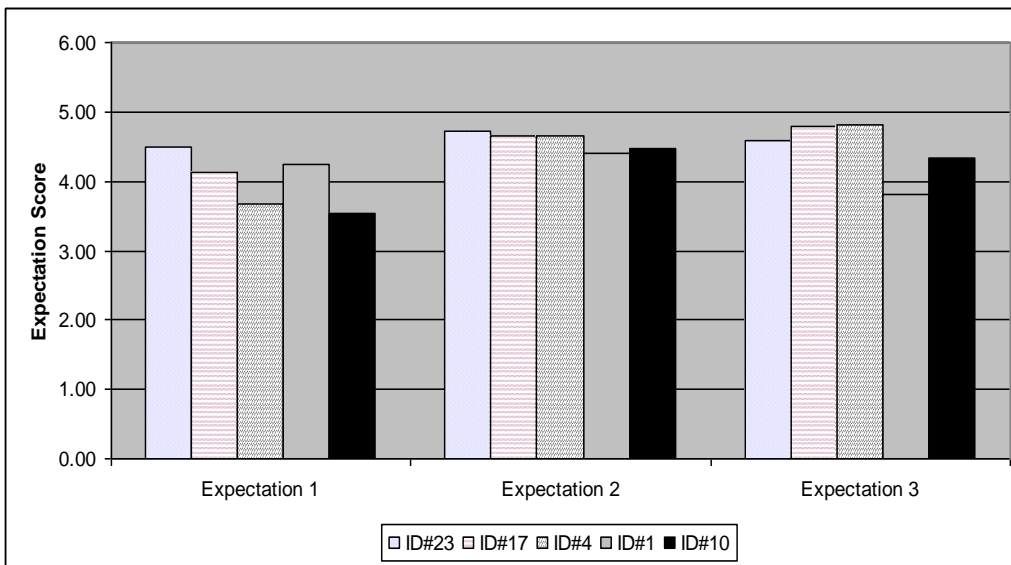
### 5.2.1 Outstanding performance level

Five participant RCAs (known as 1, 4, 10, 17 and 23) reached the ‘outstanding’ performance level. Performance at this standard is the outcome of a significant commitment to and understanding of the CDEM Act 2002 requirements and expectations. As shown in figure 5.4, these RCAs provided answers that indicated they fulfilled the requirements to a very high level.

In particular, the participant RCAs with the IDs 17 and 23 consistently scored beyond ( $E > 4$ ) – the adequate performance level – for all expectations. These RCAs had developed and maintained appropriate management structures and arrangements, which included well circulated emergency plans containing comprehensive provisions for post-event damage and impact assessments. Also, they employed skilful professionals who constantly exercised coordination and cooperation across sectors and had advanced practices in place to share and process information during disasters.

On the other hand, the participant RCAs with the IDs 1, 4 and 10 had slightly different performance levels for different expectations. For example, participant ID 10 did not reach the outstanding level for expectation 1 (emergency management structures and arrangements), but it achieved very high scores (4.46 and 4.35) for the other expectations. These results meant that participant ID 10 needed to improve its EM plans in terms of documentation and implementation. One of the reasons this RCA fell short was that it had not distributed its emergency management plan to its entire operational staff. Also, the participant ID 10 only measured its emergency management capabilities and performance following a simulation exercise or a real event through self-assessment and reference to external best practice benchmarks.

Figure 5.4 Expectation scores for participant RCAs at the outstanding performance level



### 5.2.2 Comprehensive performance level

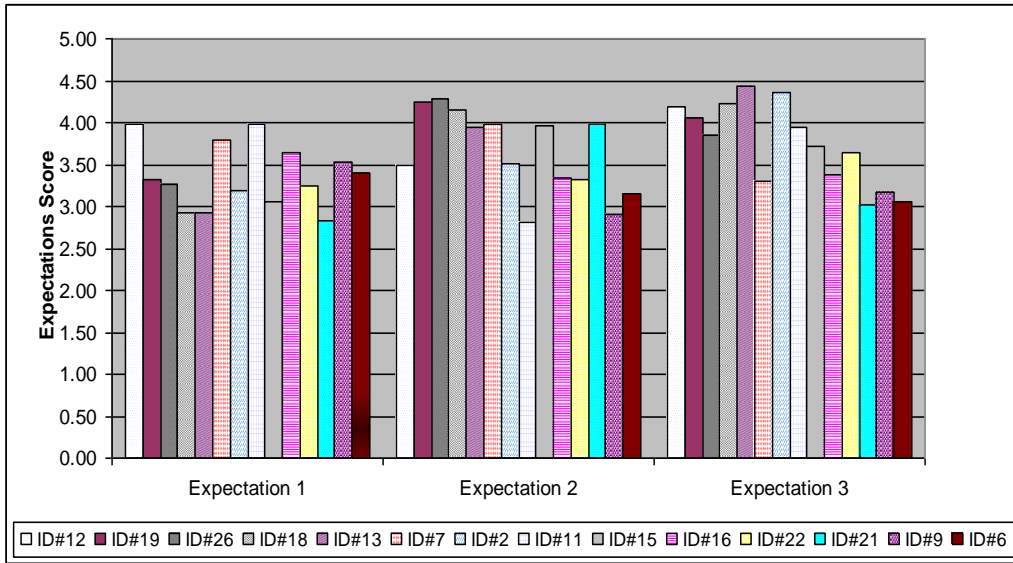
Fourteen participant RCAs (IDs 2, 6, 7, 9, 11, 12, 13, 15, 16, 18, 19, 21, 22 and 26) reached the ‘comprehensive’ performance level. These RCAs met the CDEM Act 2002 requirements and expectations, but they did not achieve excellence in certain areas. The main difference between these RCAs and those that reached the outstanding level lay in their fulfilment of expectations 1 and 2. As shown in figure 5.5, these RCAs fulfilled expectation 3 (emergency management capacity) to a very high level, meaning that they had advanced practices in place to assess resource availability, impacts, and damages during an emergency, and also that they had arrangements for mutual aid mechanisms and contractual arrangements for emergency response and personnel. On the other hand, they were not this advanced in terms of emergency management structures and capabilities (expectations 1 and 2).

The participant RCAs with the IDs 9, 11, 13, 18 and 21 scored below the performance threshold ( $E < 3$ ) for expectations 1 and 2. For example, participant RCA ID 21 performed to the comprehensive level for expectations 2 and 3, but did not achieve good scores in terms of its post-event impact assessment practices and strategies for measuring capabilities and performance following a simulation exercise or a real event.

On the other side of the spectrum, participant RCAs ID 12 and 19 performed strongly in relation to expectations 2 and 3 and also gained high scores for expectation 1.



Figure 5.5 Expectation scores for participant RCAs at the comprehensive performance level

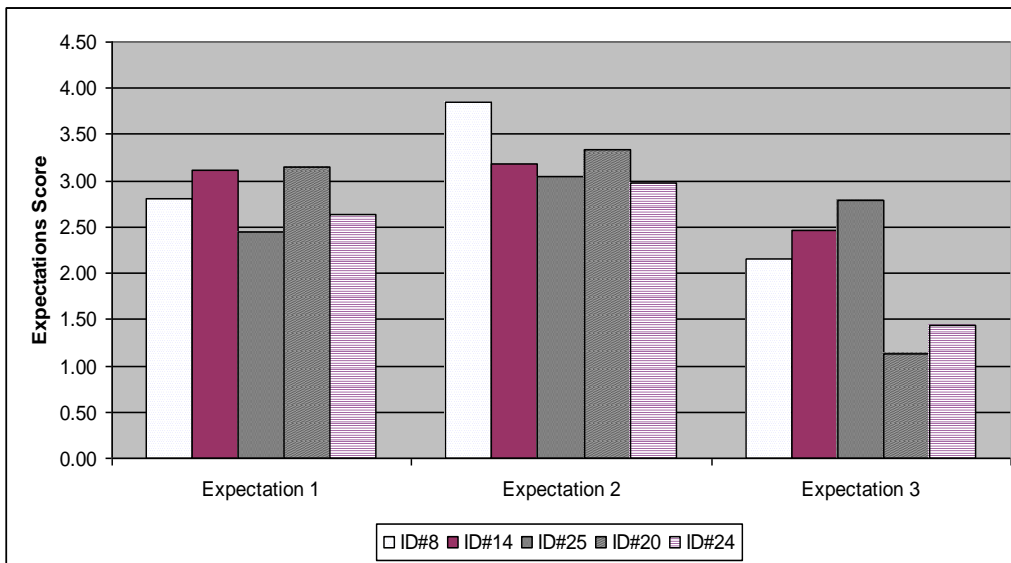


### 5.2.3 Adequate performance level

Five participant RCAs (8, 14, 20, 24 and 25) reached the ‘adequate’ performance level. Except for participants ID 20 and 24, which did not achieve the threshold score ( $E > 2$ ) for expectation 3, all participant RCAs met the CDEM Act 2002 requirements and expectations to at least this performance level. The performance of these five RCAs was significantly lower than that of the participant RCAs that reached the comprehensive level.

As shown in figure 5.6, the five participant RCAs fulfilled expectations 1 and 2 to a reasonable level. For instance, participant ID 8 had complete emergency plans for all departments/functions; it regularly participated in the lifelines/CDEM group; and it employed advanced information sharing and processing practices. On the other hand, this RCA had no special contractual arrangements or tested/updated mutual aid. As for expectation 3, participants ID 20 and 24 indicated that they were considerably limited in terms of their processes/procedures for assessing damage and impacts to the network and this impacted on their performance.

Figure 5.6 Expectation scores for participant RCAs at the adequate performance



A generally high benchmark level was achieved in the surveys of participant RCAs. A considerable proportion (73.08%) of the participant RCAs had reached outstanding and comprehensive levels of readiness. They consistently reached these performance levels for all expectations and criteria. Only in isolated instances (ID 9, 11, 13, 18 and 21) did participants not reach the comprehensive level of readiness in expectations 1 and 2, largely due to minor deficiencies in their practices.

These deficiencies were not commonly associated with specific criteria, ie different participant RCAs had slightly different problems. For example, participants ID 13 and 18 scored the same results for expectation 1 ( $E=2.93$ ) and their main limitations were observed in the implementation of their response plans. Participant ID 13 provided copies of the emergency response plan to all key people in the organisation, while participant ID 18 did not distribute the plan at all. On the other hand, participant ID 13 responded that it had not conducted any internal briefing session about the emergency response plan, whereas participant ID 18 did exactly that with all key people in the organisation.

Despite these minor limitations, these participant RCAs will very likely become the reference point for the whole sector. Participant RCAs ID 17 and 23 in particular set the following benchmarks:

- comprehensive circulation of the emergency management and response plans
- multi-volume emergency management plans completed for all department and functions
- frequent and active participation in simulation exercises, which were conducted internally and externally
- comprehensive measurement of performance in simulation exercises and real events
- comprehensive provisions for post-event damage and impact assessment
- comprehensive provisions for additional resources
- frequent participation in lifelines/CDEM groups
- comprehensive working relationship with lifelines/CDEM groups
- comprehensive capability to advise other lifelines

- comprehensive standards for data/information sharing
- comprehensive professional development initiatives
- comprehensive practices for critical resource management
- comprehensive capability to conduct assessments during events.

#### 5.2.4 Basic performance level

The scores of the remaining seven participant RCAs fell within the other two readiness levels ('basic' and 'poor'). This group's readiness levels are of particular concern, because they did not seem to meet the CDEM Act requirements in several areas. The five participant RCAs who reached the adequate level need to improve their level of preparation for all expectations, in order to achieve the benchmark set by other participants (such as ID 21). For instance, participant IDs 20 and 24 should consider addressing their extremely limited contractual arrangements for emergency events, by testing them in conjunction with multi-types of mutual aid with other organisations. Furthermore, the participants that only reached the basic level of readiness are a long way behind other participant RCAs in terms of their performance. Participant ID 3, for instance, indicated very limited coverage of the following criteria:

- very limited provisions for post-event damage and impact assessments
- limited participation in scenario-based exercises
- no circulation of the emergency management and response plans
- no copies of the emergency management and response plans issued to external people
- only emergency-related sections briefed about the emergency management and response plans
- very limited measurement of performance in real events
- no implemented practices for critical resource management
- no availability of specialised persons
- no allocation of emergency management budget
- low levels of initiatives towards professional development
- limited working relationship with lifeline groups
- very limited capability to advise other lifelines
- very limited standards for data/information sharing
- very limited tools for data/information sharing
- low levels of testing and approval of information sharing
- low levels of initiatives towards professional development
- low levels of training for individuals.

### 5.3 Feedback of results to participant RCAs and the RCA Forum

The participant RCAs received individual feedback on their respective performances by email. We produced a summary of the readiness score (*R*), a breakdown of the expectation (*E*), criteria (*C*) and

indicator (*I*) scores, and a graphical representation of the results using the template shown in table 4.5. The RCAs were also informed of their rankings amongst the other participants in the survey. The summary included an analysis of the strengths, weaknesses and overall readiness of the RCA. Appendix G shows the feedback provided to the best participant RCA (ID23).

The research team gave a presentation to the RCA Forum on 23 April 2010 in Wellington. The results of the benchmarking case study were discussed and the forum agreed upon the preliminary findings. The RCA Forum feedback suggested that the benchmarking framework and the self-assessment tool be **incorporated into RCAs' common practice. It was suggested that the RCA Forum facilitate the** implementation of the self-assessment tool. Also, there was support given to the researchers when they requested a relaxing of the confidentiality arrangements in order to make publically available the results of the participant RCAs that had reached the outstanding level of readiness.

The main findings of the survey were:

- There are RCAs that have outstanding readiness practices in place, as the result of a significant commitment to and understanding of the CDEM Act 2002 requirements and expectations;
- A small minority of participant RCAs do not meet the requirements of the CDEM Act 2002. These RCAs had significant shortcomings in terms of their ability to fulfil their requirements under the CDEM Act 2002.
- It is not statistically possible to use the survey results to express the level of readiness of all RCAs. Nevertheless, the results show that participant RCAs are working towards a high level of performance. As observed in section 5.2, over 73% of the participant RCAs have achieved the comprehensive and outstanding levels of readiness. Even though we must acknowledge that the participant RCAs are probably the ones that are mostly committed and aware about the need to meet the CDEM Act 2002, it is rather encouraging to conclude that at least 19 organisations working on the right direction; and
- As there is the potential that some responses reflect 'aspirational' rather than 'current' readiness, there may be a need to create and implement audit schemes to verify the validity of the answers provided by the participant RCAs.

## 5.4 The most common areas of significant shortcomings

Through the analysis of the results, we identified a set of **specific aspects of RCAs' planning arrangements** that would require the highest level of urgent improvement, as they demonstrated significant shortcomings in terms of meeting the expectations and requirements of the CDEM Act 2002. These areas are briefly described below:

- Emergency response plans (RP): it is recommended that RCAs improve inter- and intra-agency distribution and practice of the response plans. Specifically:
  - all operational staff should receive a copy of the emergency response plan
  - copies should be distributed to all operational staff external to the RCA
  - the emergency response plan should be exercised internally and externally at least on an annual basis
  - emergency management capabilities and performance following a simulation exercise or a real event should take into consideration internal risk management reporting, internal audit findings; independent external specialist review; and reference to external best practice benchmarks.

- Information sharing (IS): it is recommended that RCAs improve how information is collected, processed and distributed before and during a civil defence declaration. Specifically:
  - expand information sharing practices to include consultants and contractors
  - expand on tools/standards of information sharing in order to include radio and dedicated radio channel; TV in the emergency room; codified symbols and abbreviation/acronym; agreed templates/rules for collecting and sharing data and information; and dedicated and trained personnel to collect process and share info during emergency events;
  - test and approve information-sharing tools and standards to consider intra- and inter organisational needs.
- Experience, training, awareness, leadership of decision makers: it is recommended that RCAs improve professional development strategies and assessment programmes in order to enhance **staff's** capability to deal with civil defence declarations and the complexities in dealing with major disruptions to the road network services
- Robustness and redundancy of the road network: it is recommended that organisations improve the processes and procedures for assessing robustness of the road components and the network. Specifically, there is a need to work on:
  - vulnerability analysis for the network components
  - analysis of compliance with the highest standard for natural hazard protection (eg seismic design and retrofit codes)
  - analysis of road exposed to hazards and their likelihood to be cut by a possible events
  - identification of alternative routes for each road exposed to hazard
  - estimation of the time and cost of unavailability of the at risk routes
  - analysis of the connectivity, traffic capacity, traffic type, average traffic speed for alternative routes.
- Management of existing resources: it is recommended that organisations improve the management of human resources and the budget allocated for enhancing readiness. Specifically, there should be a full-time staff member working on emergency management structures and arrangements; and a specific budget allocated for the creation, exercising and maintenance of emergency management plans and arrangements as well as for an independent review of the performance following real events and/or simulation exercises CDEM needs should be identified prior to and during emergency events.

## 6 Conclusions

This research proposed and tested a benchmark framework that assessed the level of preparedness of RCAs in New Zealand in relation to the expectations of civil defence and lifeline groups and in relation to the key requirement of the CDEM Act 2002, **requiring to the road networks to** ‘function to the fullest possible extent during and after an emergency’. The RCAs’ answers to the web-based benchmark questionnaire were processed in order to assign marks to each indicator. Using multi-criteria techniques, these marks were combined to give an overall readiness score, which indicated the level to which the RCA was meeting the CDEM Act 2002.

The case study demonstrated the potential of the benchmarking framework and the web-based questionnaire as tools for self-assessments of RCAs’ readiness. Within a month, we were able to gather a comprehensive set of data through the participation of RCAs throughout the country. They quickly and comprehensively participated in the web-based survey, which was followed by a returned summary of individual performance to the participant. The summary will support each RCA in identifying areas for improvement (the areas that did not receive full marks). Due to the specific nature of the questions, participant RCAs may be able to highlight and work on their capabilities, weaknesses and to search for best practices. Finally, RCAs now have an instrument with which they can measure and rank their performance against their local peers.

According to the results of the case study, the vast majority of the participating RCAs (33% of the population) met the requirements of CDEM Act 2002 well. Several RCAs gave answers that indicated they have implemented practices, processes and plans that will eventually contribute to minimising the disruption to society and other lifeline utilities caused by disasters and civil defence declarations. The results show that generally RCAs are highly prepared for and committed to supporting response and recovery after a major event. Nevertheless, a small minority of participant RCAs did not meet the minimum requirements of the CDEM Act 2002.

Based on these results, we conclude that we have achieved the main objectives of this research. We have **obtained a better understanding of RCAs’ obligations under** the CDEM Act 2002, clarifying the expectations in terms of emergency management structures and arrangements, capabilities and capacities (via a specific questionnaire and the analysis of the responses, section 4.1). Our contribution also includes the definition of a validated benchmarking framework; and the identification of key performance indicators, which are critical to achieve outstanding readiness levels. Given that participant RCAs did not indicate the lack or limitation of options in the benchmarking questionnaire, we consider that the framework comprises the most important assessment items, if not all of them. Of course, subsequent work could potentially examine any omissions, but we are confident they would not significantly alter the core of the proposed benchmarking framework.

Despite the achievements of this research, it is necessary to highlight the limitations of the benchmarking framework and to suggest case studies that could be addressed in the future. They are:

- studying whether or not the scoring and marking system should be altered in order to incorporate relative weights amongst expectations, indicators and criteria; this research assumed that they had the same weight regardless of their contribution to emergency management etc
- studying whether or not having a common readiness *R* score for all RCAs, and analysing the possibility to introduce a weight factor to differently process the readiness level for different RCAs depending, for example, on the length of the road asset managed or any key performance indicator of the road network under analysis

- **further analysis of the influences of RCAs' characteristics (eg population, area of coverage, types of roading assets under analysis) on the readiness level** – we could not conduct detailed cross-references due to confidentiality arrangements
- understanding how the self-selection factors (more prepared RCAs have been more motivated to take part in the benchmarking process) have influenced the results presented in this report
- the development of auditing schemes in order to verify whether the RCAs actually have evidence that supports their self-assessment
- expansion of the benchmarking framework so as to consider the whole transport sector (eg contractors and consultants) and the implications of specific contractual arrangements regarding the readiness level of a study area
- on-going updating of the framework to reflect developing best practices.

## 7 References

- Agrell and Bogetof (2007) *Development of benchmarking models for German electricity and gas distribution*. Final report. Sunsvall, Sweden: Sumicsid AB.
- Allan, S (1997) Partners benchmarking, Accessed 15 April 2009. [www.benchmarking.co.uk/bmark.htm#partners](http://www.benchmarking.co.uk/bmark.htm#partners)
- Bateman, G (1994) Benchmarking management education teaching and curriculum. P6 in *Benchmarking: the search for industry best practices that lead to superior performance*. R Camp. White Plains, NY: Quality Resources.
- Brabhakaran, P (2001) Natural hazard risk management for road networks, part I: risk management strategies. *Transfund NZ research report no.217*.
- Brabhakaran, P (2002) Natural hazard risk management for road networks, part II: implementation strategies. *Transfund NZ research report no.222*.
- Brabhakaran, P, LM Wiles, S Frietag (2006) Natural hazard road risk management, part III: performance criteria. *Land Transport NZ research report no.296*. 126pp.
- Brace, I (2004) *Questionnaire design: how to plan, structure and write survey material for effective market research*. Market research in practice series. London: Kogan Page.
- Britton, NR and G Clark (2000) From response to resilience: emergency management reform in New Zealand. *Natural Hazards Review 1*, no.3: 145–150.
- Brookhart, S (1997) Benchmarking networking. Accessed 10 March 2009. [www.benchnet.com:80/bcode.txt](http://www.benchnet.com:80/bcode.txt)
- Camp, RC (1989) *Benchmarking: the search for industry best practices that lead to superior performance*. Milwaukee, WI: ASQC Quality Press.
- Charnes, A, W Cooper and E Rhodes (1978) Measuring the efficiency of decision making units. *European Journal of Operational Research 2*, no.2: 429–44.
- Cole, JW, CE Sabel, E Blumenthal, K Finnis, A Dantas, S Barnard and DM Johnston (2005) GIS-based emergency and evacuation planning for volcanic hazards in New Zealand. *Bulletin of the New Zealand Society for Earthquake Engineering 38*, no.3.
- Dattakumar, R and S Jagadeesh (2003) A review of literature on benchmarking. *Benchmarking: An International Journal 10*, no.3: 176–209.
- Dictionary.com (2006) Benchmarking definition. Accessed 3 October 2006. [www.dictionary.com](http://www.dictionary.com)
- Duffy, JAM, JA Fitzsimmons and N Jain (2006) **Identifying and studying ‘best-performing’ services: an application of DEA to long-term care**. *Benchmarking: an international journal 13*, no.3: 232–51.
- Elmuti, D and Y Kathawala (1997) An overview of benchmarking process: a tool for continuous improvement and competitive advantage. *Benchmarking: an International Journal 4*, no.4: 229–43.
- Federal Highway Administration (FHWA) (2007a) Best practices in emergency transportation operations preparedness and response: results of the FHWA workshop series. *Report FHWA-HOP-07-076*. Washington: Department of Transportation Federal Highway Administration.



- Federal Highway Administration (FHWA) (2007b) Common issues in emergency transportation operations preparedness and response: results of the FHWA workshop series. Report FHWA-HOP-07-090. Washington: Department of Transportation Federal Highway Administration.
- Federal Emergency Management Agency (FEMA) (1997) *State capability assessment for readiness*. Report to the United States Senate Committee on appropriations, December 1997. 130pp.
- Finch, BJ and RL Luebbe (1995) *Operations management*. Fort Worth: The Dryden Press. Pp112-5.
- Flood Review Team (FRT) (2004) *Review of the February 2004 flood event*. Wellington: Ministry of Civil Defence Emergency Management.
- Friesner, D, D Neufelder, J Raisor and M Khayum (2005) Benchmarking patient improvement in physical therapy with data envelopment analysis. *International Journal of Health Care Quality Assurance* 18, no.6: 441-57.
- Fuller, CW (1997) Key performance indicators for benchmarking health and safety management in intra and inter-company comparisons. *Benchmarking for Quality Management and Technology* 4, no.3: 166-74.
- Goncharuk, AG (2008) Performance benchmarking in gas distribution industry. *Benchmarking: An International Journal* 15, no.5: 548-559.
- Gordon, M and S Matheson (2008) Engineering lifelines and transport – should New Zealand be doing it better? Part one. *Land Transport NZ research report no.355A*.
- Graham, A (2005) Airport benchmarking: a review of the current situation. *Benchmarking: An International Journal* 12, no.2: 99-111.
- Haworth, N, P Vulcan and P Sweatman (2003) Benchmarking truck safety in Australia. *Road & Transport Research*.
- Hilmola, OP (2007) European railway freight transportation and adaptation to demand decline: efficiency and partial productivity analysis from period of 1980-2003. *International Journal of Productivity and Performance Management* 56, no.3: 205-25.
- Kestrel (2006) *Assessment of the capacity and capability of the Auckland Region CDEM Group to respond to a disaster impacting the Auckland Region*, Volume 1: Main Report, prepared for Auckland Region CDEM Group by Kestrel Group Ltd.
- Mathiyalakan, S and C Chung (1996) A DEA approach for evaluating quality circles. *Benchmarking: An International Journal* 3, no.3: 59-70.
- Matters, M and A Evans (1997) The nuts and bolts of benchmarking. Accessed 18 February 2009. [www.ozemail.com.au/~benchmark/nuts.bolts.html](http://www.ozemail.com.au/~benchmark/nuts.bolts.html)
- Ministry of Civil Defence & Emergency Management (MCDEM) (2002) *Working together: lifeline utilities & emergency management: Director's guidelines for lifeline utilities*. DGL 3/02. Wellington: MCDEM.
- Ministry of Civil Defence & Emergency Management (MCDEM) (2003) *Lifelines and CDEM planning: civil defence emergency management best practice guide*. BPG1/03. Wellington: MCDEM.
- Ministry of Civil Defence & Emergency Management (MCDEM) (2006a) *Guide to the National Civil Defence Emergency Management Plan*. Wellington: MCDEM.
- Ministry of Civil Defence & Emergency Management (MCDEM) (2006b) *Declaration: Director's guidelines for CDEM sector*. DGL05/06. Wellington: MCDEM.

- Oum, TH and C Yu (2004) Measuring airports operating efficiency: a summary of the 2003 ATRS global airport benchmarking report. *Transportation Research Part E* 40: 515-532.
- Perez, G, O Coskunoglu and AW Moore (1998) *Data envelopment analysis as a tool to evaluate efficiency of army real property management activities spending*. Champaign, IL: Construction Engineering Research Lab (Army).
- Sarkis, J and S Talluri (2004) Performance based clustering for benchmarking of US airports. *Transportation Research Part A* 38: 29-346.
- Seville, E and J Metcalfe (2005) Developing a hazard risk assessment framework for the New Zealand state highway network. *Land Transport NZ research report* 276. 80pp.
- Sheehan, K (2001) E-mail survey response rates: a review. *Journal of Computer Mediated Communication* 6, no.2.
- Tongzon, J (2001) Efficiency measurement of selected Australian and other international ports using data envelopment analysis. *Transportation Research Part A* 3: 107-122.
- Vaziri, HK (1992) Using competitive benchmarking to set goals. *Quality Progress* 25, no.10: 81-5.
- Verma, A and S Gavirneni (2006) Measuring police efficiency in India: an application of data envelopment analysis. *Policing: An International Journal of Police Strategies & Management* 29, no.1: 125-45.
- Webster (2006) *Benchmark*. 27 September 2006. <http://webster.com/dictionary/benchmark>
- Yoshida, Y and H Fujimoto (2004) Japanese-airport benchmarking with the DEA and endogenous-weight TFP methods: testing the criticism of overinvestment in Japanese regional airports. *Transportation Research Part E* 40: 533-546.
- Yun, GW and CW Trumbo (2000) Comparative response to a survey executed by post, e-mail, and web form. *Journal of Computer Mediated Communications* 6, no.2.

# Appendix A: Questionnaire about expectations and requirements for RCAs under the CDEM Act 2002

Organisation: \_\_\_\_\_ Location: \_\_\_\_\_

Interviewee: \_\_\_\_\_ Date: \_\_\_\_\_

Interviewee's position: \_\_\_\_\_

## QUESTION 1

Q1.1) In regards to Road Controlling Authorities (RCAs): What is your understanding of the following statement as part of CDEM Act 2002?

***“ensure that it is able to function to the fullest possible extent, even though this may be at a reduced level, during and after an emergency”?***

**Q1.2) The MCDEM Director’s Guidelines for Lifeline Utilities (DGL3/02) states that fullest possible extent means being capable. What is your understanding of “being capable” in this context?**

Q1.3) What kind of procedures or planning arrangements would contribute to ensure continuity of **service to the** “fullest possible extent”?

Q1.4) What kind of procedures or planning arrangements would you see as a minimum requirement for RCAs to meet the requirements mentioned in the previous question?

Q1.5) For each of the following measures of the fullest possible extent (identified by DGL3/02), state your understanding and provide examples of what you and your organisation would expect RCAs to have in place as a minimum to achieve these:

Strong relationships .....  
.....  
.....

Sound risk management .....  
.....  
.....

Identification of likely physical impact of particular hazards on systems .....

Identification of additional capability to call on in case of emergency .....

QUESTION 2

Q2.1) According to the Guidelines for Lifeline Utilities (DGL 3/02), lifeline utilities are expected to make available to the Director of the Ministry of Civil Defence & Emergency Management their plans for functioning during and after an emergency. **What are your organisations' expectations in terms of RCA's continuity plans?**

Q2.2) How detailed should continuity plans be? In terms of

Hazard analysis and operational consequences .....

Demand/restoration hierarchy .....

Arrangements for emergency response .....

Arrangements for recovery .....

Q2.3) For each of the following elements, give examples of how best RCA could present them as part of continuity plans.

External risks (failure of interdependent utilities or outsourcing arrangements) .....

Consequences of emergencies .....

Clarification of .....  
roles within .....  
and across the .....  
sectors .....  
  
Priority and .....  
scope of .....  
service .....  
demand .....  
during .....  
emergencies .....

QUESTION 3

Q3.1) During an emergency event, what kind of technical advice will you expect to obtain from RCAs?

**Q3.2) How detailed should the RCA's advice be during an emergency event? In terms of**

Consequences of national .....  
or regional hazards .....  
  
Restoration priorities .....  
  
Timings and processes .....

**Q3.3) How quickly would you expect the RCA's to be able to provide the following advice during an emergency event? In terms of**

Rapid damage assessment .....  
  
Consequences of national .....  
or regional hazards .....  
  
Restoration priorities .....  
  
Response and restoration .....  
timings .....

## Appendix B: Results of the questionnaire about expectations and requirements for RCAS under the CDEM ACT 2002

Table B1 Answers to Questions in Part 1 of the questionnaire: Interviewees 1 to 3

Question	Question subject	INTERVIEWEES		
		1	2	3
Q1.1	Fullest possible extent	Implemented plan	Emergency exercising;	Planning Implemented Plan
Q1.2	Capable	To have resources; To have conducted; Forward thinking/acting;	To have contingency plans; To gain rapid assessment To engage/integrate with others To communicate with others	Having contracts
Q1.3	Procedures & Planning arrangements	Memorandum of Understanding (MoU) with other RCA	Understanding credible impacts Sharing capabilities, vulnerabilities and likely levels of services	
Q1.4	Minimum	Priority routes	Relationships Communication Info sharing procedures up-to-date and correct	Participating in Lifelines groups Risk analysis
Q1.5a	Strong relationships	Contact with other infrastructure providers	Go beyond just a few players; Work together in projects Participation in Lifelines groups	Break silos mentality
Q1.5b	Sound Risk Management	Hazard identification; Impact assessment; Mitigation analysis; Implementation;	Using the same sorts of assumptions	Applying tools and managing risks
Q1.5c	Identification of likely impacts		Taking a broader approach (not only based on the corridor)	Having reliable info
Q1.5d	Identification of additional capacity	Work with other involved parties	Need to share what is available	

Table B2 Answers to Questions in Part 1 of the questionnaire: Interviewees 4 to 6

Question	Question subject	INTERVIEWEES		
		4	5	6
Q1.1	Fullest possible extent	To do as much and asap; To have a business continuity plan;	Given the financial constraints, to have processes and abilities as much and asp	To provide access to emergency vehicles; To provide roading services as much as possible
Q1.2	Capable	To "do the job" and to meet expectations;	To have plans to meet realistic expectations	Being able to rapidly assess damage and to fix/provide alternative routes;
Q1.3	Procedures & Planning arrangements	Plans for immediate actions;	Contingency plan/processes	Able to assess possible hazards potential damage and have plans and contracts to handle emergency
Q1.4	Minimum	Business continuity plans	Management plan	Even at restricted levels, to provide road access including for evacuation
Q1.5a	Strong relationships	Pre-existing relationships with all involved parties; Be part of the plan development	To be involved in lifelines groups	With emergency services, contractors and news media
Q1.5b	Sound Risk Management	link their business risk w their hazard risk management	Being part of lifelines groups will be a good indication of sound risk management	good assessment of likely hazards; Have a plan to rectify damage; Have contracts
Q1.5c	Identification of likely impacts	to hazard overlay onto the network;		
Q1.5d	Identification of additional capacity	building stock generally		Contractors for traffic management

Table B3 Answers to Questions in Part 1 of the questionnaire: Interviewees 7 to 9

Question	Question subject	INTERVIEWEES		
		7	8	9
Q1.1	Fullest possible extent	Have RCA taken reasonable steps to mitigate identified risks If not why? Is the level of mitigation reasonable?	RCAs have plans and mitigation measures in place	the utility has arrangements -alternative operations - staffing -understanding vulnerabilities -assessment of impacts -re-establishments of services to critical customers -re-establishments of temp services to all customers -advice to controllers and lifelines and public
Q1.2	Capable	Is a piece of structure like a road capable of withstanding identified threats that are reasonable and mitigated against?	To demonstrate an effective response and that risks had been identified and appropriate mitigation measures undertaken	Sufficiently what is needed to do. To the best endeavour.
Q1.3	Procedures & Planning arrangements	Intelligence= appreciation of threats to the infrastructure; Mitigation prior to the event; Business continuity procedures; interagency communication;		Planning
Q1.4	Minimum	Abovementioned answer with lower level of expectation;	Risk management plans in accordance with NZS 4360, actively reviewed (eg: six monthly) and action plans implemented.	Constraints dependant
Q1.5a	Strong relationships	A representative at the Auckland Lifelines group	active participation in lifelines group meetings and projects	...contractors.....relationships and Critical clients lifelines across the sector (need help) and CD.
Q1.5b	Sound Risk Management		Risk management plans processes as per NZS 4360	Should be incident management
Q1.5c	Identification of likely impacts	To have gone through the Regional Council's hazard guidelines;	Participation in lifelines group projects and following up internally with actions arising	Vulnerability intuitive
Q1.5d	Identification of additional capacity		include location of additional Resources and contact numbers, contracts/ mutual aid agreements	Same with a little bit of risk analysis



Table B4 Answers to Questions in Part 1 of the questionnaire: Interviewees 10 to 12

		<b>INTERVIEWEES</b>		
		<b>10</b>	<b>11</b>	<b>12</b>
<b>Question</b>	<b>Question subject</b>			
Q1.1	Fullest possible extent	access is restored as quickly as possible; facilities, systems, tools and staff in place to carry out their functions effectively and efficiently	Plan / process to quickly identify and respond to road closures; effective communication with CDEM and others	Ensures delivery of essential services ;
Q1.2	Capable	facilities, systems, tools and staff in place to carry out their functions effectively and efficiently	having direct access to suitably skilled and trained resources; having effective communications arrangements.	Protects critical infrastructure and assets;
Q1.3	Procedures & Planning arrangements	sound business continuity/service continuity plans in place; Planning across the 4Rs of risk reduction	comprehensive response plan contractual provisions	Establishes guidelines for the identification, analysis and treatment of risks;
Q1.4	Minimum	same as above	comprehensive response plan; contractual provisions	
Q1.5a	Strong relationships	Working relationships with all involved parties	identification and contact of response orgs. engagement in the CDEM group EOC	
Q1.5b	Sound Risk Management	make use of hazard analysis already done Consider all hazards robust business/service continuity plans test them regularly through training and exercising	Focus on range of consequences taking interdependencies properly into account	
Q1.5c	Identification of likely impacts	Good information is available regarding the hazards and risks lifelines utilities face to be included in RCAs	Take CDEM Group plan identified hazard and analysed under the RCA perspective	
Q1.5d	Identification of additional capacity	mutual aid agreements with other service providers (nationally, even internationally) Databases should be kept updated	priority response agreements	

Table B5 Answers to Questions in Part 2 of the questionnaire: Interviewees 1 to 3

Question	Question subject	INTERVIEWEES		
		1	2	3
Q2.1	Expectation continuity plans	An up-to-date plan;	Realistic and sufficiently challenging scenarios  Multi-hazard and complex emergencies	High level document;
Q2.2a	How detailed Hazard analysis and operational consequences	Not too detailed, but enough to allow for strategic analysis	Detailed enough to support planning.	Showing interdependencies
Q2.2b	How detailed Demand Restoration hierarchy	Identification of priorities and critical services/assets	Expressing the collaborative nature of the analysis	
Q2.2c	How detailed Arrangements for emergency response	Requires significant level of detailing; Knowing exactly what the arrangements are at any given time.	By type of event (intensity and coverage);	
Q2.2d	How detailed Arrangements for recovery	Knowing to which extent the arrangements will last and how resources will be re-deployed when response is finished	Information about transition between response to recovery	
Q2.3a	How best to present External risks	Showing the risks that are interdependent; Summary.	network diagram relationship diagram How RCA participate What resources they use	network diagram, hazards, actions to minimize impacts
Q2.3b	How best to present Consequences of Emergencies	Tabular format;	Tabular format;	Show alternative routes;
Q2.3c	How best to present Clarification of roles	Just spelling out roles of each organisation/ Individual	listing the current roles and responsibilities	Who determines what
Q2.3d	How best to present Priority and service demand during events	Tabular format having hazards type as reference	Tabular format with consequences of events	

Table B6 Answers to Questions in Part 2 of the questionnaire: Interviewees 4 to 6

		<b>INTERVIEWEES</b>		
		<b>4</b>	<b>5</b>	<b>6</b>
<b>Question</b>	<b>Question subject</b>			
Q2.1	Expectation continuity plans	practical workable plans "I pull it off the shelf. I turn to page one and it tells me what I'm to do."	To discuss the ability to comply with the Act in order to verify if they have got processes and plans to get back to the fullest possible extent asp.	To have hazards awareness plan. The plan should reduce or limit the impact of hazards. Plans in place and contracts signed
Q2.2a	How detailed Hazard analysis and operational consequences	Background info should be comprehensive, but BCP should be brief	Cross-checking analysis comparing event-risks and impacts on RCA; Per general asset.	Very detailed
Q2.2b	How detailed Demand Restoration hierarchy	Should be detailed	Listing of priorities	Full analysis of work to address identified hazards situations; Very detailed;
Q2.2c	How detailed Arrangements for emergency response	Should be detailed	By type of event having alternative arrangements	Just need to know that they are in place
Q2.2d	How detailed Arrangements for recovery	Should be detailed	By type of event having alternative arrangements	Just need to know that they are in place; As important as response arrangements
Q2.3a	How best to present External risks	Tabular format	Map	Proper written assessments
Q2.3b	How best to present Consequences of Emergencies	Show assets affected	Tabular format (list)	Overhead view of them
Q2.3c	How best to present Clarification of roles	Listing of who does what	flow chart	Knowing exactly who will be dealing with
Q2.3d	How best to present Priority and service demand during events	Listing of priority sites and assets		Tabular format

Table B7 - Answers to Questions in Part 2 of the questionnaire: Interviewees 7 to 11

		INTERVIEWEES				
		7	8	9	10	11
Question	Question subject					
Q2.1	Expectation continuity plans	Simple and are the outcome of the organisation's "buy in"	Deal in general terms with roles, responsibilities, notifications, escalation processes and they deal with specific responses to high risk events;		Standard Operating Procedures in place; Databases of where heavy; Strategies for fuel provision; Strategies for the maintenance of equipment; Availability of spares and other essential materials, skilled and experienced staff ; (engineers, equipment operators, etc.) adequate training and exercising	Regularly updated; Subject to periodic reviews with emphasis on external connections;
Q2.2a	How detailed Hazard analysis and operational consequences	Very detailed	The level of detail should relate to the level of risk: for the higher risks you would expect more detailed analysis and plans.	Detailed for critical components		To a level of detail appropriate to deal with the wider event context
Q2.2b	How detailed Demand Restoration hierarchy	Can be less detailed, because of the complex and uncertain nature of the activity				Convey a clear understanding of critical areas ('hot spots') from regional and national perspectives as appropriate.
Q2.2c	How detailed Arrangements for emergency response	Detailed				all relevant emergency response arrangements need to be covered off somewhere
Q2.2d	How detailed Arrangements for recovery	can be less detailed				Should include things such as where additional resources can be sourced, priorities for restoration, communication with other parties, etc.
Q2.3a	How best to present External risks	Tabular format				
Q2.3b	How best to present Consequences of Emergencies	Tabular format				
Q2.3c	How best to present Clarification of roles	flow chart diagram				
Q2.3d	How best to present Priority and service demand during events					

Table B8 Answers to Questions in Part 3 of the questionnaire: Interviewees 1 to 3

Question subject	INTERVIEWEES		
	1	2	3
Technical advice	Road closures (why closed and when reopened); Constant updates on the network status	Road closures provide estimates of impact and consequences as well;  Allowing for decision making in terms of additional resources required	When RCA could not cope
How detailed Consequences of national or regional hazards	Not detailed, but informative of the nature of road closures (location, duration)	It does not need to be hugely detailed;	
How detailed Restoration priorities	Route by route priority definition	Information (justification) that allows to understand what the priorities are;	
How detailed Timings and Processes	Update every 2 or 3 hours  Make updates available on the web	Complete and continuous sharing of activities	
How quickly Rapid Damage Assessment	Within 1 hour, excluding travel time to affected site	Within 2 hours, if communications are available; Otherwise, every 3 to 6 hours	Very quickly (within half a day)
How quickly Consequences of national or regional hazards	As quickly as possible	Every 8 to 12 hours minimum	Half a day plus an hour
How quickly restoration priorities	Can take longer, not essential to have the information straight away	12 to 48 hours	
How quickly response and restoration timings		12 to 48 hours	

Table B9 Answers to Questions in Part 3 of the questionnaire: Interviewees 4 to 6

		<b>INTERVIEWEES</b>		
		<b>4</b>	<b>5</b>	<b>6</b>
<b>Question</b>	<b>Question subject</b>			
Q3.1	Technical advice	The impact: damaged assets, restoration times;  The planned actions: where resources are needed	RCA should be able to join and contribute in the discussion;  Road closures (location and duration)	Road open and closed; Degree of damage; Timelines for restoration
Q3.2a	How detailed Consequences of national or regional hazards	Broad at National level Detailed at Regional level		To provide an overall picture
Q3.2b	How detailed Restoration priorities		Listing of priorities and reasoning	To provide an overall picture
Q3.2c	How detailed Timings and Processes		They can be only an estimate	Big picture information
Q3.3a	How quickly Rapid Damage Assessment	6 to 10 hours	As soon as possible	Very quickly
Q3.3b	How quickly Consequences of national or regional hazards	2 to 4 hours	As soon as possible	As soon as possible
Q3.3c	How quickly restoration priorities	2 to 4 hours	As soon as possible	As soon as possible
Q3.3e	How quickly response and restoration timings	2 to 4 hours	As soon as possible	As soon as possible

Table B10 Answers to Questions in Part 3 of the questionnaire: Interviewees 7 to 11

Question	Question subject	INTERVIEWEES				
		7	8	9	10	11
Q3.1	Technical advice	Road network status Specific information on major assets damaged	Overview of scale and extent of impact Significant change since the last status report. Provide maps of outage areas if available. Priority areas of response actions	Status of the network key outages alternatives	What's working? What can be used and what not? What's the estimated restoration time for opening roads? What equipment and materials are needed that they can't get themselves? What alternative routes can they provide and when? Priorities; other needs.	which parts of the network are and aren't open; For road closures: An estimation of the re-opening timeframe; Overall trend information; Response objectives; Activity focus.
Q3.2a	How detailed Consequences of national or regional hazards	Broad initially and slightly detailed as the event progresses	It wouldn't be given during an event	Sufficient that they are not driven by the media.	Quite detailed	For Group EOC/ Lifeline Utility Co-ordinator: big picture information; Specific and detailed info may be requested for areas of interest
Q3.2b	How detailed Restoration priorities	Broad initially and slightly detailed as the event progresses	Specific details of restoration priorities for major highways, but not specifics for local roads.		Information about access to: repairs; hospitals; movement of critical resources.	As much information as can be provided, noting that this is more high-level than 'detailed'.
Q3.2c	How detailed Timings and Processes	Broad initially and slightly detailed as the event progresses	Specific details of restoration priorities for major highways, but not specifics for local roads.		Detailed estimated times	Within the first few hours of the event
Q3.3a	How quickly Rapid Damage Assessment	As soon as possible	Initially, major roads within 4 hours All roads within 24 hours Detailed impact assessment within 3 days	Within 6 hours	Within 12-24 hours after the event;	
Q3.3b	How quickly Consequences of national or regional hazards	Probably within days or weeks		Within 12 hours After 3 days, temporary service to all customers	Within the first 48 - 72 hours	
Q3.3c	How quickly restoration priorities	As quick as possible	Within 2 days		Within the first 24 - 36 hours	
Q3.3e	How quickly response and restoration timings	As soon as possible	Within 24 hours, initial estimates Within 3 days, detailed estimates		Within the first 5 days after the event occurred	

# Appendix C: Self-assessment benchmarking questionnaire

## Introduction

The purpose of this research is to develop a conceptual framework for benchmarking the level of preparedness of road controlling authorities (RCA) in New Zealand to meet their obligations under the Civil Defence and Emergency Management Act (2002).

The final aim will be to develop a tool that enables RCAs to evaluate and to develop plans for improving their emergency response and recovery planning arrangements.

Key questions that this research aims to address include:

- How should the requirements for lifeline organisations as specified in the CDEM Act 2002 be interpreted?
- To what extent are RCA currently meeting these requirements?
- What specific aspects of RCA planning arrangements are priorities for improving, and are there ways for encouraging greater sharing of best practice?

Based upon interviews previously conducted with Ministry of Civil Defence, civil defence controllers, representatives of lifelines groups; local controlling authorities, the research team has developed a benchmarking framework.

**This questionnaire's objective is to test and obtain feedback on the benchmarking framework from various RCAs around the country.** This will significantly contribute to improve the framework, prior to its implementation as a self-assessment tool.

This questionnaire comprises 35 questions about your organisation and how it has addressed its obligations under the CDEM Act 2002.

The questions are built around three expectations. They are:

- A. management structure
- B. management capability
- C. management capacity.

Instructions:

Your responses to the questions are provided in one of three different formats:

- Single-choice: select one answer only to the question
- Multi-choice: select one or more answers to the question
- Other or specific answers –answer in additional information

Terms:

For more information about this research, please visit [www.resorgs.org.nz](http://www.resorgs.org.nz) or contact Drs. Andre Dantas ([andre.dantas@canterbury.ac.nz](mailto:andre.dantas@canterbury.ac.nz)) and/or Sonia Giovinazzi ([sonia.giovinazzi@canterbury.ac.nz](mailto:sonia.giovinazzi@canterbury.ac.nz)).

Privacy policy:

This questionnaire is confidential and answers will be used in accordance with the University of **Canterbury's Ethical Standards**.



## Expectation 1: Management structure

### Criterion 1.1 Emergency management plan

**A1) Choose the answer that best describes your organisation's emergency management plan** (multiple choices permitted)

- No plans
- In the process of developing plans
- Plans complete for some department/functions (50%–90% complete)
- Plans complete for all department/functions (over 90%)
- Single-document
- Multi-volume document
- Other (please specify).

.....

**A2) Which of the following provisions for post-event damage assessment are included in your organisation's emergency management plan?** (multiple choices permitted)

- Hazard analysis
- Analysis of external risks
- Identification and characterisation of critical links (eg bridges, tunnels)
- Identification and characterisation of road network components
- Identification of restoration priorities
- Restoration timings
- Restoration cost
- Functional assessment
- Other (please specify)

.....

**A3) Which of the following provisions for post-event impact assessment are included in your organisation's emergency management plan?** (multiple choices permitted)

- Rapid damage assessment
- Consequences of emergencies
- Hazard analysis and operational consequences
- Priority allocation and scope of service demand during emergencies
- Response priorities identification
- Restoration priorities identification
- Restoration timings
- Restoration cost
- Other (please specify)

**A4) Which of the following provisions for additional resources are included in your organisation's emergency management plan?** (multiple choices permitted)

- Clarification of roles within and across the sectors
- Arrangements for emergency response
- Arrangements for recovery
- Other (please specify)

.....

**A5) What type of emergency management exercises has your organisation conducted or participated in, in the last two years?** (multiple choices permitted)

- Operational exercises
- Desk-top exercises

- Scenario-based exercises
- Other (please specify).

.....

## Expectation 1: Management structure

### Criterion 1.2: Implementation of the emergency response plan

B1) Has your organisation distributed copies of the emergency response plan to key people within the RCA? (single choice permitted)

- No
- Yes, all key people have received a copy of the emergency response plan
- Yes, all operational staff has received a copy of the emergency response plan
- Other (please specify).

.....

B2) Has your organisation issued copies of the emergency response plan to key external people to the RCA? (single choice permitted)

- No
- Yes, copies have been distributed to key people external to the RCA
- Yes, copies have been distributed to all operational staff external to the RCA
- Other (please specify).

.....

B3) Has your organisation conducted an internal briefing session about the emergency response plan? (single choice permitted)

- No
- Yes, involved sections have participated in the internal briefing session
- Yes, all key people have participated in the internal briefing session
- Other (please specify).

.....

B4) How often does your organisation exercise the emergency response plan internally? (single choice permitted)

- Monthly
- Semi-annually
- Annually
- Never
- Other (please specify).

.....

B5) How often does your organisation exercise the emergency response plan with other key agencies? (single choice permitted)

- Monthly
- Semi-annually
- Annually
- Never
- Other (please specify).

.....

B6) How does your organisation measure its emergency management capabilities and performance following a simulation exercise or a real event? (multiple choices permitted)

- Self-assessment
- Internal risk management reporting
- Internal audits findings
- Independent external specialist review

- Reference to external best practice benchmarks
- Other (please specify).

.....

## Expectation 2: Management capability

### Criterion 2.1: Coordination and cooperation with lifeline and CDEM groups

C1) How often does your organisation participate in the lifelines group's and **CDEM group's activities?** (single choice)

- Every month
- Every 3 months
- Every 6 months
- 6-12 months
- Over 12 months
- No set frequency
- Other (please specify).

.....

C2) How often does your organisation participate in desk-top exercises with other lifelines utilities and CDEM groups in emergency events? (single choice)

- Whenever the exercises take place
- Every 6 months
- 6-12 months
- Every year
- 1-5 years
- Never
- Other (please specify).

.....

C3) How often does your organisation participate in scenario-based exercises with other lifelines utilities and CDEM groups in emergency events? (single choice)

- Whenever the exercises take place
- Every 6 months
- 6-12 months
- Every year
- 1-5 years
- Never
- Other (please specify).

.....

C4) Which of the following items has your organisation worked on together with other lifelines group members? (multiple choices permitted)

- Hazard analysis and operational consequences
- External risks
- Clarification of roles within and across the sectors
- Consequences of emergencies
- Arrangements for emergency response
- Arrangements for recovery
- Priority allocation and scope of service demand during emergencies
- Interdependencies with other lifelines utilities
- Other (please specify).

C5) Which of the following items would your organisation be capable to provide advise to other lifeline organisations during an emergency event? (multiple choices permitted)

- Damage assessment
- Impact/Consequences of national or regional hazards
- Restoration priorities
- Response and restoration timings
- Response and restoration costs
- Other (please specify).

.....

## Expectation 2: Management capability

### Criterion 2.2: Information sharing

D1) Who does your organisation share information with about your Emergency Response Arrangements? (multiple choices permitted)

- Intra-organisation
- Consultants
- Contractors
- Lifeline /CDEM groups
- Other (please specify).

.....

D2) Which of the following tools/standards would your organisation be ready to have to support information sharing during an emergency event? (multiple choices permitted)

- Radio and dedicated radio channel
- TV in the emergency room
- Back-up generators
- E-mail protocol and distribution list
- Codified symbology and abbreviation/acronym
- Agreed templates/rules for collecting and sharing data and information
- Dedicated and trained personnel to collect process and share info during emergency events
- Other (please specify).

.....

D3) Does your organisation use a software package or tool to process/share information with other organisation during an emergency management event? (multiple choices permitted)

- Microsoft Word, Microsoft Excel, Outlook
- Geographical information system (GIS, eg ArcInfo, Mapinfo Grass)
- Microsoft Access
- Specific tools (egGroove)
- Other (please specify).

.....

D4) Has your organisation tested and approved its information sharing tools and standards? (multiple choices permitted)

- No approval /testing
- Intra-organisations approved and tested
- Road sector organisations approved and tested
- Lifeline organisations approved
- Other (please specify).

## Expectation 2: Management capability

Criterion 2.3: Experience, training, awareness, leadership of decision makers

E1) How would you describe the professional development strategies and assessment programmes that your organisation is implementing? (multiple choices permitted)

- Developed according to organisational needs
- Comprehensively implemented and evaluated
- Regularly updated and improved
- Effectively exercised to train response personnel and to improve their capability
- Other (please specify).

.....

E2) Which of the following characteristics can be observed in your professional development strategies and assessment programmes? (multiple choices permitted)

- Response personnel actively and proactively participate in relevant professional development programmes and exercising
- Roles and responsibilities for the management of emergency events are identified based on effective capability following exercises and real events
- Recovery managers are identified, trained, supported and ready to perform the role
- Debrief sessions and workshops are organised after the management of real events and exercises to discuss the performance and capabilities of the response personnel, to assess the level of awareness and leadership, to summarise the lessons learnt and to identify best practices for the management of future events
- Other (please specify).

.....

## Expectation 3: Management capacity

Criterion 3.1: Robustness and redundancy of the road network

F1) Does your organisation have any processes/procedures for assessing the robustness of the road network components? (multiple choices permitted)

- No processes/procedures
- Vulnerability analysis for the network components
- Analysis of compliance with the highest standard for natural hazard protection (eg seismic design and retrofit codes)
- Other (please specify).

.....

F2) Does your organisation have any processes/procedures for assessing the redundancy of the road network and for identifying alternative routes? (multiple choices permitted)

- No processes/procedures
- Analysis of road exposed to hazards and their likelihood to be cut by a possible events
- Identification of alternative routes for each road exposed to hazard
- Estimation of the time and cost of unavailability of the at risk routes
- Analysis of the connectivity, traffic capacity, traffic type, average traffic speed for alternative routes
- Other (please specify).

.....

### Expectation 3: Management capacity

#### Criterion 3.2: Rapid damage and impact assessment capacity

G1) Does your organisation have any processes/procedures for quickly assessing the impact of an emergency event on the road network? (single choice)

- No processes/procedures
- In the process of developing procedures
- General processes/procedures
- Specific processes/procedures for critical links (eg bridges, tunnels)
- Specific processes/procedures for all the road network components
- Other (please specify).

G2) Does your organisation have any processes/procedures for quickly assessing the damage occurred to the road network during an emergency event? (single choice)

- No processes/procedures
- In the process of developing procedures
- General processes/procedures
- Specific processes/procedures for critical links (eg bridges, tunnels)
- Specific processes/procedures for all the road network components
- Other (please specify).

.....

G3) Which of the following assessments is your organisation prepared to perform in an emergency event? (multiple choices permitted)

- Rapid impact assessment
- Rapid damage assessment
- Response priorities identification
- Restoration priorities identification
- Restoration timings
- Restoration cost
- Other (please specify).

.....

G4) Which of the following characteristics can be observed in your organisation's damage/impact assessment and response planning procedures? (multiple choices permitted)

- Regular updates
- Graphical/map representation;
- Based on ad-hoc/experience based judgement
- Based on pre-defined assessment standards
- Use of ad-hoc symbols /terminology
- Other (please specify)

.....

G5) Does your organisation use a software package or tool to assess and manage data about damage occurred to the road network components and to identify response and restoration priorities? (multiple choices permitted)

- Microsoft Word, Microsoft Excel;
- Geographical information system (GIS, eg ArcInfo, Mapinfo Grass);
- Microsoft Access
- Decision support tools
- Other (please specify).

.....

## Expectation 3: Management capacity

### Criterion 3.3: Existing resources

H1) How would you describe the management of the physical critical resources management in your organisation? (multiple choices permitted)

- The location of critical resources is clearly identified
- Critical resources are constantly checked and maintained
- Critical resources can be sourced rapidly in response to an emergency
- Logistics processes are in place to manage resources effectively in an emergency
- Other (please specify).

.....

H2) Does your organisation have specialised persons in-charge to maintain/update emergency management structures and arrangements (single choice permitted)

- No
- Yes, part-time staff working on emergency management structures and arrangements
- Yes, full-time staff working on emergency management structures and arrangements
- Other (please specify)

.....

H3) Does your organisation allocate specific budget for enhancing emergency management readiness (multiple choices permitted)

- No
- Yes, specific budget is allocated for the creation, exercising and maintenance of emergency management plans and arrangements
- Yes, specific budget is allocated for independent review of the performance following real events and/or simulation exercises
- Yes, specific budget is allocated to support the identified CDEM needs prior to and during emergency events
- Other (please specify)

.....

## Expectation 3: Management capacity

### Criterion 3.4: Contractual arrangements and cooperative/mutual aid mechanisms for emergency resources or personnel

I1) Does your organisation have any special contractual arrangements to provide additional supply of resources, if needed? (single choice)

- Yes
- No
- Other (please specify).

.....

I2) How often has your organisation tested/updated these cooperative/mutual aid mechanisms? (single choice)

- Monthly
- Semi-annual
- Annual
- Never
- Other (please specify).

.....

I3) What type of resources can these cooperative/mutual aid mechanisms provide to your organisation in the case of an emergency event? (multiple choices permitted)

- Physical resources (please specify)

Human resources (please specify)

Other (please specify).

.....

Thank you

Thank you for taking the time to complete this questionnaire.



## Appendix D: Option scores

### Expectation 1: Management structure

#### Criterion 1.1: Emergency management plan

A1) Choose the answer that **best describes your organisation's emergency management plan** (multiple choices permitted)

	$O_{1j}^{1,1}$
<input type="checkbox"/> No plans;	0
<input type="checkbox"/> In the process of developing plans	20
<input type="checkbox"/> Plans complete for some department/functions (50%-90% complete)	40
<input type="checkbox"/> Plans complete for all department/functions (over 90%)	80
<input type="checkbox"/> Single-document	10
<input type="checkbox"/> Multi-volume document	20
<input type="checkbox"/> Other (please specify).	

A2) Which of the following provisions for post-**event damage assessment are included in your organisation's** emergency management plan? (multiple choices permitted)

	$O_{2j}^{1,1}$
<input type="checkbox"/> Hazard analysis	20
<input type="checkbox"/> Analysis of external risks	20
<input type="checkbox"/> Identification and characterisation of critical links (eg bridges, tunnels)	20
<input type="checkbox"/> Identification and characterisation of road network components	20
<input type="checkbox"/> Identification of Restoration priorities	20
<input type="checkbox"/> Restoration timings	20
<input type="checkbox"/> Restoration cost	20
<input type="checkbox"/> Functional assessment	20
<input type="checkbox"/> Other (please specify).	

A3) Which of the following provisions for post-**event impact assessment are included in your organisation's** emergency management plan? (multiple choices permitted)

	$O_{3j}^{1,1}$
<input type="checkbox"/> Rapid damage assessment	20
<input type="checkbox"/> Consequences of emergencies;	20
<input type="checkbox"/> Hazard analysis and operational consequences;	20
<input type="checkbox"/> Priority allocation and scope of service demand during emergencies	20
<input type="checkbox"/> Response priorities identification	20
<input type="checkbox"/> Restoration priorities identification	20
<input type="checkbox"/> Restoration timings	20
<input type="checkbox"/> Restoration cost	20
<input type="checkbox"/> Other (please specify).	

**A4) Which of the following provisions for additional resources are included in your organisation’s emergency management plan? (multiple choices permitted)**

$O_{4j}^{1,1}$

- Clarification of roles within and across the sectors 33
- Arrangements for emergency response 33
- Arrangements for recovery 33
- Other (please specify).

**A5) What type of emergency management exercises has your organisation conducted or participated in, in the last two years? (multiple choices permitted)**

$O_{5j}^{1,1}$

- Operational exercises 33
- Desk-top exercises 33
- Scenario-based exercises 33
- Other (please specify).

## Expectation 1: Management structure

### Criterion 1.2: Implementation of the emergency response plan

**B1) Has your organisation distributed copies of the emergency response plan to key people within the RCA? (single choice permitted)**

$O_{1j}^{1,2}$

- No 0
- Yes, all key people have received a copy of the emergency response plan 60
- Yes, all operational staff has received a copy of the emergency response plan 100
- Other (please specify).

**B2) Has your organisation issued copies of the emergency response plan to key external people to the RCA? (single choice permitted)**

$O_{2j}^{1,2}$

- No 0
- Yes, copies have been distributed to key people external to the RCA 60
- Yes, copies have been distributed to all operational staff external to the RCA 100
- Other (please specify).

**B3) Has your organisation conducted an internal briefing session about the emergency response plan? (single choice permitted)**

$O_{3j}^{1,2}$

- No 0
- Yes, involved sections have participated in the internal briefing session 60
- Yes, all key people have participated in the internal briefing session 100
- Other (please specify).

B4) How often does your organisation exercise the emergency response plan internally? (single choice permitted)

	$O_{4j}^{1,2}$
<input type="checkbox"/> Monthly	100
<input type="checkbox"/> Semi-annually	80
<input type="checkbox"/> Annually	60
<input type="checkbox"/> Never	0
<input type="checkbox"/> Other (please specify).	

B5) How often does your organisation exercise the emergency response plan with other key agencies? (single choice permitted)

	$O_{5j}^{1,2}$
<input type="checkbox"/> Monthly	100
<input type="checkbox"/> Semi-annually	80
<input type="checkbox"/> Annually	60
<input type="checkbox"/> Never	0
<input type="checkbox"/> Other (please specify).	

B6) How does your organisation measure its emergency management capabilities and performance following a simulation exercise or a real event? (multiple choices permitted)

	$O_{6j}^{1,2}$
<input type="checkbox"/> Self-assessment	20
<input type="checkbox"/> Internal risk management reporting;	20
<input type="checkbox"/> Internal audits findings;	20
<input type="checkbox"/> Independent external specialist review;	20
<input type="checkbox"/> Reference to external best practice benchmarks;	20
<input type="checkbox"/> Other (please specify).	

## Expectation 2: Management capability

Criterion 2.1: Coordination and cooperation with lifeline and CDEM groups

C1) How often does your organisation participate in the lifelines group's and CDEM **group's activities?** (single choice)

	$O_{1j}^{2,1}$
<input type="checkbox"/> Every month	100
<input type="checkbox"/> Every 3 months	80
<input type="checkbox"/> Every 6 months	70
<input type="checkbox"/> 6-12 months	60
<input type="checkbox"/> Over 12 months	40
<input type="checkbox"/> No set frequency	20
<input type="checkbox"/> Other (please specify).	

C2) How often does your organisation participate in desk-top exercises with other lifelines utilities and CDEM groups in emergency events? (single choice)

$O_{2j}^{2,1}$

- |  |     |
|--|-----|
| <input type="checkbox"/> Whenever the exercises take place | 100 |
| <input type="checkbox"/> Every 6 months                    | 100 |
| <input type="checkbox"/> 6-12 months                       | 80  |
| <input type="checkbox"/> Every year                        | 70  |
| <input type="checkbox"/> 1-5 years                         | 60  |
| <input type="checkbox"/> Never                             | 0   |
| <input type="checkbox"/> Other (please specify).           |     |

C3) How often does your organisation participate in scenario-based exercises with other lifelines utilities and CDEM groups in emergency events? (single choice)

$O_{3j}^{2,1}$

- |  |     |
|--|-----|
| <input type="checkbox"/> Whenever the exercises take place | 100 |
| <input type="checkbox"/> Every 6 months                    | 100 |
| <input type="checkbox"/> 6-12 months                       | 80  |
| <input type="checkbox"/> Every year                        | 70  |
| <input type="checkbox"/> 1--5 years                        | 60  |
| <input type="checkbox"/> Never                             | 0   |
| <input type="checkbox"/> Other (please specify).           |     |

C4) Which of the following items has your organisation worked on together with other lifelines group members? (multiple choices permitted)

$O_{4j}^{2,1}$

- |   |    |
|---|----|
| <input type="checkbox"/> Hazard analysis and operational consequences                       | 20 |
| <input type="checkbox"/> External risks   | 20 |
| <input type="checkbox"/> Clarification of roles within and across the sectors               | 20 |
| <input type="checkbox"/> Consequences of emergencies  | 20 |
| <input type="checkbox"/> Arrangements for emergency response                                | 20 |
| <input type="checkbox"/> Arrangements for recovery  | 20 |
| <input type="checkbox"/> Priority allocation and scope of service demand during emergencies | 20 |
| <input type="checkbox"/> Interdependencies with other lifelines utilities                   | 20 |
| <input type="checkbox"/> Other (please specify).  |    |

C5) Which of the following items would your organisation be capable to provide advise to other lifeline organisations during an emergency event? (multiple choices permitted)

$O_{5j}^{2,1}$

- |  |    |
|--|----|
| <input type="checkbox"/> Damage assessment                                   | 20 |
| <input type="checkbox"/> Impact/consequences of national or regional hazards | 20 |
| <input type="checkbox"/> Restoration priorities                              | 20 |
| <input type="checkbox"/> Response and restoration timings                    | 20 |
| <input type="checkbox"/> Response and restoration costs                      | 20 |
| <input type="checkbox"/> Other (please specify).                             |    |

## Expectation 2: Management capability

### Criterion 2.2: Information sharing

D1) Who does your organisation share information with about your emergency response arrangements? (multiple choices permitted)

	$O_{1j}^{2.2}$
<input type="checkbox"/> Intra-organisation	25
<input type="checkbox"/> Consultants	25
<input type="checkbox"/> Contractors	25
<input type="checkbox"/> Lifeline /CDEM groups	25
<input type="checkbox"/> Other (please specify).	

D2) Which of the following tools/standards would your organisation be ready to have to support information sharing during an emergency event? (multiple choices permitted)

	$O_{2j}^{2.2}$
<input type="checkbox"/> Radio and dedicated radio channel	20
<input type="checkbox"/> TV in the emergency room	20
<input type="checkbox"/> Back-up generators	20
<input type="checkbox"/> E-mail protocol and distribution list	20
<input type="checkbox"/> Codified symbology and abbreviation/acronym	20
<input type="checkbox"/> Agreed templates/rules for collecting and sharing data and information	20
<input type="checkbox"/> Dedicated and trained personnel to collect process and share info during emergency events	20
<input type="checkbox"/> Other (please specify).	

D3) Does your organisation use a software package or tool to process/share information with other organisation during an emergency management event? (multiple choices permitted)

	$O_{3j}^{2.2}$
<input type="checkbox"/> Microsoft Word, Microsoft Excel, Outlook	8
<input type="checkbox"/> Geographical information system (GIS, eg ArcInfo, Mapinfo Grass)	80
<input type="checkbox"/> Microsoft Access	40
<input type="checkbox"/> Specific tools (eg Groove)	65
<input type="checkbox"/> Other (please specify).	

D4) Has your organisation tested and approved its information sharing tools and standards? (multiple choices permitted)

	$O_{4j}^{2.2}$
<input type="checkbox"/> No approval /testing	0
<input type="checkbox"/> Intra-organisations approved and tested	60
<input type="checkbox"/> Road sector organisations approved and tested	80
<input type="checkbox"/> Lifeline organisations approved	100
<input type="checkbox"/> Other (please specify).	

## Expectation 2: Management capability

### Criterion 2.3: Experience, training, awareness, leadership of decision makers

E1) How would you describe the professional development strategies and assessment programmes that your organisation is implementing? (multiple choices permitted)

*O1j 2,3*

- Developed according to organisational needs 25
- Comprehensively implemented and evaluated 25
- Regularly updated and improved 25
- Effectively exercised to train response personnel and to improve their capability 25
- Other (please specify).

E2) Which of the following characteristics can be observed in your professional development strategies and assessment programmes? (multiple choices permitted)

*O<sub>2i</sub> 2,3*

- Response personnel actively and proactively participate in relevant professional development programmes and exercising 25
- Roles and responsibilities for the management of emergency events are identified based on effective capability following exercises and real events 25
- Recovery Managers are identified, trained, supported and ready to perform the role 25
- Debrief sessions and workshops are organised after the management of real events and exercises to discuss the performance and capabilities of the response personnel, to assess the level of awareness and leadership, to summarise the lesson learnt and to identify best practices for the management of future events; 25
- Other (please specify).

## Expectation 3: Management capacity

### Criterion 3.1: Robustness and redundancy of the road network

F1) Does your organisation have any processes/procedures for assessing the robustness of the road network components? (multiple choices permitted)

*O1j 3,1*

- No processes/procedures 0
- Vulnerability analysis for the network components; 60
- Analysis of compliance with the highest standard for natural hazard protection (eg seismic design and retrofit codes) 80
- Other (please specify).

F2) Does your organisation have any processes/procedures for assessing the redundancy of the road network and for identifying alternative routes? (multiple choices permitted)

*O2j 3,1*

- No processes/procedures 0
- Analysis of road exposed to hazards and their likelihood to be cut by a possible events 60
- Identification of alternative routes for each road exposed to hazard 80
- Estimation of the time and cost of unavailability of the at risk routes 40
- Analysis of the connectivity, traffic capacity, traffic type, average traffic speed for alternative routes; 100
- Other (please specify).

## Expectation 3: Management capacity

### Criterion 3.2: Rapid damage and impact assessment capacity

G1) Does your organisation have any processes/procedures for quickly assessing the impact of an emergency event on the road network? (single choice)

	$O_{1j}^{3,2}$
<input type="checkbox"/> No processes/procedures	0
<input type="checkbox"/> In the process of developing procedures	50
<input type="checkbox"/> General processes/procedures	60
<input type="checkbox"/> Specific processes/procedures for critical links (eg bridges, tunnels)	80
<input type="checkbox"/> Specific processes/procedures for all the road network components	100
<input type="checkbox"/> Other (please specify).	

G2) Does your organisation have any processes/procedures for quickly assessing the damage occurred to the road network during an emergency event? (single choice)

	$O_{2j}^{3,2}$
<input type="checkbox"/> No processes/procedures	0
<input type="checkbox"/> In the process of developing procedures	50
<input type="checkbox"/> General processes/procedures	60
<input type="checkbox"/> Specific processes/procedures for critical links (eg bridges, tunnels)	80
<input type="checkbox"/> Specific processes/procedures for all the road network components	100
<input type="checkbox"/> Other (please specify).	

G3) Which of the following assessments is your organisation prepared to perform in an emergency event? (multiple choices permitted)

	$O_{3j}^{3,2}$
<input type="checkbox"/> Rapid impact assessment	20
<input type="checkbox"/> Rapid damage assessment	20
<input type="checkbox"/> Response priorities identification	20
<input type="checkbox"/> Restoration priorities identification	20
<input type="checkbox"/> Restoration timings	20
<input type="checkbox"/> Restoration cost	20
<input type="checkbox"/> Other (please specify).	

G4) Which of the following characteristics can be observed in your organisation's damage/impact assessment and response planning procedures? (multiple choices permitted)

	$O_{4i}^{3,2}$
<input type="checkbox"/> Regular updates	60
<input type="checkbox"/> Graphical/map representation	70
<input type="checkbox"/> Based on ad-hoc/experience based judgement	40
<input type="checkbox"/> Based on pre-defined assessment standards	60
<input type="checkbox"/> Use of ad-hoc symbols /terminology	80
<input type="checkbox"/> Other (please specify)	

G5) Does your organisation use a software package or tool to assess and manage data about damage occurred to the road network components and to identify response and restoration priorities? (multiple choices permitted)

$O_{5i}^{3.2}$

- |   |    |
|---|----|
| <input type="checkbox"/> Microsoft Word, Microsoft Excel                                  | 8  |
| <input type="checkbox"/> Geographical information system (GIS, eg ArcInfo, Mapinfo Grass) | 80 |
| <input type="checkbox"/> Microsoft Access   | 40 |
| <input type="checkbox"/> Decision support tools   | 65 |
| <input type="checkbox"/> Other (please specify).  |    |

## Expectation 3: Management capacity

### Criterion 3.3: Existing resources

H1) How would you describe the management of the physical critical resources in your organisation? (multiple choices permitted)

$O_{1j}^{3.3}$

- |   |    |
|---|----|
| <input type="checkbox"/> The location of critical resources is clearly identified                         | 80 |
| <input type="checkbox"/> Critical resources are constantly checked and maintained                         | 80 |
| <input type="checkbox"/> Critical resources can be sourced rapidly in response to an emergency            | 60 |
| <input type="checkbox"/> Logistics processes are in place to manage resources effectively in an emergency | 80 |
| <input type="checkbox"/> Other (please specify).  |    |

H2) Does your organisation have specialised persons in-charge to maintain/update emergency management structures and arrangements (single choice permitted)

$O_{2j}^{3.3}$

- |   |     |
|---|-----|
| <input type="checkbox"/> No   | 0   |
| <input type="checkbox"/> Yes, part-time staff working on emergency management structures and arrangements | 70  |
| <input type="checkbox"/> Yes, full-time staff working on emergency management structures and arrangements | 100 |
| <input type="checkbox"/> Other (please specify).  |     |

H3) Does your organisation allocate specific budget for enhancing emergency management readiness (multiple choices permitted)

$O_{3j}^{3.3}$

- |  |    |
|--|----|
| <input type="checkbox"/> No  | 0  |
| <input type="checkbox"/> Yes, specific budget is allocated for the creation, exercising and maintenance of emergency management plans and arrangements | 70 |
| <input type="checkbox"/> Yes, specific budget is allocated for independent review of the performance following real events and/or simulation exercises | 80 |
| <input type="checkbox"/> Yes, specific budget is allocated to support the identified CDEM needs prior to and during emergency events                   | 80 |
| <input type="checkbox"/> Other (please specify).   |    |



### Expectation 3: Management capacity

Criterion 3.4: Contractual arrangements and cooperative/mutual aid mechanisms for emergency resources or personnel

I1) Does your organisation have any special contractual arrangements to provide additional supply of resources, if needed? (single choice)

- |  | $O_{1i}^{3,4}$ |
|--|----------------|
| <input type="checkbox"/> Yes                     | 100            |
| <input type="checkbox"/> No                      | 0              |
| <input type="checkbox"/> Other (please specify). |                |

I2) How often has your organisation tested/updated these cooperative/mutual aid mechanisms? (single choice)

- |  | $O_{2i}^{3,4}$ |
|--|----------------|
| <input type="checkbox"/> Monthly                 | 100            |
| <input type="checkbox"/> Semi-annual             | 80             |
| <input type="checkbox"/> Annual                  | 60             |
| <input type="checkbox"/> Never                   | 0              |
| <input type="checkbox"/> Other (please specify). |                |

I3) What type of resources can these cooperative/mutual aid mechanisms provide to your organisation in the case of an emergency event?  
(multiple choices permitted)

- |  | $O_{3j}^{3,4}$ |
|--|----------------|
| <input type="checkbox"/> Physical resources (please specify) | 50             |
| <input type="checkbox"/> Human resources (please specify)    | 50             |
| <input type="checkbox"/> Other (please specify).             |                |

## Appendix E: Worked example

This appendix describes a worked example on the implementation of the scoring and marking system proposed for the assessment of RCAs readiness. The worked example is presented through five steps. They are:

- 1 Computing the indicator score  $I_i^{e,c}$  for each  $i$ -th indicator of each  $c$ -th criterion and each  $e$ -th expectation
- 2 Computing the criterion score  $C_{e,c}$  for each  $c$ -th criterion of each  $e$ -th expectation
- 3 Computing the expectation score  $E^e$  for each  $e$ -th expectation;
- 4 Computing the readiness score,  $R$ ; and
- 5 Analysis of RCA strengths, weakness and overall readiness.

The assessment of each one of the aforementioned steps is detailed in the following sections.

### Step 1 – indicator scores

Given a set of choices/options that a participant RCA has chosen, the option scores ( $O_j^{e,c}$ ) are added up according to equation 1, in order to compute the indicator score ( $I_i^{e,c}$ ) and according to the rules provided in section 4.2.

**In this worked example, the participant RCA's answers to the questions about expectation 1 (management structure) and criterion 1 indicate that its emergency management plan has the following characteristics:**

- It is complete for some department/functions (50%–90% complete).
- It is a multi-volume document.
- It includes hazards analysis: identification and characterisation of critical links (eg bridges, tunnels).
- It has post-event provisions for impact assessments such as consequences of emergencies; hazard analysis and operational consequences; priority allocation and scope of service demand during emergencies.
- It has considered additional resources in terms of clarification of roles within and across the sectors, arrangements for emergency response and arrangements for recovery.
- It has been tested through operational, desk-top and scenario-based exercises.

Based upon these answers (represented as ticked boxes in the following example), option scores are assigned as shown in table E1. Consequently, each one of the five indicators associated to expectation 1 and criterion 1 are computed as 60, 60, 60, 99 and 99, respectively. Similar calculations are conducted for all other criteria and expectations.

Table E1 Worked example for expectation 1, criterion 1

Expectation 1: Management structure	
Criterion 1.1: Emergency management lan	
A1) Choose the answer that best describes your <b>organisation's emergency management plan</b> (multiple choices permitted)	Option scores
	$O_{1j}^{1,1}$
<input type="checkbox"/> No plans	$O_{11}^{1,1}=0$
<input type="checkbox"/> In the process of developing plans	$O_{12}^{1,1}=0$
<input checked="" type="checkbox"/> Plans complete for some department/functions (50%-90% complete)	$O_{13}^{1,1}=40$
<input type="checkbox"/> Plans complete for all department/functions (over 90%;	$O_{14}^{1,1}=0$
<input type="checkbox"/> Single-document	$O_{15}^{1,1}=0$
<input checked="" type="checkbox"/> Multi-volume document	$O_{16}^{1,1}=20$
<input type="checkbox"/> Other (please specify).	$O_{17}^{1,1}=0$
-----	
Expectation ( $e=1$ ), Criterion ( $c=1$ ) Indicator ( $i=1$ )= $I_1^{1,1} = O_{13}^{1,1} + O_{16}^{1,1} = 40 + 20 = 60$	
A2) Which of the following provisions for post-event damage assessment are included <b>in your organisation's</b> emergency management plan? (multiple choices permitted)	Option scores
	$O_{2j}^{1,1}$
<input checked="" type="checkbox"/> Hazard analysis	$O_{21}^{1,1}=20$
<input type="checkbox"/> Analysis of external risks	$O_{22}^{1,1}=0$
<input checked="" type="checkbox"/> Identification and characterisation of critical links (eg bridges, tunnels)	$O_{23}^{1,1}=20$
<input checked="" type="checkbox"/> Identification and characterisation of road network components	$O_{24}^{1,1}=20$
<input type="checkbox"/> Identification of restoration priorities	$O_{25}^{1,1}=0$
<input type="checkbox"/> Restoration timings	$O_{26}^{1,1}=0$
<input type="checkbox"/> Restoration cost	$O_{27}^{1,1}=0$
<input type="checkbox"/> Functional assessment	$O_{28}^{1,1}=0$
<input type="checkbox"/> Other (please specify).	$O_{29}^{1,1}=0$
-----	
Expectation ( $e=1$ ), Criterion ( $c=1$ ) Indicator ( $i=2$ )= $I_2^{1,1} = O_{21}^{1,1} + O_{23}^{1,1} + O_{24}^{1,1} = 20 + 20 + 20 = 60$	
A3) Which of the following provisions for post-event impact assessment are included in <b>your organisation's emergency management plan?</b> (multiple choices permitted)	Option scores
	$O_{3j}^{1,1}$
<input type="checkbox"/> Rapid damage assessment	$O_{31}^{1,1}=0$
<input checked="" type="checkbox"/> Consequences of emergencies	$O_{32}^{1,1}=20$
<input checked="" type="checkbox"/> Hazard analysis and operational consequences	$O_{33}^{1,1}=20$
<input checked="" type="checkbox"/> Priority allocation and scope of service demand during emergencies	$O_{34}^{1,1}=20$
<input type="checkbox"/> Response priorities identification	$O_{35}^{1,1}=0$
<input type="checkbox"/> Restoration priorities identification	$O_{36}^{1,1}=0$
<input type="checkbox"/> Restoration timings	$O_{37}^{1,1}=0$
<input type="checkbox"/> Restoration cost	$O_{38}^{1,1}=0$
<input type="checkbox"/> Other (please specify).	$O_{39}^{1,1}=0$
-----	
Expectation ( $e=1$ ), Criterion ( $c=1$ ) Indicator ( $i=3$ )= $I_3^{1,1} = O_{32}^{1,1} + O_{33}^{1,1} + O_{34}^{1,1} = 20 + 20 + 20 = 60$	

Table E1 Worked example for expectation 1, criterion 1(continued)

A4) Which of the following provisions for additional resources are included in your organisation's emergency management plan? (multiple choices permitted)	Option scores
	$O_{4j}^{1,1}$
<input checked="" type="checkbox"/> Clarification of roles within and across the sectors	$O_{41}^{1,1}=33$
<input checked="" type="checkbox"/> Arrangements for emergency response	$O_{42}^{1,1}=33$
<input checked="" type="checkbox"/> Arrangements for recovery	$O_{43}^{1,1}=33$
<input type="checkbox"/> Other (please specify).	$O_{44}^{1,1}=0$
-----	
Expectation (e=1), Criterion (c=1) Indicator (i=4) = $I_4^{1,1} = O_{41}^{1,1} + O_{42}^{1,1} + O_{43}^{1,1}$	= 33+33+33=99
-----	
A5) What type of emergency management exercises has your organisation conducted or participated in, in the last two years? (multiple choices permitted)	Option scores
	$O_{5j}^{1,1}$
<input checked="" type="checkbox"/> Operational exercises;	$O_{51}^{1,1}=33$
<input checked="" type="checkbox"/> Desk-top exercises	$O_{52}^{1,1}=33$
<input checked="" type="checkbox"/> Scenario-based exercises	$O_{53}^{1,1}=33$
<input type="checkbox"/> Other (please specify).	$O_{54}^{1,1}=0$
-----	
Expectation (e=1), Criterion (c=1) Indicator (i=5) = $I_5^{1,1} = O_{51}^{1,1} + O_{52}^{1,1} + O_{53}^{1,1}$	= 33+33+33=99

## Step 2 - criterion scores

The previous results (step 1 - Indicator Scores) are computed according to equation 2. Table D2 shows how the indicator scores are combined in order to calculate the scores for criterion 1 and 2 of expectation 1, which are respectively represented as  $C^{1,1}$  and  $C^{1,2}$ . Similar calculations are conducted for all other expectations, which are summarised in tables D3 and D4.

Table E2 Worked example for expectation 1 and criterion scores

Criteria	Indicators		Indicator score	Criterion score
1.1 Emergency management (EM) plans	A1	Existence/status of the EM plan	$I_{1,1,1}=60$	$C^{1,1} = \frac{(I_1^{1,1} + I_2^{1,1} + I_3^{1,1} + I_4^{1,1} + I_5^{1,1})}{20 * 5} =$ $C^{1,1} = \frac{(60 + 60 + 60 + 99 + 99)}{20 * 5} =$ $C^{1,1} = 3.78$
	A2	Damage assessment Items in the EM plan	$I_{2,1,1}=60$	
	A3	Impact assessment Items in the EM Plan	$I_{3,1,1}=60$	
	A4	Provision for additional resources in the EM	$I_{4,1,1}=99$	
	A5	Emergency management exercise in EM plan	$I_{5,1,1}=99$	
1.2 Emergency response plans (RP)	B1	Intra-agency distribution of the RP plan	$I_{1,1,2}=60$	$C^{1,2} = \frac{(I_1^{1,2} + I_2^{1,2} + I_3^{1,2} + I_4^{1,2} + I_5^{1,2} + I_6^{1,2})}{20 * 6} =$ $C^{1,1} = \frac{(60 + 60 + 100 + 60 + 60 + 20)}{20 * 6} =$ $C^{1,1} = 3.00$
	B2	Inter-agency distribution of the RP plan	$I_{2,1,2}=60$	
	B3	Intra-agency awareness of the RP plan	$I_{3,1,2}=100$	
	B4	Intra-agency practice of the RP plan	$I_{4,1,2}=60$	

	B5	Inter-agency practice of the RP plan	$I_5^{1,2}=60$	
	B6	Intra-agency exercise assessment	$I_6^{1,2}=20$	

Table E3 Worked example for expectation 2 and criterion scores

Criteria	Indicators		Indicator score	Criterion score
2.1 Coordination and cooperation with lifelines and CDEM groups	C1	Frequency of presence	$I_1^{2,1}=80$	$C^{2,1}=3.80$
	C2	Participation in desk-top exercises	$I_2^{2,1}=80$	
	C3	Participation in scenario-based exercises	$I_3^{2,1}=80$	
	C4	Effective cooperation in planning	$I_4^{2,1}=100$	
	C5	Readiness for cooperation in response	$I_5^{2,1}=40$	
2.2 Information sharing (IS)	D1	Levels of information sharing	$I_1^{2,2}=50$	$C^{2,2}=4.13$
	D2	Tools/standards to support IS	$I_2^{2,2}=100$	
	D3	Software to support IS	$I_3^{2,2}=100$	
	D4	Approval and testing of IS tools/standards	$I_4^{2,2}=80$	
2.3 Experience, training, awareness, leadership of decision makers	E1	Professional development strategies	$I_1^{2,3}=25$	$C^{2,3}=1.25$
	E2	Items to support professional development	$I_2^{2,3}=25$	

Table E4 Worked example for expectation 3 and criterion scores

Criteria	Indicators		Indicator score	Criterion score
3.1 Robustness and redundancy of the road network	F1	Processes and procedures for assessing robustness of the road components	$I_1^{3,1}=0$	$C^{3,1}=2.50$
	F2	Processes and procedures for assessing redundancy of the road network	$I_2^{3,1}=100$	
3.2 Rapid damage and impact assessment capacity	G1	Processes and procedures for quickly assessing the impact to the road network	$I_1^{3,2}=60$	$C^{3,2}=1.48$
	G1	Processes and procedures for quickly assessing the damage to road components	$I_2^{3,2}=0$	
	G3	Identification of response and restoration priorities	$I_3^{3,2}=40$	
	G4	Check on assessment and restoration procedures	$I_4^{3,2}=40$	
	G5	Software to support damage, impact assessment and priority identification	$I_5^{3,2}=8$	
3.3 Existing resources	H1	Management of critical physical resources	$I_1^{3,3}=100$	$C^{3,3}=5.00$
	H2	Management of human resources	$I_2^{3,3}=100$	

	H3	Budget allocated for enhancing readiness	$I_{3^{3,3}}=100$	
3.4 Contractual arrangements (CA) and mutual aid mechanisms (MoUs) for emergency resources and personnel	I1	Existence of CA and MoUs	$I_{1^{3,4}}=100$	$C^{3,4}=3.33$
	I2	Test and Update of CA and MoUs	$I_{2^{3,4}}=0$	
	I3	Type of resources provided under CA and MoUs	$I_{3^{3,4}}=100$	

### Step 3 – expectation scores

The previous results (step 2 – criteria scores) are computed according to equation 3. Table D5 shows how the criterion scores are combined in order to calculate the scores for the expectations 1, 2 and 3 ( $E^1$ ,  $E^2$  and  $E^3$ ). For instance, the score for expectation 1 is simply the average between the criterion scores 1 and 2.

Table E5 Worked example for all expectations

Expectation	Criteria	Criterion scores	Expectation score
1 - Management structures	1.1 Emergency management (EM) plans	$C^{1,1}=3.78$	$E^1 = \frac{(C^{1,1} + C^{1,2})}{2}$
	1.2 Emergency response plans (RP)	$C^{1,2}=3.00$	$E^1 = \frac{(3.78 + 3.00)}{2}$ $E^1 = 3.39$
2 - Management capability	2.1 Coordination and cooperation with lifelines and CDEM groups	$C^{2,1}=3.80$	$E^2 = \frac{(C^{2,1} + C^{2,2} + C^{2,3})}{3}$
	2.2 Information sharing	$C^{2,2}=4.13$	$E^2 = \frac{(3.80 + 4.13 + 1.13)}{3}$
	2.3 Experience, training, awareness, leadership of decision makers	$C^{2,3}=1.25$	$E^2 = 3.06$
3- Management capacity	3.1 Robustness and redundancy of the road network	$C^{3,1}=2.50$	$E^3 = \frac{(C^{3,1} + C^{3,2} + C^{3,3} + C^{3,4})}{4}$
	3.2 Rapid damage and impact assessment capacity	$C^{3,2}=1.48$	$E^3 = \frac{(2.50 + 1.48 + 5.00 + 3.33)}{4}$
	3.3 Existing resources	$C^{3,3}=5.00$	
	3.4 Contractual arrangements (CA) and mutual aid mechanisms (MoUs) for emergency resources and personnel	$C^{3,4}=3.33$	$E^3 = 3.08$

### Step 4 – readiness scores

Considering the values presented in table D5, readiness score ( $R$ ) of the participant obtained through the application of equation 4a. The expectation scores  $E^1$ ,  $E^2$ , and  $E^3$  are averaged, which corresponds to  $R$  equal to  $R=3.18$ .

## Step 5 – analysis of RCA strengths, weakness and overall readiness

Criteria results indicate that the participant RCA has the following strengths, which should be recognised and maintained:

- Utilization of existing resources: **‘Outstanding’ level** ( $C^{3,3}=5.00$ ), the organisation has a well-set up programme of resource management, which includes human and financial resources; and
- Information sharing practices **‘Outstanding’ level** ( $C^{2,2}=4.13$ ), in terms of having tools/standards to support data collection, dissemination and processing throughout the response activities.

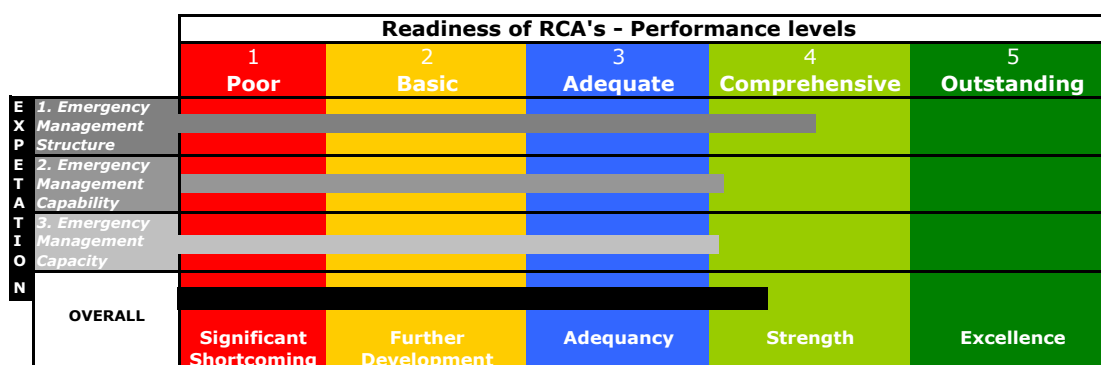
On the other hand, criteria results indicate that the participant RCA has the following weaknesses:

- Training and mentoring of the whole organisation: **‘Basic’ level** ( $C^{2,3}=1.25$ ), staff have not participated in any specific training that would help them in assessing the robustness of the road network components. Hence, there is an urgent need to invest in professional development strategies and professional development support; and
- **Rapid damage and impact assessment capacity: ‘Basic’ level** ( $C^{3,2}=1.48$ ).

In terms of overall readiness, according to the performance levels defined in table 4.6 (section 4.1), the participant RCA reached a readiness level  $R=3.18$ , which means that the RCA has a **‘comprehensive level of readiness’** and meets the requirements of the CDEM Act 2002.

Figure E1 graphically represents the participant RCA’s performance in each one of the three expectations considered, and the level of overall readiness.

Figure E1 **Graphical representation of the participant RCA’s performance**







## Appendix G: Feedback to the best participant RCA

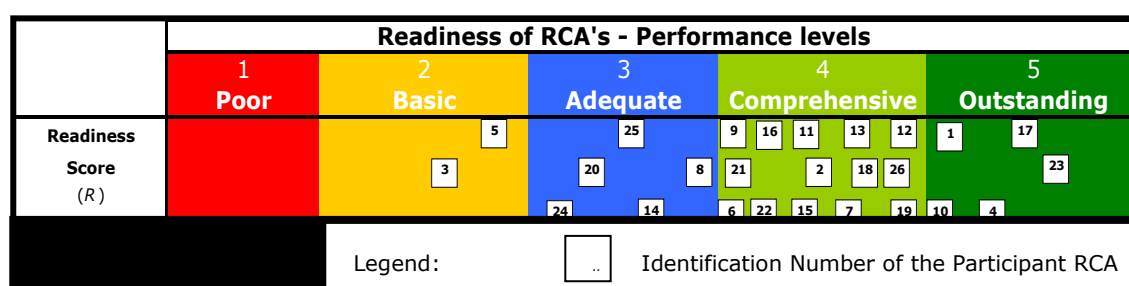
Dear Participant,

This document summarises the performance of your organisation in terms of meeting CDEM Act 2002 requirements.

Overall performance

Based upon the answers provided to the web-based questionnaire, your organisation (ID 23) was ranked 1<sup>st</sup> out of 26 participant RCAs. Figure 1 shows the relative performance of your organisation.

Figure 1 - Distribution of the participant RCAs according to their performance level



Your organisation has reached the Outstanding Performance Level, which demonstrates a significant commitment to and understanding of the CDEM Act 2002 requirements and expectations. Your **organisation's performance level will very likely become the benchmark for the whole sector.**

Areas of excellence

Your organisation has consistently scored beyond the Comprehensive Performance level for all expectations. This performance means that your organisation has:

- developed and maintained appropriate management structures and arrangements, which include well circulated emergency plans that contain comprehensive provisions for post-event damage and impact assessments;
- employed skilful professionals that constantly exercise co-ordination and cooperation across sectors and have advanced practices in place to share and process information during disasters; and
- assessed the adequacy of its resources in terms of quantity and suitability of equipment facilities, personnel and finances; assessed the adequacy of the road network in terms of robustness and redundancy; arranged for mutual aid mechanisms and contractual arrangements for emergency response and personnel.

In particular, your organisation has reached the highest scores in terms of:

- Comprehensive circulation of the emergency management and response plans;
- Multi-volume emergency management plans completed for all department and functions;
- Frequent and active participation in simulation exercises, which were conducted internally and externally;
- Comprehensive measurement of performance in simulation exercises and real events;
- Comprehensive provisions for post-event damage and impact assessment;

- Comprehensive provisions for additional resources;
- Frequent participation in lifelines/CDEM groups;
- Comprehensive working relationship with lifelines/CDEM groups;
- Comprehensive capability to advise other lifelines;
- Comprehensive standards for data/information sharing;
- Comprehensive professional development initiatives;
- Comprehensive practices for critical resource management; and
- Comprehensive capability to conduct assessments during events.

#### Areas for minor improvement

Your organisation could potentially improve its performance if the following indicators were addressed:

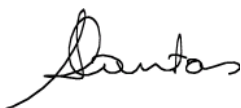
- Intra-agency distribution of the RP plan: it is recommended that all operational staff should receive a copy of the emergency response plan;
- Inter-agency awareness of the RP plan: it is recommended that all copies should be distributed to all operational staff external to the RCA;
- Management of Human Resources: it is recommended that a full-time staff should be working on emergency management structures and arrangements; and
- Budget Allocated for enhancing readiness: it is recommended that a specific budget is allocated for the creation, exercising and maintenance of emergency management plans and arrangements. It is also recommended that a specific budget is allocated to support the identified CDEM needs prior to and during emergency events.

We would like to thank you very much for your participation in this research project. We hope that this feedback will be useful to your organisation in improving its readiness and meeting the obligations under the Civil Defence and Emergency Management Act (2002).

**Should you require any additional information or clarification about your organisation's benchmarking,** please do not hesitate to contact us. Also for more information about this research, please visit [www.resorgs.org.nz](http://www.resorgs.org.nz).

The final report prepared for New Zealand Transport Agency (NZTA), which funded this research project, will be soon released for public circulation.

Best Regards,



Andre Dantas

[andre.dantas@canterbury.ac.nz](mailto:andre.dantas@canterbury.ac.nz)



Sonia Giovinazzi

[sonia.giovinazzi@canterbury.ac.nz](mailto:sonia.giovinazzi@canterbury.ac.nz)

Resilient Organisations Research Programme

Department of Civil and Natural Resources Engineering

University of Canterbury, Christchurch, New Zealand